

CR, CRI, CRN, CRT

Installation and operating instructions



CONTENTS

	Page
1. Limited warranty	2
2. Symbols used in this document	3
3. Introduction	3
4. Shipment inspection	3
4.1 Lifting instructions	3
4.2 Ensure you have the right pump	3
4.3 Checking the condition of the pump	3
4.4 Electrical requirements	4
5. Identification	4
5.1 Nameplate data	4
5.2 Type keys	5
6. Application	7
7. Operating conditions	7
7.1 Ambient temperature and altitude	7
7.2 Liquid temperatures	7
7.3 Minimum inlet pressures	7
7.4 Maximum inlet pressures	8
7.5 Maximum operating pressures	8
8. Installation	9
8.1 Pump location	9
8.2 Foundation	9
8.3 Pump mounting	10
8.4 Suction pipe	10
8.5 Discharge pipe	10
8.6 Bypass	11
8.7 Flange forces and torques	11
8.8 Minimum continuous duty flow rates [gpm]	12
8.9 Check valves	13
8.10 Temperature rise	13
8.11 Electrical connection	13
8.12 Motor	13
8.13 Position of terminal box	13
8.14 Field wiring	13
8.15 Motor protection	14
9. Commissioning and start-up	14
9.1 Priming	14
9.2 Operating parameters	15
9.3 Pump cycling	15
9.4 Boiler feed installations	15
9.5 Frost protection	15
10. Maintaining the pump	15
11. Maintaining the motor	16
11.1 Motor inspection	16
11.2 Motor lubrication	16
11.3 Recommended lubricant	16
11.4 Lubricating chart (for motors with grease zerks)	16
11.5 Lubricating procedure	17
12. Replacing the motor	17
12.1 Disassembly	17
12.2 Assembly	17
13. Parts list	19
13.1 Spare parts	19
14. Preliminary electrical tests	20
14.1 Supply voltage	20
14.2 Current	20
14.3 Insulation resistance	20
15. Start-up of pump with air-cooled top (Cool-Top®)	21
16. Diagnosing specific problems	22
17. Worksheet for three-phase motors	25

**Warning**

Prior to installation, read these installation and operating instructions. Installation and operation must comply with local regulations and accepted codes of good practice.

**Warning**

Electrical work: All electrical work should be performed by a qualified electrician in accordance with the latest edition of national, state, and local codes and regulations.

**Warning**

Shock Hazard: A faulty motor or wiring can cause electrical shock that could be fatal, whether touched directly or conducted through standing water. For this reason, proper grounding of the pump to the power supply's grounding terminal is required for safe installation and operation. In all installations, the above-ground metal plumbing should be connected to the power supply ground as described in Article 250-80 of the National Electrical Code.

1. Limited warranty

Products manufactured by GRUNDFOS PUMPS CORPORATION (Grundfos) are warranted to the original user only to be free of defects in material and workmanship for a period of 24 months from date of installation, but not more than 30 months from date of manufacture. Grundfos' liability under this warranty shall be limited to repairing or replacing at Grundfos' option, without charge, F.O.B. Grundfos' factory or authorized service station, any product of Grundfos' manufacture. Grundfos will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by Grundfos are subject to the warranty provided by the manufacturer of said products and not by Grundfos' warranty. Grundfos will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with Grundfos' printed installation and operating instructions.

To obtain service under this warranty, the defective product must be returned to the distributor or dealer of Grundfos' products from which it was purchased together with proof of purchase and installation date, failure date, and supporting installation data. Unless otherwise provided, the distributor or dealer will contact Grundfos or an authorized service station for instructions. Any defective product to be returned to Grundfos or a service station must be sent freight prepaid; documentation supporting the warranty claim and/or a Return Material Authorization must be included if so instructed.

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limit actions on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

2. Symbols used in this document



Warning

If these safety instructions are not observed, it may result in personal injury.



Warning

If these instructions are not observed, it may lead to electric shock with consequent risk of serious personal injury or death.



Caution

If these safety instructions are not observed, it may result in malfunction or damage to the equipment.



Note

Notes or instructions that make the job easier and ensure safe operation.

3. Introduction

The CR range is based on the inline multistage centrifugal pump first pioneered by Grundfos. CR is available in four basic materials and over one million configurations. CR is suitable for pumping water and water-like liquids in industry, petrochemical, water treatment, commercial buildings, and many other applications. Some of the outstanding characteristics of CR are:

- superior efficiency
- reliability
- easy maintenance
- compact size and small footprint
- quiet operation.

4. Shipment inspection

Examine the components carefully to make sure no damage has occurred to the pump during shipment. Care should be taken to ensure the pump is NOT dropped or mishandled.

4.1 Lifting instructions



Caution

Do not use the lifting eyes of the motor for lifting the entire pump and motor assembly.

Lift pump assembly with lifting straps that pass through the motor stool. Ensure that the load is not applied to the pump shaft.



Fig. 1 Correct lifting of a CR pump

TM04 0339 0608

4.2 Ensure you have the right pump

Check the pump nameplate to make sure that it is the one you ordered.

- **CR:** Centrifugal pump with standard cast iron and AISI 304 stainless steel construction
- **CRI:** Centrifugal pump; all parts in contact with the pumped liquid are AISI 304 stainless steel
- **CRN:** Centrifugal pump; all parts in contact with the pumped liquid are AISI 316 stainless steel
- **CRT:** Centrifugal pump; all parts in contact with the pumped liquid are made of titanium
- **CRE:** Centrifugal pump with a Grundfos MLE variable frequency drive motor.

4.3 Checking the condition of the pump

The packing in which your pump arrived is specially designed for your pump to prevent damage during shipment. As a precaution, leave the pump in the packing until you are ready to install it. Examine the pump for any damage that may have occurred during shipping. Examine any other parts of the shipment as well for any visible damage.

If the shipment consists of a complete unit (motor attached to pump end), the position of the coupling connecting the pump shaft to the motor shaft is set to factory specifications. No adjustment is required. If the shipment is a pump end without motor, follow the adjustment procedures in section 12. Replacing the motor.

Note

Pump without motor (CR, CRI, CRN 1s, 1, 3, 5, 10, 15, and 20 only):

If you purchased a pump end without motor, the shaft seal has been set from factory. Do not loosen the three set screws on the shaft seal when attaching the motor.

Pump without motor (CR, CRN 32, 45, 64, 90, 120, and 150 only):

If you purchased a pump end without motor, you must install the shaft seal. The shaft seal is protected in its own box inside the pump packing crate. To protect the shaft and bearings during shipment, a transport protector is used. Remove the transport protector prior to installation of the shaft seal. Read the seal installation instructions which are included in the pump packing.

4.4 Electrical requirements



Warning

Electrical work: All electrical work should be performed by a qualified electrician in accordance with the current national, state, and local codes and regulations.

Warning

Shock hazard: A faulty motor or faulty wiring can cause electric shock that could be fatal, whether the motor is touched directly or the current is conducted through standing water. For this reason, safe installation and operation require proper grounding of the pump to the power supply ground (earth) terminal.



In all installations, connect the above-ground metal plumbing to the power supply ground terminal as described in Article 250-80 of the National Electrical Code.

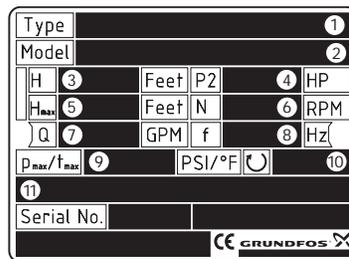
Verify the power supply to make sure that the voltage, phases and frequency match those of the pump. The proper operating voltage and other electrical information appear on the motor nameplate. These motors are designed to run on - 10 %/+ 10 % of the rated nameplate voltage. For dual-voltage motors, the motor should be internally connected to operate on the voltage closest to the 10 % rating, i.e., a 208V motor should be wired according to the 208V wiring diagram. The wiring diagram can be found on either a plate attached to the motor or on a label inside the terminal box cover.



Do not operate the pump if voltage variations are greater than -10 % / +10 %.

5. Identification

5.1 Nameplate data



1. Type designation
2. Model, material number, production number
3. Head in feet at rated flow
4. Rated motor Hp
5. Head at zero flow
6. Rated rpm
7. Rated flow
8. Rated frequency
9. Maximum pressure and maximum liquid temperature
10. Direction of rotation
11. Production country

TM04 3895 2609

Fig. 1 Example of nameplate CR, CRI, CRN, CRT

Specification of the model line in nameplates:

