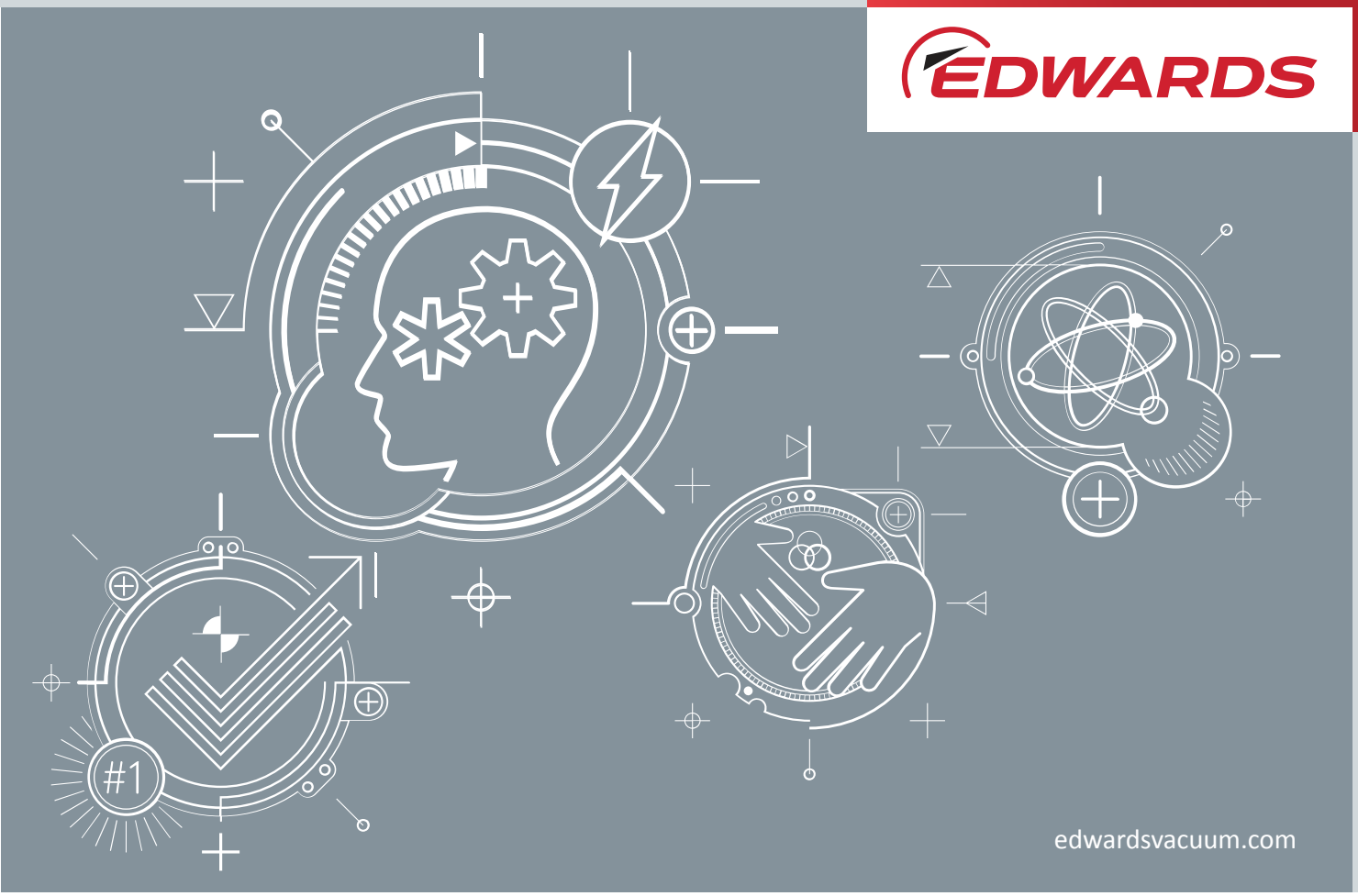

Diffusion Pumps
nHT

INSTRUCTION MANUAL

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Disclaimer

The content of this manual may change from time to time without notice. We accept no liability for any errors that may appear in this manual nor do we make any expressed or implied warranties regarding the content. As far as practical we have ensured that the products have been designed and constructed to be safe and without risks when properly installed and used in accordance with their operating instructions.

We accept no liability for loss of profit, loss of market or any other indirect or consequential loss whatsoever.

Product warranty and limit of liability are dealt with in our standard terms and conditions of sale or negotiated contract under which this document is supplied.

You must use this product as described in this manual. Read the manual before you install, operate, or maintain the product.

Declaration of Conformity

P200101199B

Edwards Ltd,
Innovation Drive,
Burgess Hill,
West Sussex,
RH15 9TW, UK

The following product:

Vapour Diffusion Pumps:

nHT10:	B31130400 / B31130460 / B31132400 / B31132460
nHT16:	B31230400 / B31230460 / B31232400 / B31232460
nHT20:	B31430400 / B31430460 / B31432400 / B31432460
nHT35:	B31530400 / B31530460 / B31532400 / B31532460

conform to the relevant requirements of European CE legislation:

EN 1012-2:1996+A1:2009	Compressors and vacuum pumps - Safety requirements Part 2: Vacuum pumps
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines Part1: General requirements
EN 61000-6-2:2005/AC:2005	Electromagnetic compatibility (EMC) – Part 6-2: Generic standards - Immunity for industrial environments
EN 61000-6-4:2007/A1:2011	Electromagnetic compatibility (EMC) – Part 6-4: Generic standards - Emission standard for industrial environments

And fulfils all relevant provisions of

2006/42/EC	Machinery Directive

The safety objectives of the Low Voltage Directive 2014/35/EU were complied with in accordance with Appendix 1 No. 1.5.1 of Machinery Directive 2006/42/EC

2014/30/EU	Electromagnetic Compatibility (EMC) Directive

Note: This declaration covers all product serial numbers from the date this Declaration was signed onwards.

Cologne, February 11th, 2019

Andries Desiron
VP Engineering
Industrial Vacuum

Cologne, February 11th, 2019

i.V. Martin Laerbusch
Head of Production Systems
Cologne Product Company

This product has been manufactured under a quality management system certified to ISO 9001:2015.
This declaration is based on the requirements of EN ISO 17050-1 and the relevant directives.

Contents

List of Figures

1. Safety and compliance

1.1 Definition of Warnings and Cautions

NOTICE:

For safe operation from the start, read these instructions carefully before you install or commission the equipment and keep them safe for future use.

Read all the safety instructions in this section and the rest of this manual carefully and make sure that you obey these instructions. The equipment must only be operated and maintained by trained personnel in the proper condition and as described in this instruction manual.

Obey local and state requirements and regulations. If you have any questions about safety, operation or maintenance of the device, please contact our nearest subsidiary.

Important safety information is highlighted as warning and caution instructions. Obey these instructions.

WARNING:

If you do not obey a warning, there is a risk of injury or death. Different symbols are used according to the type of hazard.

CAUTION:

If you do not obey a caution, there is a risk of minor injury, damage to equipment, related equipment or process.

NOTICE:

Information about properties or instructions for an action which, if ignored, will cause damage to the pump or the system.

We reserve the right to change the design and the stated data. The illustrations are not binding.

Keep the instructions for future use.

1.2 Safety symbols

The safety symbols on the products shows the areas where care and attention is necessary.

The safety symbols that follow are used on the product or in the product documentation.

	Warning/Caution An appropriate safety instruction must be followed or caution to a potential hazard exists.
	Warning - Heavy object Identifies a possible hazard from a heavy object.
	Warning - Dangerous voltage Identifies possible hazards from dangerous voltages.
	Warning - Hot surfaces Identifies a potential hazard from a hot surface.
	Warning - Use protective equipment Use appropriate protective equipment for the task.
	Warning - Risk of explosion There is a risk of explosion when you do the task.
	Warning - Toxic material The material is toxic.

2. Important safety information

2.1 Mechanical hazards

WARNING: HIGH PRESSURE

Ejection of parts through bursting of the vacuum system due to excessive pressure, caused by errors like malfunction at the gas inlet into the vacuum system.

The pump must be securely anchored during operation.

The pump may be vented only if the pump fluid temperature is < 100 °C, otherwise there is a risk of explosion.

Reverse venting must be ruled out. The cooled pump should be vented from the high vacuum side.

Turn off the cooling water supply only after the pump has cooled down to < 100 °C.

Pump operation with a closed inlet and outlet and an isolated cooling water supply is a dangerous condition and must be prevented (for example, by an interlock circuit).

WARNING: HEAVY OBJECT

Loss of stability during transport.

Uncontrolled movement through incorrect fastening or raising or lifting of the pump system.

Use all lifting eyes when moving the pump body. Pay attention to the centre of gravity.

Transportation flanges (blank flanges) and the supplied clamps may be used only for transportation purposes; they are not suitable for the assembly of the pumps in systems.

Uncontrolled movement through inertia of mobile pump systems (wheels or mobile frame). Mount and move mobile pumps with wheels only on flat, solid, horizontal surfaces.

Move the pump at slow speed.

CAUTION: EXPOSURE TO VACUUM

Risk of injury. Do not operate the pump system with open inlet and outlet ports.

During installation connect the system mechanically via the inlets and outlets before making the electrical connections.

CAUTION: EJECTION OF PARTS

Ejection of parts through implosion of a part of the pump or the pump system.

If the boiler overheats as a result of little or no oil or low cooling water flow, the boiler can implode.

The water cooling system must not be interrupted if a fault occurs. Observe the installation regulations.

CAUTION: OIL LEAKAGE

Slip, trip or fall hazard due to oil leakage from the pump.

Depending on the work process, oil may leak from the pump.

Check the pump for any oil that has leaked. Take appropriate measures.

CAUTION: AUTOMATIC RESTART

Hazards that may occur through independent restart of a pump after a shut down due to an error.

Connect the pump in such a way that if a monitoring element is triggered (thermostat, thermal protective switch, water flow guard) it does not automatically restart after the fault condition has ended.

2.2 Electrical hazards

WARNING: HAZARDOUS VOLTAGE

Electric shock through direct or indirect contact of live parts.

Electric shock by touching active electrical components.

The electrical connection must be carried out by a trained person.

Observe the national regulations in the country of the user, for example, for Europe EN 50110-1.

A protective earth check between the PE connection and every touchable part that requires a protective connection, must be carried out before initial operation. Do this for the test current, use 10 A d.c. or a.c. (RMS), while not more than 0.1 Ω impedance.

The temperature sensor (Pt 100) which is built into one of the heating cartridges may become live in a heater fault condition. The operator must take suitable precautions for protection against inadvertent contact. For example, a temperature transducer with double or reinforced insulation can be used for this purpose.

Connect a second protective earthing conductor.

There are hazardous voltages present on the mains cables (danger to life).

Before you do maintenance or service work on the product, turn off the mains supply.

WARNING: LOSS OF POWER SUPPLY

Explosion hazard due to uncontrolled venting.

If fitted, an inlet valve must close in the event of a power failure.

Air infiltration into an operation ready, warm diffusion pump is a dangerous condition and must be reliably ruled out.

If electro-pneumatically operated inlet and outlet vacuum valves are used, these must be “normally closed” when in a “de-energised” or “unpressurised” condition. Also for these valves, the ventilation of a ready-to-operate, hot diffusion pump must be prevented through appropriate interlock circuits.

The components must be connected correctly. Electrical safety tests, in particular the insulation and protective grounding conductor examination, must be done.

CAUTION: MOISTURE ABSORPTION

High electrical fault currents due to moisture absorption by mineral insulating material of the heating elements.

The hygroscopic insulation of the heating element could lead to a burn-out of the heater cartridge. Risk occurs through longer shut off cycles and humid ambient conditions.

Take note of the installation instructions for the replacement and connection of the heater cartridge.

Check stock before changing/inserting (measured value: 49 to 55 Ω) and degas if necessary.

Check heaters if they have not been used for more than 1 year.

2.3 Thermal hazards

WARNING: HOT SURFACES

Burns from touching hot surfaces.

Burning of fingers, hands, arms on hot surfaces up to +140 °C. Hazard of burns with open covers.

Handle the pump only in vented and cooled condition. Wear suitable protective equipment. Take note of the cooling time after switching off.

WARNING: HOT SURFACES

Scalding by touching hot equipment or lubricants.

Risk of scalding when opening the hot pump through pump fluid vapour.

Only open fluid drain port or fill port if the pump is cooled down to room temperature and is vented.

Let cooling water pipes cool down before removing and then shut off the feed line. Wear suitable protective equipment.

2.4 Danger through substances and materials

WARNING: TOXIC SUBSTANCES

Danger through expulsion of transported toxic gases/vapours. Fire or explosion in case of transport or ejection of flammable gases/vapours, oxidising agents or pyrophoric gases.

Transported process gases can escape out of the exhaust pipe and from leaking areas of the vacuum system.

Transport of toxic gases/vapours, flammable gases/vapours, oxidising agents or pyrophoric gases is not permitted.

In its standard version, the pump system is not suitable for operation in EX zones.

The operator is responsible for the assessment of the hazard potential of the process media and/or mixtures. For this purpose, the operator must perform a risk or hazard assessment. The operator must take appropriate measures to make sure that there is no danger to man and the environment.

Do not use flammable materials near the hot pump area.

WARNING: HARMFUL VAPOUR

Hazards through emission of harmful gases/vapours.

During the start-up and the new installation of the heater cartridge, smoke and an unpleasant smell may develop. Therefore, turn on new pumps and pumps after successful servicing of the heater cartridges only in well ventilated areas. Avoid direct contact with the smoke or gases that can develop during start-up.

WARNING: LUBRICANT REACTION

Danger as a result of contact with toxic decay/reaction products of lubricants, equipment or pumped substances during the maintenance of the pump.

There may be deposits in the pump during servicing. The pumping of toxic gases and vapours is prohibited.

The operator is responsible for the assessment of the hazard potential of the process media and/or mixtures. For this purpose, the operator must perform a risk or hazard assessment. The operator must take appropriate measures to make sure that there is no danger to people and/or the environment.

For this purpose, we recommend that the pump is flushed for a longer time with inert gas before opening. Wear appropriate protective clothing (gloves, goggles, respiratory protection, personal protective equipment).

Avoid body contact with plant oil, process residues and contaminated surfaces. Perform maintenance in clean, dry and well ventilated rooms.

WARNING: HAZARDOUS WORKING CONDITION

Danger as a result of contact with toxic decay/reaction products of lubricants, equipment or pumped substances during the maintenance of the pump.

Wear appropriate protective clothing (gloves, goggles, respiratory protection, personal protective equipment).

Avoid body contact with plant oil, process residues and contaminated surfaces. Perform maintenance in clean, dry and well ventilated rooms.

3. Description

The pumps in the nHT series are high vacuum pumps (< 10^{-2} mbar). They are always operated together with the backing pumps.

The pumps are water cooled and utilise the oil diffusion principle in their operation. They are used in high vacuum technology to evacuate vacuum chambers.

The pumps achieve the highest pumping speeds in pressure ranges from 10^{-2} to 10^{-7} mbar.

3.1 Design and function

The pumps comprise the following component assemblies:

- A water cooled pump housing with inlet and outlet vacuum connection flanges
- An interior assembly
- An internal vaporisation chamber (boiler) with heating elements
- A water cooled cold cap baffle
- A backing baffle
- An electrical terminal box.

Interior assembly

The pumps are fitted with a five-stage precision interior assembly. It consists of four diffusion jet stages and an ejector stage, made of light alloy metal.

Pump body

The pump body is made of standard grade steel. The inlet connection flange and the outlet vacuum flange are made of stainless steel. The external cooling coils are made of copper.

Heat diffusion fins

The external coiled heating fins on the cartridge heaters are made of stainless steel and are immersed for the most part in the pump fluid in the vaporisation chamber.

The section of the heating fin immersed in the pump fluid produces intense but surge free vaporisation of the pump fluid.

The section of the heating fin located above the level of the pump fluid applies additional energy to the pumping vapour.

Thermostat

To protect the heating element, a thermostat sensor is attached to one of the heater cartridges. When installed, it protrudes above the fluid. It must be used to turn off the pumps heaters as soon as the bimetallic switch temperature reaches the preset trip point.

Note:

The sensor has to be installed into the system control by the customer so that it will safely turn off the power.

Heating cartridges

The heating cartridges can be easily replaced when required. It is not necessary to remove the pump from the system to replace the cartridges.

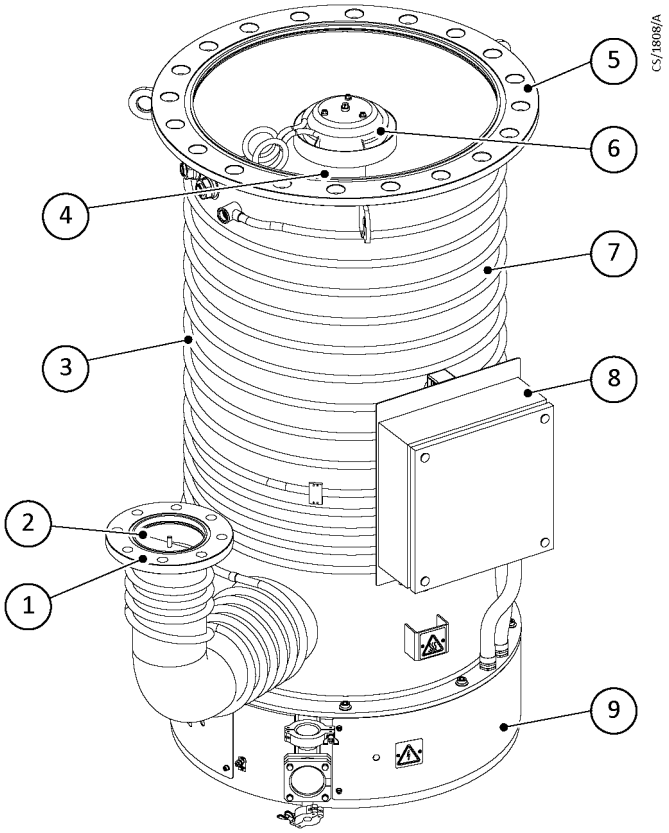
Cold cap baffle

To prevent vapour from back-flow into the vacuum chamber, the pump is fitted with a nickel plated copper, water cooled cold cap baffle in the area of the inlet port.

Backing baffle

A water cooled backing baffle located on the fore vacuum side effectively prevent the fluid being swept into the backing pump.

Figure 1 Overview of nHT diffusion pump



1. Outlet connection flange
2. Backing baffle
3. External cooling coils
4. Interior assembly
5. Inlet connection flange
6. Cold cap baffle
7. Pump body
8. Electrical terminal box
9. Heater cover plate

3.2 Supplied equipment

All pumps are shipped without pump fluid. Standard equipment included with the pump are:

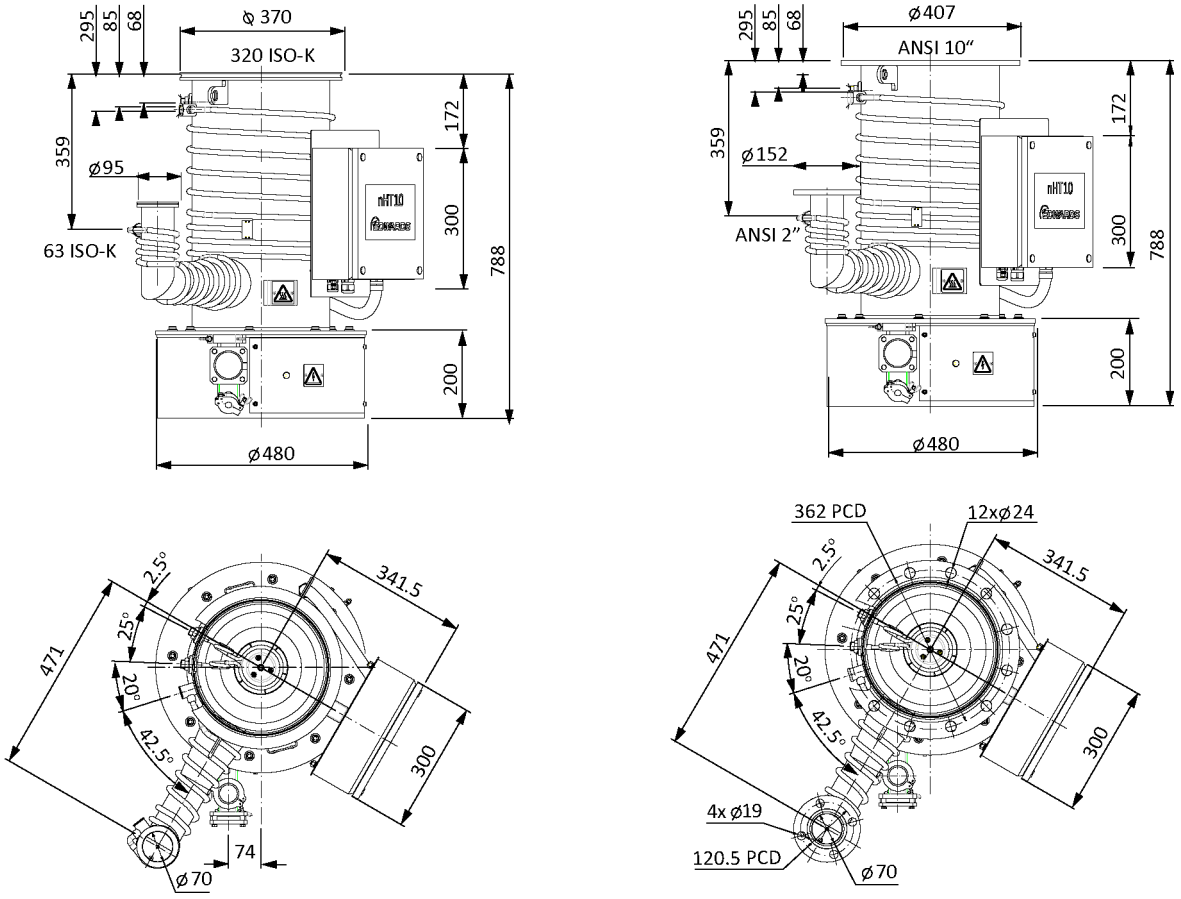
- Inlet seal O-ring for ANSI pumps
- Centring ring seal for ISO pumps.
- Outlet seal O-ring for ANSI pumps

The inlet and outlet vacuum flanges are covered with shipping flanges. The inside of the pump is cleaned and evacuated before shipment.

