



Test plan Electric Machines

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Registration number

19.12.24X1

Date

Dec 19, 2024

Version

0.2

Status

Definitive

Section

HHNK PAO

Total Pages

40

1. Machine Test Document

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Machine Test Requirements

Torque measurement or calculated ⁽¹⁾

Machine test performed with:

- torque measurement
- calculated torque

X

Variable Speed Drive (VSD) ⁽¹⁾

Machine tests performed:

- without VSD
- with VSD from test bench
- with new VSD of end-user HHNK

X

Machine Testing Witnesses ⁽¹⁾

Witnesses machine testing of end-user HHNK:

- No
- Yes

X

(2 persons HHNK)

(1) : If not otherwise selected the preferred choice is: torque measurement, machine test with new HHNK VSD and test witnessed by HHNK.

Abbreviations in Test Plan

N.A. = Not Applicable

N.I. = Not Inspected

N.T. = Not Tested

This Test Plan has been drawn up for testing one electrical machine.
If multiple machines are supplied, copy the Test Plan and apply it repeatedly.

1.1 Project Information

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



1.1 Project

Project name	Gemaal De Helsdeur	
Pump number	P1	
Motor type		
Serial number		
Motor description		
Power		kW
Speed		rpm

1.2 Manufacturer

Company name	
Visiting address	
Postal address	
Telephone	
e-mail	
Website	
Order nr.	

1.3 Supplier

Company name	
Visiting address	
Postal address	
Telephone	
e-mail	
Website	
Order nr.	

1.4 Test location

Company name	
Visiting address	
Postal address	
Telephone	
e-mail	
Website	
Order nr.	

1.5 Customer

Company name	
Visiting address	
Postal address	
Telephone	
e-mail	
Website	
Order nr.	

1.6 End customer

Company name	Hoogheemraadschap Hollands Noorderkwartier (HHNK)
Visiting address	Stationsplein 136, 1703 WC Heerhugowaard, Nederland
Postal address	Postbus 250, 1700 AG Heerhugowaard, Nederland
Telephone	+31(0)72-582 8282
e-mail	n.a.
Website	www.hhnk.nl
Order nr.	

1.2 Test approval

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Function	Name and signature	Place and Date
Electric machine measured by		
Electric machine test approved by supplier		
Electric machine test approved by tester of test location		
Electric machine test approved by customer		
Electric machine test approved by end customer		

Company stamp test location	Test Status
	Not - approved Approved

2.1 Test Protocols

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



		Mandatory Tests IM	Mandatory Tests PM	IEC-34-1	Test Sequence	
3.1	Visual Inspection	X	X	R	1	
3.2	Basic Tests	X	X	R	2	
3.3	Insulation resistance (cold)	X	X	R	3	
3.4	Winding resistance method (cold)	X	X	R	4	
3.5	Resistance measurement PT-100 (cold)	X	X	R	5	
3.6	Resistance PTC stop (cold)	X	X	R	6	
3.7	Resistance PTC warning (cold)	X	X	R	7	
3.8	Insulation AC High Potential Test (AC HiPot)	X	X	R	8	
3.9	BEMF measurement (cold)	-	X	-	9	only in case of PM machine
3.10	Overspeed test	X	X	R	10	
3.11	Temperature Rise Test ETD (cold & hot)	X	X	R	11	
3.12	Temperature Rise Test Bearings (cold & hot)	X	X	R	12	
3.13	Winding resistance method (hot)	X	X	R	13	
3.14	Calculated winding temperature rise test	X	X	R	14	
3.15	Load test	X	X	R	15	
3.16	No-load test	X	X	R	16	
3.17	Vibration test	X	X	R	17	
3.18	Noise test	X	X	R	18	
3.19	Locked rotor test	X	-	R	19	only in case of IM machine
3.20	BEMF measurement (hot)	-	X	-	20	only in case of PM machine
3.21	Insulation tests (hot)	X	X	R	21	
3.22	Resistance measurement PT-100 (hot)	X	X	R	22	

(a) Mandatory Tests to perform are depending on machine type: IM = Induction Machine, PM = Permanent Magnet Machine (Surface Mounted);

(b) Non-Salient;

(c) X = Mandatory test that has been carried out, depends on IM or PM.

(d) IEC-34, refers to the comparable tests according to norm NEN EN IEC 60034-1, R = Routine Test, T=Type Test, - = not specified.

3.1.1 Visual Inspection

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3.1.1.1 Check values nameplate							
Check values nameplate	Imposed		Remarks	Pass	Fail	N.A.	N.I.
Fabricate							
Type							
Serial number							
Voltage	500	V					
Current		A					
PF		-	100% full load				
Efficiency	94,00	%	100% full load				
Frequency		Hz					
Power		kW					
Speed		rpm					
Connection		-					
Rated torque (full load)		Nm					

3.1.1.2 Check specifications							
Check specifications	Imposed		Remarks	Pass	Fail	N.A.	N.I.
Frame material							
Cooling medium	air						
Cooling type	IC-416		Totally Enclosed Forced Ventilation (TEFV)				
Paint colour	RAL-1005						
	Honey Yellow						

3.1.1.3 Check parts position							
Check parts position	Imposed		Remarks	Pass	Fail	N.A.	N.I.
Main terminal box	drawing						
Aux. terminal box	drawing						
Heater	drawing						
Cool Fan	drawing						
Cool Fan Motor	drawing						
Lubrication points	drawing						
Vibration measuring points	drawing						
Mounting arrangement	IM-3011 / IM-V1						