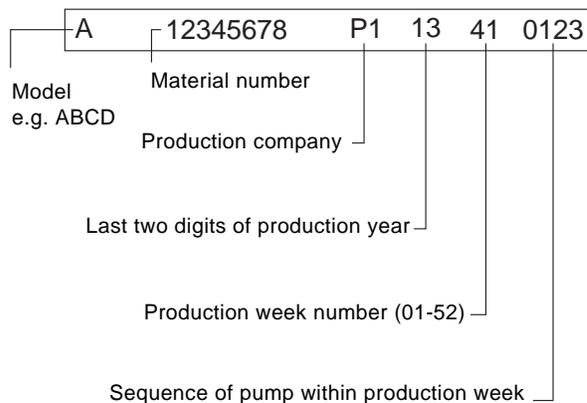


Fig. 2 Key to model line in nameplates

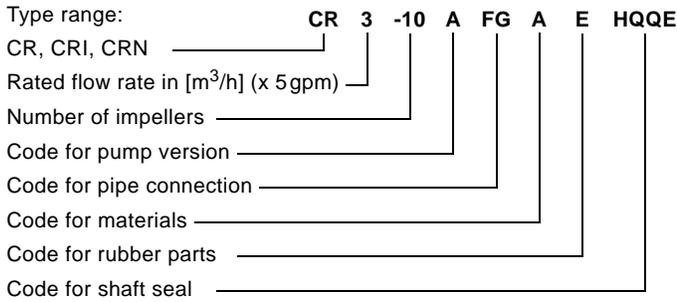
TM04 3904 3913

5.2 Type keys

Type key

CR, CRI, CRN 1s, 1, 3, 5, 10, 15, and 20

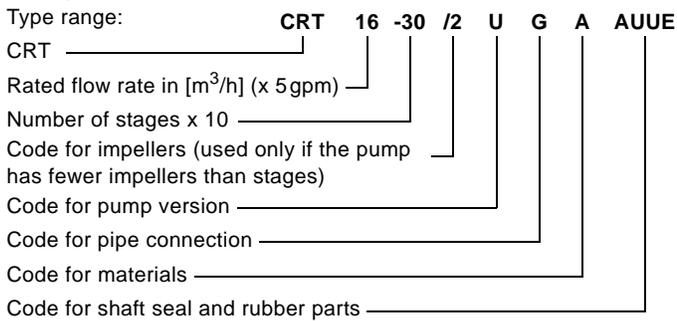
Example



Type key

CRT 2, 4, 8, and 16

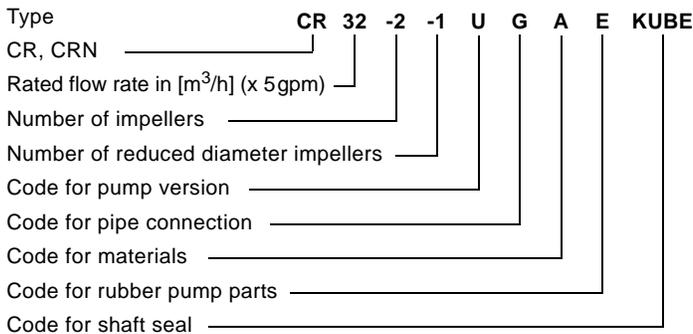
Example



Type key

CR, CRN 32, 45, 64, 90, 120, and 150

Example



5.2.1 Codes

Example	A	G	-A	-E	-H	QQ	E
Pump version							
A							
B							
E							
F							
H							
HS							
I							
J							
K							
M							
N							
P							
R							
SF							
T							
U							
X							
Pipe connection							
A							
B							
CA							
CX							
F							
G							
J							
N							
P							
X							

Materials							
A							
D							
G							
GI							
I							
II							
K							
S							
X							
Code for rubber parts							
E							
F							
K							
V							

Example	A	G	-A	-E	-H	QQ	E
Shaft seal							
A							
B							
E							
H							
K							
O							
P							
X							
B							
H							
Q							
U							
X							
E							
F							
K							
V							

¹⁾ In August 2003 the NEMA version pump code was discontinued for all material numbers created by Grundfos manufacturing companies in North America. The NEMA version pump code will still remain in effect for existing material numbers. NEMA version pumps built in North America after this change will have either an A or U as the pump version code depending on the date the material number was created.

²⁾ If a pump incorporates more than two pump versions, the code for the pump version is X. X also indicates special pump versions not listed above.

6. Application

Compare the pump's nameplate data or its performance curve with the application in which you plan to install it. Make sure the application falls within the following limits.

Type	Application/liquid
CR	Hot and chilled water, boiler feed, condensate return, glycols and solar thermal liquids.
CRI/CRN	Deionized, demineralized and distilled water. Brackish water and other liquids unsuitable for contact with iron or copper alloys. (Consult manufacturer for specific liquid compatibilities.)
CRN-SF	High pressure washdown, reverse osmosis or other high pressure applications.
CRT	Salt water, chloride based liquids and liquids approved for titanium.

7. Operating conditions

7.1 Ambient temperature and altitude

If the ambient temperature exceeds the maximum temperature limits of the pump or the pump is installed at an altitude exceeding the altitude values in the chart below, the motor must not be fully loaded due to the risk of overheating.

Overheating may result from excessive ambient temperatures or the low density and consequently low cooling effect of the air at high altitudes. In such cases, it may be necessary to use a motor with a higher rated output (P₂).

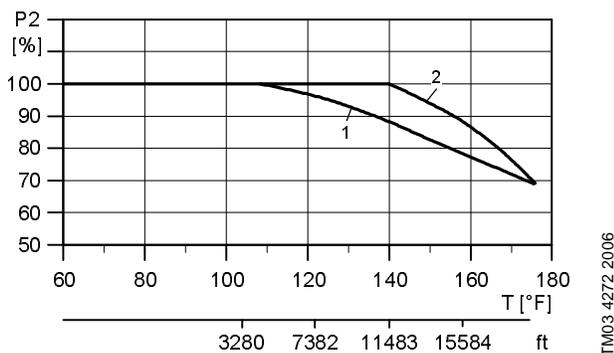


Fig. 3 Relationship between motor output (P₂) and ambient temperature/altitude

Legend

Pos.	Description
1	NEMA standard-efficiency motors
2	NEMA premium-efficiency motors

Example: From fig. 3 it appears that P₂ must be reduced to 88 % when a pump with a NEMA premium-efficiency ML motor is installed 15,584 feet above sea level. At an ambient temperature of 167 °F, P₂ of a standard-efficiency motor must be reduced to 74 % of rated output.

In cases where both the maximum temperature and the maximum altitude are exceeded, the derating factors must be multiplied.

Example: $0.89 \times 0.89 = 0.79$.

7.2 Liquid temperatures

Pump	Liquid temperature
CR, CRI, CRN 1s, 3, 5, 10, 15, and 20	-4 to +248 °F (-20 to +120 °C)
CR, CRN 32, 45, 64, and 90 *	-22 to +248 °F (-30 to +120 °C)
CR, CRN 120 and 150 * (up to 60 hp)	-22 to +248 °F (-30 to +120 °C)
CR, CRN 120 and 150 (75 and 100 hp)	+32 to +248 °F (0 to +120 °C)
CRT 2, 4, 8, 16	-4 to +248 °F (-20 to +120 °C)
CRN-SF	-4 to +221 °F (-15 to +105 °C)
Pumps with Cool-Top™	up to +356 °F (+180 °C)

All motors are designed for continuous duty in +104 °F (+40 °C) ambient air conditions. For higher ambient temperature conditions, consult Grundfos.

* xUBE shaft seals are recommended for temperatures above +200 °F. Pumps with KUHE hybrid shaft seals can only operate up to +200 °F (+90 °C). Pumps with xUUE shaft seals can be operated down to -40 °F (-40 °C). ("x" is the seal type).

7.3 Minimum inlet pressures

All CR, CRI, CRN	NPSHR + 2 feet
CRN-SF	29 psi (2 bar)

7.4 Maximum inlet pressures

Pump type	Stages		Max. [psi (bar)]
	60 Hz	50 Hz	
CR, CRI, CRN 1s	2 to 36	2 to 36	145 (10)
	27		217 (15)
CR, CRI, CRN 1	2 to 36	2 to 36	145 (10)
	27		217 (15)
CR, CRI, CRN 3	2 to 15	2 to 29	145 (10)
	17 to 25	31 to 36	217 (15)
CR, CRI, CRN 5	2 to 9	3 to 16	145 (10)
	10 to 24	18 to 36	217 (15)
CR, CRI, CRN 10	1 to 5	1 to 6	116 (8)
	6 to 18	7 to 22	145 (10)
CR, CRI, CRN 15	1 to 2	1 to 3	116 (8)
	3 to 12	4 to 17	145 (10)
CR, CRI, CRN 20	1	1 to 3	116 (8)
	2 to 10	4 to 17	145 (10)
CR, CRN 32	1-1 to 2	1-1 to 4	58 (4)
	3-2 to 6	5-2 to 10	145 (10)
	7-2 to 11-2	11 to 14	217 (15)
CR, CRN 45	1-1 to 1	1-1 to 2	58 (4)
	2-2 to 3	3-2 to 5	145 (10)
	4-2 to 8-1	6-2 to 13-2	217 (15)
CR, CRN 64	1-1	1-1 to 2-2	58 (4)
	1 to 2-1	2-1 to 4-2	145 (10)
	2 to 5-2	4-1 to 8-1	217 (15)
CR, CRN 90		1-1 to 1	58 (4)
	1-1 to 1	2-2 to 3-2	145 (10)
	2-2 to 4-1	3 to 6	217 (15)
CR, CRN 120	1-1 to 1	1 to 2-1	145 (10)
	2-2 to 3	2 to 5-1	217 (15)
	4-1 to 5-2	6-1 to 7	290 (20)
CR, CRN 150	1-1	1-1 to 1	145 (10)
	1 to 2	2-1 to 4-1	217 (15)
	3-2 to 4-2	5-2 to 6	290 (20)
CRT 2	2 to 6	2 to 11	145 (10)
	7 to 18	13 to 26	217 (15)
CRT 4	1 to 7	1 to 12	145 (10)
	8 to 16	14 to 22	217 (15)
CRT 8	1 to 16	1 to 20	145 (10)
CRT 16	2 to 10	2 to 16	145 (10)
CRN-SF	all	all	72 (5)* 362 (25)**

* while pump is off or during start-up

** during operation

7.5 Maximum operating pressures

+250 °F (194 °F for CRN-SF)

Pump type/ connection	Stages		Max. [psi (bar)]
	60 Hz	50 Hz	
CR, CRI, CRN 1s			
Oval flange	1 to 17	1 to 23	232 (16)
FGJ, PJE	1 to 27	1 to 36	362 (25)