4. Technical data

4.1 Dimension drawings

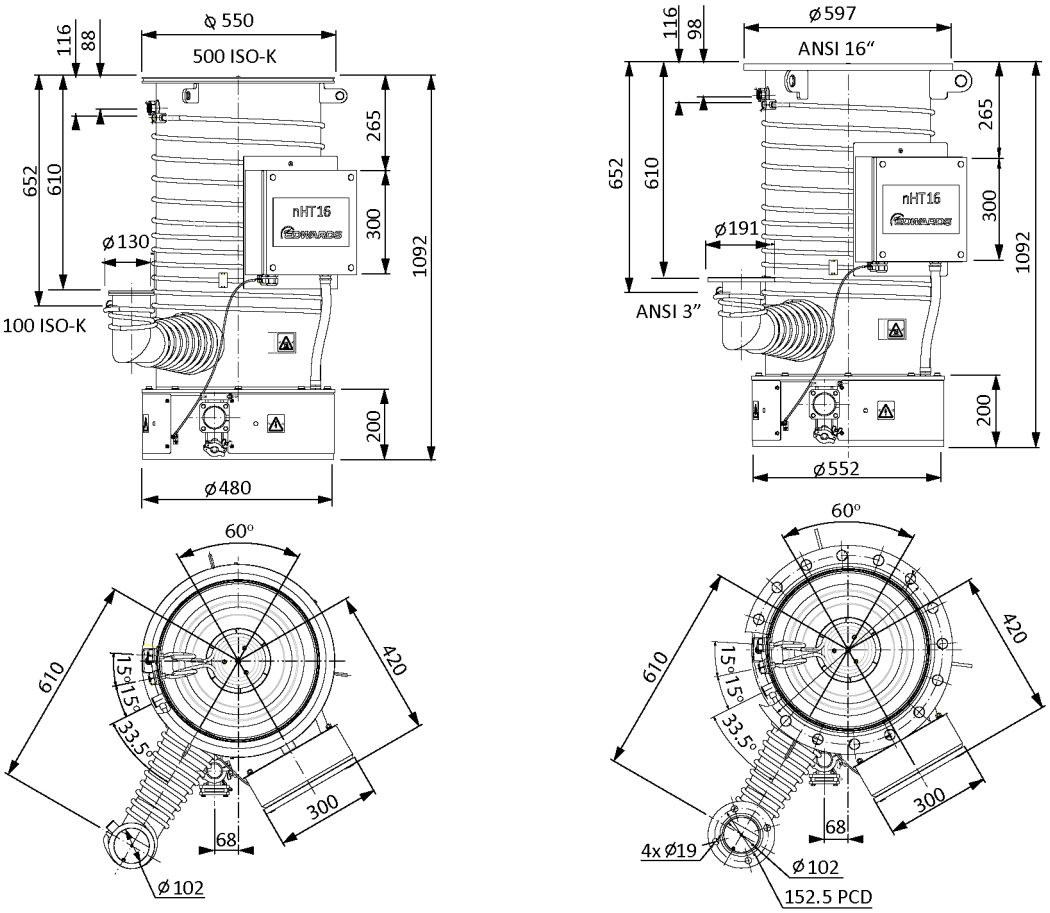
Figure 2 nHT10 Dimensions



nHT10 ISO

nHT10 ANSI

Figure 3 nHT16 Dimensions



nHT16 ISO

nHT16 ANSI

Figure 4 nHT20 Dimensions

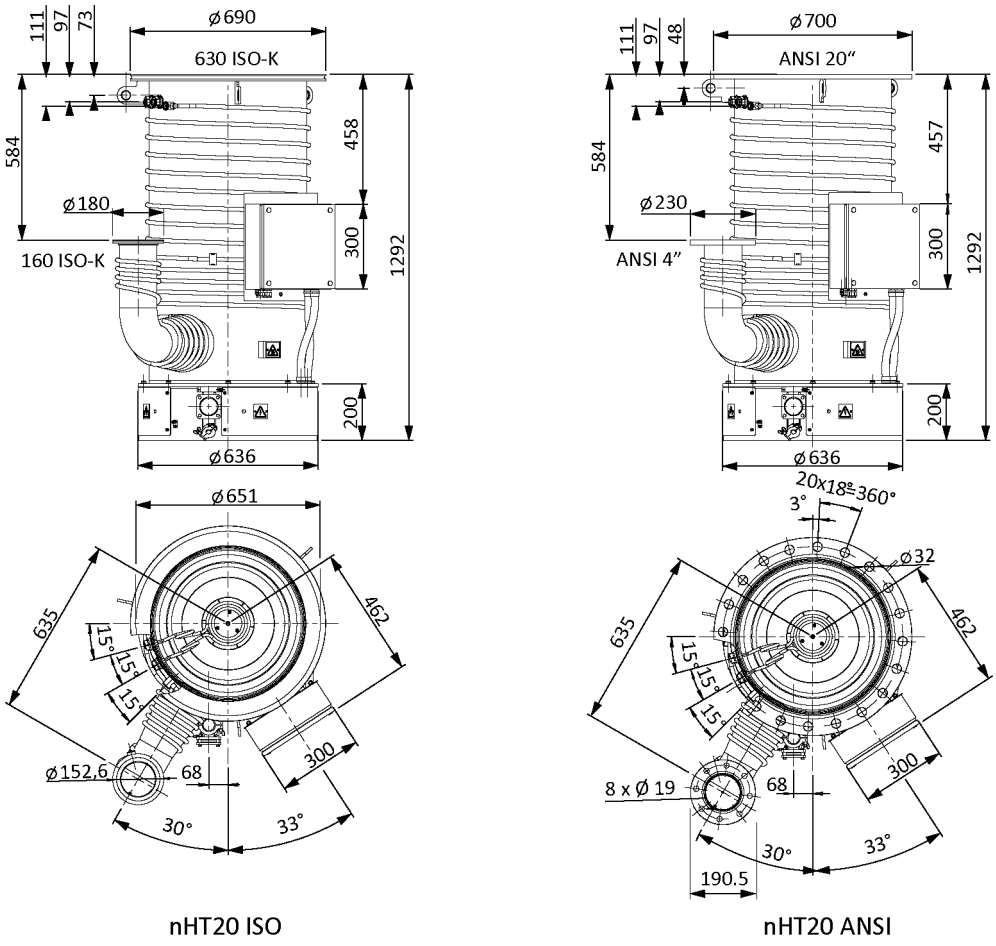
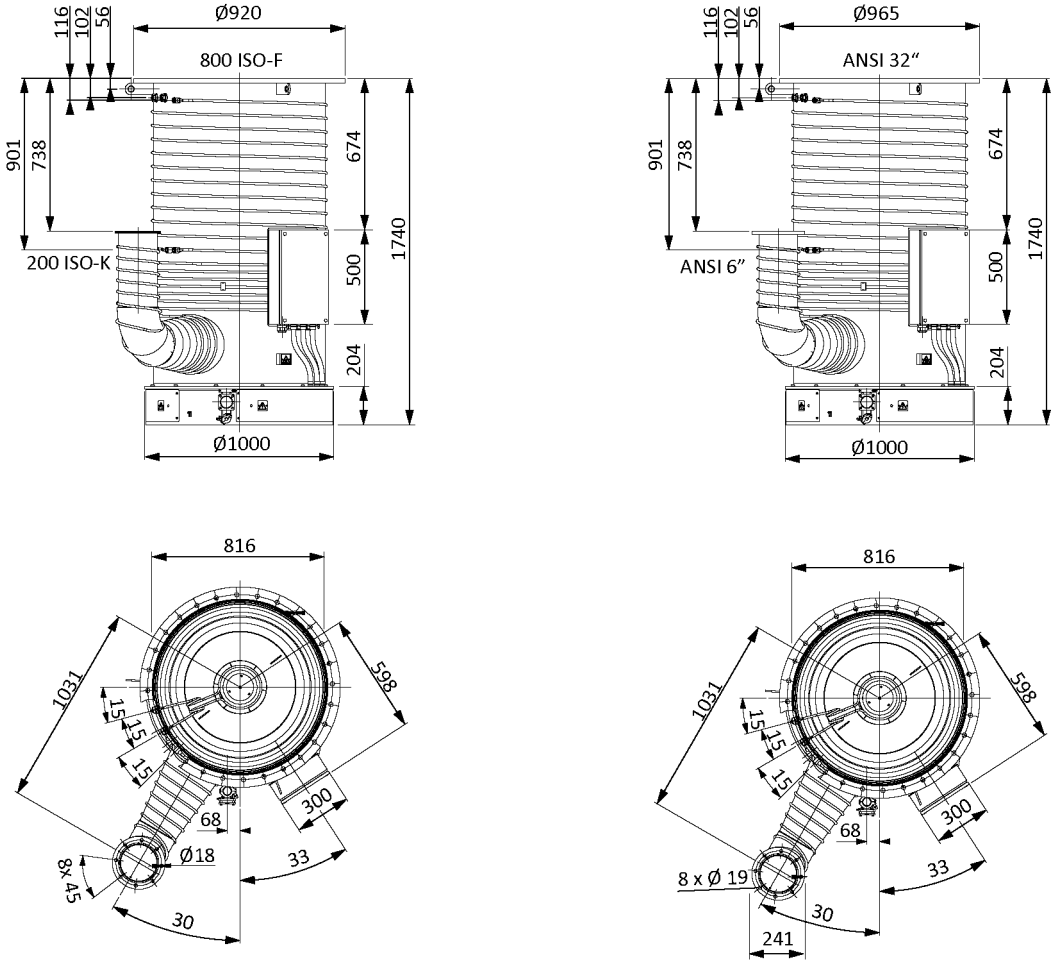