3.1.2 Visual Inspection

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3.1.2.1 Check dimensions

Check dimensions	Imposed		Remarks	Pass	Fail	N.A.	N.I.
Main terminal box	drawing						
Main cable glands	drawing....						
Aux. terminal box	drawing						
Aux. cable glands	drawing....						
Motor outer dimensions	drawing						
Motor frame	drawing						
Flange	drawing						
Shaft coupling	drawing						
Heater	drawing						
Cool Fan	drawing						
Cool Fan Motor	drawing						
Lubrication points	drawing						

3.1.2.2 Check housing protection

Check housing protection	Imposed		Remarks	Pass	Fail	N.A.	N.I.
Main terminal box	>=IP-55						
Aux. terminal box	>=IP-55						
Motor	>=IP-23						
Heater	>=IP-23						
Cool Fan Motor	>=IP-23						

3.1.2.3 Check terminal coding

Check terminal coding	Imposed		Remarks	Pass	Fail	N.A.	N.I.
Main terminal box	drawing						
Aux. terminal box	drawing						

3.1.3 Visual Inspection

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3.1.3.1 Check bearings

Check bearings	Imposed		Remarks	Pass	Fail	N.A.	N.I.
Bearing DE							
Bearing NDE							
Bearing NDE insulated	yes						
Bearings filled with lubrication							
Shaft grounding ring	Aegis						

3.1.3.2 Check for damage and/or production errors

Check for damage and/or production errors	Remarks	Pass	Fail	N.A.	N.I.
Main terminal box					
Main cable glands					
Aux. terminal box					
Aux. cable glands					
Motor outer dimensions					
Motor frame					
Flange					
Shaft coupling					
Heater					
Cool Fan					
Cool Fan Motor					
Lubrication points					

3.2. Basic Tests

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3.2.1 Check weight and inertia measurements

Check weight and inertia measurements	Imposed		Remarks	Pass	Fail	N.A.	N.I.
Total weight of the machine		kg	max. lifting weight crane				
Total weight of the rotor		kg					
Moment of inertia rotor		Kgm ²					

3.2.2 Check Rotor shaft is sufficiently centred

Check Rotor shaft is sufficiently centred	Remarks	Pass	Fail	N.A.	N.I.
Is the rotor shaft mechanically centred?					
Is the rotor shaft magnetically centred?					

3.3 Insulation Resistance Cold

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Test Voltage 1000 VDC
Norm Insulation Resistance >= 100 MΩ

Stator Winding phase-phase

Riso(MΩ)
U-V
V-W
W-V

Stator Winding phase-ground

Riso(MΩ)
U-PE
V-PE
W-PE

Thermal protection phase-PE

Riso(MΩ)
PTC stop (main)
PTC stop (spare)
PTC warning (main)
PTC warning (spare)

Auxiliaries Fan stator winding phase-phase

Riso(MΩ)
U-V
V-W
W-V

Auxiliaries Fan stator winding phase-PE

Riso(MΩ)
U-PE
V-PE
W-PE

Temperature Measurement Stator phase-ground

Riso(MΩ)
PT100 U-PE (main)
PT100 V-PE (main)
PT100 W-PE (main)

Temperature Measurement Stator phase-ground

Riso(MΩ)
PT100 U-PE (spare)
PT100 V-PE (spare)
PT100 W-PE (spare)

Temperature Measurement Bearings phase-ground

Riso(MΩ)
PT100 DE - PE (main)
PT100 DE - PE (spare)
PT100 NDE - PE (main)
PT100 NDE - PE (spare)

Auxiliaries Heater phase-ground

Riso(MΩ)
heater L1-PE
-
-

Auxiliaries

Riso(MΩ)
-
-
-

Insulation resistance (cold)			
Pass	Fail	N.T.	N.A.

3.4 Resistance Winding Cold

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Rs stator winding phases, cold				Tolerance		Test Results			
	Rs, Measured	Rs, Calculated	Rs, Imposed	Calculated	Imposed				
	mΩ @ Ta	mΩ @ Ts	mΩ	%	%				
U1 - U2		0,00			5				
V1 - V2		0,00			5				
W1 - W2		0,00			5				
Ta Tambient		Ts Tstandard		Winding material		k			
°C		°C							
		20,00		Cu		235			

3.5 RTD PT-100 Cold

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Tambient
Fault class

Ω

IEC 60751

R0	100	Ω	Fault class	0,1	0,0017	
A	3,91E-03	-	F0,1	0,10	0,0017	F0,1 class B 1/3 DIN
B	-5,78E-07	-	F0,15	0,15	0,0020	F0,15 class A
C, t < 0 °C	-4,18E-12	-	F0,3	0,30	0,0050	F0,3 class B
C, t >= 0 °C	0	-	F0,6	0,60	0,0100	F0,6 class 2B

Temperature measurement	R Measured (Ω)	T Calculated ($^{\circ}\text{C}$)	Tolerance ($^{\circ}\text{C}$)	Tolerance ($^{\circ}\text{C}$)	PT-100 Test			
					Pass	Fail	N.T.	N.A.
PT100 U ₁		-246,86	0,100000	-246,96/-246,76				
PT100 U ₂		-246,86	0,100000	-246,96/-246,76				
PT100 V ₁		-246,86	0,100000	-246,96/-246,76				
PT100 V ₂		-246,86	0,100000	-246,96/-246,76				
PT100 W ₁		-246,86	0,100000	-246,96/-246,76				
PT100 W ₂		-246,86	0,100000	-246,96/-246,76				
PT100 DE ₁		-246,86	0,100000	-246,96/-246,76				
PT100 DE ₂		-246,86	0,100000	-246,96/-246,76				
PT100 NDE ₁		-246,86	0,100000	-246,96/-246,76				
PT100 NDE ₂		-246,86	0,100000	-246,96/-246,76				

RTD = Resistance Temperature Detector

3.6 PTC stop

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PTC T_{NF} = nominal trip temperature.