CR, CRI, CRN 1			
Oval flange	1 to 17	1 to 23	232 (16)
FGJ, PJE	1 to 27	1 to 36	362 (25)
CR, CRI, CRN 3			
Oval flange	1 to 17	1 to 23	232 (16)
FGJ, PJE	1 to 27	1 to 36	362 (25)
CR, CRI, CRN 5			
Oval flange	1 to 16	1 to 22	232 (16)
FGJ, PJE	1 to 24	1 to 36	362 (25)
CR, CRI 10			
Oval flange CR	1 to 6		145 (10)
Oval flange, CRI	1 to 10	1 to 16	232 (16)
FGJ, GJ, PJE	1 to 10	1 to 16	232 (16)
FGJ, GJ, PJE	12 to 17	17 to 22	362 (25)
CRN 10			
All	1 to 17	1 to 22	362 (25)
CR, CRI 15			
Oval flange	1 to 5	1 to 7	145 (10)
FGJ, GJ, PJE	1 to 8	1 to 10	232 (16)
FGJ, GJ, PJE	9 to 12	12 to 17	362 (25)
CRN 15			
All	1 to 12	1 to 17	362 (25)
CR, CRI 20			
Oval flange	1 to 5	1 to 7	145 (10)
FGJ, GJ, PJE	1 to 7	1 to 10	232 (16)
FGJ, GJ, PJE	8 to 10	12 to 17	362 (25)
CRN 20			
All	1 to 10	1 to 17	362 (25)
CR, CRN 32			
	1-1 to 5	1-1 to 7	232 (16)
	6-2 to 11-2	8-2 to 14	435 (30)
CR, CRN 45			
	1-1 to 4-2	1-1 to 5	232 (16)
	4-2 to 8-1	6-2 to 13-2	435 (30)
CR, CRN 64			
	1-1 to 3	1-1 to 5	232 (16)
	4-2 to 5-2	6-2 to 8-1	435 (30)
CR, CRN 90			
	1-1 to 3	1-1 to 4	232 (16)
	4-2 to 4-1	5-2 to 6	435 (30)
CR, CRN 120			
	1-1 to 3		232 (16)
	4-2 to 5-2	1-1 to 5-2	435 (30)
CR, CRN 150			
	1-1 to 3		232 (16)
	4-1 to 4-2	1-1 to 4-2	435 (30)
CRT 2	2 to 18	2 to 26	305 (21)
CRT 4	1 to 16	1 to 22	305 (21)
CRT 8	1 to 8	1 to 12	232 (16)
	10 to 16	14 to 20	362 (25)
CRT 16	1 to 8	1 to 8	232 (16)
	10 to 12	10 to 16	362 (25)

Consult Grundfos in case of other operating conditions.

8. Installation



Warning
Do not turn on the power supply until the pump is properly installed.

8.1 Pump location

Locate the pump in a dry, well-ventilated, frost-free area which is not subject to extreme variation in temperature.

Make sure the pump is mounted at least 6 inches (150 mm) clear of any obstruction or hot surfaces.

The motor requires an adequate air supply to prevent overheating and adequate vertical space to remove the motor for repair.

In open systems requiring suction lift, locate the pump as close to the liquid source as possible to reduce friction loss in pipes.

8.2 Foundation

Use concrete or similar foundation material to provide a secure, stable mounting base for the pump.

See table below for bolt hole center line dimensions for the various pump types.

Secure the pump to the foundation using all four bolts and shim pump base to assure the pump is vertical and all four pads on the base are properly supported (uneven surfaces can result in pump base breakage when mounting bolts are tightened).

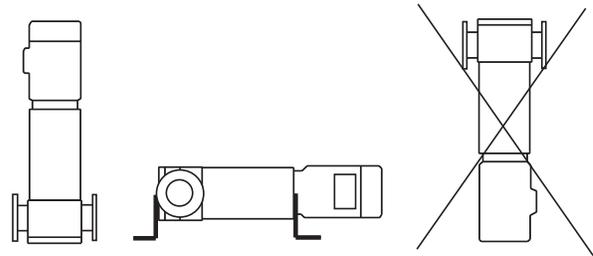


Fig. 4 Pump position

The pump can be installed vertically or horizontally. See fig. 4. Ensure that an adequate supply of cool air reaches the motor cooling fan. The motor must never fall below the horizontal plane.

Arrows on the pump base show the direction of flow of liquid through the pump.

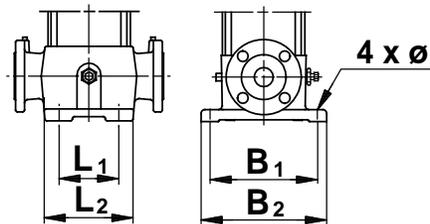
To minimize possible noise from the pump, it is advisable to fit expansion joints on either side of the pump and anti-vibration mountings between the foundation and the pump.

Note Make sure the vent plug is located in the uppermost position.

Fit isolating valves on either side of the pump to avoid draining the system if the pump needs to be cleaned, repaired or replaced.

TM04 3906 0409

Base and bolt hole center line dimensions



TM00 2256 3393

Pump type	L1		L2		B1		B2		Ø	
	[inches]	[mm]								
CR 1s, 1, 3, 5	3 15/16	100	5 11/16	145	7 1/16	180	8 11/16	220	1/2	13
CR1, CRN 1s 1, 3, 5 CRT 2, 4	3 15/16	100	5 7/8	150	7 1/16	180	8 11/16	220	1/2	13
CR 10, 15, 20	5 1/8	130	6 15/16	176	8 7/16	215	10 1/16	256	9/16	13.5
CRN 10, 15, 20 CRT 8, 16	5 1/8	130	7 7/8	200	8 7/16	215	9 3/4	248	1/2	13
CR 32	6 11/16	170	8 3/4	223	9 7/16	240	11 3/4	298	9/16	14
CRN 32	6 11/16	170	8 7/8	226	9 7/16	240	11 3/4	298	9/16	14
CR 45,64	7 1/2	190	9 3/4	248	10 1/2	266	13 1/16	331	9/16	14
CRN 45,64	7 1/2	190	9 7/8	251	10 1/2	266	13 1/16	331	9/16	14
CR, CRN 90	7 13/16	199	10 1/4	261	11	280	13 11/16	348	9/16	14
CR, CRN 120, 150	10 13/16	275	13 9/16	344	14 15/16	380	18 9/16	472	11/16	18

8.3 Pump mounting



Warning
CR, CRI, CRN pumps are shipped with covered suction and discharge ports. Remove the covers before the pipes are connected to the pump.

8.3.1 Recommended installation torques

Pump type	Recommended foundation torque [ft-lbs]	Recommended flange torque [ft-lbs]
CR, CRI, CRN 1s/1/3/5 and CRT 2/4	30	37-44
CR, CRI, CRN 10/15/20 and CRT 8/16	37	44-52
CR, CRN 32/45/64/90/120/150	52	52-59

8.4 Suction pipe

The suction pipe should be adequately sized and run as straight and short as possible to keep friction losses to a minimum (minimum of four pipe diameters straight run prior to the suction flange). Avoid using unnecessary fittings, valves or accessory items. Use butterfly or gate valves in the suction line only when it is necessary to isolate a pump because of a flooded suction condition. This would occur if the water source is above the pump. See fig. 5 and fig. 6. Flush piping prior to pump installation to remove loose debris.

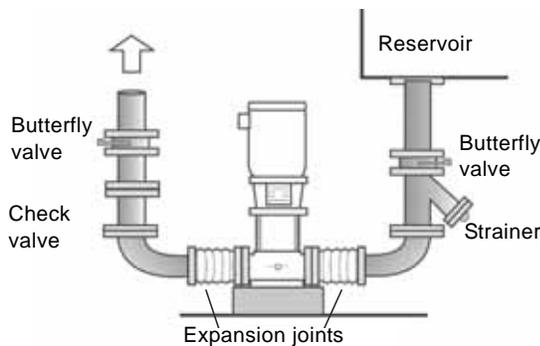


Fig. 5 Flooded suction

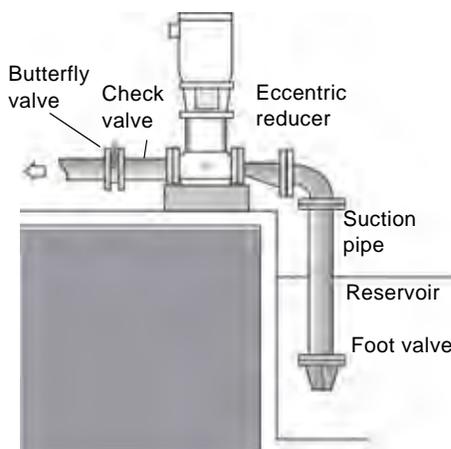


Fig. 6 Suction lift*

* The suction pipe should have a fitting on it for priming. CRN-SF pumps cannot be used for suction lift.

8.4.1 Suction pipe sizes

The following recommended suction pipe sizes are the smallest sizes which should be used with any specific CR pump type. The suction pipe size should be verified with each installation to ensure good pipe practices are being observed and excess friction losses are not encountered.

High temperatures may require larger diameter pipes to reduce friction and improve NPHSA.

Pump type	Min. suction pipe size	Min. suction pipe size
CR, CRI, CRN 1s, 1, 3; CRT 2	1"	Nominal diameter acc. to ANSI schedule 40
CR, CRI, CRN 5; CRT 4	1-1/4"	Nominal diameter acc. to ANSI schedule 40
CR, CRI, CRN 10, 15, 20; CRT 8, 16	2"	Nominal diameter acc. to ANSI schedule 40
CR, CRN 32	2-1/2"	Nominal diameter acc. to ANSI schedule 40
CR, CRN 45	3"	Nominal diameter acc. to ANSI schedule 40
CR, CRN64, 90	4"	Nominal diameter acc. to ANSI schedule 40
CR, CRN 120, 150	5"	Nominal diameter acc. to ANSI schedule 40

8.5 Discharge pipe

We suggest to install a check valve and an isolating valve in the discharge pipe.