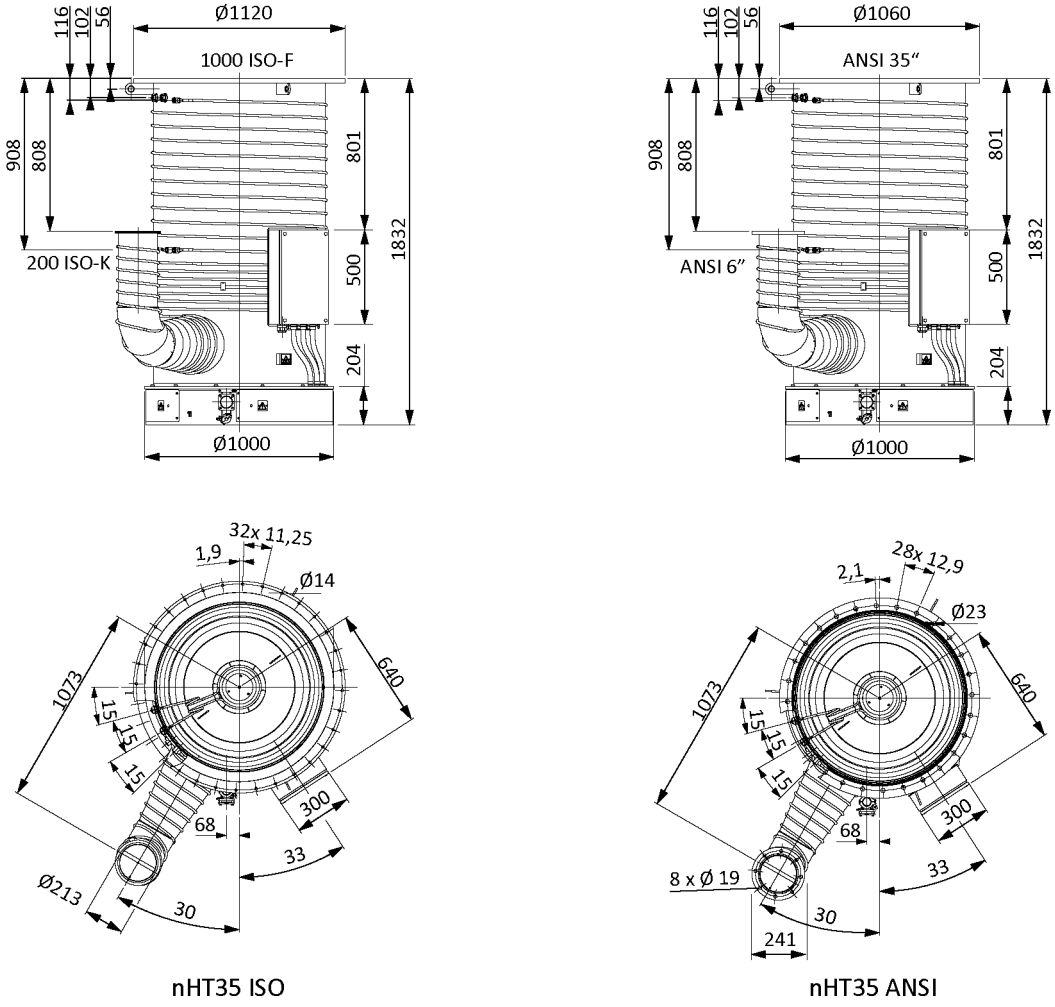
Figure 5 nHT32 Dimensions



nHT32 ISO

nHT32 ANSI

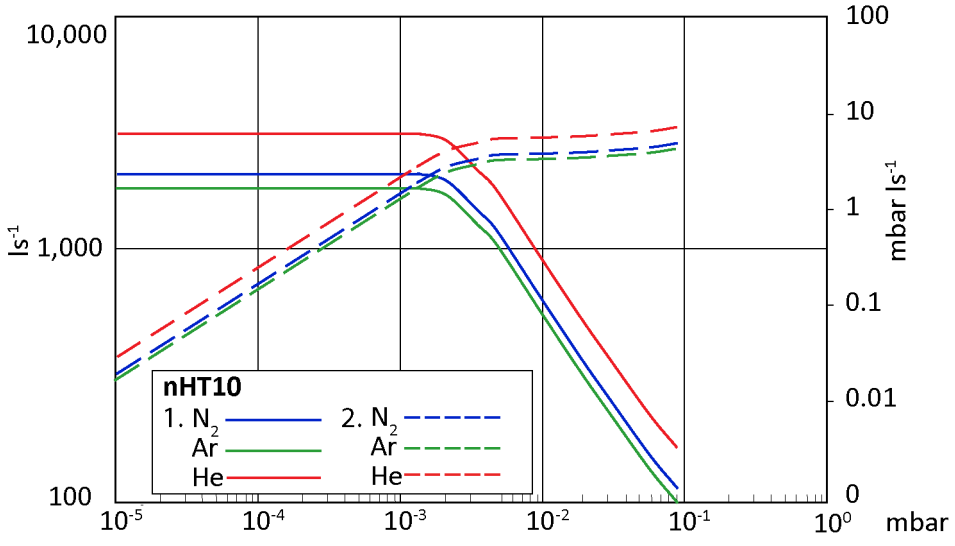
Figure 6 nHT35 Dimensions



nHT35 ISO nHT35 ANSI

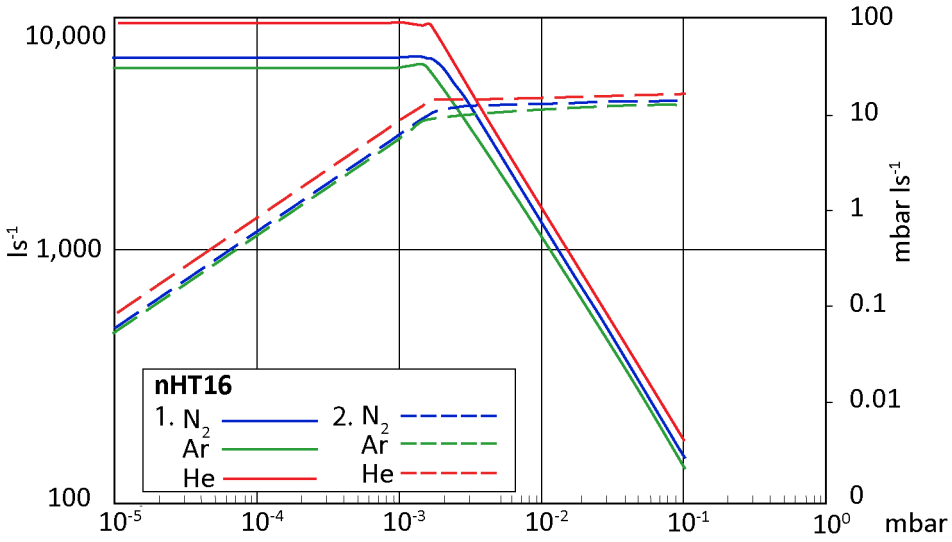
4.2 Pumping speed curves

Figure 7 Pumping speed overview for nHT10



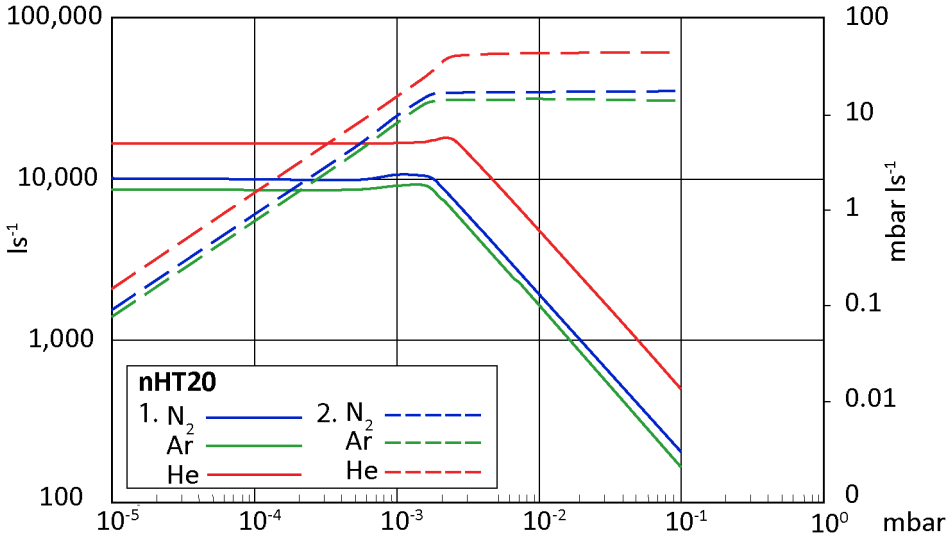
1. Pumping speed 2. Throughput

Figure 8 Pumping speed overview for nHT16



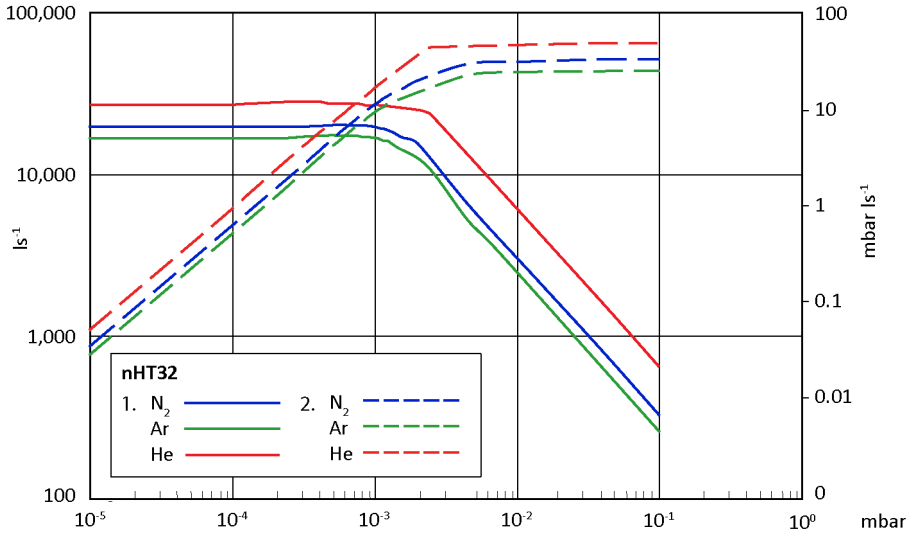
1. Pumping speed 2. Throughput

Figure 9 Pumping speed overview for nHT20



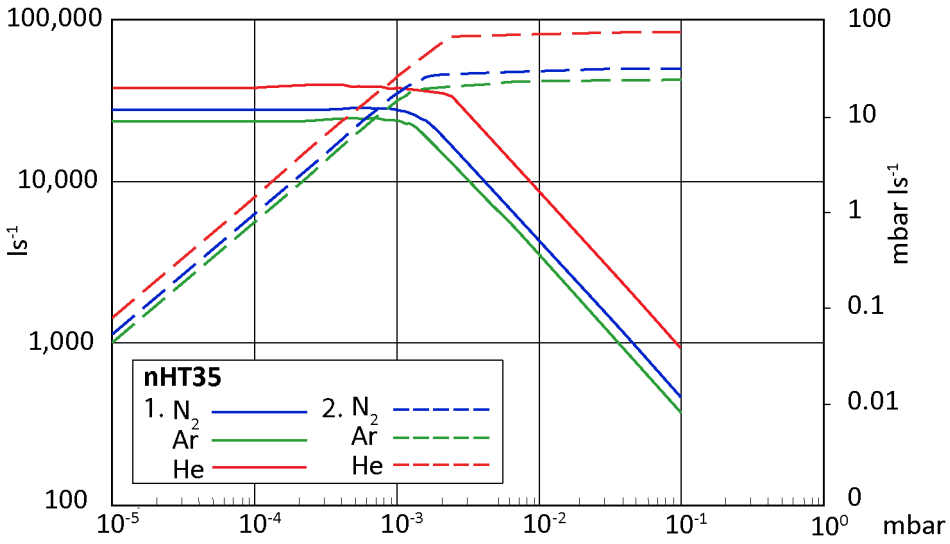
1. Pumping speed 2. Throughput

Figure 10 Pumping speed overview for nHT32



1. Pumping speed 2. Throughput

Figure 11 Pumping speed overview for nHT35



1. Pumping speed 2. Throughput

Table 1 Technical data

Parameter	Unit	nHT10 ANSI	nHT10 ISO	nHT16 ANSI	nHT16 ISO	nHT20 ANSI	nHT20 ISO	nHT32 ANSI	nHT32 ISO	nHT35 ANSI	nHT35 ISO
High vacuum connection		10 inch ANSI	320 ISO-K	16 inch ANSI	500 ISO-K	20 inch ANSI	630 ISO-K	32 inch ANSI	800 ISO-F	35 inch ANSI	1000 ISO-F
Backing connection		2 inch ANSI	63 ISO-K	3 inch ANSI	100 ISO-K	4 inch ANSI	160 ISO-K	6 inch ANSI	200 ISO-K	6 inch ANSI	200 ISO-K
Pumping speed* for											
▪ Nitrogen < 10^{-4} mbar	ls^{-1}	3000		6800		10000		21000		30000	
▪ Argon < 10^{-4} mbar	ls^{-1}	2750		6350		9000		18000		26000	
▪ Helium < 10^{-4} mbar	ls^{-1}	4500		9500		17000		30000		42000	
Maximum throughput	mbar.l/s	8		11		17		36			
Weight, approximately	kg	95		152		210		570		610	
Recommended backing pump		nES200, E2M80, EDS200, EH1200		nES200, E2M175, EDS200, EH1200		nES300, E2M175, EDS300, EH1200		nES630, GXS450, EH2600			
Recommended holding pump		E2M40						E2M80			
Pump fluid fill, minimum/ maximum	l	3.0/4.0		3.5/4.5		5.5/7.0		9.0/11.0			
Heating power	kW	3.6		7.2		10.8		21.6			
Heating cartridges		3		6		9		18			
Warm up period	min	< 15		< 25							
Coolant (minimum)											
▪ for the pump†	lh^{-1}	500		700				900			
▪ for the cold cap baffle	lh^{-1}	80									
Number of cooling circuits (including cold cap baffle)		2				3					
Coolant connection											

Parameter	Unit	nHT10 ANSI	nHT10 ISO	nHT16 ANSI	nHT16 ISO	nHT20 ANSI	nHT20 ISO	nHT32 ANSI	nHT32 ISO	nHT35 ANSI	nHT35 ISO
▪ Pump	G	3/8 inch		1/2 inch							
▪ Cold cap baffle	G	1/4 inch		3/8 inch							
Working range	mbar	$< 10^{-1}$ to 10^{-7}					$< 10^{-2}$ to 10^{-7}				
Ultimate total pressure§	mbar	$< 5 \times 10^{-7}$						$< 1 \times 10^{-6}$			
Maximum permissible backing pressure	mbar	5×10^{-1}									
Mains voltage‡	V	3 ~ 400 /N/PE									
depending on variant, 50/ 60 Hz	V	3 ~ 460 /N/PE									
Pump IP rating		IP20									
Terminal box# IP rating		IP65									

** Measured as per DIN 28 427 using Edwards 704 normal as the pump fluid.*

§ Measured as per DIN 28 427 using Edwards 704 normal as the pump fluid. When using Edwards 704 pump fluid and FPM (fluoroelastomer) gaskets, the pumps with water cooled baffles will achieve pressures below 1 x 10^{-7} mbar following suitable bake-out procedures.

‡ Mains voltage tolerance ± 10%

† The coolant water volume is referenced to ΔT = 10 K. The discharge temperature should not be more than 30 °C.

 # We recommend to connect an existing neutral conductor.

4.3 Ordering information

Table 2 Ordering information

Parameter	nHT10 ANSI	nHT10 ISO	nHT16 ANSI	nHT16 ISO	nHT20 ANSI	nHT20 ISO	nHT32 ANSI	nHT32 ISO	nHT35 ANSI	nHT35 ISO
400V/50/60Hz /3 ph PN/Y	B31130400	B31132400	B31230400	B31232400	B31430400	B31432400	B31630400	B31632400	B31530400	B31532400
460V/50/60Hz /3 ph PN/Y	B31130460	B31132460	B31230460	B31232460	B31430460	B31432460	B31630460	B31632460	B31530460	B31532460
Water flow monitor	500006623									
Thermostatic safety switch	12284									
Pump fluid	(See *Table: Pump fluid technical data*)									

4.4 Centre of gravity overview

Table 3 Centre of gravity

	Case size L x W x H (mm)	Gross/net weight (kg)	COG A, B, C (mm)
nHT10 ANSI/ISO	700 x 700 x 1000	123/95	291, 291, 450
nHT16 ANSI/ISO	1000 x 900 x 1300	198/152	416, 391,550
nHT20 ANSI/ISO	1210 x 1020 x 1574	340/230	462, 472, 770
nHT32 ANSI/ISO	1500 x 1800 x 2200	620/570	570,582,925
nHT35 ANSI/ISO	1500 x 1800 x 2200	660/610	570, 582,950

4.5 Pump fluids

Table 4 Pump fluid technical data

Parameter	Unit	Silicone oils	
		Edwards 704	Edwards 705
Vapour pressure at 25 °C	mbar	1.0×10^{-9}	2.0×10^{-11}
Boiling Temperature at 1.3 mbar	°C	215	245
Viscosity at 25 °C	cSt	37 - 42	168 - 185
Pour point	°C	-34	-14
Flash point	°C	> 210	> 243
Specific gravity at 25 °C		1.06 - 1.07	1.09 - 1.1

Table 5 Pump fluid ordering information

		Silicone oils	
		Edwards 704	Edwards 705
Pump fluid/oils	500 ml	H02400060	H02400070
	1 kg	H02400061	H02400071
	5 kg	H02400062	-

Table 6 Pump fluid characteristics

Oil type	Characteristics	nHT all sizes
Edwards 704	Silicone oil, exhibits extreme chemical, thermal, oxidation, hydrolysis and radiation resistance. It also has extremely low back-streaming properties.	Default
Edwards 705	Silicone oil, has an extremely low vapour pressure and back-streaming rate. It exhibits extreme chemical, thermal, oxidation, hydrolysis and radiation resistance.	Possible

5. Transport and storage

WARNING: HEAVY OBJECT

Loss of stability during transport.

Uncontrolled movement through incorrect fastening/raising/lifting of the pump system. Use all lifting eyes when moving the pump body. Be aware of the centre of gravity.

Transportation flanges (blank flanges) and claws may be used only for transportation purposes; they are not suitable for the assembly of the pumps in systems.

Uncontrolled movement through inertia of mobile pump systems (wheels/mobile frame). Mount and move mobile pumps with wheels only on flat, solid, horizontal surfaces.

Move pumps at slow speed.

The pump is shipped upright on a pallet and packed in a wooden crate. Refer to *Figure: Pump in the shipping case*. To unpack the pump, do the steps that follow:

- Remove the shipping documents from the pocket.
- Position the pallet on a flat and level surface.
- Remove the tightening straps.
- Loosen the upper part of the wooden crate and turn the brackets upward. Connect the lifting gear to the brackets and lift the wooden crate up and away.
- Remove the plastic wrap.
- The pump is now freely accessible on the pallet.
- Remove the desiccant bag.

The pump may be moved only when it is standing upright on a pallet or suspended by the lifting eyes. After unpacking the unit, examine the shipment for completeness and any possible shipping damage (Refer to *Supplied equipment* on page 15).

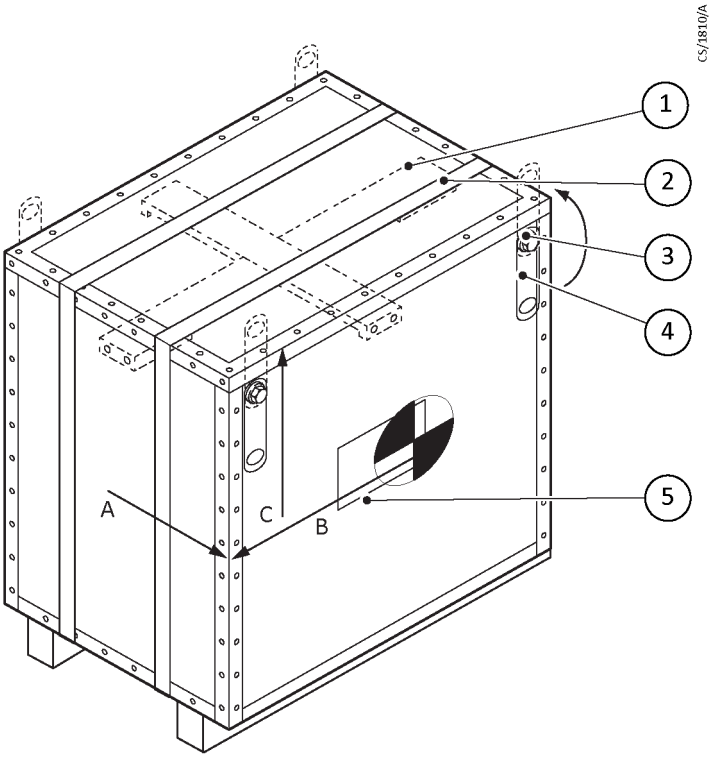
The pumps are shipped evacuated (for corrosion protection). Do not vent the pumps until just before installation.

To vent the pump, pull the closure plug out of the hose nozzle in the outlet shipping flange.

Note:

The ambient temperature range must not be greater than -20 °C to +70 °C during transport and storing.

Figure 12 nHT pump shipping case



1. Stabilising cross
2. Tightening straps
3. Hex-head bolts
4. Brackets
5. Pocket for shipping docs

5.1 Storage

Maintain the pump in storage so that it is dry and not exposed to frost. The cooling coils need to be blown out and must be dry.

Keep the pump in the upright position when stored.

6. Installation

The nHT series pumps are high vacuum pumps. They are always operated together with the backing pumps.

The pumps are used in high vacuum technology to evacuate vacuum chambers.

The pumps are not suitable for handling oxygen above normal atmospheric concentration. If you plan to use the pump with inflammable and explosive gases, please contact us in advance. The pumps are suitable for the pumping of gas mixtures containing oxygen concentrations of more than 21%.

The pumps are suitable for conveying of oxidative substances in combination with the suitable pump fluid.

The pump operating backing pressure is less than 5×10^{-1} mbar.

Ambient conditions

Ambient conditions for the pump must be within the following ranges:

- Temperature: 0 to 55 °C
- Humidity: < 85%
- Installation site altitude < 1500 metres (NHN)

The pumps should not be used to pump:

- Oxygen in concentrations of > 21%
- Radioactive substances
- Ignitable gas mixtures
- Pyrophoric gases
- Liquids
- Toxic gases according to GHS category I and II.

Consult us for permission, if you want to use the pump for the following:

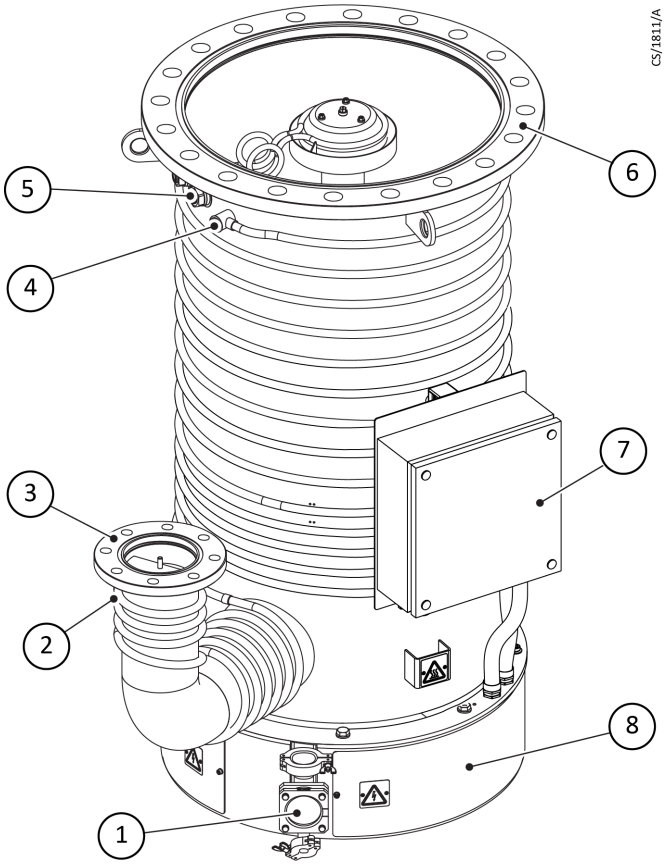
- Corrosive gases
- Toxic gases according to GHS category III and IV
- Oxidative gases

Risk of pump damage

1. When deviating too far from the vertical installation orientation (> 1°), there is a risk that the heating cartridges will run dry, thereby damaging the pump.
2. Switching the heating cartridge on and off repeatedly will result in its premature failure.
3. Missing or wrong connections for the safety thermostats can cause the pump to overheat or destroy the heating cartridges.
4. Connect the pump to prevent accidental operation after a monitoring component (thermostat, overheating protection switch, coolant flow monitor) has been tripped.
5. All the pump's interior surfaces must be carefully cleaned before filling the pump with a different oil compound.

6. The pump can be vented only after the pump fluid temperature has fallen to below 100 °C. Venting should be from the high vacuum side, into the cool pump.
7. The pressure of the steam cleaner can not be more than 4 bar when you clean the heat conducting fins of the heater cartridge. The pressure must not exceed 10 bar for the remainder of the pump.
8. The interior assembly should only be dismantled by trained personnel.
9. Do not use any chlorine based de-calcifier as this will damage the cooling coils due to crevice corrosion.
10. Only install dry heater cartridges. During longer storage periods the heater cartridges can absorb moisture due to the hygroscopic nature of the insulation materials used. In this case, the cartridges may be dried in a drying oven for 8 hours at 180 °C.
11. After longer system downtimes, slowly start the diffusion pump by a cyclic and gradual heat up.

Figure 13 Connection elements



1. Oil level sight glass with pump fluid fill and drain ports
2. Coolant outlet from pump
3. Outlet connection flange
4. Coolant inlet for pump
5. Coolant inlet and outlet for cold cap baffle
6. Inlet connection flange
7. Electrical terminal box
8. Heater cover plate

6.1 Inlet connection

The pumps are evacuated before shipment. Do not vent the pump until it is ready to be installed. To do so, open the closure plug at the outlet shipping flange. Remove the inlet shipping flange.

The pump must be standing flat and level or vertically suspended from the inlet connection flange when installed on the system.

Note:

When deviating too far from the vertical installation orientation (> 1°), there is the risk that the heating cartridges will run dry. If this happens, the pump will be damaged.

We recommend a clearance of 500 mm on top and around the pump to other system components as well as a ground clearance of 100 to 150 mm. This makes maintenance work on the pump's heating unit with the pump left in place in the system easier.

Make sure that the terminal box side is easily accessible and does not create a potentially dangerous situation for the operator.

Check to make sure that the centring ring, together with the O-ring and the outer ring are seated securely in the inlet flange. Refer to *Figure: Connection elements*.

Use suitable nuts and bolts, to fasten the nHT ANSI flange to the customer's plant. For nHT ISO use our claw clamps/half claw clamps, to join the ISO-K flange.

Note:

The shipping flange (blank flange) and claws may be used only for shipping purposes. They are not correct for mounting the pumps in systems.

To maintain uniform pressure and when working in pressure ranges of less than 10^{-6} mbar, we recommend the use of optional ISO sealing rings, instead of centring rings and O-rings, for all high vacuum connections.

In order to achieve maximum conductance at the high vacuum line use the largest possible nominal diameter pipework and keep it as short as possible.

The pump must be suspended vertically.

6.2 Backing connection

A backing pump system is required for pump operation. We recommend our E2M, nES, or GXS range of pumps in conjunction with roots booster pumps.

Remove the outlet shipping flange.

Connect the backing line with the centring ring, O-ring and outer ring at the outlet port. Refer to *Figure: Connection elements*.

Note:

The shipping flange (blank flange) and claws may be used only for shipping purposes. They are not correct for mounting the pumps in systems.

The diameter of the backing line should be at least as large as the outlet flange nominal diameter. The line should be as short as possible to achieve the maximum conductance value.

6.3 Coolant connection

CAUTION: EJECTION OF PARTS

Ejection of parts through implosion of a part of the pump or the pump system.

If the boiler overheats due to too little or no oil or too little cooling water flow, the boiler can implode.

The water cooling system cannot be interrupted in the case of a malfunction. Follow the installation regulations.

It is necessary to connect the coolant system before operating the pump.

Coolant pressure must not exceed 6 bar.

When the pump is connected to a closed coolant circuit, make sure that the coolant temperatures are within the recommended limit. We recommend coolant feed temperatures of between 15 °C and 20 °C. The coolant return temperature must not be greater than 30 °C at the outlet.

If it is not possible to keep the coolant discharge temperature below 30 °C, the back-streaming may occur. The discharge outlet temperature must not be greater than 55 °C at any time. Above 55 °C, the back-streaming will rise logarithmically and will reduce the pumping speed.

We recommend using conditioned water to avoid the formation of scale deposits (which will impair cooling performance).

The pumps have a number of coolant circuits which can be connected in series: Refer to *Figure: Connection elements*.

- Cold cap baffle: coolant inlet and outlet
- Pump: coolant inlet and coolant outlet

It is important that the coolant flows into the cold cap baffle first.

Note:

In case of an operational disruption, make sure that the water cooling remains functional.

