

CHROMOS

CHROMOS GC

LABORATORY GAS CHROMATOGRAPH

OPERATION MANUAL



Table of Contents	Page
1.1 System Description and Operation	5
1.1.1 System Application	5
1.1.2 System Specifications.....	6
1.1.3 System Configuration	8
1.1.4 System Design and Operation	8
1.1.5 System Marking and Sealing	10
1.1.6 System Packaging.....	11
1.2 Description and Operation of System Components	11
1.2.1 General information.....	11
1.2.2 Operation of System Components	13
2 System Intended Use	13
2.1 Operating Restrictions.....	13
2.2 System Preparation for Use	14
2.2.1 Safety Measures during System Preparation for Use	14
2.2.2 System Installation.....	14
2.3 System Use	15
2.3.1 Procedure for Maintenance Personnel Using the System	15
2.3.2 Product Operability Test Procedure	15
2.3.3 List of Possible Malfunctions.....	15
2.3.4 System Operating Modes	15
2.3.5 Safety Measures When Using the System	15
3 Maintenance	16
3.1 System Maintenance	16
3.1.1 General	16
3.1.2 Maintenance Personnel Qualification Requirements.....	16
3.2 Safety Measures during Maintenance	16
3.3 Maintenance Procedure	16
4 Routine Repair of the System and its Components	16
5 System Storage	18
6 Transportation	18
7 Disposal	18

Safety

Read these instructions carefully before installation and commissioning. These instructions do not contain all details on all types of devices and do not explain all assembly, operating, or maintenance scenarios. Ask the manufacturer for further information.

Observe warning signs on packaging and on the device. Safety symbols are in accordance with IEC 60417 or ISO 7000.

Assign only qualified and authorized specialists for the assembly, electrical connection, commissioning, and maintenance of the equipment. Specialist qualifications include:

- Training, instruction, and authorization to operate and maintain devices or systems according to safety engineering standards for electrical circuits, high pressures, and aggressive media
- Training in accordance with safety engineering standards regarding maintenance and use of adequate safety systems



WARNING: According to EN 60900, use only sufficiently insulated tools for electrical connection.

Also consider the following regulations:

- The applicable standards and safety regulations concerning the construction and operation of electrical installations
- The regulation on technical working materials (safety guidelines for tools)
- The regulations and recommendations relating to explosion protection
- The regulations and codes that apply in the country of use

Potential safety hazards



WARNING – Bodily injury. Read and follow instructions contained in this guide before and during equipment installation. Failure to do so could result in bodily injury or equipment damage.



WARNING – Bodily injury. A grounding conductor may or may not be required depending on the hazardous classification. If required, any interruption of the grounding conductor inside or outside the equipment, or a loose connection of the grounding conductor, can result in a dangerous device. Intentional interruption of the grounding conductor is not permitted. If a grounding conductor is required, it should be connected to the grounding terminal before any other connections are made. Before applying the power, check that the operating voltage listed on the equipment agrees with the power being connected to the equipment.



WARNING – Bodily injury. Apply power only after the procedures are complete. Technicians must perform the procedures in order: plan, install, wire, verify the power-on sequence, and configure. Do not open the equipment to perform any adjustments, measurements, maintenance, parts replacement or repairs until all external power supplies have been disconnected. When opening covers or removing parts, exercise extreme care as live parts or connections can be exposed. Capacitors in the equipment can still be charged even after the device CHR been disconnected from all power supplies.



CAUTION: Hot surface. To indicate that the marked item can be hot and should not be touched without taking care



NOTICE – Equipment damage or loss of data. Potential electrostatic charging hazard: clean only with a damp cloth.

This Operation Manual (hereinafter — the OM) is intended for the personnel using the Chromos GC laboratory gas chromatograph to perform their work (installation, assembly, configuration, day-to-day operation, maintenance and repair). The OM describes the application, specifications, configuration, design and operation of the System. The OM contains requirements for the room where the System is installed; personnel operating the System; requirements for the System assembly, operation, maintenance, preservation, storage and transportation.