Pipe, valves and fittings should be at least the same diameter as the discharge pipe or sized in accordance with good piping practices to reduce excessive liquid velocities and friction losses in pipes.

Caution *The pressure rating of pipes, valves and fittings must be equal to or greater than the maximum system pressure.*

Before installing the pump, pressure check the discharge piping to at least the maximum pressure the pump is capable of generating or as required by codes or local regulations.

Whenever possible, avoid high pressure loss fittings, such as elbows or branch tees directly on either side of the pump. The piping should be adequately supported to reduce thermal and mechanical stresses on the pump.

According to good installation practices, clean the system thoroughly and flush it of all foreign materials and sediment prior to pump installation. Furthermore, never install the pump at the lowest point of the system due to the natural accumulation of dirt and sediment. If there is excessive sediment or suspended particles, we recommend that a strainer or filter is used. Grundfos recommends that pressure gauges are installed on suction and discharge flanges or in pipes to monitor pump and system performance.



Warning
To avoid problems with water hammer, do not use quick-closing valves in CRN-SF applications.

TM05 9273 3613

TM05 9274 3613

8.6 Bypass

Install a bypass in the discharge pipe if there is any risk that the pump may operate against a closed valve in the discharge line. Flow through the pump is required to ensure that adequate cooling and lubrication of the pump is maintained. See [7.3 Minimum inlet pressures](#) for minimum flow rates. Elbows should be at least 12" from the bypass opening to prevent erosion.

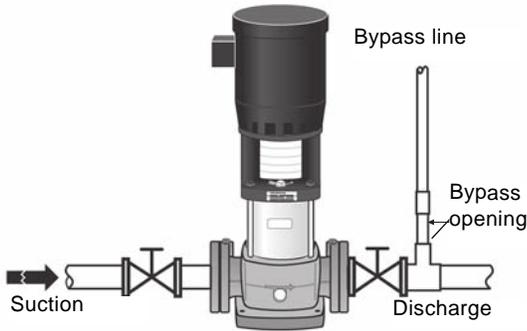


Fig. 7 Recommended bypass arrangement

TM04 3926 3613

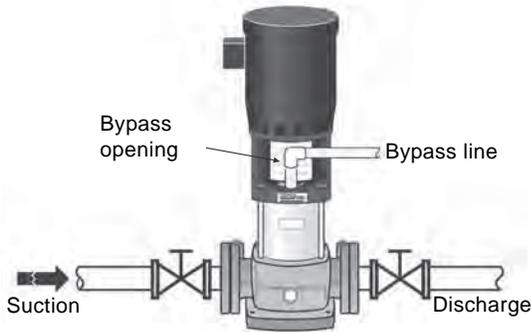


Fig. 8 Optional bypass arrangement

TM04 3909 3613

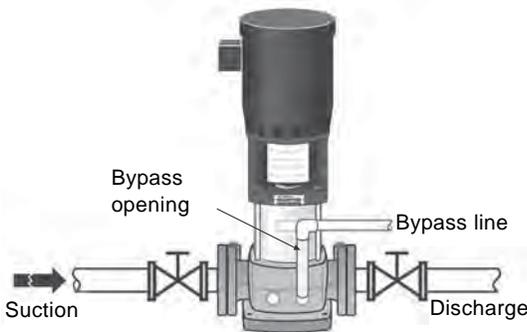
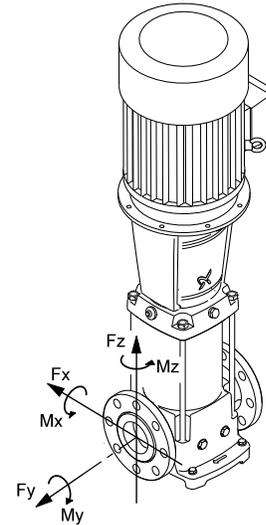


Fig. 9 Optional bypass arrangement for CR, CRI, CRN 32, 45, 64 and CR 90, 120 and 150 only

TM04 3924 0409

8.7 Flange forces and torques

If not all loads reach the maximum permissible value stated in the tables after fig. 10, one of these values may exceed the normal limit. Contact Grundfos for further information.



Y-direction: Direction of chamber stack
 Z-direction: 90 ° from inlet/outlet
 X-direction: Inlet/outlet

TM04 0346 1613

Fig. 10 Flange forces and torques

Flange	CR, CRI, CRN	Force [F]		
		Y-direction [lb]	Z-direction [lb]	X-direction [lb]
1 1/4"	1s to 5	171	263	175
2"	10, 15 and 20	303	371	337
2 1/2"	32	382	466	422
3"	45	461	562	506
4"	64 and 90	607	753	674
5", 6"	120 and 150	607	753	674

Flange	CR, CRI, CRN	Torque [M]		
		Y-direction [ft-lb]	Z-direction [ft-lb]	X-direction [ft-lb]
1 1/4"	1s to 5	605	715	900
2"	10, 15 and 20	738	848	1,033
2 1/2"	32	793	904	1,106
3"	45	848	959	1,180
4"	64 and 90	922	1,069	1,291
5", 6"	120 and 150	922	1,069	1,291

8.8 Minimum continuous duty flow rates [gpm]

Pump type	min. °F to 176 °F (min. °C to 80 °C)	at 210 °F (at 99 °C)	at 248 °F (at 120 °C)	at 356 °F (at 180 °C)
CR, CRI, CRN 1s	0.5	0.7	1.2	1.2*
CR, CRI, CRN 1	0.9	1.3	2.3	2.3*
CR, CRI, CRN 3	1.6	2.4	4.0	4.0*
CR, CRI, CRN 5	3.0	4.5	7.5	7.5*
CR, CRI, CRN 10	5.5	8.3	14	14*
CR, CRI, CRN 15	9.5	14	24	24*
CR, CRI, CRN 20	11	17	28	28*
CR, CRN 32	14	21	35	35*
CR, CRN 45	22	33	55	55*
CR, CRN 64	34	51	85	85*
CR, CRN 90	44	66	110	110*
CR, CRN 120	60	90	N/A	N/A
CR, CRN 150	75	115	N/A	N/A
CRT 2	1.3	2.0	3.3	N/A
CRT 4	3.0	4.5	7.5	N/A
CRT 8	4.0	6.0	10	N/A
CRT 16	8.0	12	20	N/A

* Grundfos Cool-Top® is only available in the following pump types:

Pump type	CR 1s	CR 1	CR 3	CR 5	CR 10	CR 15	CR 20	CR 32	CR 45	CR 64	CR 90
Standard (CR)								•	•	•	•
I version (CRI)	•	•	•	•	•	•	•				
N version (CRN)	•	•	•	•	•	•	•	•	•	•	•

8.9 Check valves

A check valve may be required on the discharge side of the pump to prevent the pump's inlet pressure from being exceeded.

When a pump with no check valve is stopped because there is no demand on the system (all valves are closed), the high system pressure on the discharge side of the pump will "find" its way back to the inlet of the pump.

This is especially critical for CRN-SF applications because of the very high discharge pressures involved. As a result, most CRN-SF installations require a check valve on the discharge piping.

8.10 Temperature rise

It may sometimes be necessary to stop the flow through a pump during operation.

When the flow is stopped, the power to the pump is transferred to the pumped liquid as head, causing a temperature rise in the liquid.

The result is risk of overheating and consequent damage to the pump. The risk depends on the temperature of the pumped liquid and for how long the pump is operating without flow. See the following temperature rise table.

Pump type	Time for temperature rise of 18 °F (10 °C)	
	Seconds	Minutes
CR 1s, 1, 3	210	3.5
CR 5	240	4.0
CR 10	210	3.5
CR 15	150	2.5
CR 20	120	2.0
CR 32, 45, 64, 90, 120, 150	60	1.0

Conditions/reservations

The listed times are subject to the following conditions/reservations:

- No exchange of heat with the surroundings.
- The pumped liquid is water with a specific heat capacity of $1.0 \text{ Btu/lb. } ^\circ\text{F}$ ($4.18 \text{ kJ/kg } ^\circ\text{C}$).
- Pump parts (chambers, impellers and shaft) have the same heat capacity as water.
- The water in the base and the pump head is not included.

These reservations should give sufficient safety margin against excessive temperature rise.

The maximum temperature must not exceed the pump maximum temperature rating.

8.11 Electrical connection

Warning

The safe operation of this pump requires that it is grounded in accordance with the National Electrical Code and local codes and regulations. Connect the ground conductor to the grounding screw in the terminal box and then to the ACCEPTABLE grounding point. All electrical work must be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code and local codes and regulations.



8.12 Motor

Grundfos CR pumps are supplied with heavy-duty, 2-pole (3600 rpm), ODP or TEFC, NEMA C frame motors selected to our rigid specifications.

Motors with other enclosure types and for other voltages and frequencies are available on a special-order basis.

CRN-SF pumps are supplied with an IEC (metric) type motor with a reverse thrust bearing.

If you replace the pump, but keep a motor previously used on another CR pump, be sure to read [11. Maintaining the motor](#) for proper adjustment of the coupling height.

8.13 Position of terminal box

The motor terminal box can be turned to any of four positions in steps of 90 °.

To rotate the terminal box, remove the four bolts securing the motor to the pump but do not remove the coupling. Turn the motor to the desired position; replace and securely tighten the four bolts. See [fig. 11](#).