Water quality

To make sure long trouble free operation, the cooling water must not contain any oils, greases and suspended solids. We recommend compliance with the following limit values:

Appearance	Clear, free of oils and greases
Suspended matter	< 250 mg/l
Particle size	< 150 µm
Electrical conductivity	< 700 µS/cm

pH value	7.0 to 9.0
Total hardness (total alkaline earth)	< 8 °dH
Aggressive carbon dioxide	None, not detectable
Chloride	< 100 mg/l
Sulphate	< 150 mg/l
Nitrate	≤ 50 mg/l
Iron	< 0.2 mg/l
Manganese	< 0.1 mg/l
Ammonium	< 1.0 mg/l
Free chlorine	< 0.2 mg/l
8 °dH (degrees German hardness)	= 1.4 mmol/l = 10 °e (degrees English hardness) = 14 °f (degrees French hardness)

If there is the danger of frost, you may use a water glycol mixture of up to 30%. Demineralised water can be used for cooling the pump, if the pH value is 7.0 to 9.0.

6.4 Electrical connection

Obey the safety instructions explained in *Electrical hazards* on page 9 when you do the electrical connections.

Grounding

The external grounding connection M6 is located to the left of the oil sight glass.

6.5 Connecting the heaters

WARNING: AUTOMATIC RESTART

Hazards that may occur through independent restart of a pump after a shut down due to an error.

Connect the pump in such a way that if a monitoring element is triggered (thermostat, thermal protective switch, water flow guard) it does not automatically restart after the inadmissible operating condition has ended.

General installation notes

There is a basic insulation between the mains supply and the temperature sensor (Pt100 heater cartridge's temperature). The operator has to provide suitable protection measures against indirect contact. For example, a temperature transmitter with electrical insulation between the input and output circuits.

On all nHT pumps, the heating cartridges are supplied wired in a "star" (Y) circuit. This means that they are pump-type dependent, supplied for connection to either a 400 V (±10%), 3-phase, 50/60 Hz, or a 460 V (±10%), 3-phase, 50/60 Hz power source. A 400 V pump can be re-configured to 230 V 3-phase 50/60 Hz operation by using the alternative Delta configuration shown in *Terminal box layouts* on page 35.

You must refer to *Table: Cable and fuse data* to select the wire and appropriate circuit breakers for installation.

Use a correct sized supply cable when making the connection. The parameters which affect include current load, ambient temperature, cable placement and type of cable and conductors. Follow the local regulations when sizing the connection cable.

We recommend to connect an existing neutral conductor. If the neutral conductor is not connected, there will be no symmetry if a heater cartridge malfunctions or fails. This can lead to an untimely destruction of the other heating cartridges.

Note:

The operator must check the impedance of the fault loop, and verify that the corresponding over-current protection device is sufficient. After installation, the required safety tests (for example, PE conductor test, among others) have to be carried out.

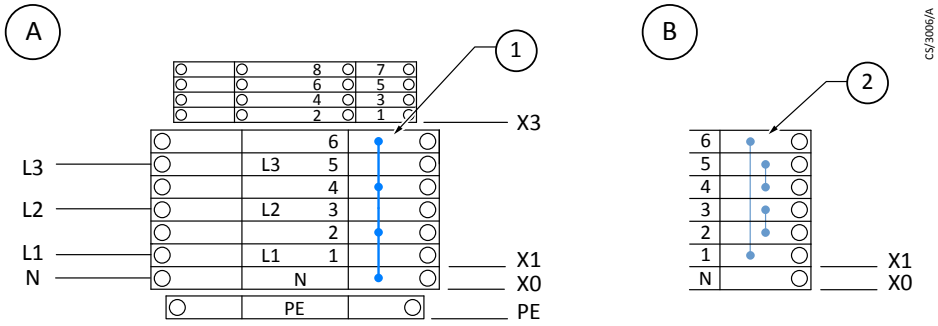
The PE conductor test must include its connection and any accessible part which require a protective connection. Use a test current of 10 A (effective value a.c. or d.c.) with a resulting impedance of < 0.1 Ω.

Table 7 Cable and fuse data

Pump	Star(Y) connection voltage ± 10%	Recommended fuse	Cable cross-section
nHT10	400 V, 3~, 50/60 Hz or 460 V, 3~, 50/60 Hz	10 A	4 mm^2 insulation type C
nHT16		20 A	
nHT20		25 A	
nHT32		50 A	
nHT35		50 A	

6.5.1 Terminal box layouts

Figure 14 nHT10 terminal box layout



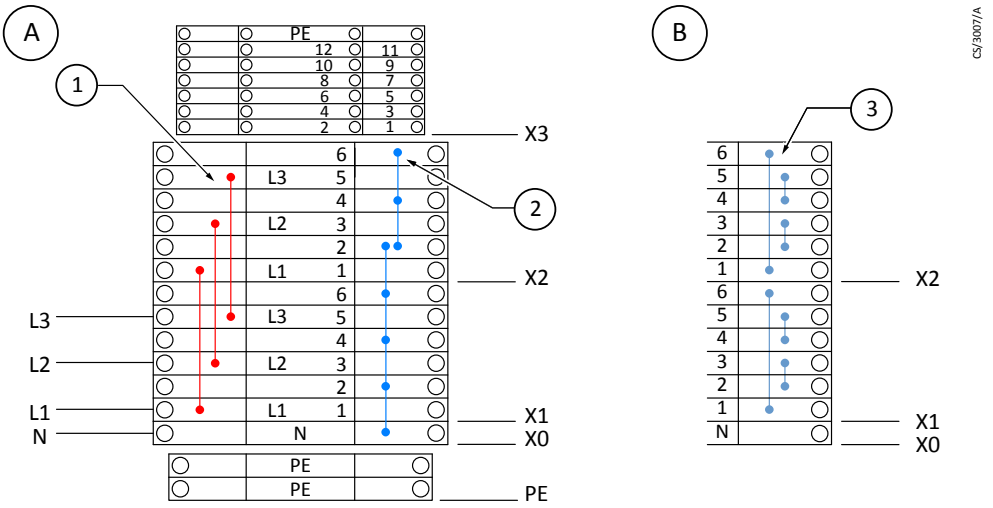
A. Standard Star configuration as supplied for either 400 V or 460 V, 3~, 50/60 Hz

B. Alternative Delta configuration for 400 V pump to give 230 V, 3~, 50/60 Hz

1. Blue power jumpers

2. Grey jumpers (supplied with terminal box)

Figure 15 nHT16 terminal box layout

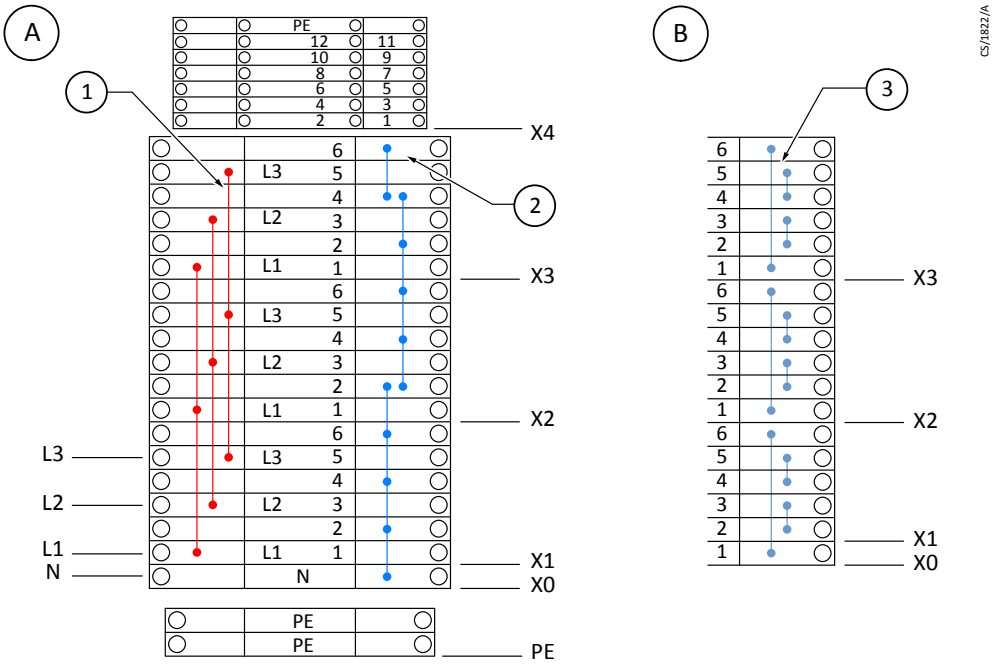


A. Standard Star configuration as supplied for either 400 V or 460 V, 3~, 50/60 Hz

B. Alternative Delta configuration for 400 V pump to give 230 V, 3~, 50/60 Hz

1. Red power jumpers
2. Blue jumpers
3. Grey jumpers (supplied with terminal box)

Figure 16 nHT20 terminal box layout

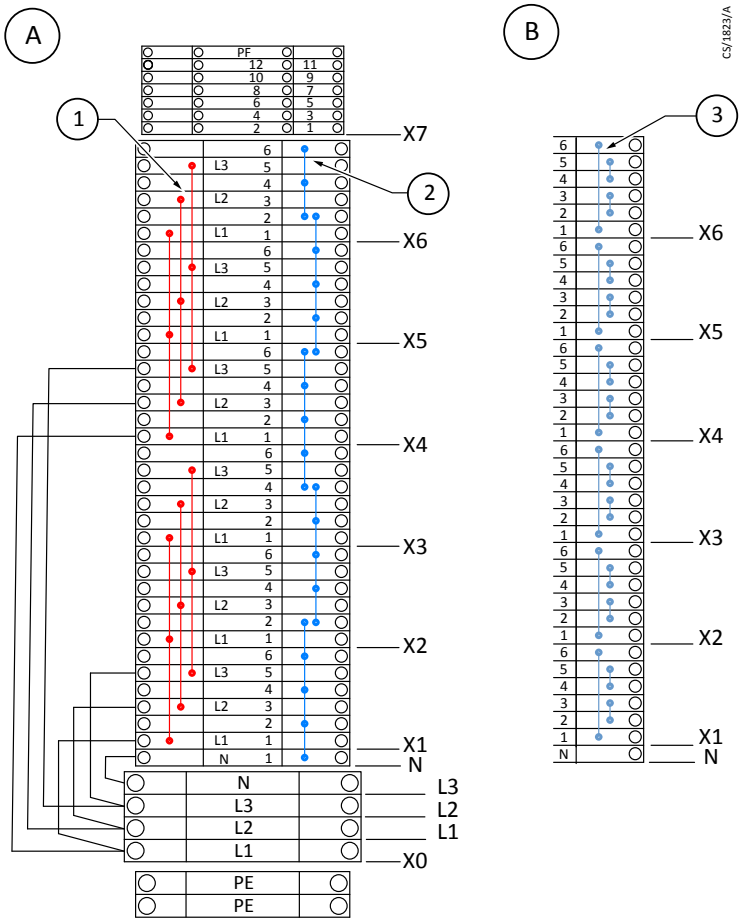


A. Standard Star configuration as supplied for either 400 V or 460 V, 3~, 50/60 Hz

B. Alternative Delta configuration for 400 V pump to give 230 V, 3~, 50/60 Hz

1. Red power jumpers
2. Blue jumpers
3. Grey jumpers (supplied with terminal box)

Figure 17 nHT32/35 terminal box layout



A. Standard Star configuration as supplied for either 400 V or 460 V, 3~, 50/60 Hz

B. Alternative Delta configuration for 400 V pump to give 230 V, 3~, 50/60 Hz

1. Red power jumpers
2. Blue jumpers
3. Grey jumpers (supplied with terminal box)

6.5.2 Thermal safety switch

One of the cartridge heaters is equipped with a thermal safety switch that causes a shut down if the temperature reaches 330 °C. The operator must make sure that the pump will be turned off automatically when reaching this point.

Electrical connection to the pump must be connected through a power relay of correct capacity (not included as standard equipment).

The control circuit for the relay coil must be connected with the switching contact for the thermal safety switch. The relay must isolate the pump from the power supply if unacceptably high temperatures are detected. Use terminals 1 and 2 at the switch for the connection.

Note:

Connect the thermal safety switch so that the pump cannot re-start spontaneously until the system has cooled down again, if tripped.

The pumps are also equipped with Pt 100 thermal sensors, to control the temperatures of oil and to control heater temperature for additional system monitoring.

Electrical connection to the thermal switch

To set up the protective interlock system, connect the switching contact for the thermal safety switch with the appropriate power circuit to control the relay coil.

Remove the cover of the electrical terminal box.

1. Pass the end of the supply line through the type PG threaded fitting.
2. Connect the conductors with the connector contacts at the thermal safety switch.
3. Attach the ground conductor in the supply lead to the central grounding point on the backing plate (PE bus).
4. Connect the supply line with the system control unit in order to make sure that this protective interlock is set-up correctly.

Note:

Missing or wrong connections for the thermal safety switch can cause the pump to overheat or untimely destroy the heating cartridges.

Connect the supply line to the electrical terminal box

1. Pass the end of the supply lead through the type PG threaded fitting.
2. Attach the ground and neutral conductors at the appropriate PE and N buses inside the terminal box.
3. Connect the neutral conductor only after determining that it can carry the required load.

   We recommend that you provide the pump connection with a neutral conductor, as the pump is supplied with a default Y wiring. If during operation a heater cartridge failure occurs, there will be phase shifting, possibly leading to accelerated failure of the other heater cartridges (leakage current).
4. Connect the hot conductor(s) (L1, L2 and L3) at the appropriate connection strips.
5. Tighten down the PG threaded fitting to activate the strain relief feature.
6. Install the cover on the electrical terminal box.
7. Do the corresponding electrical safety tests.

6.5.3 Connecting monitoring components (optional)

Cooling fail switch

We recommend installing a special thermostatic safety switch (B61003100) for monitoring the coolant temperature. A mounting plate is located on the coolant pipe. The switch contacts remain closed at temperatures below 50 °C during normal operations. If the temperature at the sensor rises above 50 °C (for example, in case of coolant circulation failure), then the contacts will open and shut down the pump heating by the use of a relay (customer supplied).

Connect one phase of the power supply relay through the thermal protection switch. Use four cap screws, M3 x 6 to mount the thermal protection switch.

Note:

Connect the pump so it will not start again spontaneously once a monitoring component (overheating protection switch, coolant flow monitor) has been tripped and the operating parameters have returned from unacceptable to normal status.

Coolant flow monitor

The optional coolant flow monitor (500006623) must be installed in the outlet port of the pump coolant circuit.

If coolant circulation fails, the flow monitor can, for example, be used to drive a relay which will turn off the pump heating, activate an alarm system or carry out another suitable switching function. The minimum coolant flow rates are given in *Technical data* on page 16.

6.6 Pump fluid

WARNING: OIL LEAKAGE

Hazard of slipping, tripping or falling due to oil leakage from the pump.

Depending on the work process, oil may escape from the pump.

Check the pump for any oil that has run out. Take appropriate safety measures.

Note:

The pump's interior surfaces must be carefully cleaned before filling the pump with a different oil compound (for example, from mineral oil to silicone oil).

The nHT pumps are shipped without pump fluid. We recommend to use either Edwards 704 or 705 silicone oil. These compounds are suitable because of their high thermal and chemical stability. Silicone oils are distinguished by their very low vapour pressure and great resistance to oxidation and decomposition.

Fill the pump fluid through the pump fluid fill port. Refer to *Figure: Oil level sight glass with pump fluid fill and drain ports*.

The quantities of fluid vary slightly due to the pump design. Refer to *Technical data* on page 16. Always fill in oil up to the maximum mark of the oil level sight glass.

Measure the quantity of pump fluid and pour into the pump oil fill port. When filling the pump for the first time or when filling it after cleaning, we recommend filling the pump to its maximum mark.

After filling the pump, wait a few minutes for the pump fluid to settle and then check the oil level through the oil level sight glass. Refer to *Figure: Check the pump fluid level*.

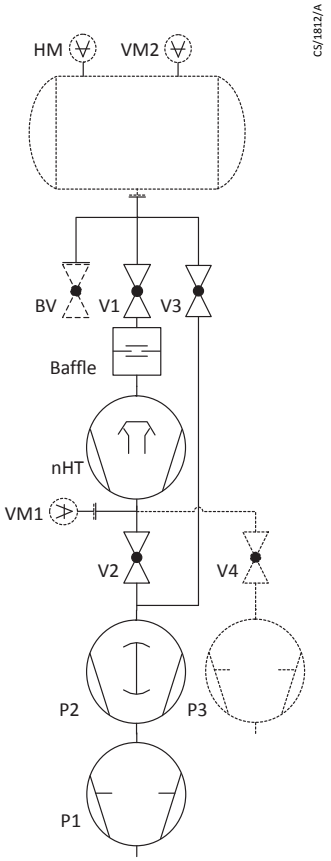
Always make sure that the oil level is at the maximum mark of the level indicator during pump operation.

If you operate the pump for long periods with a low oil level (at or below the minimum mark) it will cause problems with replacing the heater cartridges and damage to the pump.

Note:

There is a risk of slipping if oil leaks from the pump during fill/drain or heater replacement. Remove and dispose of any leaked oil.

Figure 18 Schematic for a diffusion-type vacuum pump system



nHT	Diffusion pump with cold cap baffle
P1	Rotary vane vacuum pump
P2	Roots vacuum pump
P3	Rotary vane vacuum pump (optional as holding pump)
V1	High vacuum valve
V2	Backing valve
V3	Roughing valve
V4	Backing valve (optional for holding pump)
Baffle	Inlet baffle
BV	Air admittance valve
HM	High vacuum measurement point
VM1	Fore vacuum measurement point
VM2	Fore vacuum measurement point (vacuum chamber customer)

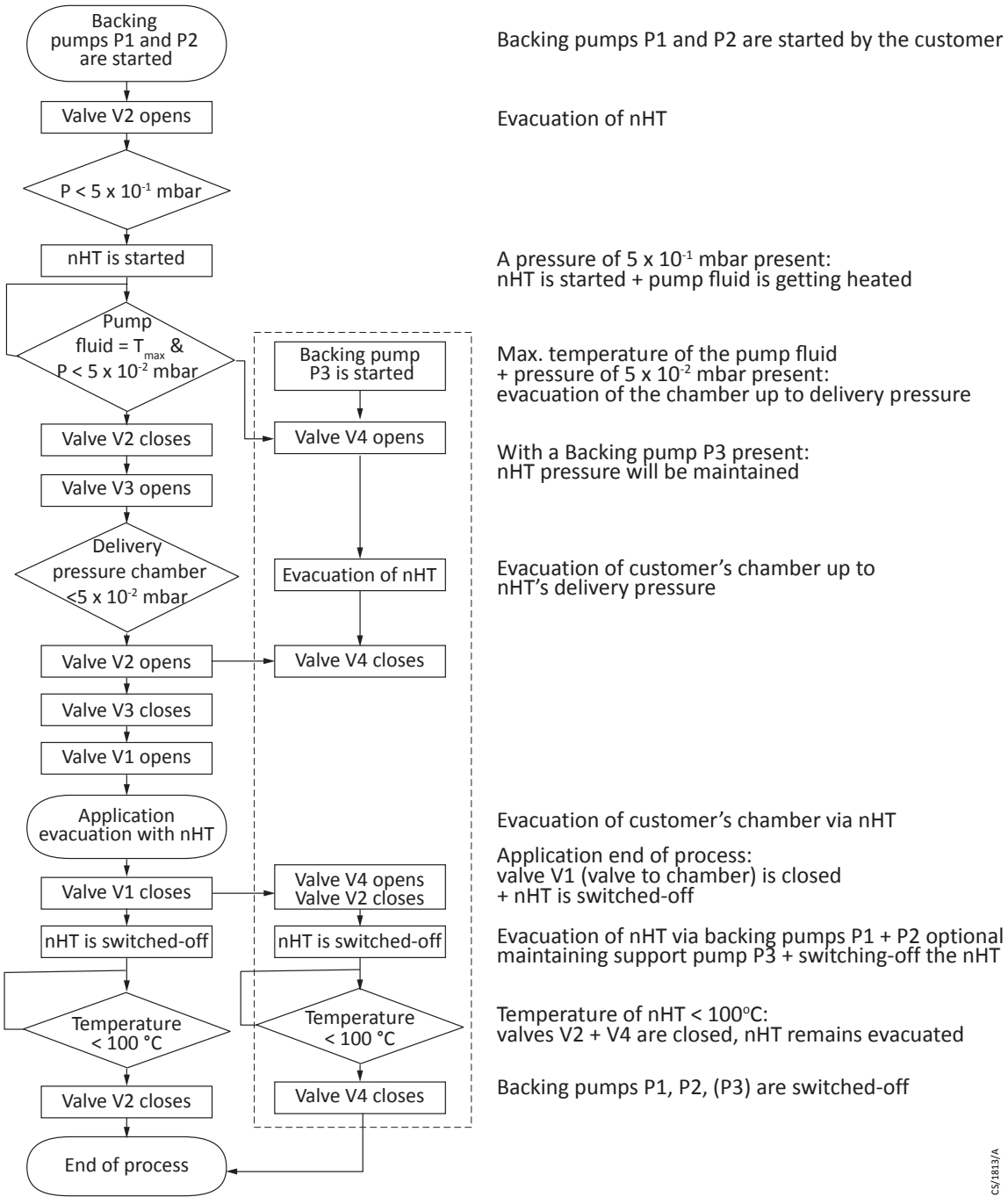
7. Operation

7.1 Media compatibility

The pump is not suitable for handling oxygen above normal atmospheric concentration.