Manufacturer: CHROMOS ELECTRICAL MEASURING & CONTROL SYSTEMS MANUFACTURING CO. L.L.C.

Address: Warehouse S05, Plot 943-0 Makani No 11799 64285, Jabal Ali Industrial First, Dubai, UAE.

E-mail: info@chromosGC.com

1.1 System Description and Operation

1.1.1 System Application

The "Chromos GC" laboratory gas chromatograph (hereinafter — the System) is designed for qualitative and quantitative analysis of organic and inorganic gaseous, liquid and some solid samples of various objects of natural and industrial origin.

The System scope includes:

Industry (inspection of raw materials and finished products, inspection of process media, etc.).

Environment (monitoring of environmental parameters, such as air, water, soil, food, consumer goods, etc.).

Power industry (monitoring the state of oil-filled equipment at power facilities).

Medical industry (control of pharmaceutical drugs).

Forensic science (forensic and other types of examination).

Science (use for research and educational purposes).

The System shall be operated in laboratories under the following conditions:

– Ambient air temperature, °C	+10 to +35.
– Relative air humidity, %	30–80.
– Atmospheric pressure, kPa	84–106.7.

It is forbidden to operate Chromos GC in rooms whose atmosphere contains aggressive and/or poisonous substances. In such cases, it is mandatory:

– To install the System in a box vented with purified air.

– To install the System in a special room (analyzer room).

Chromos GC is powered from a single-pCHRe AC network with voltage $230\text{ V} \pm 10\%$.

The following gases are used for the System gas supply:

– Gaseous nitrogen of special purity, with volume fraction of basic substance 99.999%.

– Gaseous argon of premium grade, with volume fraction of basic substance 99.993%.

– Gaseous argon of high purity, with volume fraction of basic substance 99.9995%.

– Gaseous argon of high purity, with volume fraction of basic substance 99.9996 to 99.9999%.

– Gaseous helium, with volume fraction of basic substance 99.995%.

– Helium of high purity, with volume fraction of basic substance 99.9995%.

– Helium of high purity with volume fraction of basic substance 99.9999%.

– Technical hydrogen, with volume fraction of basic substance at least 99.99%.

– Compressed air.

The type of gases used is indicated in the measurement procedure (hereinafter — the MP).

- Operating pressure of gases:
- Carrier gas, MPa 0.3–0.5.
 - Hydrogen, MPa 0.1–0.3 (to power flame detectors).
 - Air, MPa 0.1–0.3 (to power flame detectors).

1.1.2 System Specifications

Basic specifications are given in Table 1.

Table 1 — Basic Specifications

System chromatograph characteristic	Value
Column oven temperature, °C	(T _{amb} +2) to +450
with column oven cooling system, °C	-20 to +450
with cryogenic cooling device, °C	-100 to +450
temperature in temperature-controlled zones, °C	(T _{amb} +4) to +450
Maximum vaporizer temperature, °C	+450
Maximum valve temperature, °C	+350
Maximum detector temperature, °C	+450
Temperature setting increment in all zones, °C	0.01
Maximum temperature programming speed in column oven, °C/min*	140
Programming speed setting increment, °C	0.01
Deviation of average steady-state oven temperature from setpoint, %	±0.15
Chromatograph power supply: **	
- VAC, V	230 ± 23
- AC frequency, Hz	50 ± 0.2
Power consumed by chromatograph (without additional devices), kVA, max:	
- when reaching the mode/in steady-state mode	2.5/0.9
Overall dimensions of chromatograph without additional devices and packaging (width x depth x height), mm, max:	
CHR 2.320.003 (column oven volume 14.2 dm ³)	390 x 570 x 480
CHR 2.320.003-01 (column oven volume 18.9 dm ³)	390 x 630 x 480
CHR 2.320.003-02 (column oven volume 5.3 dm ³)	360 x 450 x 430
Chromatograph weight (without additional devices, packaging), kg, max	42
Mean time between failures, taking into account maintenance specified in the Operation Manual (without additional devices), h, min	3000
Average service life, years, min	8
* For 5.3L ovens.	
** Normal operation of the chromatograph is guaranteed with mains voltage values of 187 to 253 V and frequency of (50 ± 1) Hz.	