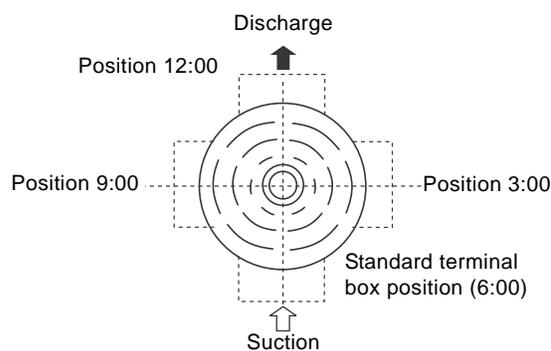


Fig. 11 Motor terminal box positions (top view)

8.14 Field wiring

Lead sizes should be based on the current carrying properties of conductors required by the latest edition of the National Electrical Code or local regulations. Direct-on-line (DOL) starting is approved due to the extremely short run-up time of the motor and the low moment of inertia of the pump and motor. If DOL starting is not acceptable and reduced starting current is required, use an auto transformer, resistant starter or soft starter. We suggest to use a fused disconnect for each pump in case standby pumps are installed.

TM04 3923 0409

8.15 Motor protection

8.15.1 Single-phase motors

All CR pumps with single phase motors, except 10 Hp, are equipped with multi-voltage, squirrel cage induction motors which include built-in thermal protection.

8.15.2 Three-phase motors

CR pumps with three-phase motors must be used with the proper size and type of motor-protective circuit breaker to ensure the motor is protected against damage from low voltage, phase failure, current unbalance and overloads.

Use a properly sized circuit breaker with manual reset and ambient-temperature compensated extra quick trip in all three phases. The overload protection should be set and adjusted to the full-load current rating of the motor. Under no circumstances should the overload protection be set to a higher value than the full-load current shown on the motor nameplate. This will void the warranty.

Set overload protection for auto transformers and resistant starters in accordance with the recommendations of the manufacturer.

Three-phase MLE motors (CRE-pumps) require only fuses as circuit breaker. They do not require a motor-protective circuit breaker. Check for phase unbalance (worksheet is provided; see section 17. *Worksheet for three-phase motors*).

Caution Standard allowable phase unbalance is 5 %.

8.15.3 CRN-SF

The CRN-SF is typically operated in series with a feed pump. Because the maximum allowable inlet pressure of the CRN-SF increases from 73 psi (when pump is off and during start-up) to 365 psi (during operation), use a control device to start the CRN-SF pump one second before the feed pump starts. Similarly, the CRN-SF must stop one second after the feed pump stops. See CRN-SF start-up timeline below.

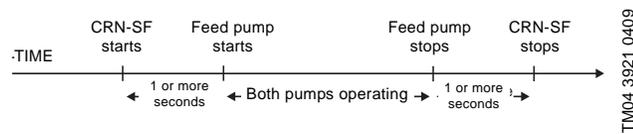


Fig. 12 CRN-SF start-up

TM04 3921 0409

9. Commissioning and start-up

9.1 Priming

To prime the pump in a closed system or an open system where the water source is above the pump, close the pump isolating valve(s) and open the priming plug on the pump head. See fig. 13, fig. 14, and fig. 15.

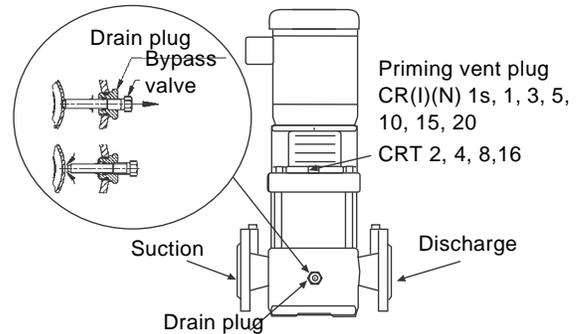


Fig. 13 Position of plugs and valve

TM04 3922 3613

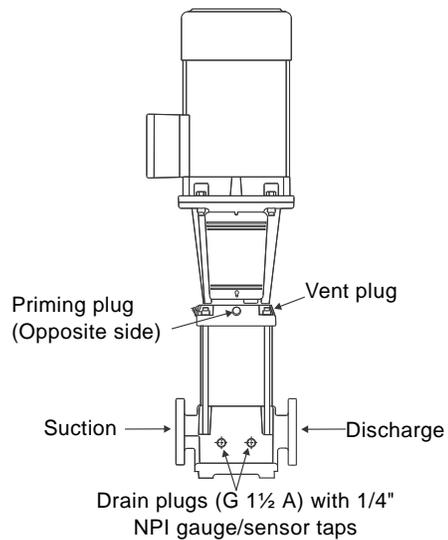


Fig. 14 Position of plugs CR, CRN 32, 45, 64, 90, 120, 150

TM04 4036 3613

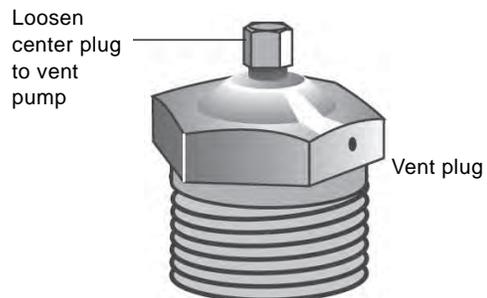


Fig. 15 Vent plug

TM04 3920 3613

Gradually open the isolating valve in the suction line until a steady stream of airless water runs out of the priming hole. Close the plug and tighten securely. Completely open the isolating valves.

In open systems where the water level is below the pump inlet, the suction pipe and pump must be filled with liquid and vented before starting the pump. Close the discharge isolating valve and remove the priming plug. Pour water through the priming hole until the suction pipe and pump are completely filled with liquid. If the suction pipe does not slope downwards away from the pump, the air must be purged while priming the pump. Replace the priming plug and tighten securely. For pumps with Cool-Top®, see section 15. *Start-up of pump with air-cooled top (Cool-Top®)*.

Follow these steps:

1. Switch off the power supply.
2. Check to make sure the pump has been filled and vented.
3. Remove the coupling guard and rotate the pump shaft by hand to make sure it turns freely.
4. Verify that the electrical connections are in accordance with the wiring diagram on the motor.
5. Switch on the power and observe the direction of rotation. When viewed from above, the pump should rotate counter-clockwise (clockwise for CRN-SF).
6. To reverse the direction of rotation, first switch off the power supply.
7. On three-phase motors, interchange any two phases of the power supply.
On single-phase motors, see wiring diagram on the nameplate. Change wiring as required.
8. Switch on the power again and check for proper direction of rotation. Once direction of rotation has been verified, switch off the power again. Do not attempt to reinstall the coupling guards while the motor is on. Replace the coupling guard if the direction of rotation is correct. When the guards are in place, the power can be switched on again.

Note

For CR, CRI, CRN 1s to 5 it is advisable to open the bypass valve during start-up. See fig. 13. The bypass valve connects the suction and discharge sides of the pump, thus making the filling procedure easier. Close the bypass valve when operation is stable.

Caution

Motors should not be run unloaded or uncoupled from the pump at any time; damage to the motor bearings will occur.

Do not start the pump before priming or venting the pump. See fig. 15. Never let the pump run dry.

9.2 Operating parameters

CR multi-stage centrifugal pumps installed in accordance with these instructions and sized for correct performance will operate efficiently and provide years of service. The pumps are water-lubricated and do not require any external lubrication or inspection. The motors may require periodic lubrication as described in section 11. *Maintaining the motor*.

Under no circumstances should the pump be operated for any prolonged periods of time without flow through the pump. This can result in motor and pump damage due to overheating. A properly sized relief valve should be installed to allow sufficient liquid to circulate through the pump to provide adequate cooling and lubrication of the pump bearings and seals.

9.3 Pump cycling

Pump cycling should be checked to ensure the pump is not starting more often than the following max. starts per hour:

Grundfos ML motors:

- 200 times per hour on 1/3 to 5 hp models
- 100 times per hour on 7 1/2 to 15 hp models
- 40 times per hour on 20 to 30 hp models.

Baldor motors:

- 20 times per hour on 1/3 to 5 hp models
- 15 times per hour on 7 1/2 to 15 hp models
- 10 times per hour on 20 to 100 hp models.

Rapid cycling is a major cause of premature motor failure due to overheating of the motor. If necessary, adjust controller to reduce the frequency of starts and stops.

9.4 Boiler feed installations

If the pump is used as a boiler feed pump, make sure the pump is capable of supplying sufficient water throughout its entire evaporation and pressure ranges. Where modulating control valves are used, a bypass around the pump must be installed to ensure pump lubrication. See section 7.3 *Minimum inlet pressures*.

9.5 Frost protection

If the pump is installed in an area where frost could occur, the pump and system should be drained during freezing temperatures to avoid damage. To drain the pump, close the isolating valves, remove the priming plug and drain plug at the base of the pump. Do not replace the plugs until the pump is to be used again. Always replace the drain plug with the original or an exact replacement. Do not replace with a standard plug. Internal recirculation will occur, reducing the output pressure and flow.

10. Maintaining the pump

Depending on the conditions and operating time, make the following checks at regular intervals:

- Check that the pump meets the required performance and is operating smoothly and quietly.
- Check that there are no leaks, particularly at the shaft seal.
- Check that the motor is not overheating.
- Remove and clean all strainers or filters in the system.
- Check that the tripping function of the motor overload protection works.
- Check the operation of all controls.
- If the pump is not operated for unusually long periods, maintain the pump in accordance with these instructions. In addition, if the pump is not drained, the pump shaft should be manually rotated or run for short periods of time at monthly intervals.
- In severe duty applications, pump life may be extended by performing one of the following actions:
 - Drain the pump after each use.
 - Flush the pump with water or other liquid that is compatible with the pump materials and process liquid.
 - Disassemble the pump and thoroughly rinse or wash components in contact with the pumped liquid with water or other liquid that is compatible with the pump materials and process liquid.