PTC STOP sensor

T_{NF} switch temperature, Statorwinding (main)
 T_{NF} switch temperature, Statorwinding (spare)
 (each phase, in serie U, V, W)

Temperature values

	155 ⁰ C
	155 ⁰ C

PTC Wire Colours Triplet

black-blue
black-blue

Resistance PTC STOP sensor, main

PTC stop (main)
 PTC stop (spare)
 Resistance, PTC $T_{NF} - 5^0$ C (max)
 Resistance, PTC T_{NF} (typ)
 Resistance, PTC $T_{NF} + 5^0$ C (min)
 Resistance, PTC $T_{NF} + 15^0$ C (min)

Measuring voltage		Temperature (°C)	(VDC)	Single PTC (Ω)	Triple PTC (Ω)
		25	0,2	100	300
		25	0,2	250	750
		150	2,5	250	750
		155	2,5	1.000	3.000
		160	2,5	1.330	3.990
		170	7,5	4.000	12.000

Resistance PTC STOP sensor, spare

Type-A, Resistance PTC 25⁰C (max)
 Type-B, Resistance PTC 25⁰C (max)
 Resistance, PTC $T_{NF} - 5^0$ C (max)
 Resistance, PTC T_{NF} (typ)
 Resistance, PTC $T_{NF} + 5^0$ C (min)
 Resistance, PTC $T_{NF} + 15^0$ C (min)

Measuring voltage		Temperature (°C) (VDC)	Single PTC (Ω)	Triple PTC (Ω)
	25	0,2	100	300
	25	0,2	250	750
	150	2,5	250	750
	155	2,5	1.000	3.000
	160	2,5	1.330	3.990
	165	7,5	4.000	12.000

Inspection Results PTC wire colours (Stop)			
Pass	Fail	N.T.	N.A.

Test Results PTC resistance (Stop, main)			
Pass	Fail	N.T.	N.A.

Test Results PTC resistance (Stop, spare)			
Pass	Fail	N.T.	N.A.

3.7 PTC warning

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PTC T_{NF} = nominal trip temperature.

PTC Warning sensor

T_{NF} switch temperature, Statorwinding (main)

T_{NF} switch temperature, Statorwinding (spare)

(each phase, in serie U, V, W)

Temperature values

140	$^{\circ}\text{C}$
140	$^{\circ}\text{C}$

PTC Wire Colours Triplet

blue-white
blue-white

Resistance PTC Warning sensor, main

PTC stop (main)

PTC stop (spare)

Resistance, PTC $T_{NF} - 5^{\circ}\text{C}$ (max)

Resistance, PTC T_{NF} (typ)

Resistance, PTC $T_{NF} + 5^{\circ}\text{C}$ (min)

Resistance, PTC $T_{NF} + 15^{\circ}\text{C}$ (min)

Measuring voltage		Temperature (°C)	(VDC)	Single PTC (Ω)	Triple PTC (Ω)
	25	0,2		100	300
	25	0,2		250	750
	135	2,5		250	750
	140	2,5		1.000	3.000
	145	2,5		1.330	3.990
	155	7,5		4.000	12.000

Resistance PTC Warning sensor, spare

Type-A, Resistance PTC 25°C (max)

Type-B, Resistance PTC 25°C (max)

Resistance, PTC $T_{NF} - 5^{\circ}\text{C}$ (max)

Resistance, PTC T_{NF} (typ)

Resistance, PTC $T_{NF} + 5^{\circ}\text{C}$ (min)

Resistance, PTC $T_{NF} + 15^{\circ}\text{C}$ (min)

Measuring voltage		Temperature (°C)	(VDC)	Single PTC (Ω)	Triple PTC (Ω)
		25	0,2	100	300
		25	0,2	250	750
		135	2,5	250	750
		140	2,5	1.000	3.000
		145	2,5	1.330	3.990
		150	7,5	4.000	12.000

Inspection Results PTC wire colours (Warning)

Pass	Fail	N.T.	N.A.

Test Results PTC resistance (Warning, main)

Pass	Fail	N.T.	N.A.

Test Results PTC resistance (Warning, spare)

Pass	Fail	N.T.	N.A.