Consult us before specifying pumps for use with high hydrogen content. Refer to *Installation* on page 30.

Figure 19 Commission and operation schematic



7.2 Start-up

WARNING: HAZARDOUS GASES OR VAPOURS

Danger through expulsion of transported toxic gases or vapours. Fire or explosion in case of transport or ejection of flammable gases, vapours, oxidising agents or pyrophoric gases.

Transported process gases can escape from the exhaust pipe and leaking areas of the vacuum system.

Transport of toxic gases or vapours, flammable gases or vapours, oxidising agents or pyrophoric gases is not permitted.

The standard pump system is not suitable for operation in EX zones.

The operator is responsible for the assessment of the hazard potential of the process media and/or mixtures. For this purpose, the operator must perform a risk or hazard assessment. The operator must take appropriate measures to make sure that there is no danger to people or environment.

Do not use any flammable materials in the area around a hot pump.

WARNING: HARMFUL GASES OR VAPOURS

Hazards through emission of harmful gases/vapours.

During the start-up and new installation of the heater cartridge, smoke and an unpleasant smell may develop. Therefore, turn on new and serviced pumps in well ventilated areas. Avoid direct contact with the smoke or gases that can develop during start-up.

Backing/roughing line

We recommend to connect the vacuum chamber directly to the backing pump via a valve V3 and a roughing line. A high vacuum valve V1 and a backing valve V2 are required for correct functioning of the roughing line.

The vacuum chamber is evacuated down to the transfer pressure via the roughing line. The diffusion pump and pump fluid will operate normally when the high vacuum valve V1 is opened. Close the backing valve V2 and the high vacuum valve V1 before venting the vacuum chamber. The diffusion pump will be ready for operation.

High vacuum valve

The high vacuum valve in its closed state must provide a reliable seal. If it leaks, then large quantities of gas will be pumped through the pump. This will result in premature ageing of the oil and significant increase in oil loss.

Make sure that the high vacuum valve is opened slowly to reduce flow disturbances within the pump as well as oil loss.

Note:

Check the heater cartridges after long periods of system downtimes (after one year at the latest) or if the pump is in storage.

7.3 Operate

WARNING: EJECTION OF PARTS

Ejection of parts through bursting of the vacuum system due to excessive pressure, caused by errors like malfunction at the gas inlet into the vacuum system.

When venting the pump at > 100 °C there is a danger of explosion. The pump must be securely anchored during operation.

The pump can be vented only if the pump fluid temperature is < 100 °C.

Reverse venting must be ruled out. The cooled pump should be vented from the high vacuum side.

Turn off the cooling water supply after the pump has cooled down to < 100 °C.

The pump operation with closed high vacuum and backing line and simultaneously switched off cooling water supply is a dangerous condition and must be prevented (for example, by an interlock circuit).

WARNING: EXPOSURE TO VACUUM

Do not operate the pump system with opened intake and/or outlet port.

During installation, connect the system mechanically via the inlets and outlets first. Only then make the electrical connections.

WARNING: BOILER OVERHEAT

Ejection of parts through implosion of a part of the pump or the pump system.

If the boiler overheats due to too little or no oil or too little cooling water flow, the boiler can implode.

The water cooling system cannot be interrupted in the case of a malfunction. Observe the installation regulations.

WARNING: HOT SURFACE

Burns from touching hot surfaces.

Burning of fingers, hands, arms on hot surfaces up to +140 °C. Hazard of burns with open covers.

Handle the pump only in ventilated and cooled down condition. Wear suitable protective equipment. Take note of the cooling time after turning off.

Note:

Operate the pump only in the installed condition. During operation, pumps must not be opened or vented.

1. The operator must conduct process dependent considerations regarding risks with the general starting and stopping, operation, and automatic restarts after system power failures.

2. Switch on the backing pump and evacuate the pump down to a pressure < 5 x 10^{-2} mbar.
3. Open the coolant supply valve.
4. Switch on the pump heaters. The pump will begin functioning after sometime.
5. Open the high vacuum valve (if installed) between the diffusion pump and the vacuum chamber when the pump is hot and after the pressure in the vacuum chamber is below 5 x 10^{-2} mbar.
6. When inlet and backing line temperatures are above the maximum permissible levels, it is possible for pump fluid to pass into other parts of the vacuum system.

We recommend to monitor the the high vacuum and backing pressures. Coolant flow and temperature, and the quantity and temperature of the pump fluid, can be monitored when the pump is in operation.

Where there is an unacceptable rise in oil temperature caused, for instance, by failure of the coolant circuit, the built-in thermal switch will turn off the heating cartridges at the pump. If you have optionally installed a cooling fail thermal safety switch to monitor the coolant temperature or a coolant flow monitor, these will also turn off the pump heaters.

7.3.1 Air inrush

WARNING: OPERATIONAL SAFETY

The pump fluid is no longer heated in case of failure of the power supply. There is no risk from the pump. The pump fluid cools down. The risk of the entire system cannot be assessed. In the worst case, the system will be vented rearward and can explode.

The valves must be closed in the event of a power failure.

Do not admit air into an operation ready, warm, diffusion pump.

If electro-pneumatically actuated high vacuum and backing valves are used, these must be normally closed in the “de-energised” and “unpressurised” condition. Also, for these valves, the ventilation of a ready-to-operate, hot diffusion pump must be ruled out through appropriate latch circuits.

The components must be connected correctly. Electrical safety examinations, in particular the insulation and protective grounding conductor examination, must be done.

We recommend to interlock the high vacuum valve V1 and the backing valve V2 to prevent venting the hot diffusion pump when it is ready for operation.

7.3.2 Regular checks

To make sure trouble-free operation of the pump, we recommend the following periodic checks:

Check	Interval	Action	Section
Pump fluid filling level	1 week	If required, top up oil using the same oil grade.	*Check the pump fluid level* on page 48 *Top-up pump fluid* on page 49
Pump fluid condition	1 month	If required, change the oil.	*Exchange the pump fluid* on page 51
Nozzle assembly cleaning	1 year	Use suitable solvents, for example, soap-impregnated stainless-steel wool, petroleum, ether or acetone. Final cleaning with alcohol.	*Clean the pump* on page 51
Cleaning of the heat conducting fins on the heater cartridges	1 year	Use a commercial high pressure cleaner, 4 bar maximum pressure.	*Clean the pump* on page 51
Cooling water flow	1 year	If required, clean the cooling coils.	*Clean the cooling coils* on page 53

7.4 Turn off/shut down

WARNING: EXCESSIVE PRESSURE

Ejection of parts through bursting of the vacuum system due to excessive pressure, caused by errors like malfunction at the gas inlet into the vacuum system.

When venting the pump at > 100 °C, there is a danger of explosion. The pump must be securely anchored during operation.

The pump may be vented only if the pump fluid temperature is < 100 °C.

Reverse venting must be ruled out. The cooled pump should be vented from the high vacuum side.

Turn off the cooling water supply after the pump has cooled down to < 100 °C.

The pump operation with closed high vacuum and fore vacuum side and simultaneously switched off cooling water supply is a dangerous condition and must be prevented (for example, by an interlock circuit).

WARNING: HOT SURFACE

Scalding by touching hot equipment or lubricants.

Risk of scalding when opening the hot pump through pump fluid steam.

Only open fluid drain port or inlet port if the pump is vented and is cooled down to room temperature.

Let cooling water pipes cool down before removing and then shut off the feed line. Wear suitable protective equipment.

To shut down the pump, do the steps that follow:

1. Close the high vacuum valve V1.
2. Turn off the pump heating and wait until the pump has cooled down sufficiently (< 100 °C).
3. Close the backing valve V2.
4. Shut off the coolant supply.
5. Shut off and vent the backing pump.

7.5 Disconnect the pump from the system

WARNING: DANGEROUS GASES OR VAPOURS

Danger as a result of contact with toxic decay/reaction products of lubricants, equipment or pumped substances during the maintenance of the pump.

There may be deposits in the pump during servicing. The pumping of toxic gases and vapours is prohibited.

The operator is responsible for the assessment of the hazard potential of the process media and/or mixtures. For this purpose, the operator must perform a risk or hazard assessment. The operator must take appropriate measures to make sure that there is no danger to people and/or the environment.

For this purpose, we recommend that the pump is flushed for a longer time with inert gas before opening. Wear appropriate protective clothing (gloves, goggles, respiratory protection, personal protective equipment).

Avoid body contact with plant oil, process residues and contaminated surfaces. Perform maintenance in clean, dry and well ventilated rooms.

Vacuum pumps which are operated with Perflouropolyether (PFPE) fluid can in the case of thermal decomposition release toxic and corrosive gases.

Wear appropriate protective clothing (gloves, goggles, respiratory protection, personal protective equipment).

To disconnect the pump from the system, do the steps that follow:

1. Turn off and vent the pump as described in *Turn off/shut down* on page 45.
2. Isolate the pump from the power supply and remove the electrical connection terminals.
3. Disconnect the coolant system and use compressed air to blow out the piping network.

4. Separate the pump inlet and outlet flanges from the system and remove the pump. Use all lifting eyes when you move the pump.
5. Open the pump fluid drain ports and drain the pump fluid into a suitable container.

Note:

Dispose of the pump fluid correctly (may possibly have to be handled as toxic waste).

6. Pack the pump so that it cannot be damaged during shipment. Protect the flanges and the coolant connections.
7. Follow the precautions described in *Service* on page 76 , if you return a pump to us.

An electrical safety test EN 60204 must be done if the pump or electrical parts were replaced. The compliance with the corresponding technical documents (PE conductor continuity, functional tests) must be checked.

8. Maintenance

WARNING: DANGEROUS GASES OR VAPOURS

Danger as a result of contact with toxic decay/reaction products of lubricants, equipment or pumped substances during the maintenance of the pump.

There may be deposits in the pump during servicing. The pumping of toxic gases and vapours is prohibited.

The operator is responsible for the assessment of the hazard potential of the process media and/or mixtures. For this purpose, the operator must perform a risk or hazard assessment. The operator must take appropriate measures to make sure that there is no danger to people and/or the environment.

For this purpose, we recommend that the pump is flushed for a longer time with inert gas before opening. Wear appropriate protective clothing (gloves, goggles, respiratory protection, personal protective equipment).

Avoid body contact with plant oil, process residues and contaminated surfaces. Perform maintenance in clean, dry and well ventilated rooms.

Vacuum pumps which are operated with Perflouropolyether (PFPE) fluid can in the case of thermal decomposition release toxic and corrosive gases.

Wear appropriate protective clothing (gloves, goggles, respiratory protection, personal protective equipment).

WARNING: HAZARDOUS VOLTAGES

Electric shock through direct or indirect contact of live parts.

There are hazardous voltages present on the mains cables (danger to life).

Before you do maintenance or service work on the product, isolate the mains power supply. After the mains power is off, wait for 5 minutes.

8.1 Check the pump fluid level

The fluid fill level can be observed through the sight glass on the pump. There are markings for minimum and maximum levels. When the pump is running, the fill level should be at the maximum mark of the sight glass (slightly oscillating). Operating the pump for longer periods with lower oil levels (at or below the minimum mark) will lead to overheating resulting in premature failures of and problems with replacing heater cartridges.

Cold and vented pump

The oil fill level can only be accurately checked when the pump is cold and vented. In order to correctly determine the oil level, read the sight glass at eye level.

The fill level will fluctuate hardly at all during normal operation. There may be differences depending on the oil used. If the pump has to be vented frequently or is operated with a vacuum chamber that is vented regularly (batch operation), then we recommend keeping the fluid at the maximum level.

Loss of pump fluid

If the heated pump fluid lowers rapidly and falls below the expected fill level (*Figure: Oil level sight glass with pump fluid fill and drain ports*), the oil return path is blocked and the pump must be cleaned. If during operation the pump loses oil too quickly, check the velocity of the high vacuum valve. A gas throughput being too high or a gas inrush may be possible other causes (leakages).

8.2 Top-up pump fluid

WARNING: EXCESSIVE PRESSURE

Ejection of parts through bursting of the vacuum system due to excessive pressure, caused by malfunction at the gas inlet into the vacuum system.

When venting the pump at > 100 °C, there is a danger of explosion. The pump must be securely anchored during operation.

WARNING: HOT SURFACE

Risk of scalding when opening the hot pump through pump fluid steam.

Only open the fluid drain port or the inlet port if the pump is vented and is cooled down to room temperature.

Let cooling water pipes cool down before removing and then shut off the feed line. Wear suitable protective equipment.

WARNING: OIL LEAKAGE

Hazard of slipping, tripping or falling due to oil leakage from the pump.

Depending on the work process, oil may escape from the pump.

Check the pump for any oil that has leaked. Take appropriate security measures.

The pump may be vented only if the pump fluid temperature is less than 100 °C.

The cooled pump should be vented from the high vacuum side, not from the backing line. Turn off the cooling water supply only after the pump has cooled down to < 100 °C.

If an operating pump is isolated with a closed high vacuum and backing valves, then simultaneously switching off the cooling water supply is a dangerous condition and must be reliably ruled out (for example, by an interlocking circuit).

1. Switch the pump off, wait for it to cool down and vent it. Refer to *Turn off/shut down* on page 45.
2. Read off the filling level at eye level. Be sure to use the same grade of pump fluid.
3. Open the fluid fill port and fill in the pump fluid ensuring not to fill over the maximum mark.
4. We recommend that you replace the fluid fill port seal.
5. Close the fluid fill port.

Figure 20 Checking the level of the pump fluid

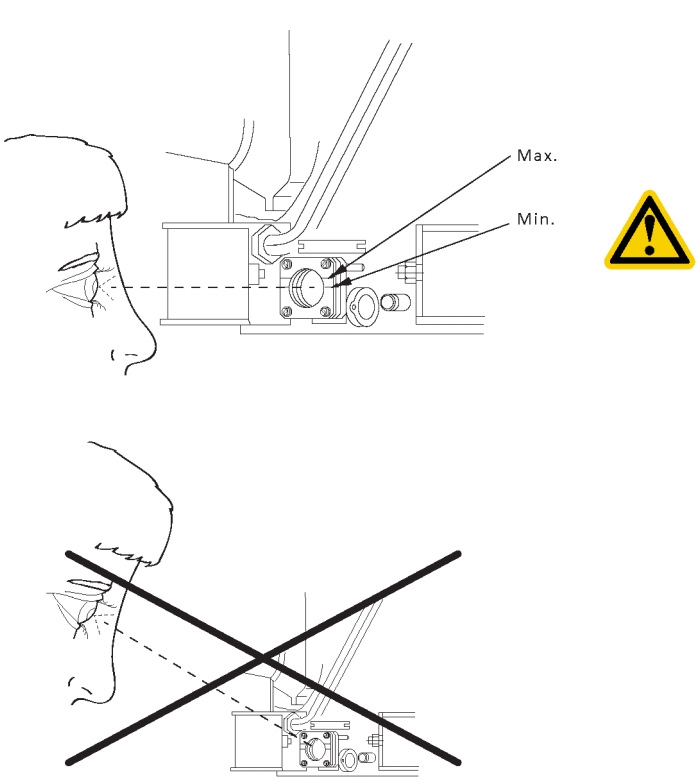
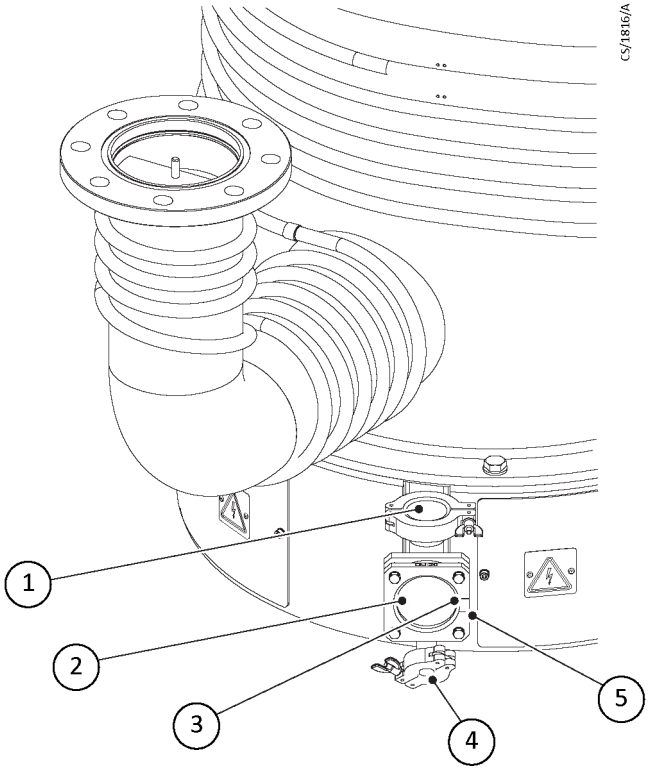


Figure 21 Oil level sight glass with pump fluid inlet and outlet ports



1. Pump fluid fill port
2. Oil fill level sight glass
3. Maximum mark
4. Pump fluid drain port
5. Minimum mark

8.3 Exchange the pump fluid

Unused pump fluid (mineral and silicone oil) is as translucent and clear as water. Exchange the pump fluid when it changes its colour to honey-yellow.

1. Turn the pump off and wait for it to cool down and then vent the pump.
2. Open the drain port and drain the pump fluid into an appropriate container. Leave the drain port open for at least 30 minutes to make sure as much pump fluid as possible can drain out.
3. Each time the pump fluid is exchanged, you must replace the gaskets at the fill port and the drain port (see *Figure: General view*).
4. Close the drain port.
5. Open the fluid fill port and add pump fluid. Refer to *Technical data* on page 16 for the required quantity of fluid.
6. Measure the quantity of pump fluid and pour into the pump. When filling the pump for the first time or when filling it after cleaning, we recommend always to fill the pump to its maximum level.
7. After the pump fluid is added, wait a few minutes for the pump fluid to settle and then observe the oil level through the oil level sight glass. In order to correctly determine the oil level, view at eye level.
8. Close the fluid fill port.
9. There is a risk of slipping if oil spills when topping-up. Clean up the affected areas and correctly dispose the oil. Refer to *Disposing of used fluid* on page 58.

8.4 Clean the pump

The inner surfaces of the pump must be cleaned at least once in a year or if switching to a different grade of pump fluid.

Dismantle the pump

1. Disconnect the power supply and coolant circuit (refer to *Turn off/shut down* on page 45).
2. Open the pump fluid drain port and allow the pump fluid to drain.
3. Separate the pump outlet and high vacuum flanges from the system. Remove the cold cap baffle.
4. Remove the nut and washer. Unscrew the mounting bolt. Carefully lift and remove the cold cap baffle from the pump housing.
5. Loosen the connection ports by tapping lightly with a rubber hammer or wooden mallet.
6. When removing the baffle, carefully remove the two insulating washers and the spacer.
7. Unscrew the cap, loosen the nut of the main axis, and lift out the interior assembly.
8. Grasp the interior assembly at the first stage and lift it out of the pump body.

Clean the pump

The interior assembly and the inner parts of the pump may be cleaned with a commercial steam cleaner.

Stubborn dirt (burnt-in residues of the pump fluid) may be removed with an acceptable solvent or with fine grain detergents or fine emery paper.

Place the pump at a slight angle (make sure that it cannot topple over) so that the cleaning fluid can run out. At the end of the cleaning process, dry all inner surfaces with a commercial hot air fan.

Note:

The pressure of the steam cleaner must not be more than 4 bar when you clean the heat conducting fins of the heater cartridge (risk of breaking the copper lamellae). The pressure must not exceed 10 bar for the remainder of the pump.

Oil level sight glass

Remove the screws at the flange mount to remove the oil level sight glass.

We recommend replacing the two O-rings in front of and behind the sight glass during assembly.

Make sure the sight glass bezel marking is in the correct position. The line indicating the upper level for the pump fluid must be located above the middle of the oil level sight glass. The marking lines are located on the right side of the oil glass frame. The bezel is marked with a number that has to be readable above the oil glass.

Note:

Do not swap bezels of different pumps, as pumps may be configured for individual filling levels. If arrows are present on the bezel, it must point downwards.