If the pump fails to operate or there is a loss of performance, see to section 16. *Diagnosing specific problems*.

11. Maintaining the motor



Warning

Before starting work on the motor, make sure that all power supplies to the motor have been switched off and that they cannot be accidentally switched on. Electric shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation, and maintenance of this equipment.

11.1 Motor inspection

Inspect the motor approximately every 500 hours of operation or every three months, whichever occurs first. Keep the motor clean and the ventilation openings clear.

Go through the following steps during each inspection:

1. Check that the motor is clean. Check that the interior and exterior of the motor are free of dirt, oil, grease, water, etc. Oily residue, paper, pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use an ohmmeter periodically to ensure that the winding insulation is OK. Record the ohmmeter readings, and immediately investigate any significant drop in insulation resistance.
3. Check all electrical connections to be sure that they are tightened securely.

11.3 Recommended lubricant

Severity of duty	Ambient temp. (max.)	Environment	Approved types of grease
Standard	+104 °F (+40 °C)	Clean, little corrosion	Grundfos ML motors are greased for life, or the grease type will be stated on the nameplate. Baldor motors are greased with Polyrex EM (Exxon Mobile).
Severe	+122 °F (+50 °C)	Moderate dirt, corrosion	
Extreme	>122 °F (+50 °C) or class H insulation	Severe dirt, abrasive dust, corrosion	

11.4 Lubricating chart (for motors with grease zerks)

New motors that have been stored for a year or more should be regreased according to the following table:

NEMA (IEC) frame size	Service intervals [hours]			Weight of grease [oz (grams)]	Volume of grease [in ³ (teaspoons)]
	Standard duty	Severe duty	Extreme duty		
Up to and incl. 210 (132)	5500	2750	550	0.30 (8.4)	0.6 (2)
Over 210 up to and incl. 280 (180)	3600	1800	360	0.61 (17.4)	1.2 (3.9)
Over 280 up to and incl. 360 (225)	2200	1100	220	0.81 (23.1)	1.5 (5.2)
Over 360 (225)	2200	1100	220	2.12 (60.0)	4.1 (13.4)

11.2 Motor lubrication

Electric motors are pre-lubricated from factory and do not require additional lubrication at start-up. Motors without external grease zerks have sealed bearings that cannot be re-lubricated. Motors with grease zerks should only be lubricated with approved types of grease. Do not over-grease the bearings. Over-greasing will cause increased bearing heat and can result in bearing or motor failure. Do not mix oil-based grease and silicon grease in motor bearings.

Bearing grease will lose its lubricating ability over time. The lubricating ability of a grease depends primarily on the type of grease, the size of the bearings, the speed at which the bearings operate and the severity of the operating conditions.

Good results can be obtained if the following recommendations are used in your maintenance program. It should also be noted that multistage pumps, pumps running to the left of the performance curve, and certain pump ranges may have higher thrust loads. Pumps with high thrust loads should be greased according to the next service interval level.



Warning

The grease outlet plug *MUST* be removed before adding new grease.

11.5 Lubricating procedure

Keep grease free from dirt to avoid damage to motor bearings. If the environment is extremely dirty, contact Grundfos, the motor manufacturer, or an authorized service center for additional information.

Caution

Do not mix dissimilar types of grease.

1. Clean all grease zerks. If the motor does not have grease zerks, the bearing is sealed and cannot be greased externally.
2. If the motor is equipped with a grease outlet plug, remove it. This will allow the old grease to be displaced by the new grease. If the motor is stopped, add the recommended amount of grease. If the motor is to be lubricated while running, add a slightly greater quantity of grease.
3. Add grease SLOWLY taking approximately one minute until new grease appears at the shaft hole in the flange or grease outlet plug. Never add more than 1 1/2 times the amount of grease shown in the lubricating chart.

If new grease does not appear at the shaft hole or grease outlet, the outlet passage may be blocked. Contact Grundfos service center or certified motor shop.

Note

4. Let motors equipped with a grease outlet plug run for 20 minutes before replacing the plug.

12. Replacing the motor

Motors used on CR pumps are specifically selected to our rigid specifications. Replacement motors must be of the same frame size, should be equipped with the same or better bearings and have the same service factor. Failure to follow these recommendations may result in premature motor failure.

Caution

If the motor is damaged due to bearing failure, burning or electrical failure, observe the following instructions as to how to remove the motor and how to mount the replacement motor.



Warning

Before starting work on the motor, make sure that the mains switch has been switched off. It must be ensured that the power supply cannot be accidentally switched on.

12.1 Disassembly

Proceed as follows:

1. Disconnect the power supply leads from the motor. Remove the coupling guards.

Note

For CR 1s, 1, 3, 5, 10, 15, and 20: Do not loosen the three hexagon socket head cap screws securing the shaft seal.

2. Use the proper metric hexagon key to loosen the four cap screws in the coupling. Remove coupling halves completely. On CR 1s-CR 20, the shaft pin can be left in the pump shaft. CR, CRN 32, 45, 64, 90, 120, and 150 do not have a shaft pin.
3. Use the correct size spanner to loosen and remove the four mounting bolts joining motor and pump.
4. Lift the motor straight up until the shaft has cleared the motor stool.

12.2 Assembly

Proceed as follows:

1. Remove key from motor shaft, if present, and discard.
2. Thoroughly clean the surfaces of the motor and pump mounting flanges. The motor and shaft must be clean of all oil or grease and other contaminants where the coupling attaches. Place the motor on top of the pump.
3. Turn the terminal box to the desired position by rotating the motor.
4. Insert the four mounting bolts, then tighten diagonally and evenly:
 - for 3/8" bolts (1/2 - 2 hp), torque = 17 ft-lb
 - for 1/2" bolts (3 - 40 hp), torque = 30 ft-lb
 - for 5/8" bolts (50 - 100 hp), torque = 59 ft-lb
 - follow instructions for particular pump model in sections [12.2.2 CR 1s, 1, 3, and 5](#) to [12.2.5 CR, CRN 32, 45, 64, 90, 120, and 150](#).

12.2.1 Torque specifications

Torque specifications CR, CRI, CRN 1s, 1, 3, 5, 10, 15, and 20 CRT 2, 4, 8, and 16	
Coupling screw size	Minimum torque
M6	10 ft-lb
M8	23 ft-lb
M10	46 ft-lb

12.2.2 CR 1s, 1, 3, and 5

1. Insert shaft pin into shaft hole.
2. Mount the coupling halves onto shaft and shaft pin.
3. Fit the coupling screws and leave loose. Check that the gaps on either side of the coupling are even and that the motor shaft keyway is centered in the coupling half as shown in fig. 16.
4. Tighten the screws to the correct torque. See section [12.2.1 Torque specifications](#).

12.2.3 CR 10, 15 and 20

1. Insert shaft pin into shaft hole.
2. Insert plastic shaft seal spacer beneath shaft seal collar.
3. Mount the coupling halves onto shaft and shaft pin.
4. Fit the coupling screws and leave loose. Check that the gaps on either side of the coupling are even and that the motor shaft keyway is centered in the coupling half as shown in fig. 16.
5. Tighten the screws to the correct torque. See section [12.2.1 Torque specifications](#).
6. Remove plastic shaft seal spacer and hang it on inside of coupling guard.

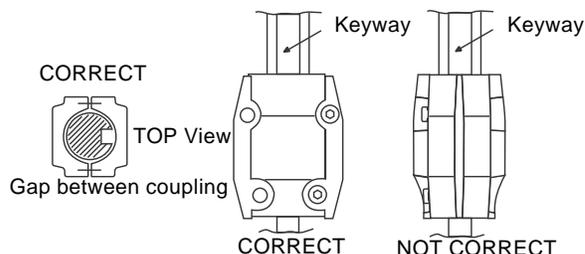


Fig. 16 Coupling adjustment all CR, CRI, CRN, CRT

12.2.4 CRT 2, 4, 8 and 16

1. Mount coupling halves. Make sure the shaft pin is located in the pump shaft.
2. Put the cap screws loosely back into the coupling halves.
3. Using a large screwdriver, raise the pump shaft by placing the tip of the screwdriver under the coupling and carefully raising the coupling to its highest point. See fig. 17.

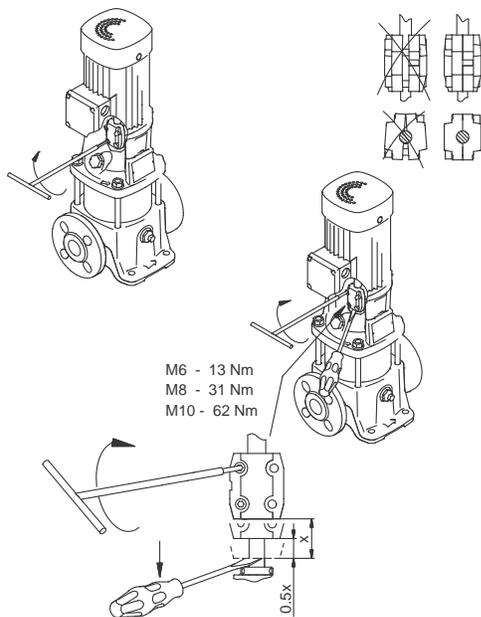


Fig. 17 Coupling adjustment CRT 2, 4, 8, and 16

Note *The shaft can only be raised approximately 0.20 inches (5 mm).*

4. Now lower the shaft halfway back the distance you just raised it and tighten the coupling screws (finger tight) while keeping the coupling separation equal on both sides. When the screws are tight enough to keep the coupling in place, then cross-tighten the screws.

- Note the clearance below the coupling.
- Raise the coupling as far as it will go.
- Lower it halfway back down (1/2 the distance you just raised it).
- Tighten screws (see torque specifications).