Detection limits of detectors are given in Table 2.

Table 2 — Detection Limits of Detectors

Detection limits of detectors, max:	
FID, for carbon in hydrocarbons (heptane, propane), Gs/s	$1.3 \cdot 10^{-12}$
High-sensitivity FID, for carbon in hydrocarbons (heptane, propane), Gs/s	$1.0 \cdot 10^{-12}$
Flow TCD, for heptane, propane, nitrogen, helium carrier gas, g/cm ³	$8.0 \cdot 10^{-10}$
Flow TCD, for hydrogen, argon carrier gas, g/cm ³	$1.0 \cdot 10^{-10}$
High-sensitivity flow TCD, for heptane, propane, nitrogen, (helium carrier gas), g/cm ³	$3.5 \cdot 10^{-10}$
High-sensitivity flow TCD, for hydrogen, (argon carrier gas), g/cm ³	$8.0 \cdot 10^{-11}$
Semi-diffusion TCD, for hydrogen, (argon carrier gas), g/cm ³	$8.0 \cdot 10^{-11}$
Micro-volumetric TCD, for heptane, propane, nitrogen, (helium carrier gas), g/cm ³	$1.0 \cdot 10^{-9}$
Micro-volumetric TCD, for hydrogen, (argon carrier gas), g/cm ³	$7.0 \cdot 10^{-10}$
Micro-volumetric Valco TCD, for heptane or propane, (helium carrier gas), g/cm ³	$5.0 \cdot 10^{-9}$
TID, for phosphorus in metaphos, Gy/s	$1.4 \cdot 10^{-14}$
ECD, for lindane in hexane, g/s	$1.7 \cdot 10^{-14}$
FPD-S, for sulfur in metaphos	$1.0 \cdot 10^{-12}$
FPD-S, for hydrogen sulfide in nitrogen, g/s	$1.0 \cdot 10^{-13}$
FPD-S, for hydrogen sulfide in methane, g/s	$8.0 \cdot 10^{-13}$
PID (KrRV lamp), for benzene, g/s	$2.0 \cdot 10^{-13}$
PDD, for methane in helium, g/s	$2.2 \cdot 10^{-13}$
CCD, for hydrogen, g/cm ³	$5.0 \cdot 10^{-11}$
for oxygen, g/cm ³	$5.0 \cdot 10^{-10}$
CLD-S, for sulfur, Gs/s	$5.0 \cdot 10^{-13}$
PFPD, for sulfur, Gs/s	$2.0 \cdot 10^{-12}$
FED, for nitrogen, g/cm ³	$5.0 \cdot 10^{-11}$
for hydrogen, oxygen, methane, g/cm ³	$1.0 \cdot 10^{-11}$
HSD, for lindane in hexane, for dichloromethane, chloroform, dichloroethane, carbon tetrachloride, trichloroethylene, tetrachloroethylene, g/s	$2.0 \cdot 10^{-12}$

The signal-to-noise ratio and the permissible relative variation limit of output signal per 8-hour measurement cycle for MSD are given in Table 3.

Table 3 — Signal-to-noise ratio and permissible relative variation limit of output signal per 8-hour measurement cycle for MSD

Detector	Reference substance	Signal-to-noise ratio	Permissible relative variation limit of output signal per 8-hour measurement cycle (by peak areas), %
MSD	Hexachlorobenzene (0.01 µg/cm ³)	1500:1 (for m/z 283.8)	5

1.1.3 System Configuration

The Systems consist of a gas chromatograph (hereinafter — the chromatograph), a personal computer, software (to operate the chromatograph, collect and process chromatographic data), additional devices, auxiliary equipment and software for specialized calculations, as well as accessories.