Assemble the pump

Note:

The interior assembly should only be dismantled by trained technician. Please contact us if you notice defects on the interior assembly. A deformed interior assembly is an indicator for serious air ingress during pump operation.

When you assemble the pump, make sure that the individual components are mounted in the correct order (Refer *Figure: Overall view of the nHT20 ANSI*).

1. Install the interior assembly centred in the pump housing. Check to make sure that it is seated in the centre of the pump body.
2. Make sure that the interior assembly locates correctly with the ejector stage nozzle in line with the axis of the backing arm.
3. Mount the cold cap baffle. Make sure of correct seating of the gasket rings for the coolant liquid port.
4. Make sure of correct positioning of the two insulating washers and the spacer between the cold cap baffle and the nozzle assembly.
5. Close the pump fluid drain port and reinstall the pump in the system. Do a leak test.

Note:

Make sure of correct positioning, properties and cleanliness for all gaskets. Only use new heat resistant gaskets (FPM/FKM, Silicone).

Add new pump fluid through the fluid filling port. Refer to *Technical data* on page 16, for specifications on the amount of pump fluid required.

8.5 Clean the cooling coils

Clean the cooling coils with a commercial decalcifier based on formic acid or ethanol acid.

Note:

Do not use any chlorine based decalcifier as this will damage the cooling coils due to crevice corrosion.

8.6 Replace the heating cartridges

WARNING: MOISTURE ABSORPTION

High electrical fault currents due to moisture absorption by mineral insulating material of the heating elements.

The hygroscopic insulation of the heating element could lead to a burn-out of the heater cartridge. Risk occurs through longer shut-off cycles and humid ambient conditions.

Take note of the installation instructions for the replacement and connection of the heater cartridge.

Check stock before changing/inserting (measured value: 49 to 55 Ω) and degas if necessary. If unused, check heater cartridge after one year.

WARNING: DANGEROUS GASES OR VAPOUR

Hazards through emission of harmful gases and/or vapour.

During the start-up and the new installation of the heater cartridge, smoke and an unpleasant smell may develop. Therefore, turn on new pumps and heating cartridge serviced pumps in well ventilated areas. Avoid direct contact with the smoke or gases that can develop during start-up.

Note:

Only install heater cartridges which are dry.

The heating cartridges contain magnesium oxide (MgO) and thus attract moisture. Keep the replacement heater cartridges in dry rooms only or in air-tight sealed plastic bags. If the heater cartridges have absorbed moisture, they may be dried in a drying oven for 8 hours at 180 °C.

Check the heater cartridges annually (metered resistance: 49 to 55 Ω). Depending on the load, we recommend to un-install the heater cartridges and apply never seize spray onto

the gasket faces on an annual basis. This preventative measure facilitates exchanging cartridges if replacement is required.

1. Turn off the pump in preparation for replacing the heating cartridge.
2. Prevent reconnection (lockout/tagout).
3. Drain the oil from the pump.
4. Remove the heater cover panels at the base of the pump by loosening the screws.
5. Disconnect the leads for the defective heater cartridge.
6. Remove the four heater cartridge mounting screws (M6 x 16).
7. Pull out the heater cartridge.
8. Check the sealing surfaces for damage and dirt or contaminations and remove the old gasket.
9. Insert the new heater cartridge with its new gasket and tighten the fixing flange (12 Nm).
10. Reconnect the heater electrical connections.
11. Fill the pump fluid according to the quantity given in *Technical data* on page 16.

Before recommissioning the pump, do an electrical safety check.

9. Fault finding

To achieve the ultimate total pressure specified in *Technical data* on page 16, make sure that

- the chamber must be leak-tight and if possible, baked-out. The interior surfaces must be clean.
- the out gassing of sealing elements used in the unit must be minimum. You can prefer to use FPM gaskets instead of NBR or silicone sealing rings. If very low working pressure is required, install metal seals.

If the desired ultimate pressure is not achieved even after the conditions are met, then the pump can be defective.

Fault	**Insufficient pump fluid**
Cause	**Heating units turn off and on with pump fluid level that is not sufficient.**
Remedy	Top up the pump fluid.
Fault	**Pump fluid contaminated**
Cause	**Pump fluid has decomposed as a result of frequent air ingress or there are contaminants originating from the process.**
Remedy	Clean the pump. Replace the pump fluid.
Fault	**Pump fluid crystallises (silicone oil)**
Cause	**Incorrect cleaning agents have been used.**
Remedy	Do not use acetone, benzole or acetic acid as cleaning agents. If there is no other option, wash with alcohol and clean pump afterwards.
Cause	**Process or product waste (PVC plasticizers) or high oxygen environment.**
Remedy	Clean the pump. Replace the pump fluid.
Fault	**Pump fluid vanishes after heating up**
Cause	**Internal oil return path blocked.**
Remedy	Clean the oil return path.
Fault	**Heater output not correct**
Cause	**Line voltage too low or defective heating cartridge.**
Remedy	Replace the defective heating cartridge.
Fault	**Insufficient cooling, pump runs too hot**
Cause	**Coolant circuits connected incorrectly.**
Remedy	Connect the coolant circuits as described in *Coolant connection* on page 33.
Cause	**Insufficient coolant pressure.**

Remedy	Raise the coolant pressure to a maximum of 6 bar.
Cause	**Clogged lines, scale deposits**
Remedy	Clean the lines, run water through the system in the reverse direction.
	Do not use any de-scaling products containing chlorine compounds. Use commercially available products based on formic or acetic acid.
Fault	**Pump does not get full pumping speed nor satisfactory ultimate pressure.**
Cause	**Nozzle assembly not correctly mounted.**
Remedy	Remove and clean the nozzle assembly and then carefully reinstall (refer to *Clean the pump* on page 51). Make sure that the nozzle assembly is centred in the pump.
Cause	**Insufficient backing pressure.**
Remedy	Examine the backing line for potential leaks and seal where needed. Make sure the required backing pressure upline from the diffusion pump is correct.
Cause	**Device leaking or soiled.**
Remedy	Use a leak tester to check the apparatus; clean thoroughly, dry and bake out if indicated.
Cause	**Oil contaminated or aged.**
Remedy	Change the oil.
Cause	**Pump is not suspended vertically/standing flat and level.**
Remedy	Connect the pump correctly.
Fault	**High pump fluid loss**
Cause	**Gas throughput too high.**
Remedy	Check the process.
Cause	**High vacuum valve leaky.**
Remedy	Clean or repair the valve.

10. Storage

Store the pump so that it is dry and not exposed to frost. The cold cap coils, cooling coils, and any connecting pipework need to be blown out with compressed air and must be dry.

Store the pump in an upright position. When storing the pump for longer periods or in environments with high humidity, enclose the pump in a foil bag, including a desiccant bag, to protect it against corrosion and ageing of the heater cartridges.

11. Waste disposal

WARNING: TOXIC SUBSTANCES

Danger as a result of contact with toxic decay/reaction products of lubricants, equipment or pumped substances during the maintenance of the pump.

There may be deposits in the pump during servicing. The pumping of toxic gases and vapours is prohibited.

The operator is responsible for the assessment of the hazard potential of the process media and/or mixtures. For this purpose, the operator must perform a risk or hazard assessment. The operator must take appropriate measures to make sure that there is no danger to people and/or the environment.

For this purpose, we recommend that the pump is flushed for a longer time with inert gas before opening. Wear appropriate protective clothing (gloves, goggles, respiratory protection, personal protective equipment).

Avoid body contact with plant oil, process residues and contaminated surfaces. Perform maintenance in clean, dry and well ventilated rooms.

Vacuum pumps which are operated with Perflouropolyether (PFPE) fluid can in the case of thermal decomposition release toxic and corrosive gases.

Wear appropriate protective clothing (gloves, goggles, respiratory protection, personal protective equipment).

The equipment may have been contaminated by the process or environmental influences. In this case the equipment must be decontaminated in accordance with the relevant regulations.

Separate clean components according to their materials and dispose of correctly.

11.1 Disposing of used fluid

The owner of used fluid is responsible for its correct disposal.

Used fluid from vacuum pumps may not be mixed with other substances.

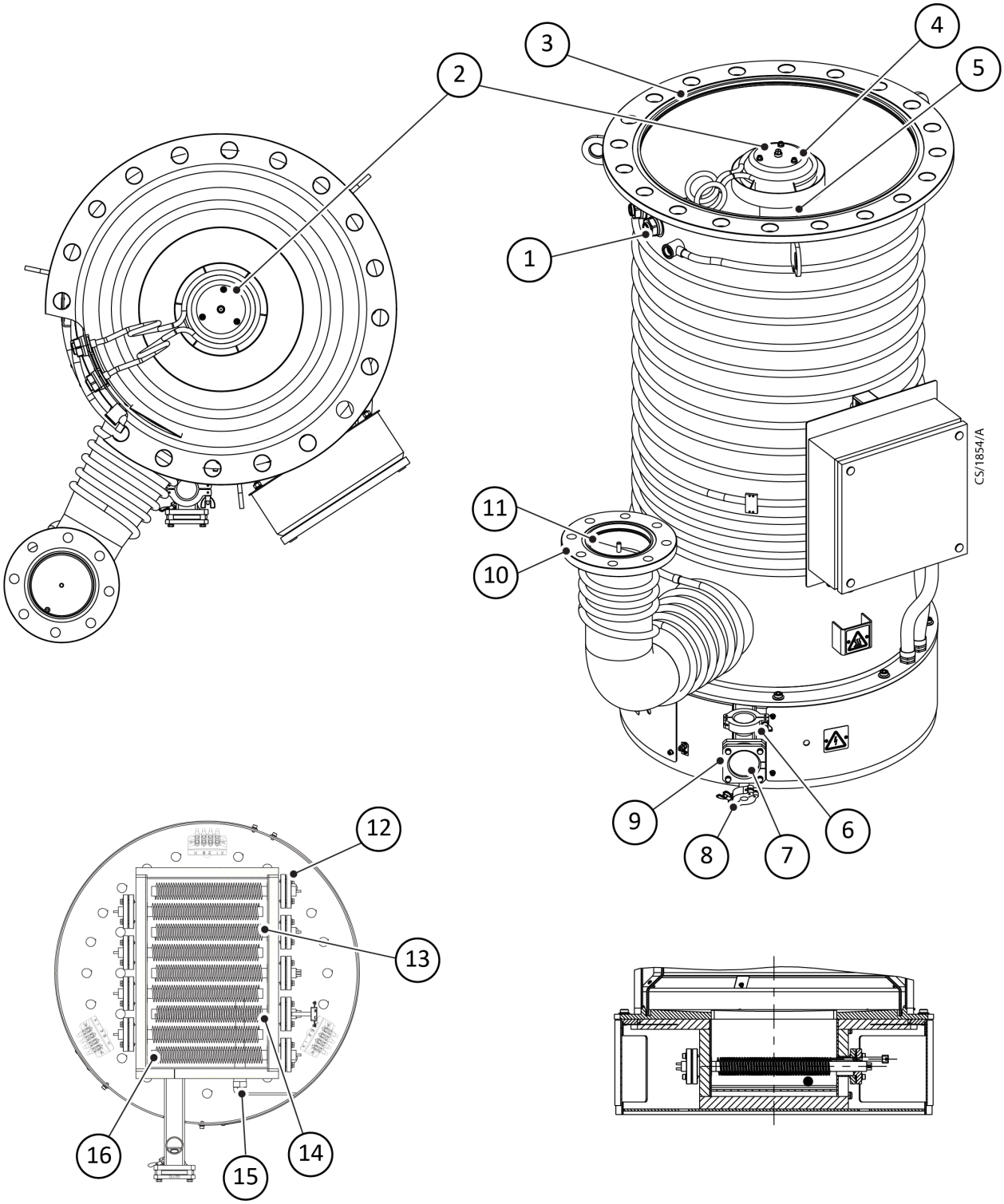
Used fluids from vacuum pumps which are contaminated only as a result of normal use due to the effects of atmospheric oxygen, elevated temperature and mechanical strain can be disposed of in the same way as used motor oils.

Used oils from vacuum pumps which were contaminated with other substances will have to be marked to identify the contaminant and stored and disposed of as toxic wastes.

European, national and local regulations concerning the disposal of waste need to be observed. The waste must only be handled and disposed of through an approved waste disposal vendor.

12. Spares and accessories

Figure 22 Overall view of the nHT20 ANSI



Note:

All other models are similar.

Item in Figure 22	nHT10 ANSI	nHT10 ISO	nHT16 ANSI	nHT16 ISO	nHT20 ANSI	nHT20 ISO	nHT32 ANSI	nHT32 ISO	nHT35 ANSI	nHT35 ISO	Opt. extras	Designation, dimension, material	Part number	Comments
1	2	2	2	2	2	2	2	2	2	2		O-ring 25 x 2.5; NBR ; PK10	H02121770	Cold cap / body seal
8	1	1	1	1	1	1	1	1	1	1		O-ring 18 x 5; FPM ; PK10	H02123770	NW 16 Fluid drain port
6	1	1	1	1	1	1	1	1	1	1		O-ring 42 x 5; FPM ; PK10	H02123771	NW40 Fluid fill port
9	2	2	2	2	2	2	2	2	2	2		O-ring 65 x 5; FPM ; PK10	H02123772	Oil sight glass seal
10		1										O-ring 75.5 x 5.3; FPM ; PK5	ES210635	63 ISO-K outlet seal
3		1										O-ring 315 x 5; FPM ; PK5	E400000104	320 ISO-K inlet seal
10				1								O-ring 100 x 5; FPM ; PK5	ES210645	100 ISO-K outlet seal
3				1								O-ring 506 x 7; FPM ; PK1	E210675	500 ISO-K inlet seal
10						1						O-ring 150 x 5; FPM ; PK5	H02123777	160 ISO-K outlet seal
3						1						O-ring 640 x 8; FPM ; PK1	H02123775	630 ISO-K inlet seal
10								1		1		O-ring 195 x 5; FPM ; PK5	H02123778	200 ISO-K outlet seal
3							1	1		1		O-ring 820 x 8; FPM ; PK1	E210746	800 ISO-F / 32" ANSI outlet seal
3										1		O-ring 1023 x 8; FPM ; PK1	H02123781	1000 ISO-F inlet seal
10	1											O-ring 75 x 5; FPM ; PK5	E6531917	2" ANSI outlet seal
3	1											O-ring 315 x 5; FPM ; PK5	E400000104	10" ANSI inlet seal
10			1		1							O-ring 135 x 5; FPM ; PK5	H02123776	3" ANSI / 4" ANSI outlet seal
3			1									O-ring 475 x 8; NBR ; PK1	E6530298	16" ANSI inlet seal
3					1							O-ring 560 x 8; FPM ; PK1	H02123773	20" ANSI inlet seal
10							1		1			O-ring 200 x 5; FPM ; PK5	H02123779	6" ANSI outlet seal

Item in Figure 22	nHT10 ANSI	nHT10 ISO	nHT16 ANSI	nHT16 ISO	nHT20 ANSI	nHT20 ISO	nHT32 ANSI	nHT32 ISO	nHT35 ANSI	nHT35 ISO	Opt. extras	Designation, dimension, material	Part number	Comments
3									1			O-ring 910 x 8; FPM ; PK1	H02123780	35" ANSI inlet seal
3											(1)	ISO sealing ring AL/CR ; PK1	B31432751	Optional 320 ISO-K inlet seal
3											(1)	ISO sealing ring AL/CR ; PK1	B31432752	Optional 500 ISO-K inlet seal
3											(1)	ISO sealing ring AL/CR ; PK1	B31432750	Optional 630 ISO-F inlet seal
3											(1)	ISO sealing ring AL/CR ; PK1	B31532750	Optional 1000 ISO-F inlet seal
											(1)	Silicone O-ring pack	EK6526563	Optional silicone Drain, Fill and sight glass seals
2	1	1										Spare cold cap assy nHT10	E6529962	
2			1	1								Spare cold cap assy nHT16	E6530632	
2			1	1								Extended cold cap nHT16	B61233100	Accessory
2			1	1								Inlet baffle nHT16	B61234100	Accessory
2					1	1						Spare cold cap assy nHT20	E6530632	
2					1	1						Extended cold cap nHT20	B61433100	Accessory
2					1	1						Inlet baffle nHT20	B61434100	Accessory
							1	1				Spare cold cap assy nHT32	E6533789	
							1	1				Extended cold cap nHT32	B61633100	Accessory
							1	1				Inlet baffle nHT32	B61634100	Accessory
2									1	1		Spare cold cap assy nHT35	B31530710	
2									1	1		Extended cold cap nHT35	B61533100	Accessory
2									1	1		Inlet baffle nHT35	B61534100	Accessory

Item in Figure 22	nHT10 ANSI	nHT10 ISO	nHT16 ANSI	nHT16 ISO	nHT20 ANSI	nHT20 ISO	nHT32 ANSI	nHT32 ISO	nHT35 ANSI	nHT35 ISO	Opt. extras	Designation, dimension, material	Part number	Comments
4	1	1										Spare cold cap insulating washers kit nHT10	E20005471	
4			1	1	1	1						Spare cold cap insulating washers kit nHT16 / nHT20	B61000701	
4							1	1	1	1		Spare cold cap insulating washers kit nHT32 / nHT35	B61000704	
11	1	1										Spare backing baffle nHT10	E6521085	
11			1	1								Spare backing baffle nHT16	E6521088	
11					1	1						Spare backing baffle nHT20	B31430711	
11							1	1	1	1		Spare backing baffle nHT32 / nHT35	B31530711	
5	1	1										Spare interior assy nHT10	B31130712	
5			1	1								Spare interior assy nHT16	B31230712	
5					1	1						Spare interior assy nHT20	B31430712	
							1	1				Spare interior assy nHT32	B31630712	
5									1	1		Spare interior assy nHT35	B31530712	
7											(1)	Sight glass mounting kit	B61000702	Pack includes glass, spacers and seals
15	1	1	1	1	1	1	1	1	1	1		Spare over temperature switch 330 ^{0}C PK2	B61000700	Bimetallic switch
											(1)	PT100 with 5 m cable	B61000705	Accessory
											(1)	Double PT100 with 3 m cable	B61000706	Accessory

Item in Figure 22	nHT10 ANSI	nHT10 ISO	nHT16 ANSI	nHT16 ISO	nHT20 ANSI	nHT20 ISO	nHT32 ANSI	nHT32 ISO	nHT35 ANSI	nHT35 ISO	Opt. extras	Designation, dimension, material	Part number	Comments
											(1)	Cooling fail switch	B61003100	Accessory cooling water monitoring > 50 ^{0}C
12												Spare heater gasket PK10	H01720708	
13	1	1	4	4	7	7	16	16	16	16		Spare heater 230 V 1200 W	H01720710	400 V, 230 V pumps
16	1	1	1	1	1	1	1	1	1	1		Spare heater 230 V 1200 W with PT100	H01720711	400 V, 230 V pumps
14	1	1	1	1	1	1	1	1	1	1		Spare heater 230 V 1200 W with TSS	H01720712	400 V, 230 V pumps
13	1	1	4	4	7	7	16	16	16	16		Spare heater 270 V 1200 W	H01720720	460 V pumps
16	1	1	1	1	1	1	1	1	1	1		Spare heater 270 V 1200 W with PT100	H01720721	460 V pumps
14	1	1	1	1	1	1	1	1	1	1		Spare heater 270 V 1200 W with TSS	H01720722	460 V pumps
											(1)	Graphite grease	ES6471174	
	1	1										Spare terminal box complete nHT10	B31130714	
			1	1								Spare terminal box complete nHT16	B31230714	
					1	1						Spare terminal box complete nHT20	B31430714	
							1	1				Spare terminal box complete nHT32	B31630714	
									1	1		Spare terminal box complete nHT35	B31530714	
	1	1	2	2	3	3	6	6	6	6		Spare terminal block 6 way PK3	B61000703	
	1	1										Seals kit / Clean and overhaul nHT10	B31130715	
			1	1								Seals kit / Clean and overhaul nHT16	B31230715	
					1	1						Seals kit / Clean and overhaul nHT20	B31430715	
							1	1				Seals kit / Clean and overhaul nHT32	B31630715	