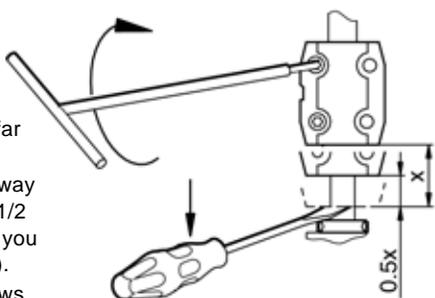


Fig. 18 Coupling adjustment clearance CRT 2, 4, 8, and 16

12.2.5 CR, CRN 32, 45, 64, 90, 120, and 150

1. Make sure pump shaft is all the way down. Tighten the set screws on the mechanical shaft seal.
2. Place the plastic adjusting fork under the cartridge seal collar. See fig. 19.

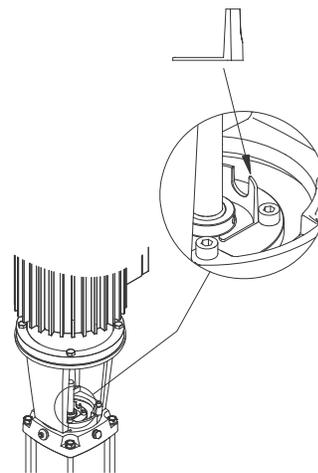


Fig. 19 Coupling adjustment CR, CRN 32, 45, 64, 90, 120, and 150

3. Fit the coupling on the shaft so that the top of the pump shaft is flush with the bottom of the clearance chamber in the coupling. See fig. 20.

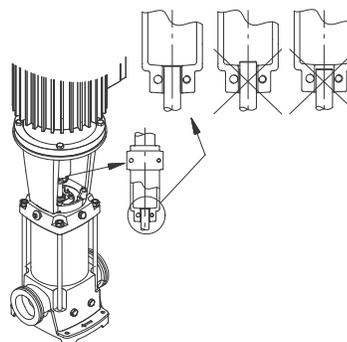
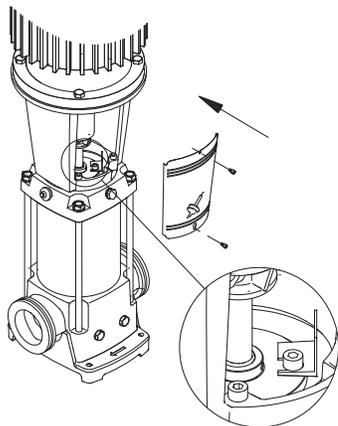


Fig. 20 Coupling adjustment clearance CR, CRN 32, 45, 64, 90, 120, and 150

Caution *To avoid damaging the coupling halves, ensure that the motor shaft keyway is centered in the coupling half as shown in fig. 16.*

4. Lubricate the coupling screws with an anti-seize, lubricating compound. Tighten the coupling screws (finger tight) while keeping the coupling separation equal on both sides and the motor shaft keyway centered in the coupling half as shown in fig. 16. When the screws are tight enough to keep the coupling in place, then cross-tighten the screws.

- Tighten coupling screws to 62 ft-lbs (75 and 100 hp motors to 74 ft-lbs). Remove the adjusting fork from under the cartridge seal collar and replace it to the storage location. See fig. 21.



TM04 3915 3613

Fig. 21 Adjusting fork storage CR, CRN 32, 45, 64, 90, 120, and 150

- Check to see that the gaps between the coupling halves are equal. Loosen and readjust, if necessary.
- Make sure the pump shaft can be rotated by hand. If the shaft cannot be rotated or it jams, disassemble and check for misalignment.
- Prime the pump.
- Follow the wiring diagram on the motor label for the correct motor wiring combination which matches your supply voltage. Once this has been confirmed, reconnect the power supply leads to the motor.
- Check the direction of rotation by bump-starting the motor. Direction of rotation must be left to right (counter-clockwise) when looking directly at the coupling.
- Switch off the power, then mount the coupling guards. When the coupling guards have been mounted, the power can be switched on again.

13. Parts list

Grundfos offers an extensive parts list for each CR pump model. A parts list typically covers the following items:

- a diagram of pump parts which we recommend to have on hand for future maintenance
- a list of prepacked service kits covering the pump components most likely to be exposed to wear over time
- complete impeller stacks needed to replace the rotating assembly of each model.

These parts lists are available separately from the Grundfos literature warehouse or as a set with extensive service instructions in the Grundfos CR Service Manuals.



TM05 9272 3613

Fig. 22 Prepacked impeller stack kits



TM04 3916 1609

Fig. 23 Prepacked flange kits

13.1 Spare parts

Grundfos offers an extensive list of spare parts. For a current list of these parts, see Grundfos All Product Spare Parts/Service Kits Price List, part number L-SK-SL-002.

14. Preliminary electrical tests

Warning

When working with electrical circuits, use caution to avoid electrical shock. It is recommended that rubber gloves and boots be worn, and metal terminal boxes and motors are grounded before any work is done. For your protection, always disconnect the pump from its power source before handling.

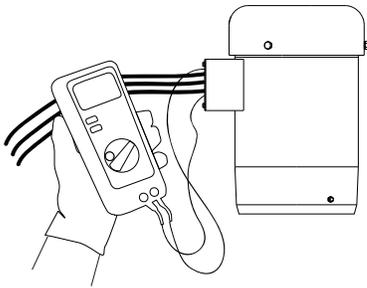


14.1 Supply voltage

14.1.1 How to measure the supply voltage

Use a voltmeter, (set to the proper scale) measure the voltage at the pump terminal box or starter. On single-phase units, measure between power leads L1 and L2 (or L1 and N for 115 volt units). On three-phase units, measure between:

- Power leads L1 and L2
- Power leads L2 and L3
- Power leads L3 and L1.



TM04 3911 2609

Fig. 24 Measuring supply voltage

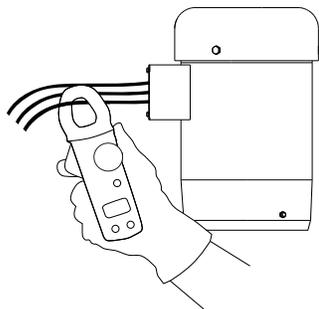
14.1.2 What the supply voltage measurement means

When the motor is under load, the voltage should be within $\pm 10\%$ of the nameplate voltage. Larger voltage variation may cause winding damage. Large variations in the voltage indicate a poor electrical supply and the pump should not be operated until these variations have been corrected. If the voltage constantly remains high or low, the motor should be changed to the correct supply voltage.

14.2 Current

14.2.1 How to measure the current

Use an ammeter (set on the proper scale) to measure the current on each power lead at the terminal box or starter. See the motor nameplate for amp draw information. Current should be measured when the pump is operating at constant discharge pressure.



TM04 3908 2609

Fig. 25 Measuring current

14.2.2 What the current measurement means

If the amp draw exceeds the listed service factor amps (SFA) or if the current imbalance is greater than 5% between each leg on three-phase units, check the following:

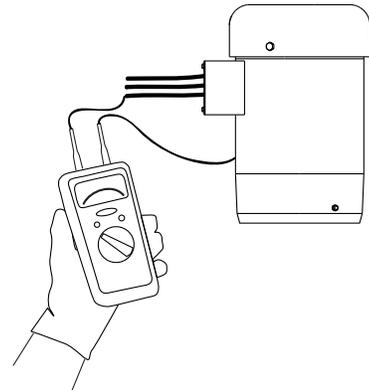
- Burned contacts on motor starter.
- Loose terminals in starter or terminal box or possible wire defect.
- Too high or too low supply voltage.
- Motor windings are shorted or grounded. Check winding and insulation resistances.
- Pump is damaged causing a motor overload.

Fault	Remedy
Burned contacts in the motor-protective circuit breaker.	Replace contacts.
Loose terminals in motor-protective circuit breaker or terminal box or possibly defective lead.	Tighten terminals or replace lead.
Too high or too low supply voltage.	Reestablish correct supply voltage.
Motor windings are short-circuited or grounded. (Check winding and insulation resistances).	Remove cause of short circuit or earthing.
Pump is damaged causing motor overload.	Replace defective pump parts.

14.3 Insulation resistance

14.3.1 How to measure the insulation resistance

Turn off power and disconnect the supply power leads in the pump terminal box. Using an ohm or mega ohm meter, set the scale selector to Rx 100K and zero adjust the meter. Measure and record the resistance between each of the terminals and ground.



TM04 3907 2609

Fig. 26 Measuring insulation resistance

14.3.2 What the insulation resistance measurement means

Motors of all hp, voltage, phase and cycle duties have the same value of insulation resistance. Resistance values for new motors must exceed 1,000,000 ohms. If they do not, the motor should be repaired or replaced.

15. Start-up of pump with air-cooled top (Cool-Top®)

Caution Do not start the pump until it has been filled with liquid and vented.



Warning

Pay attention to the direction of the vent hole and ensure that the escaping liquid does not cause injury to persons or damage to the motor or other components. In hot-liquid installations, pay special attention to the risk of injury caused by scalding hot liquid. We recommend you to connect a drain pipe to the 1/2" air vent in order to lead the hot water/steam to a safe place.