There are SPTA sets for the chromatograph, additional devices and auxiliary equipment.

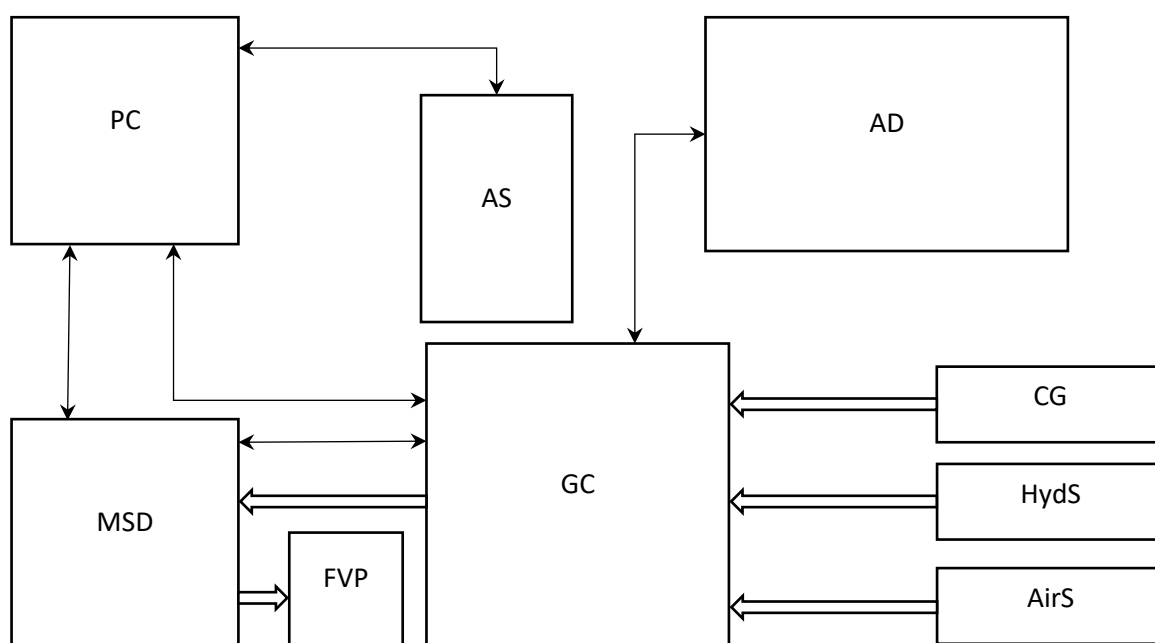
The System configuration depends on its analytical task.

The configuration of each specific System is described in CHR 1.550.001 FO form to be stored together with the System.

A set of operational documentation is supplied with the System in accordance with operational documentation list CHR 1.550.001 VE.

1.1.4 System Design and Operation

The System flowchart is shown in Figure 1.



GC — gas chromatograph; CG — carrier gas source; HydS — hydrogen source; AirS — air source; PC — personal computer; AS — autosampler; AD — additional devices (with connection to GC CCB); MSD — mass-spectrometer detector; FVP — forevacuum pump.

Figure 1 — System Flowchart

The chromatograph is made as a monoblock and consists of the following devices:

- Analytical unit with column oven;
- Detectors;
- Sample injectors;
- Gas circuit elements;
- Additional devices.

The analytical unit includes:

- Body;
- Column oven;
- Power transformer;