Item in Figure 22	nHT10 ANSI	nHT10 ISO	nHT16 ANSI	nHT16 ISO	nHT20 ANSI	nHT20 ISO	nHT32 ANSI	nHT32 ISO	nHT35 ANSI	nHT35 ISO	Opt. extras	Designation, dimension, material	Part number	Comments
									1	1		Seals kit / Clean and overhaul nHT35	B31530715	
												Water flow monitor	500006623	Accessory
												Energy efficient controller (EEC)	B61001100	Accessory
												Cable 10 m for EEC nHT32/35	B61001120	Accessory
												Cable 10 m for EEC nHT20	B61001121	Accessory
												Cable 10 m for EEC nHT10/16	B61001022	Accessory
												nHT10 ANSI inlet valve	B61130100	Accessory
												nHT10 ISO inlet valve	B61132100	Accessory
												nHT16 ANSI inlet valve	B61230100	Accessory
												nHT16 ISO inlet valve	B61232100	Accessory
												nHT20 ANSI inlet valve	B61430100	Accessory
												nHT20 ISO inlet valve	B61432100	Accessory
												nHT32 ANSI inlet valve	B61630100	Accessory
												nHT32 ISO inlet valve	B61632100	Accessory
												nHT35 ANSI inlet valve	B61530100	Accessory
												nHT35 ISO inlet valve	B61532100	Accessory

13. Terminal and circuit diagrams

Table 8 Annotation

Technical data	nHT10	nHT16	nHT20	nHT32	nHT35
Mains supply	3 ~ 400 /N/PE / 3 ~ 460 /N/PE				
Mains supply tolerance	± 10%				
Frequency (Hz)	50/60				
Rated output power (kVA)	3.6	7.2	10.8	21.6	21.6
Rated current (A)	5.2/4.4	10.4/8.9	15.6/13.6	31.2/26.7	31.2/26.7
Control voltage	24 V d.c.				
Wire colours marking					
▪ Main circuit 400 V a.c.	Black				
▪ Main circuit neutral	Azure RAL 5015				
▪ Control circuit 230 V a.c.	Red				
▪ Control circuit 230 V a.c. neutral	Red/White				
▪ Control circuit 24 V d.c.	Gentian blue RAL 5010				
▪ Control circuit 24 V d.c. neutral	Gentian blue RAL 5010/White				
▪ Analog circuits 0 to10 V	White				
▪ Analog circuits 4 to 20 mA	Brown				
▪ Data lines	Violet				
▪ External voltage/potential free contacts	Orange				
▪ Protective earth	Green/Yellow				
All wires not signed in the:					
▪ Main circuit	1.5 mm² AWG 16				
▪ Control circuit	1.0 mm² AWG 18				
Core type to be used	Standard				

Figure 23 nHT10 Circuit diagram (1 of 2)

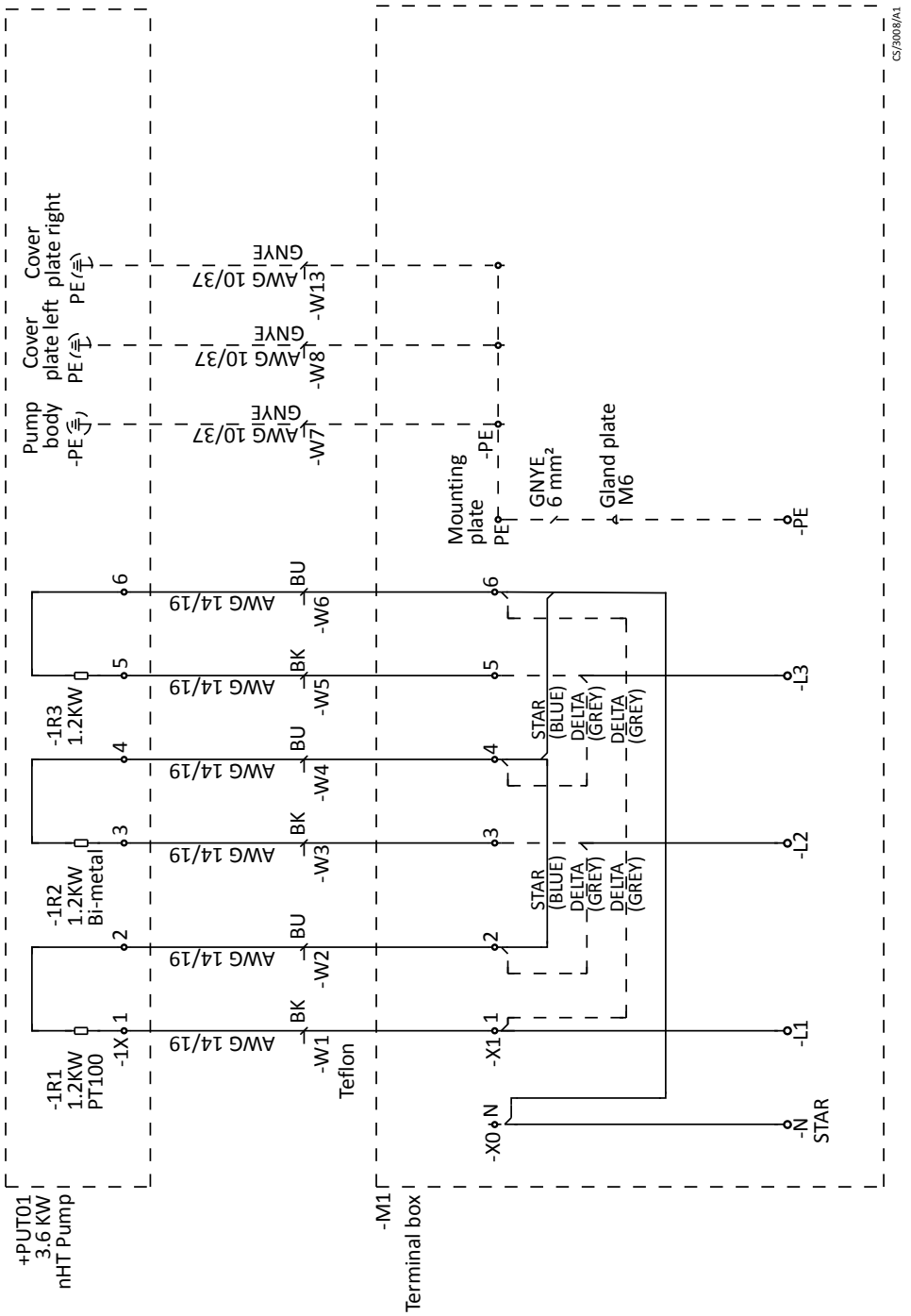


Figure 24 nHT10 Circuit diagram (2 of 2)

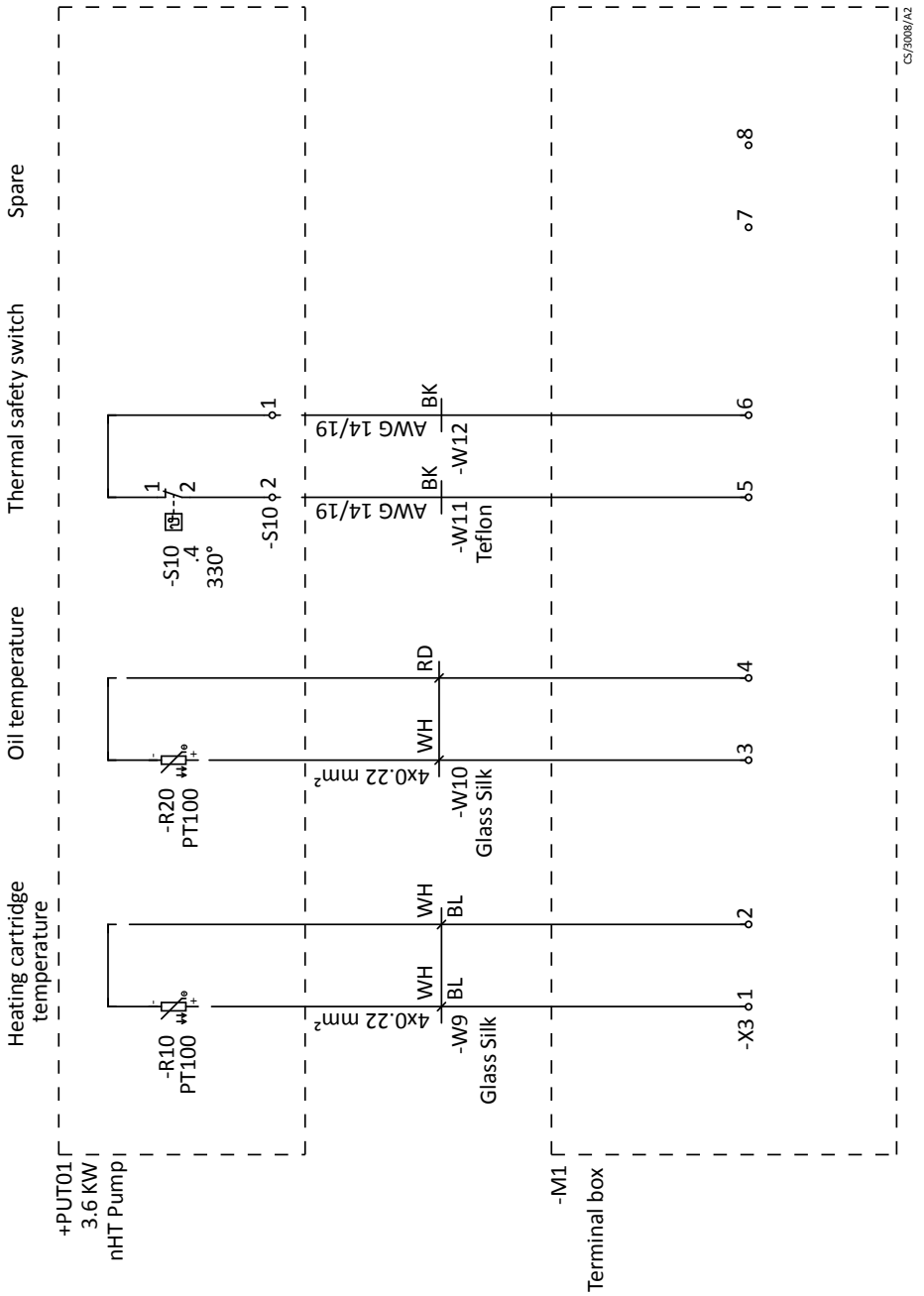


Figure 25 nHT16 Circuit diagram (1 of 2)

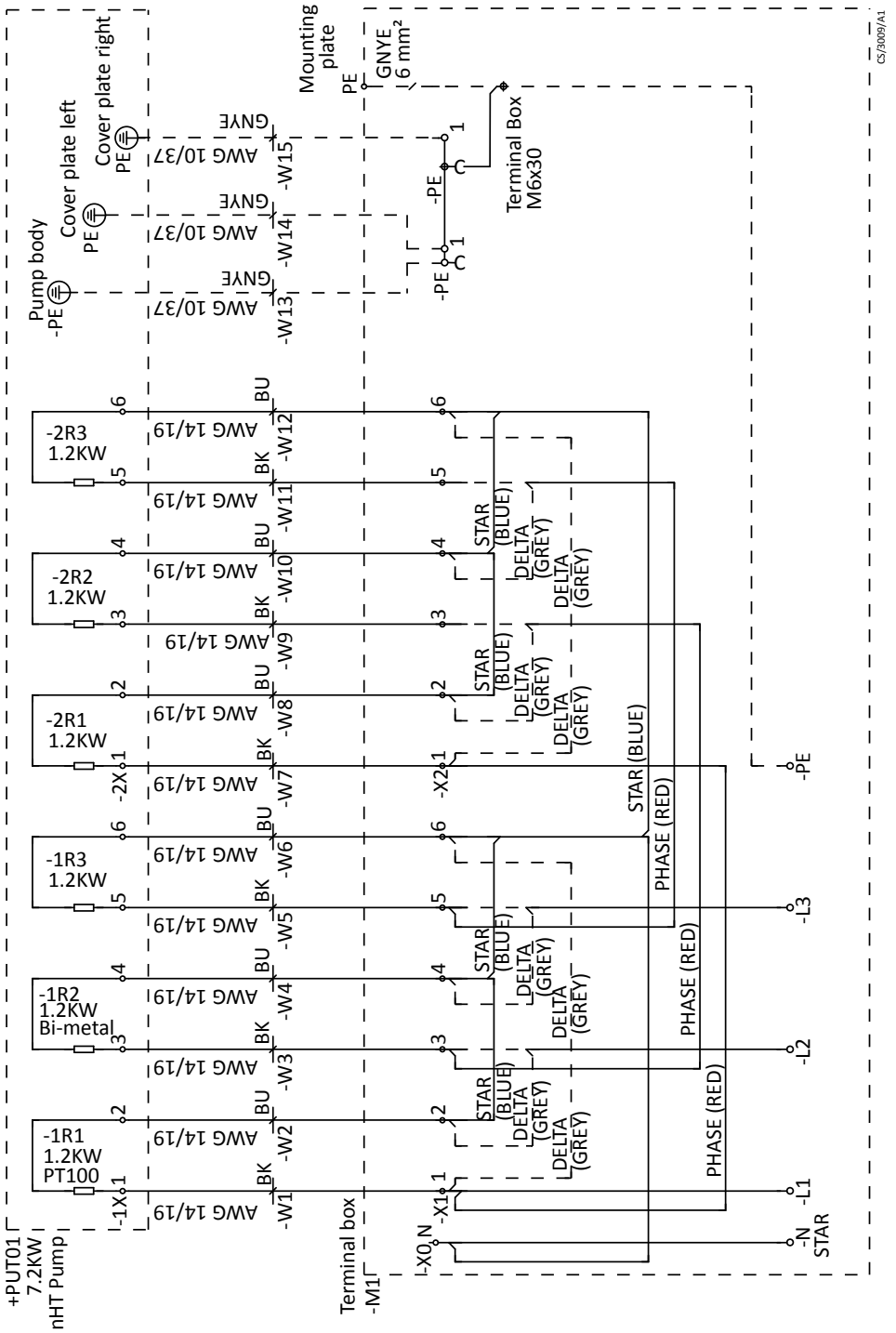


Figure 26 nHT16 Circuit diagram (2 of 2)

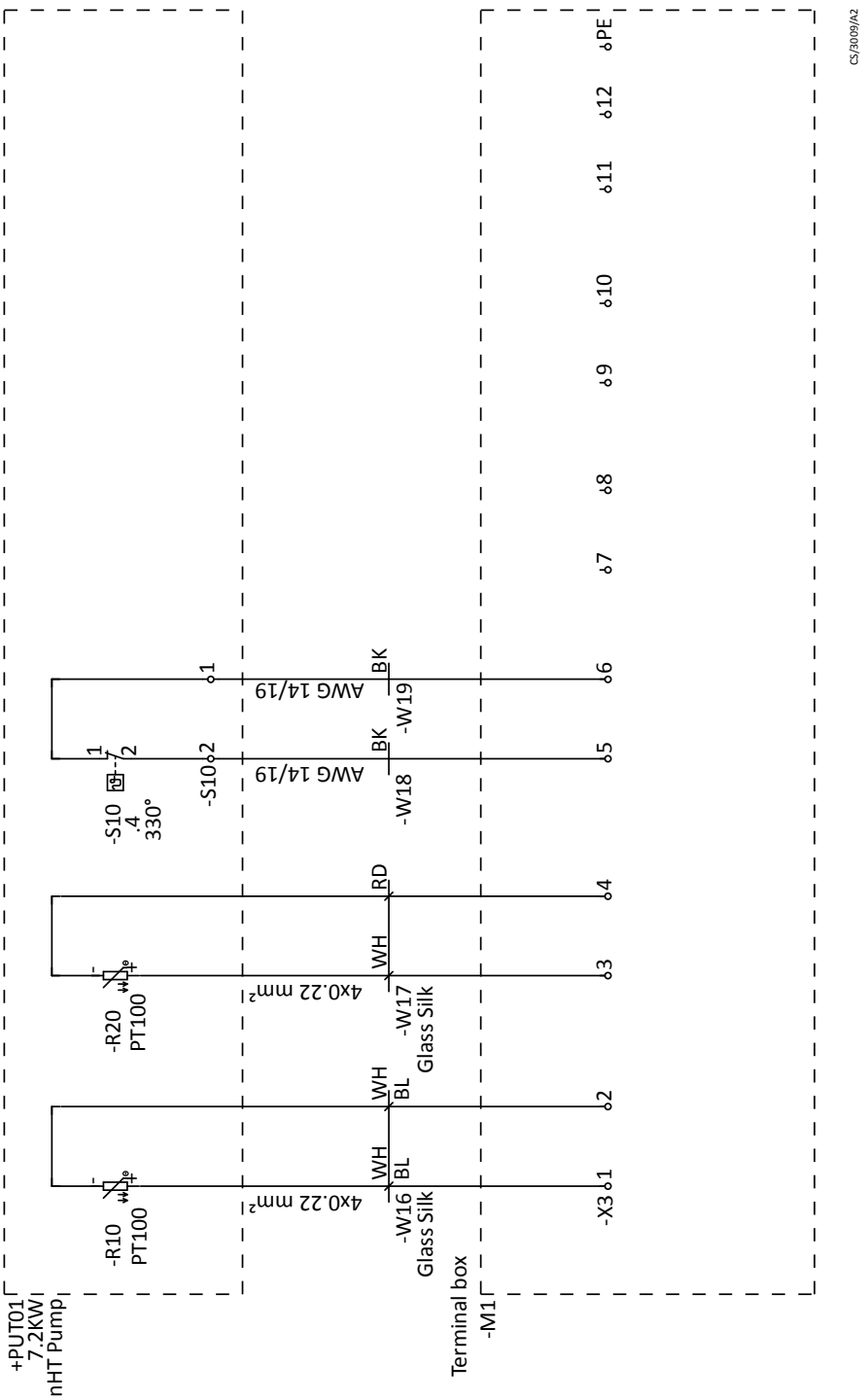


Figure 27 nHT20 Circuit diagram (1 of 3)

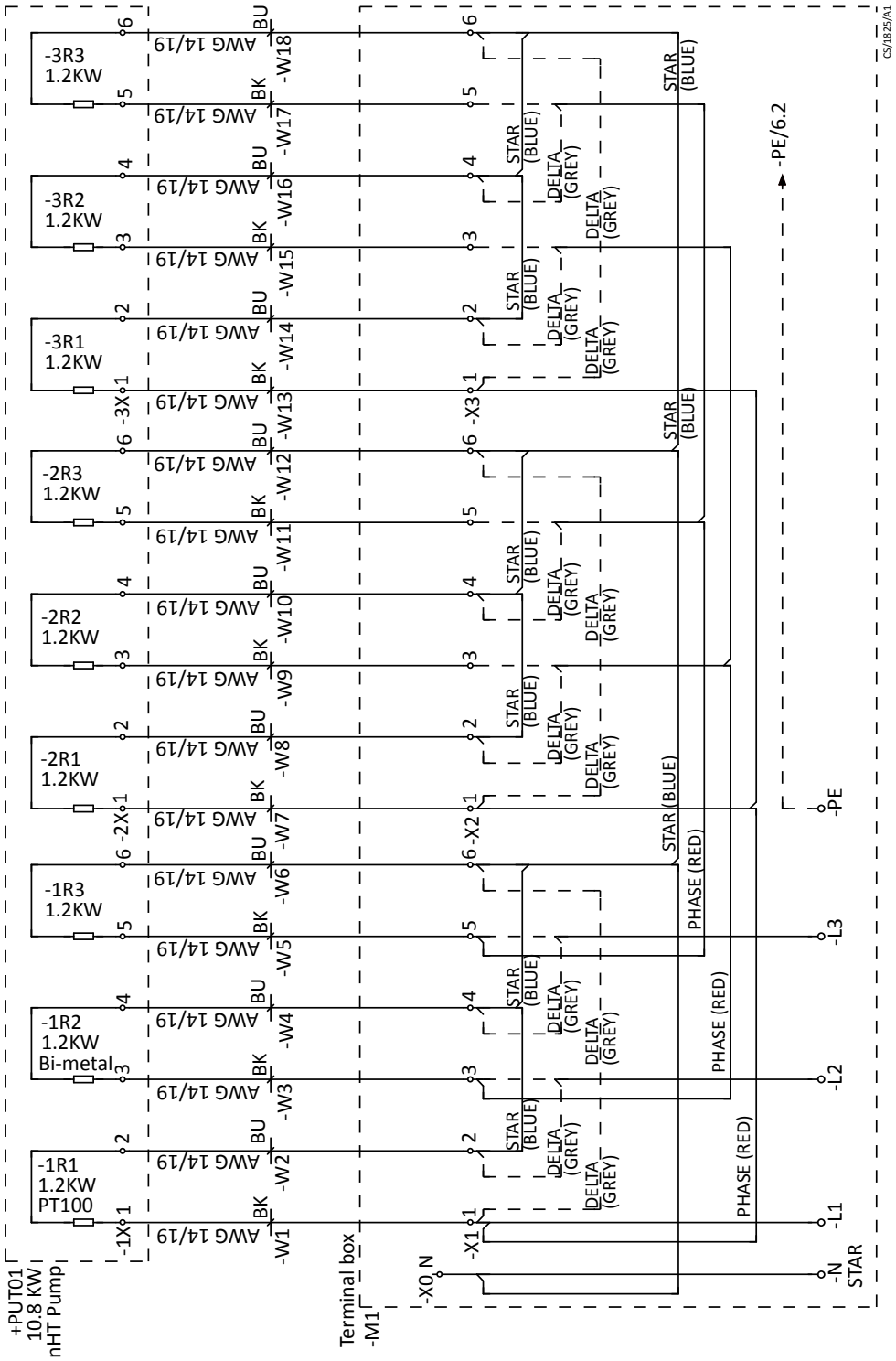


Figure 28 nHT20 Circuit diagram (2 of 3)