3.8 Insulation HiPot AC

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Rated voltage windings	500 VAC
Test voltage auxiliaries	1500 VAC

Test Voltage Percentage	100 %
100% first time, 80% repetitive	



Description	Test Voltage IEC34-1	Test Time	Test Voltage
Statorwinding	2000 VAC	60 sec	Test Voltage 100% = 2000VAC
Auxiliaries	1500 VAC	15 sec	Test Voltage 100% = 1500VAC

Stator Winding phase-phase

U-V
V-W
W-V

HiPot(AC)

Temperature Measurement Stator phase-ground

PT100 U-PE (main)
PT100 V-PE (main)
PT100 W-PE (main)

HiPot(AC)

Stator Winding phase-ground

U-PE
V-PE
W-PE

HiPot(AC)

Temperature Measurement Stator phase-ground

PT100 U-PE (spare)
PT100 V-PE (spare)
PT100 W-PE (spare)

HiPot(AC)

Thermal protection phase-PE

PTC stop (main)
PTC stop (spare)
PTC warning (main)
PTC warning (spare)

HiPot(AC)

Temperature Measurement Bearings phase-ground

PT100 DE - PE (main)
PT100 DE - PE (spare)
PT100 NDE - PE (main)
PT100 NDE - PE (spare)

HiPot(AC)

Auxiliaries Fan stator winding phase-phase

U-V
V-W
W-V

HiPot(AC)

Auxiliaries Heater phase-ground

heater L1 - PE
-
-

HiPot(AC)

Auxiliaries Fan stator winding phase-PE

U-PE
V-PE
W-PE

HiPot(AC)

Insulation HiPot (AC)			
Pass	Fail	N.T.	N.A.

3.9 BEMF(Cold)

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Ubemf specification

Ubemf (cold)
rated speed

BEMF test, only in case of PM machine

V at 1000 rpm
 rpm

At rated rpm

#WAARDE!

Upk (peak)

Upk-pk

Typical

V
#WAARDE! V
#WAARDE! V

Tol. Min

-10 %
V
V
V

Tol Max

2 %
#WAARDE! V
#WAARDE! V
#WAARDE! V

With measured speed

Ubemf at 0 rpm

Upk (peak)

Upk-pk

Typical

#WAARDE! V
#WAARDE! V
#WAARDE! V

Tol. Min

V
V
V

Tol. Max

#WAARDE! V
#WAARDE! V
#WAARDE! V

Voltage and speed measured

Measured Upk-pk

Upk (peak)

Ubemf

V
0,00 V
0,00 V

measured
calc.

rpm
#WAARDE! Hz

Speed

rated frequency

pole pairs

rated speed

ω

$K_e = \text{Upk} / \omega$

T period

Typical

Hz
#WAARDE! pp.
#WAARDE! rpm
#WAARDE! rad/s
#WAARDE! V.s/rad
#WAARDE! msec

measured
calc.
calc.
calc.
calc.
calc.

Measured

Hz
0 pp.
0 rpm
0,00 rad/s
0,0000 V.s/rad
#WAARDE! msec

BEMF (cold)

Pass	Fail	N.T.	N.A.

3.10 Overspeed Test

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Mechanical test how the machine performs at a higher speed and measurement Bemf.

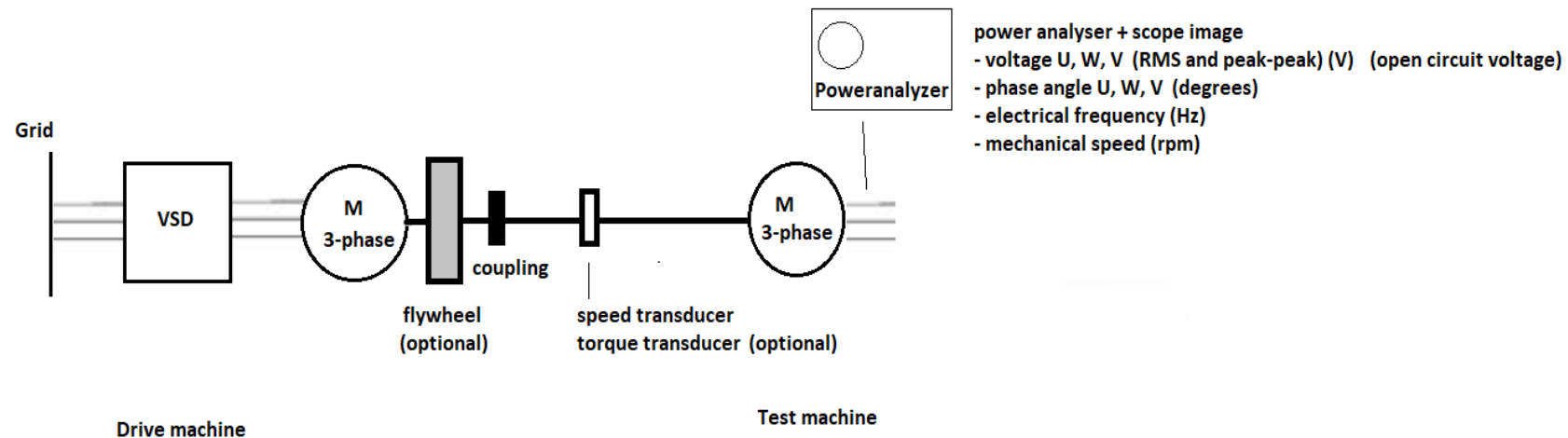


Fig. 3.9: Mechanical overspeed test and BEMF.

Description	Test speed (%) IEC 60034-1	n (rpm)	Test speed	Test time (s)
Overspeed test	120			120

Test	Measured speed (rpm)	Norm test speed (rpm)	Overspeed	
			Pass	Fail
Overspeed				
			N.A.	N.I.

3.11 Temperature Rise Test ETD

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Embedded temperature detector method (ETD)

The temperature is determined by means of temperature detectors (e.g. resistance thermometers, RTD = Resistance Temperature Detector, PT-100) built into the machine during construction, at points which are inaccessible after the machine is completed.