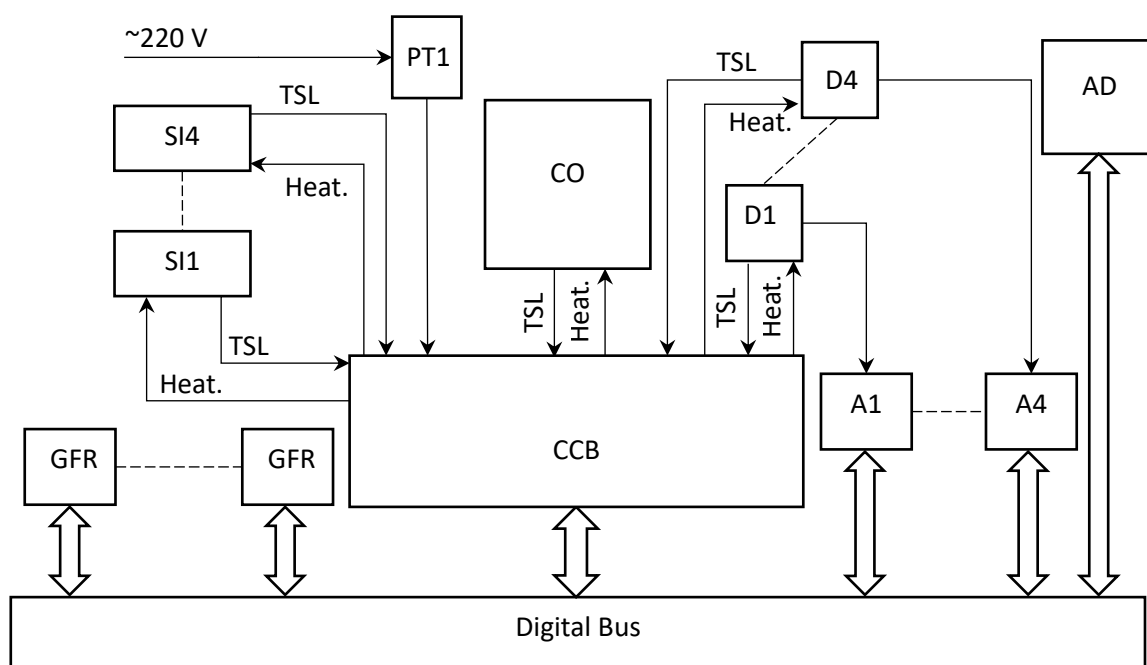
- Central control board (hereinafter — CCB);
- Control panel with four-line digital display.

Up to four sample injectors (vaporizers, valves, etc.) can be installed in the chromatograph — SI1...SI4 in Figure 2) and up to four detectors (D1...D4 in Figure 2). Vaporizers and detectors are temperature-controlled individually. Valves can be both temperature-controlled and unheated.

Gas flow regulators (GFRs) control gas flows in the chromatograph. To control carrier gas flows, various modifications of CG GFRs are used; to control hydrogen and air flows, two-channel HA GFRs are used. CG GFRs can be single-channel or dual-channel. CG GFRs have inlet and outlet pressure sensors (modifications with built-in and remote sensors), HA GFRs have only inlet pressure sensors.

The chromatograph CHR a multiprocessor modular design. Each module is equipped with a microprocessor that stores operating settings. The chromatograph and CCB modules are integrated into an internal information network; information exchange and control of modules are carried out via a digital bus.

The schematic circuit diagram of chromatograph assemblies is shown in Figure 2.



PT1 — power transformer; CO — column oven; CCB — central control board; GFR — gas flow regulators; SI1...SI4 — sample injectors; D1...D4 — detectors; A1...A4 — amplifiers; AD — additional devices in chromatograph; Heat. — heater lines; TSL — temperature sensor lines.

Figure 2 — Schematic circuit diagram of chromatograph assemblies

Additional devices allow to expand the chromatograph functionality, implement various MPs and automate the analysis process.

The chromatograph and the PC communicate via RS-232, USB or Ethernet protocol.

The Chromos software (hereinafter — the Chromos SW) is used to control the chromatograph operation, collect and process chromatographic data, and maintain a database of chromatographic analyzes.

During the System operation, the Chromos SW keeps a log (log-file) to record the operator's actions transmitted to the chromatograph and parameters received from it. The Operation Log is used for the System remote diagnostics.

The Chromos SW allows to set and control the chromatograph operating mode parameters, and to continuously record any parameter as a graph (chromatogram).