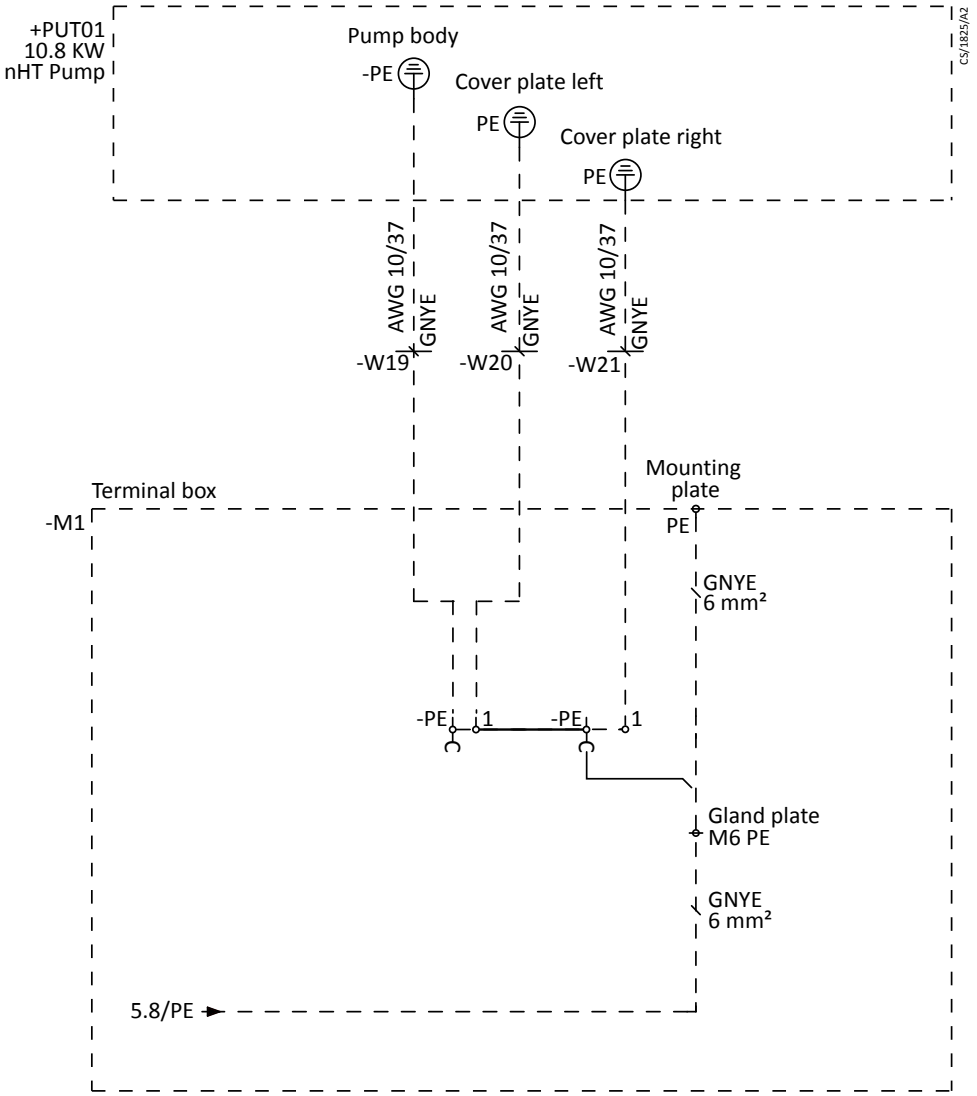


Figure 29 nHT20 Circuit diagram (3 of 3)

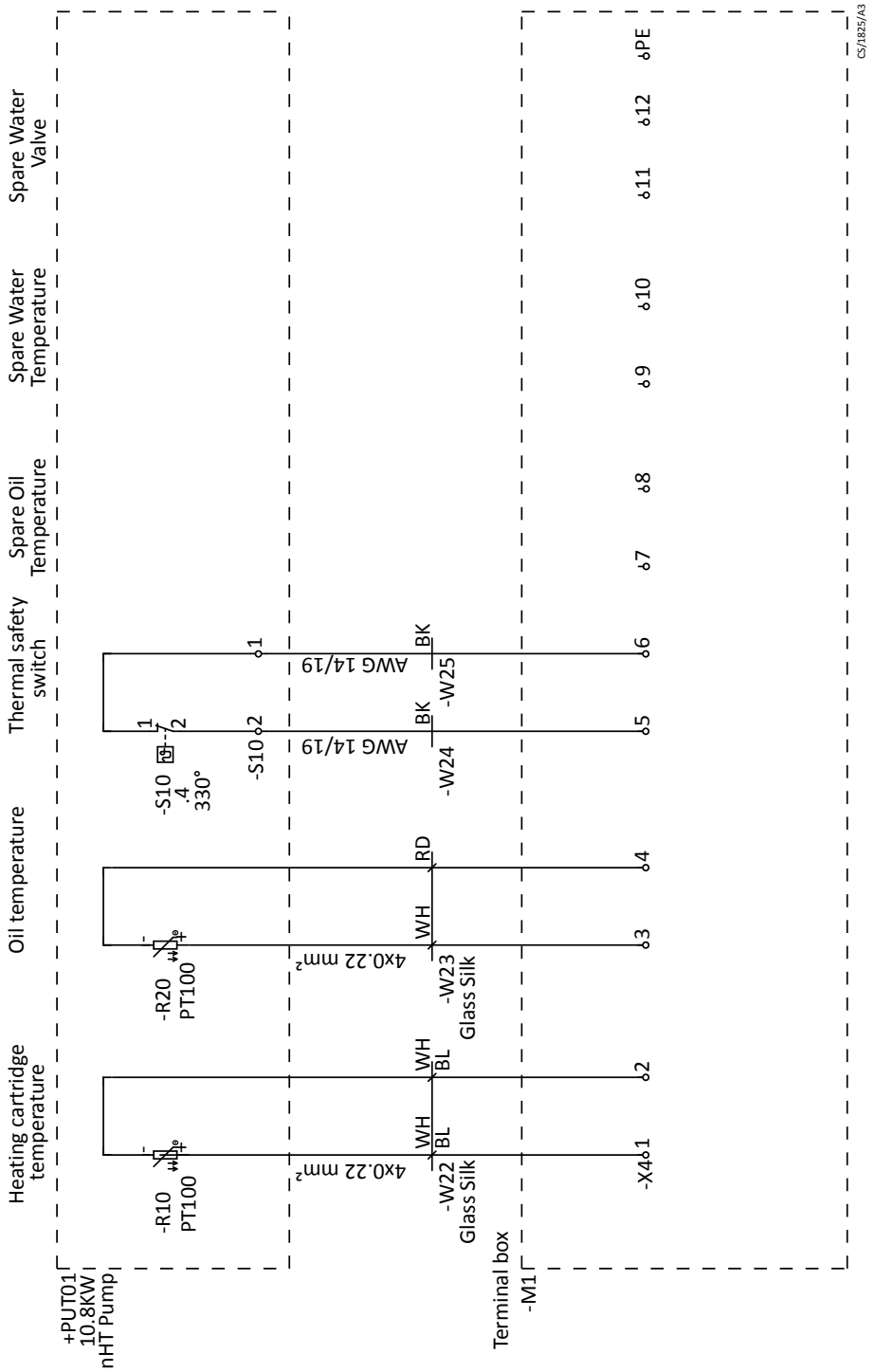


Figure 30 nHT32/35 Circuit diagram (1 of 3)

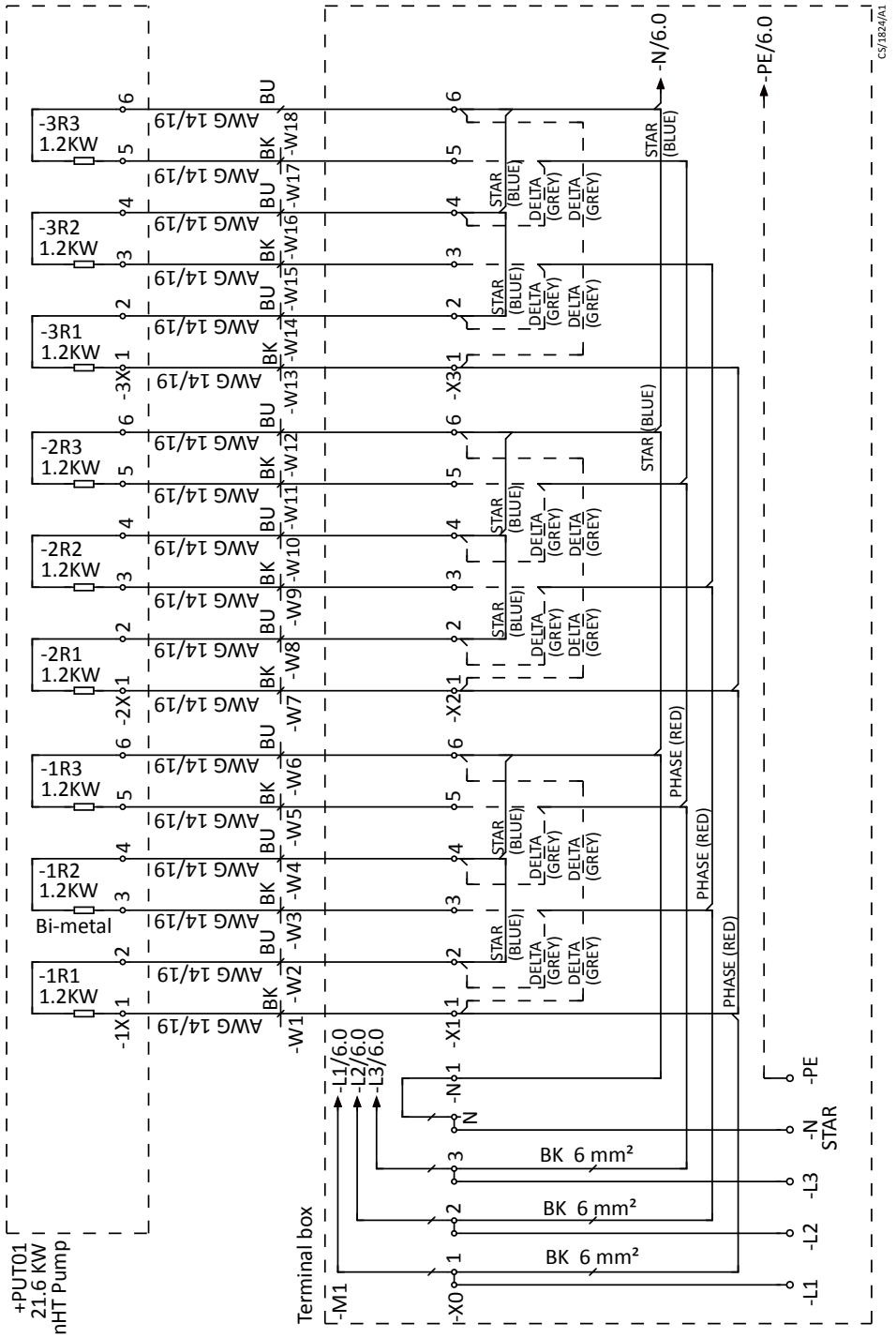


Figure 31 nHT32/35 Circuit diagram (2 of 3)

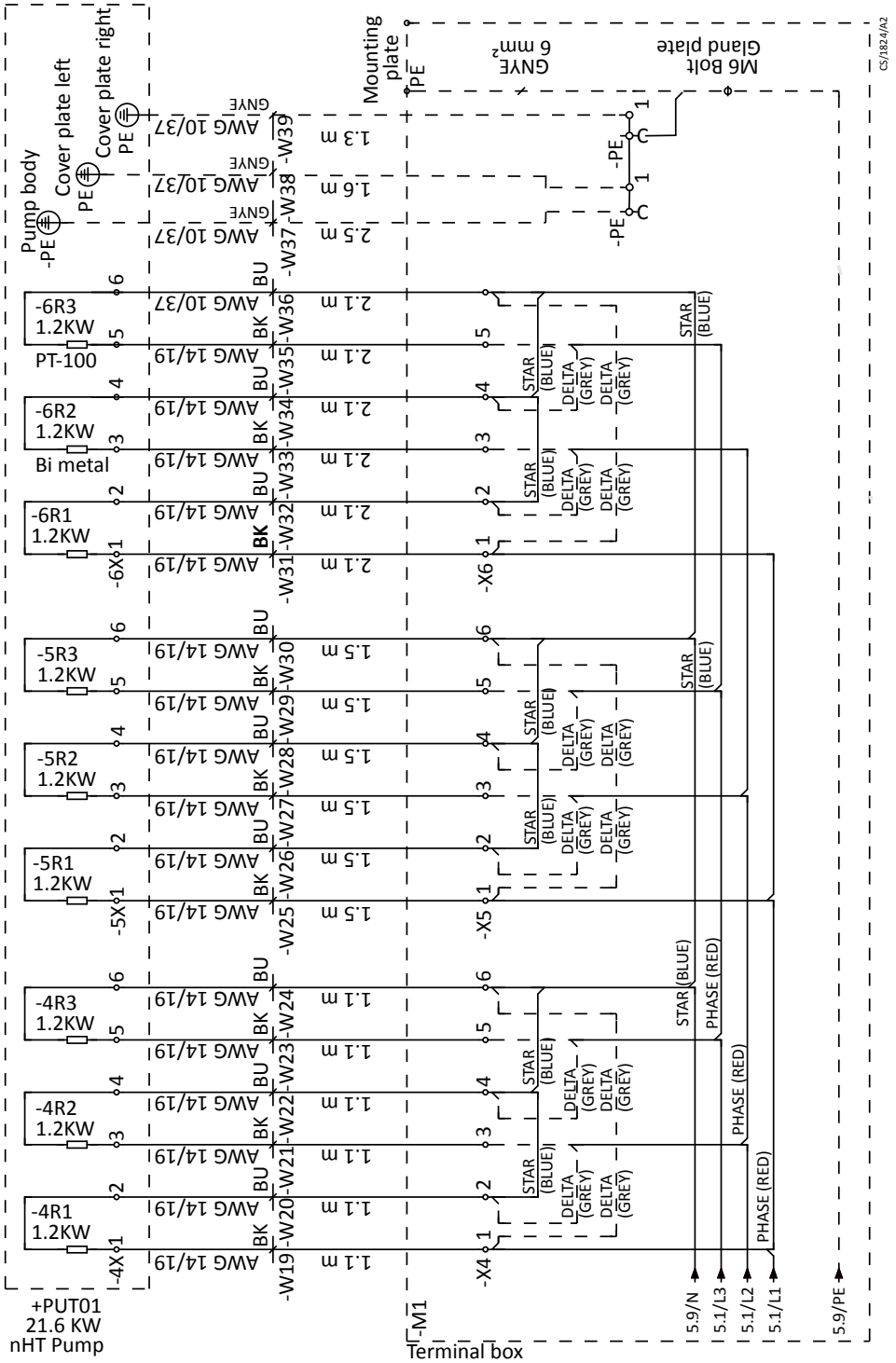
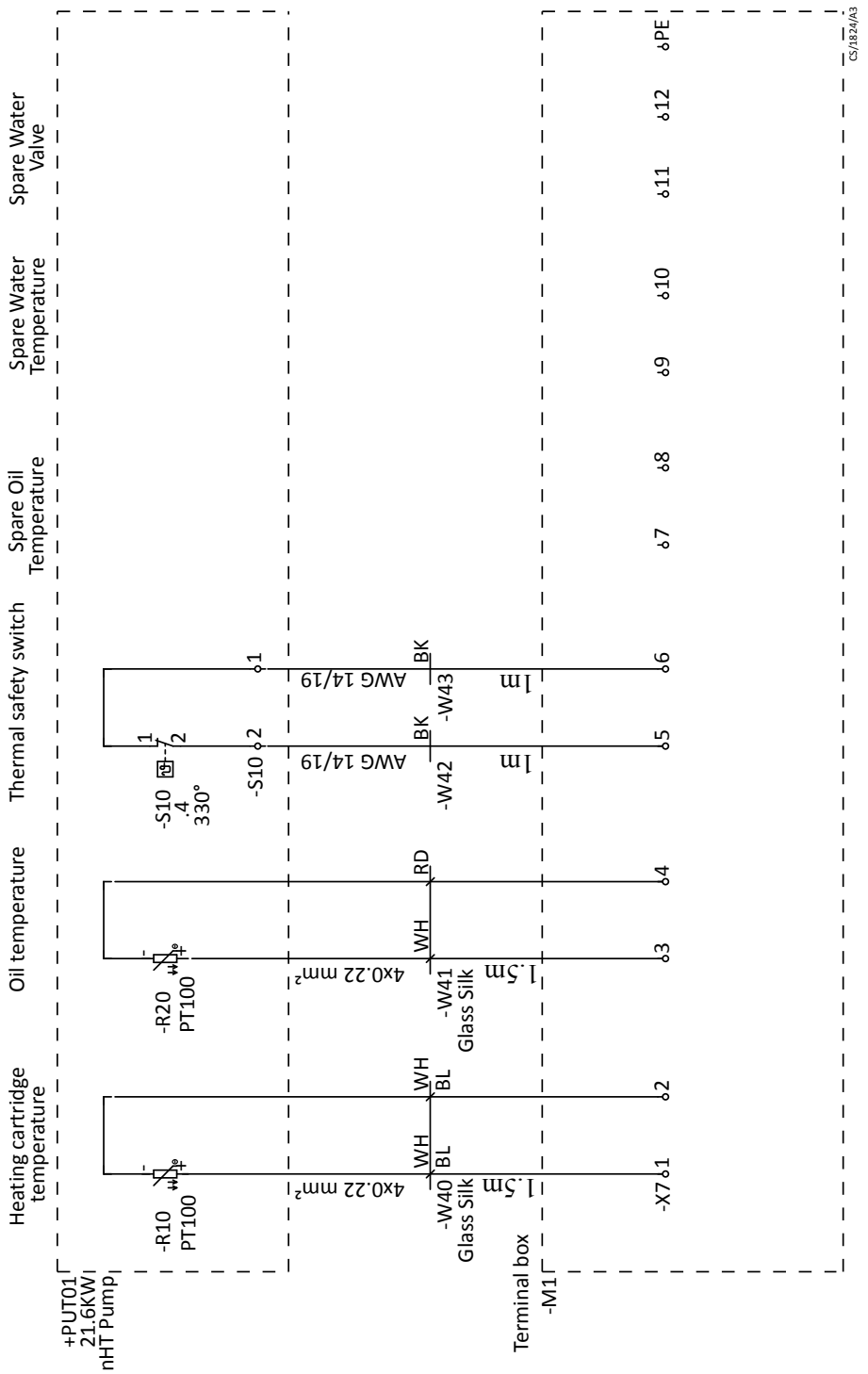


Figure 32 nHT32/35 Circuit diagram (3 of 3)



14. Service

14.1 Return the equipment or components for service

Before you send your equipment to us for service or for any other reason, you must send us a completed Declaration of Contamination of Vacuum Equipment and Components – Form HS2. The HS2 form tells us if any substances found in the equipment are hazardous, which is important for the safety of our employees and all other people involved in the service of your equipment. The hazard information also lets us select the correct procedures to service your equipment.

We provide instructions for completing the form in the Declaration of Contamination of Vacuum equipment and Components – Procedure HS1.

If you are returning a vacuum pump, note the following:

- If a pump is configured to suit the application, make a record of the configuration before returning the pump. All replacement pumps will be supplied with default factory settings.
- Do not return a pump with accessories fitted. Remove all accessories and retain them for future use.
- The instruction in the returns procedure to drain all fluids does not apply to the lubricant in pump oil reservoirs.

Download the latest documents from *edwardsvacuum.com/HSForms/*, follow the procedure in HS1, fill in the electronic HS2 form, print it, sign it, and return the signed copy to us.

NOTICE:

If we do not receive a completed HS2 form, your equipment cannot be serviced.