RTD stator winding phases, cold	T Measured (°C)
U1 - U2	
V1 - V2	
W1 - W2	
Ta Tambient, cold	

RTD stator winding phases, hot	T Measured (°C)
U1 - U2	
V1 - V2	
W1 - W2	
Ta Tambient, hot	

Temperature Rise Test ETD			
Pass	Fail	N.T.	N.A.

Powered by VSD (y/n)	VSD = Variable Speed Drive
y	

ETD-method stator winding temperature rise test	$\Delta\Theta_u$ temperature rise stator winding by PT100(hot) minus PT100(cold)	Maxium rise temperature imposed	$\Delta\Theta_v + t_a$ absolute temperature stator winding	$\Delta\Theta_v + t_a$ absolute temperature stator winding
	(°C)	(°C)	(°C) ta cold	(°C) ta hot
U1 - U2	0	90	0	0
V1 - V2	0	90	0	0
W1 - W2	0	90	0	0

3.12 Temp. Rise Test Bearings

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Embedded temperature detector method (ETD) or Thermometer method (without ETD on bearings)

The temperature is determined by means of temperature detectors (e.g. resistance thermometers, RTD = Resistance Temperature Detector, PT-100) built into the machine during construction, at points which are inaccessible after the machine is completed. Or the temperature is determined by thermometers applied (RTD, PT-100 or thermocouples) to accessible surfaces of the completed machine.

RTD stator winding phases, cold	T Measured (°C)
Drive End (DE)	
Non Drive end (NDE)	
Ta Tambient, cold	

RTD stator winding phases, hot	T Measured (°C)
Drive End (DE)	
Non Drive end (NDE)	
Ta Tambient, hot	

Temperature Rise Test ETD			
Pass	Fail	N.T.	N.A.

Note:

Bearing temperature directly measured after temperature rise test.

- Drive End (DE);
- Non Drive End (NDE).

ETD-method stator winding temperature rise test	$\Delta\theta_u$ temperature rise bearings by PT100(hot) minus PT100(cold) (°C)	Maxium temperature imposed (°C)	$\Delta\theta_v + t_a$ absolute temperature bearings (°C) ta cold	$\Delta\theta_v + t_a$ absolute temperature bearings (°C) ta hot
Drive End (DE)	0	100 (120)	0	0
Non Drive end (NDE)	0	100 (120)	0	0

3.13 Resistance Winding Hot

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Rs stator winding phases, hot				Tolerance		Test Results			
	Rs, Measured	Rs, Calculated	Rs, Imposed	Calculated	Imposed				
	mΩ @ Ta	mΩ @ Ts	mΩ	%	%				
U1 - U2		0,00	0,00		5				
V1 - V2		0,00	0,00		5				
W1 - W2		0,00	0,00		5				
Ta Tambient		Ts Tstandard		Winding material			k		
		°C							
		20,00		Cu			235		

3.14 Winding Rise Test Calc

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Resistance Winding Test	
see 3.4 Cold	see 3.13 Hot

Rs stator winding phases		Temperature Rise		Test Results					
		Rs, Measured mΩ @ T1	Rs, Measured mΩ @ T2	Calculated °C	Imposed °C				
U1 - U2					90	Pass	Fail	N.T.	N.A.
V1 - V2					90				
W1 - W2					90				

Powered by
VSD

(y/n)
y

Tambient
T1 Cold

°C
0,00

Tambient
T2 Hot

°C
0,00

VSD = Variable Speed Drive

Winding material

Cu

k

235

3.15.1 Load Test 1

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Load Test 1			
Pass	Fail	N.T.	N.A.

Power calculation factor

Pin VSD	0,57735	x
Pin motor	0,57735	x

Machine load test 1: 25%, 50%, 75%, 100% and 110% of rated power at rated speed.

Pin VSD

Load (%)	Load (kW)	Speed (Hz)	Speed (rpm)	U _{L1} (V)	U _{L2} (V)	U _{L3} (V)	I _{L1} (A)	I _{L2} (A)	I _{L3} (A)	COS ϕ_{L1} (-)	COS ϕ_{L2} (-)	COS ϕ_{L3} (-)	Pin _{L1} (kW)	Pin _{L2} (kW)	Pin _{L3} (kW)	Tolerance (U.I.PF versus P)				η vsd (%)
25,00	157,50	#####	0,00																	
50,00	315,00	#####	0,00																	
75,00	472,50	#####	0,00																	
100,00	630,00	#####	0,00																	
110,00	693,00	#####	0,00																	

Pin Motor

Load (%)	Load (kW)	Speed (Hz)	Speed (rpm)	U _U (V)	U _V (V)	U _W (V)	I _U (A)	I _V (A)	I _W (A)	COS ϕ_U (-)	COS ϕ_V (-)	COS ϕ_W (-)	Pin _U (kW)	Pin _V (kW)	Pin _W (kW)	Tolerance (U.I.PF versus P)			
25,00	157,50	#####	0,00																
50,00	315,00	#####	0,00																
75,00	472,50	#####	0,00																
100,00	630,00	#####	0,00																
110,00	693,00	#####	0,00																