The Chromos SW allows to transmit measurement results to automatic process control systems (APCS) of LIMS enterprises.

It is recommended to use a hydrogen generator as a source of hydrogen.

It is recommended to use a compressor as a source of air.

The design and operation of the System components are set out in operational documentation according to CHR 1.550.001 VE.

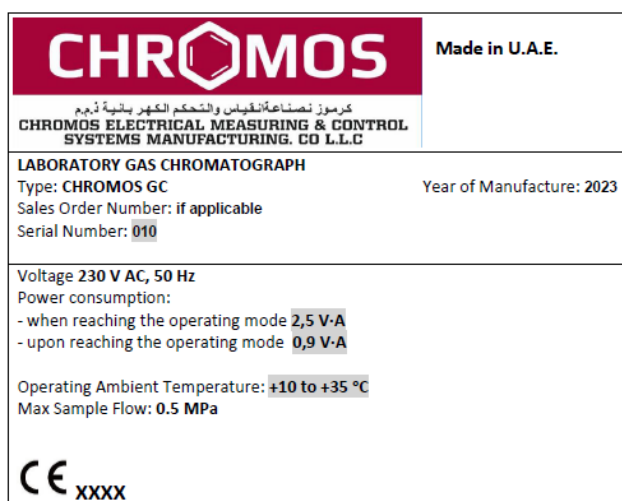
1.1.5 System Marking and Sealing

The marking is made in the form of a plate located on the chromatograph rear side.

The marking provides the following information:

- the manufacturer's trademark;
- the name of the manufacturer;
- the product description;
- CE marking;
- Technical Specifications;
- the serial number of the product, including the year and month of manufacture;
- the country of manufacture.

The exemplary nameplate is shown in Figure 3.





The following markings are applied:

- Caution! Hot surface (on the inside of the chromatograph top cover).
- Caution! Cold (on the rear wall of the cry concentration system, the column oven cooling system).
- Electrical hazard!

The following markings are applied to the transport packaging:

- Fragile. Caution!
- Keep dry.
- No stacking.
- This side up.

If the System is equipped with an ECD, a radiation hazard symbol shall be applied to the ECD body surface.

No sealing of the System is required.

The ECD is sealed when the radioactive source is installed in the detector housing at the source manufacturing plant.

1.1.6 System Packaging

The System components shall be packed in boxes made of type VI sheet wood.

The chromatograph, SPTA set, packing list and operational documentation shall be put in package No.1.

When packing the chromatograph, a transport lock shall be installed to prevent any damage to the impeller motor. An information plate shall be placed on the chromatograph under the inner packaging with a warning to remove the transport lock.

1.2 Description and Operation of System Components

1.2.1 General information

The System components include:

- Chromatograph;
- Sample injection units;
- Detectors;
- Additional devices;
- Auxiliary equipment;
- Accessories.

General information about the chromatograph is given in subsection 1.1.4.

Sample injection units are designed to inject various types of samples (liquid and gaseous) into the carrier gas flow. The sample injectors include:

- Vaporizers;

- Valves;
- Thermal desorbers;
- Headspace samplers;
- Liquefied gas sampling devices;
- High-pressure sample injectors.

Detectors (together with amplifiers) are designed to convert changes in physical or physicochemical properties of binary mixtures of a component and carrier gas (as compared to pure carrier gas) into electrical signal and transmit it digitally via digital bus and CCB to a processing system (PC with the Chromos SW).

The types of detectors used are given in Tables 2 and 3.

Additional devices are designed to improve the System performance, implement complex multi-column and multi-channel procedures, run special analyzes and automate the analysis process.

Auxiliary equipment designed for analysis support includes:

- Gas generators;
- Sample preparation devices;
- Gas purification devices;
- Other equipment.

Accessories include syringes, samplers, etc.

1.2.2 Operation of System Components

The operation of the chromatograph, sample injection units and detectors is described in the chromatograph Operation Manual.

The operation of additional devices is described in Operation Manuals for relevant devices.