Step	Action	
1		<p>Note The air-cooled top should only be started up with cold liquid. Close the isolating valve on the discharge side and open the isolating valve on the suction side of the pump.</p>
2		<p>Remove the priming plug from the air-cooled chamber (pos. 2) and slowly fill the chamber with liquid.</p> <p>When the chamber is completely filled with liquid, replace the priming plug and tighten securely.</p>
3		<p>Open the isolating valve on the discharge side of the pump. The valve may have to be partially closed when pump is started if there is no counter pressure (i.e. boiler not up to pressure).</p>
4		<p>Start the pump and check the direction of rotation.</p> <p>See the correct direction of rotation of the pump on the motor fan cover.</p> <p>If the direction of rotation is wrong, interchange any two of the incoming power supply leads.</p> <p>After 3 to 5 minutes, the air vent has been filled with liquid.</p> <p>Note During start-up of a cold pump with hot liquid, it is normal that a few drops of liquid are leaking from the sleeve.</p>

16. Diagnosing specific problems



Warning

Before removing the terminal box cover and before removing/dismantling the pump, make sure that the power supply has been switched off and that it cannot be accidentally switched on.

Problem	Possible cause	Remedy
1. The pump does not run.	a) No power at motor.	Check voltage at motor terminal box. If no voltage at motor, check feeder panel for tripped circuits and reset circuit.
	b) Fuses are blown or circuit breakers are tripped.	Turn off power and remove fuses. Check for continuity with ohmmeter. Replace blown fuses or reset circuit breaker. If new fuses blow or circuit breaker trips, the electrical installation, motor and wires must be checked.
	c) Motor starter overloads are burned or have tripped out.	Check for voltage on line and load side of starter. Replace burned heaters or reset. Inspect starter for other damage. If heater trips again, check the supply voltage and starter holding coil.
	d) Starter does not energize.	Energize control circuit and check for voltage at the holding coil. If no voltage, check control circuit fuses. If voltage, check holding coil for shorts. Replace bad coil.
	e) Defective controls.	Check all safety and pressure switches for operation. Inspect contacts in control devices. Replace worn or defective parts or controls.
	f) Motor is defective.	Turn off power and disconnect wiring. Measure the lead to lead resistances with ohmmeter (RX-1). Measure lead to ground values with ohmmeter (RX-100K). Record measured values. If an open or grounded winding is found, remove motor and repair or replace.
	g) Defective capacitor (single-phase motors).	Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity (h). Replace if defective.
	h) Pump is bound.	Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair.

Problem	Possible cause	Remedy
2. The pump runs but at reduced capacity or does not deliver water.	a) Wrong rotation.	Check wiring for proper connections. Correct wiring.
	b) Pump is not primed or is airbound.	Turn pump off, close isolation valve(s), remove priming plug. Check fluid level. Refill the pump, replace plug and start the pump. Long suction lines must be filled before starting the pump.
	c) Strainers, check or foot valves are clogged.	Remove strainer, screen or valve and inspect. Clean and replace. Reprime pump.
	d) Suction lift too large.	Install compound pressure gauge at the suction side of the pump. Start pump and compare reading to performance data. Reduce suction lift by lowering pump, increase suction line size or removing high friction loss devices.
	e) Suction and/or discharge piping leaks.	Pump spins backwards when turned off. Air in suction pipe. Suction pipe, valves and fittings must be airtight. Repair any leaks and retighten all loose fittings.
	f) Pump worn.	Install pressure gauge, start pump, gradually close the discharge valve and read pressure at shutoff. Convert measured pressure (in psi) to head (in feet): (Measured psi x 2.31 ft/psi = ____ ft). Refer to the specific pump curve for shutoff head for that pump model. If head is close to curve, pump is probably OK. If not, remove pump and inspect.
	g) Pump impeller or guide vane is clogged.	Disassemble and inspect pump passageways. Remove any foreign materials found.
	h) Incorrect drain plug is installed.	If the proper drain plug is replaced with a standard plug, water will recirculate internally. Replace with proper plug.
	i) Improper coupling setting.	Check/reset the coupling; see page 18.
3. Pump cycles too much	a) Pressure switch is not properly adjusted or is defective.	Check pressure setting on switch and operation. Check voltage across closed contacts. Readjust switch or replace if defective.
	b) Level control is not properly adjusted or is defective.	Check setting and operation. Readjust setting (refer to level control manufacturer's data). Replace if defective.
	c) Insufficient air charging or leaking tank or piping.	Pump air into tank or diaphragm chamber. Check diaphragm for leak. Check tank and piping for leaks with soap and water solution. Check air to water volume. Repair as necessary.
	d) Tank is too small.	Check tank size and air volume in tank. Tank volume should be approximately 10 gallons for each gpm of pump capacity. The normal air volume is 2/3 of the total tank volume at the pump cut-in pressure. Replace tank with one of correct size.
	e) Pump is oversized.	Install pressure gauges on or near pump suction and discharge ports. Start and run pump under normal conditions, record gauge readings. Convert psi to feet (Measured psi x 2.31 ft/psi = ____ ft) Refer to the specific pump curve for that model, ensure that total head is sufficient to limit pump delivery within its design flow range. Throttle pump discharge flow if necessary.

Problem	Possible cause	Remedy
4. Fuses blow or circuit breakers or overload relays trip	a) Tank is too small.	Check voltage at starter panel and motor. If voltage varies more than -10% / $+10\%$, contact power company. Check wire sizing.
	b) Motor overloads are set too low.	Cycle pump and measure amperage. Increase heater size or adjust trip setting to a maximum of motor nameplate (full load) current.
	c) Three-phased current is imbalanced.	Check current draw on each lead to the motor. Must be within -5% / $+5\%$. If not, check motor and wiring. Rotating all leads may eliminate this problem.
	d) Motor is shorted or grounded.	Turn off power and disconnect wiring. Measure the lead-to-lead resistance with an ohmmeter (RX-1). Measure lead-to-ground values with an ohmmeter (RX-100K) or a megaohm meter. Record values. If an open or grounded winding is found, remove the motor, repair and/or replace.
	e) Wiring or connections are faulty.	Check proper wiring and loose terminals. Tighten loose terminals. Replace damaged wire.
	f) Pump is bound.	Turn off power and manually rotate pump shaft. If shaft does not rotate easily, check coupling setting and adjust as necessary. If shaft rotation is still tight, remove pump and inspect. Disassemble and repair.
	g) Defective capacitor (single-phase motors).	Turn off power and discharge capacitor. Check with ohmmeter (RX-100K). When the meter is connected to the capacitor, the needle should jump towards 0 ohms and slowly drift back to infinity (h). Replace if defective.
	h) Motor overloads at higher ambient temperature than motor.	Use a thermometer to check the ambient temperature near the overloads and motor. Record these values. If ambient temperature at motor is lower than at overloads, especially where temperature at overloads is above $+104^{\circ}\text{F}$ ($+40^{\circ}\text{C}$), ambient-compensated heaters should replace standard heaters.

17. Worksheet for three-phase motors

Below is a worksheet for calculating current unbalance on a three-phase hookup. Use the calculations below as a guide.

Note

Current unbalance should not exceed 5% at service factor load or 10% at rated input load. If the unbalance cannot be corrected by rolling leads, the source of the unbalance must be located and corrected. If, on the three possible hookups, the leg farthest from the average stays on the same power lead, most of the unbalance is coming from the power source. However, if the reading farthest from the averages moves with the same motor lead, the primary source of unbalance is on the "motor side" of the starter. In this instance, consider a damaged cable, leaking splice, poor connection, or faulty motor winding.

Explanation and examples

Here is an example of current readings at maximum pump loads on each leg of a three-wire hookup. You must make calculations for all three hookups. To begin, add up all three readings for hookup numbers 1, 2, and 3.

Hookup 1	
T1 =	51 amps
T2 =	46 amps
T3 =	53 amps
TOTAL =	150

Divide the total by three to obtain the average.

Hookup 1	
	50 amps
3	150 amps

Calculate the greatest current difference from the average.

Hookup 1	
	50 amps
—	46 amps
	4 amps

Divide this difference by the average to obtain the percentage of the unbalance. In this case, the current unbalance for **Hookup 1** is 8%.

Hookup 1	
	.08 or 8%
50	4.00 amps

Blank worksheet

Hookup 1	
L ₁ to T ₁ =	___ amps
L ₂ to T ₂ =	___ amps
L ₃ to T ₃ =	___ amps
TOTAL =	___ amps

Hookup 2	
L ₁ to T ₃ =	___ amps
L ₂ to T ₁ =	___ amps
L ₃ to T ₂ =	___ amps
TOTAL =	___ amps

Hookup 3	
L ₁ to T ₂ =	___ amps
L ₂ to T ₃ =	___ amps
L ₃ to T ₁ =	___ amps
TOTAL =	___ amps

Hookup 1	
	___ amps
3	___ amps

Hookup 2	
	___ amps
3	___ amps

Hookup 3	
	___ amps
3	___ amps

Hookup 1	
	___ amps
	___ amps
	___ amps

Hookup 2	
	___ amps
	___ amps
	___ amps

Hookup 3	
	___ amps
	___ amps
	___ amps

Hookup 1	
	___ or ___ %
___	___ amps

Hookup 2	
	___ or ___ %
___	___ amps

Hookup 3	
	___ or ___ %
___	___ amps

GRUNDFOS Kansas City

17100 West 118th Terrace
Olathe, Kansas 66061
Phone: (913) 227-3400
Fax: (913) 227-3500

www.grundfos.us

GRUNDFOS Canada

2941 Brighton Road
Oakville, Ontario L6H 6C9 Canada
Phone: +1-905 829 9533
Telefax: +1-905 829 9512

www.grundfos.ca

GRUNDFOS México

Boulevard TLC No. 15
Parque Industrial Stiva Aeropuerto
C.P. 66600 Apodaca, N.L. México
Phone: 011-52-81-8144 4000
Fax: 011-52-81-8144 4010

www.grundfos.mx

L-CR-TL-001

98419736 0913

ECM: 1120715

© Copyright Grundfos Holding A/S

The name Grundfos, the Grundfos logo, and be think innovate are registered trademarks owned by Grundfos Holding A/S or Grundfos A/S, Denmark. All rights reserved worldwide.