Pout Motor

Load (%)	Load (kW)	Speed (Hz)	Speed (rpm)	Imposed T(Nm)	Measured T(Nm)	Measured Calc. n(rpm)	Calc. n(rad/s)	Calc. Pn out(kW)	Calc. Pn in(kW)	Calc. η (%)	Imposed η motor (%)	Efficiency	Pout>=Pr	T >= Tr	Ir(A)	Tolerance (asymetric current)		
																I _U (A)	I _V (A)	I _W (A)
25,00	157,50	#####	0,00	#WAARDE!			0,00	0,00	0,00	0,00	91,00	fail	fail	#####	227,25	-100,00	-100,00	-100,00
50,00	315,00	#####	0,00	#WAARDE!			0,00	0,00	0,00	0,00	92,00	fail	fail	#####	454,50	-100,00	-100,00	-100,00
75,00	472,50	#####	0,00	#WAARDE!			0,00	0,00	0,00	0,00	93,00	fail	fail	#####	681,75	-100,00	-100,00	-100,00
100,00	630,00	#####	0,00	#WAARDE!			0,00	0,00	0,00	0,00	94,00	fail	fail	#####	909,00	-100,00	-100,00	-100,00
110,00	693,00	#####	0,00	#WAARDE!			0,00	0,00	0,00	0,00	93,00	fail	fail	#####	999,90	-100,00	-100,00	-100,00

3.15.2 Load Test 2

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Load Test 2			
Pass	Fail	N.T.	N.A.

Power calculation factor

Pin VSD	0,57735	x
Pin motor	0,57735	x

Machine load test 2: Five load and speed points selected from pumpcurve.

P_{in} VSD

Load (%)	Load (kW)	Speed (Hz)	Speed (rpm)	U _{L1} (V)	U _{L2} (V)	U _{L3} (V)	I _{L1} (A)	I _{L2} (A)	I _{L3} (A)	COS ϕ_{L1} (-)	COS ϕ_{L2} (-)	COS ϕ_{L3} (-)	Pin _{L1} (kW)	Pin _{L2} (kW)	Pin _{L3} (kW)	Tolerance (U.I.PF versus P)			η vsd (%)
																Tol. U(%)	Tol. V(%)	Tol. W(%)	
#WAARDE!	#####	#####	0,00																
#WAARDE!	#####	#####	0,00																
#WAARDE!	#####	#####																	
#WAARDE!	#####	#####																	
#WAARDE!	#####	#####																	

P_{in} Motor

Load (%)	Load (kW)	Speed (Hz)	Speed (rpm)	U _U (V)	U _V (V)	U _w (V)	I _U (A)	I _V (A)	I _w (A)	COS φ _U (-)	COS φ _V (-)	COS φ _w (-)	Pin _U (kW)	Pin _V (kW)	Pin _w (kW)	Tolerance (U.I.PF versus P)		
																Tol. U(%)	Tol. V(%)	Tol. W(%)
#WAARDE!	#####	#####	0,00															
#WAARDE!	#####	#####	0,00															
#WAARDE!	#####	#####																
#WAARDE!	#####	#####																
#WAARDE!	#####	#####																

P_{out} Motor

Load (%)	Load (kW)	Speed (Hz)	Speed (rpm)	Imposed T(Nm)	Measured T(Nm)	Measured Calc. n(rpm)	Calc. n(rad/s)	Calc. Pn out(kW)	Calc. Pn in(kW)	Calc. η (%)	Imposed η motor(%)	Efficiency	Pout>=Pr	T >= Tr	Ir(A)	Tolerance (asymetric current)		
																I _U (A)	I _V (A)	I _W (A)
#WAARDE!	#####	#####	0,00	#WAARDE!			0,00	0,00	0,00	0,00	91,00	fail	#####	#####	#####	#####	#####	#####
#WAARDE!	#####	#####	0,00	#WAARDE!			0,00	0,00	0,00	0,00	92,00	fail	#####	#####	#####	#####	#####	#####
#WAARDE!	#####	#####		#WAARDE!			0,00	0,00	0,00	0,00	93,00	fail	#####	#####	#####	#####	#####	#####
#WAARDE!	#####	#####		#WAARDE!			0,00	0,00	0,00	0,00	94,00	fail	#####	#####	#####	#####	#####	#####
#WAARDE!	#####	#####		#WAARDE!			0,00	0,00	0,00	0,00	93,00	fail	#####	#####	#####	#####	#####	#####

3.16 No-Load Test

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



No-Load Test			
Pass	Fail	N.T.	N.A.

P_{in} VSD (grid)

U ₀ (%)			80,00	100,00	110,00	
U ₀ (V)			400,00	500,00	550,00	
f(Hz)						
n(rpm)						
U _{L1} (V)						
U _{L2} (V)						
U _{L3} (V)						
I _{L1} (A)						
I _{L2} (A)						
I _{L3} (A)						
COS φ _{L1} (-)						
COS φ _{L2} (-)						
COS φ _{L3} (-)						
Pin _{L1} (W)						
Pin _{L2} (W)						
Pin _{L3} (W)						
PL (W)	0,00	0,00	0,00	0,00	0,00	0,00
PL (W)	0,00	0,00	0,00	0,00	0,00	0,00

R _{Fe} (Ω)	
X _m (Ω)	

Calculated resistance for core losses.

Calculated resistance for magnetic reactance.