The operation of the Chromos SW is described in the User Manual.

The Operation Manuals for the chromatograph and additional devices are delivered to the customer on electronic media. The Operation Manuals and SW User Manuals can be issued on paper if requested so.

The operation of auxiliary equipment is described in Operation Manuals for relevant equipment.

2 System Intended Use

2.1 Operating Restrictions

The System operation conditions are given in paragraph 1.1.1 of this Operation Manual.

The System shall be installed and operated without any changes to its design and in compliance with all safety requirements.

When implementing some MPs during normal chromatograph operation, there can be a dangerous concentration of toxic gases or vapors at the outlet points (purge lines, sample discharge lines, detector output lines). In these cases, it is necessary to take safety precautions, such as the use of personal protective equipment, special lines to remove harmful substances outside the premises, and the System installation in the exhaust hood.

2.2 System Preparation for Use

2.2.1 Safety Measures during System Preparation for Use

Assembly, adjustment and maintenance shall be performed by personnel who have at least group two qualification according to the Regulations for Operation of Consumer Electrical Installations (PTEEP), who have undergone special training at the manufacturing plant and have appropriate certificates.

During assembly, adjustment, and maintenance of the System, requirements of the following documents (current version) shall be met:

- Electrical Installations Code (PUE);
- Regulations for Operation of Consumer Electrical Installations (PTEEP);
- Occupational Safety Rules for Operation of Electrical Installations (POTEE);
- Fire Safety Regulations;
- Federal Rules and Regulations in the field of industrial safety “Industrial Safety Regulations for Using Equipment Operating Under Excessive Pressure”;
- Customer Occupational Safety Instructions.

All the System components with power circuits shall be grounded.

2.2.2 System Installation

Unpack boxes with the System components. In winter, before unpacking, the System components shall be kept at a temperature of not lower than plus 10 °C for at least a day.

Open the transport packaging of the System components.

Install the System components at the workplace (table, exhaust hood). When installing the chromatograph in the exhaust hood, it is forbidden to carry out other types of work and store reagents in the same space.

Assemble gas lines. The gas lines shall be installed using tubes from the SPTA set. Before connecting the lines to the equipment inlets, the lines shall be purged.

Hook up electrical connections.

The System components shall be grounded.

All electrical connections shall be hooked up only when the equipment is deenergized.

2.3 System Use

2.3.1 Procedure for Maintenance Personnel Using the System

The procedure for maintenance personnel using the System depends on the System configuration and the implemented MP.

The operator's actions when using the System are determined by the following documents:

- Chromatograph Operation Manual;
- Software User Manual;
- Operation Manuals for additional devices;
- User Manual for analysis procedure;
- Measurement Procedure.

2.3.2 Product Operability Test Procedure

The System operability (basic and additional metrological characteristics) shall be confirmed by periodic testing.

The operability testing of the System components (if applicable) is described in relevant Operation Manuals.

2.3.3 List of Possible Malfunctions

Possible malfunctions and methods to eliminate them are described in Operation Manuals for the chromatograph and System components.

2.3.4 System Operating Modes

The System operating mode is determined by the MP implemented with the System.

The System operating mode is set in the Chromos SW. The current state of the System parameters is monitored in the Chromos SW and on the chromatograph control panel display.

The Chromos SW allows to create and save the required number of instruments operating modes, storing each in a method file on the PC.

2.3.5 Safety Measures When Using the System



Sign on the back of the gas chromatograph, warning of the danger of burns during the heating and cooling cycle of the thermostat.



The label on the flip cover warns of the risk of burns.



The label on the flip cover, a warning about the presence of dangerous voltage



The label on the flip cover the ECD thermostat warning of radiation hazard.



Sign and inscription on the door of the thermostat, warning of the danger of an explosion in the housing.

Persons who are at least 18 years old and have experience of operating chromatographic systems and PC are permitted to use the System as intended.

The System shall be used as intended only by personnel who have read the entire operational documentation for the System and its components.