P_{in} Motor

U ₀ (%)			80,00	100,00	110,00	
U ₀ (V)			400,00	500,00	550,00	
f(Hz)						
n(rpm)						
U _U (V)						
U _V (V)						
U _w (V)						
I _U (A)						
I _V (A)						
I _w (A)						
COS φ _U (-)						
COS φ _V (-)						
COS φ _w (-)						
Pin _U (W)						
Pin _V (W)						
Pin _w (W)						
Pm (W)	0,00	0,00	0,00	0,00	0,00	0,00
Pm (W)	0,00	0,00	0,00	0,00	0,00	0,00
Io(A)						
P0(W)						
Rs(mΩ)						
Ld(mH)						
Lq(mH)						

3.17.1 Vibration test

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Description	Value	Unit
Speed during measurement		rpm
Vibration severity class	B	-
Shaft height H		mm
Maximum velocity value <=	1,5	V rms (mm/s)
Machine installation (free or rigid)	rigid	-
Test rig, machine on floor or free shaft hanging in crane (preferably).	machine on floor	-
Machine position during measurement is always horizontal, regardless of the installation setup at the end customer.	horizontal	-

Table 3.17.1: Imposed vibration parameters for testing.

Vibration severity grades	Machine installation	Shaft height H (mm)	
		56 ≤ H ≤ 132	H > 132
		Vrms (mm/s)	Vrms (mm/s)
A	Free suspension	2,8	2,8
	Rigid clamping	-	2,3
B	Free suspension	1,1	1,8
	Rigid clamping	-	1,5

Table 3.17.2: Vibration limits for maximum vibration severity in terms of vibration velocity (Vrms) for the shaft height

3.17.2 Vibration test

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



The vibration measurement of the machine is measured according to the standard NEN-EN-IEC 60034-14, edition 2018, without load (no-load) and rigid or free suspension (see table 3.17.1).

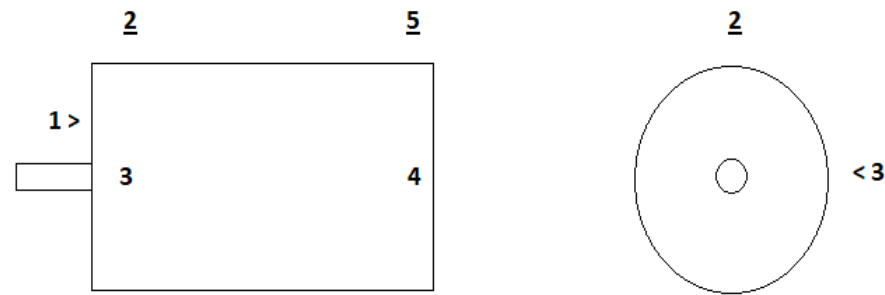


Fig. 3.17: Vibration test set up (DE = Drive End, NDE = Non Drive End).

Measuring point	Vibration no-load forced cool fan on	Vrms(mm/s)	Vibration no-load forced cool fan off	Vrms(mm/s)
1 Axial DE				
2 Top DE				
3 Right side seen from shaft, halfway at DE				
4 Right side seen from shaft, halfway at NDE				
5 Top NDE				

Table 3.17.3: Measured vibrations.

Vibration Test			
Pass	Fail	N.T.	N.A.

3.18.1 Noise test

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



The noise measurement of the machine is measured with an A-weighted pressure level L_{pa} (dBa). The noise measurement takes place at 6 different measuring points around the machine at a distance of 1 meter from the outside. The measurement is carried out at no load with a nominal speed. If forced cooling is present, noise will be measured with forced cooling switched on and off.

Description	Value	Unit
Speed during measurement		rpm
Imposed maximum value L_{pa}	76	dB(A)
Tolerance maximum value L_{pa}	2	dB(A)
Maximum value always < 80 dBa (with VSD)	78	dB(A)
Cooling type	IC-416	-
Cooling description	Totally Enclosed Forced Ventilation (TEFV)	
Machine position during measurement (vertical / horizontal)	horizontal	-

Table 3.18.1: Imposed noise parameters for testing.

3.18.2 Noise test

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx

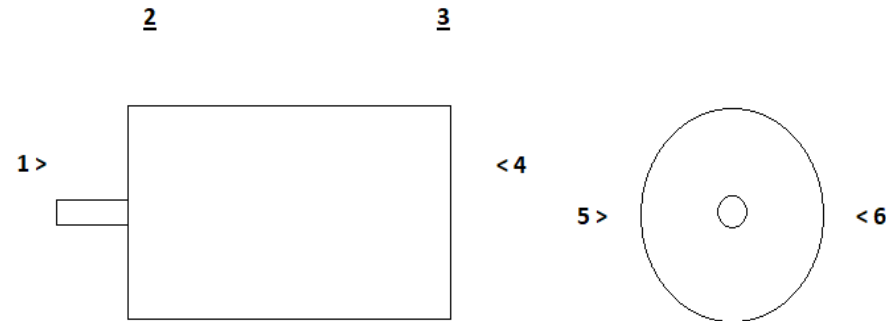


Fig. 3.18: Noise test set up (DE = Drive End, NDE = Non Drive End).

Measuring point distance 1 meter	Noise no-load forced cool fan on Lpa (dBa)	Noise no-load forced cool fan off Lpa (dBa)
1 Axial DE		
2 Top DE		
3 Top NDE		
4 Axial NDE		
5 Left side seen from shaft, halfway, between DE and NDE.		
6 Right side seen from shaft, halfway, between DE and NDE.		
7 Background, machine switched off		

Table 3.18.2: Measured noises

L_A = level of acoustic pressure (dBa), $d = 1$ m.

Noise Test			
Pass	Fail	N.T.	N.A.

3.19 Locked Rotor Test

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Locked Rotor Test (aka: Blocked Rotor Test, Short-Circuit Test), **only in case of IM Machines**.
It determines torque, motor characteristics and short-circuit current at normal voltage.