The System shall be used as intended only by personnel who have received a safety briefing applicable at the company operating the System.

It is forbidden to make any changes to the System design during operation.

ATTENTION: Before turning on the chromatograph, make sure that the input line is plugged or connected to the column.

3 Maintenance

3.1 System Maintenance

3.1.1 General

Maintenance is a set of process operations and organizational actions to keep the System operable or serviceable during its intended use, storage and transportation.

During the System intended use, scheduled and unscheduled maintenance can be carried out.

Scheduled maintenance shall be carried out according to a set timetable.

Unscheduled maintenance shall be carried out after assessing the actual technical condition of the System (when any technical or metrological characteristics of the System change).

3.1.2 Maintenance Personnel Qualification Requirements

To carry out maintenance, the maintenance personnel shall meet the requirements set out in subsection 2.3.5 of this Manual.

3.2 Safety Measures during Maintenance

During maintenance, the safety measures given in subsections 2.2.1 and 2.3.5 of this manual shall be observed.

3.3 Maintenance Procedure

Maintenance procedure for the System components is given in appropriate Operation Manuals.

When carrying out maintenance, it is necessary to fill in the Maintenance Registration table in the relevant section of CHR 1.550.001 FO form.

4 Routine Repair of the System and its Components

Routine repair of the System and its components shall be carried out at the manufacturing plant or at the company operating the System, by persons who have undergone special training at the manufacturing plant and have appropriate certificates.

In some cases, the repair can be performed by the personnel of the company operating the System, with a written permission of the manufacturer.

When carrying out routine repair, it is necessary to fill in the Maintenance Registration table in the relevant section of CHR 1.550.001 FO form.

5 System Storage

The System (except for the PC, water treatment systems and hydrogen generator) shall be stored in packaged form in closed or other rooms with natural ventilation without artificially controlled climatic conditions, where temperature and humidity fluctuations are significantly less than in the open air (for example, in stone, concrete, metal storage facilities with thermal insulation, etc.), located in macroclimatic areas with a moderate and cold climate.

The PC, water treatment systems and hydrogen generators shall be stored in heated and ventilated warehouses or air-conditioned storage facilities in any macroclimatic areas.

During long-term storage of hydrogen generators (for more than 2 months), it is necessary to carry out their scheduled maintenance according to the hydrogen generator Operation Manual.

6 Transportation

Transportation and handling IEC 60721-3-2 classifies the groups of environmental parameters and their severities to which a product is subjected while being transported and handled.

The System is supplied to the customer in packaged form in accordance with subsection 2.2.2 of this Manual.

The System can be transported by any type of enclosed transport, except for unsealed compartments of aircraft and open decks of water transport.

It is strictly prohibited to transport hydrogen generators and water treatment systems at an air temperature below plus 5°C without their prior preservation.

The boxes shall be so stowed in a vehicle as to exclude their movement during transportation.

When handling the boxes, any shock and precipitation shall be avoided.

The movement of goods weighing more than 18 kg in the technological process should occur with the help of built-in lifting and transport machines or mechanization.

A lifting operation should be performed using lifting equipment.

7 Disposal

Waste Electrical and Electronic Equipment (WEEE)

EU Directive 2012/19/EU

CHROMOS ELECTRICAL MEASURING & CONTROL SYSTEMS MANUFACTURING CO. L.L.C (hereinafter CHROMOS) is committed to actively protecting the environment. Do not dispose of WEEE as unsorted municipal waste. Collect WEEE separately. Participation in the management of WEEE is critical to the success of WEEE collection.



Electrical and electronic equipment marked using the crossed-out wheeled bin symbol shall not be mixed with general household waste. Correct disposal at a recycling facility will help save valuable resources and prevent potential negative effects on health and the environment. These steps ensure compliance with the Waste Electrical and Electronic Equipment (WEEE) Directive.

Waste electrical and electronic equipment (WEEE) shall be treated separately using the national collection framework available to customers for the return, recycling, and treatment of WEEE.