Procedure

- 1 Connect circuit diagram
- 2 Block Rotor
- 3 Apply **low** voltage to stator (start with 0V)
- 4 Measure voltage, current, power, cos phi and frequency
- 5 Increase voltage in small steps till rated current

Rated current

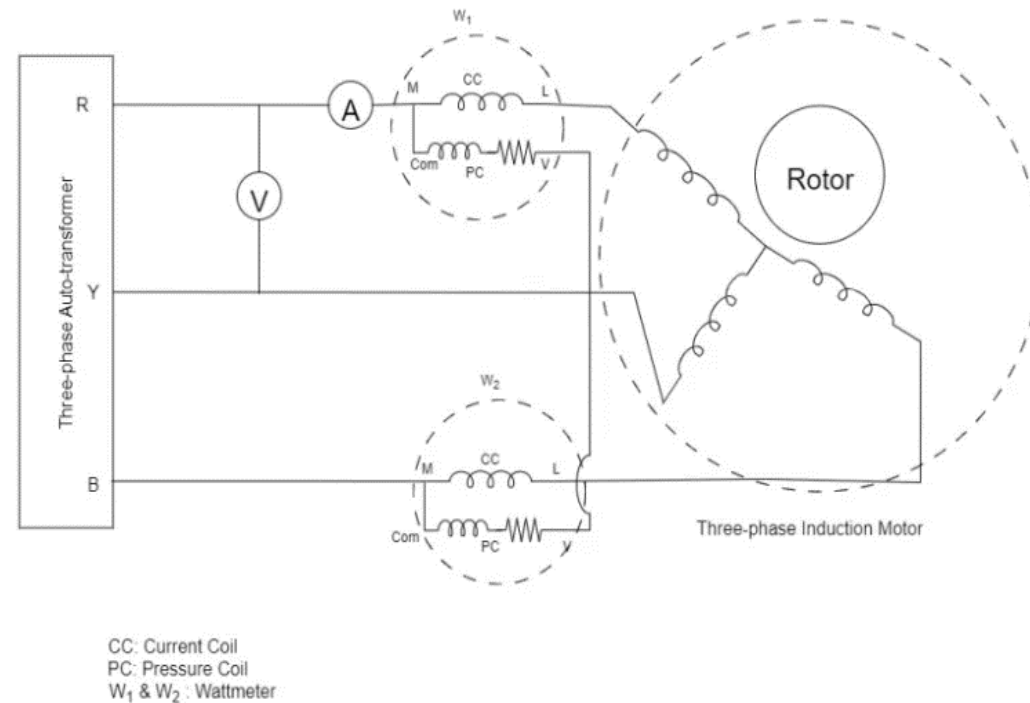
Ir(A)

Rated voltage

Ur(V)

br = blocked rotor

Isc = short circuit current at rated voltage



$$P_{br} = W1 + W2$$

U _{br} (V)	I _{br} (A)	I _{sc} (kA)	W1(W)	W2(W)	P _{br} (W)	Cos φ (-)	f(Hz)

3.20 BEMF(Hot)

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Ubemf specification

Ubemf (hot)

rated speed

BEMF test, only in case of PM machine

V

at

1000 rpm

rpm

At rated rpm

#WAARDE!

Upk (peak)

Upk-pk

Typical

#WAARDE! V

#WAARDE! V

#WAARDE! V

Tol. Min

-10 %

#WAARDE! V

#WAARDE! V

#WAARDE! V

Tol. Max

2 %

V

V

V

With measured speed

Ubemf at 0 rpm

Upk (peak)

Upk-pk

Typical

#WAARDE! V

#WAARDE! V

#WAARDE! V

Tol. Min

#WAARDE! V

#WAARDE! V

#WAARDE! V

Tol. Max

V

V

V

Voltage and speed measured

Measured Upk-pk

Upk (peak)

Ubemf

V

0,00 V

0,00 V

measured

calc.

rpm

Hz

Speed

rated frequency

pole pairs

rated speed

ω

$K_e = \text{Upk} / \omega$

T period

Typical

Hz

#WAARDE! pp.

#WAARDE! rpm

#WAARDE! rad/s

#WAARDE! V.s/rad

#WAARDE! msec

measured

calc.

calc.

calc.

calc.

calc.

Measured

Hz

0 pp.

0 rpm

0,00 rad/s

0,0000 V.s/rad

msec

BEMF (hot)

Pass

Fail

N.T.

N.A.

3.21 Insulation Resistance Hot

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Test Voltage

1000

 VDC
Norm Insulation Resistance >=

100

 MΩ

Stator Winding phase-phase

U-V
V-W
W-V

Riso(MΩ)

Stator Winding phase-ground

U-PE
V-PE
W-PE

Riso(MΩ)

Thermal protection phase-PE

PTC stop (main)
PTC stop (spare)
PTC warning (main)
PTC warning (spare)

Riso(MΩ)

Auxiliaries Fan stator winding phase-phase

U-V
V-W
W-V

Riso(MΩ)

Auxiliaries Fan stator winding phase-PE

U-PE
V-PE
W-PE

Riso(MΩ)

Temperature Measurement Stator phase-ground

PT100 U-PE (main)
PT100 V-PE (main)
PT100 W-PE (main)

Riso(MΩ)

Temperature Measurement Stator phase-ground

PT100 U-PE (spare)
PT100 V-PE (spare)
PT100 W-PE (spare)

Riso(MΩ)

Temperature Measurement Bearings phase-ground

PT100 DE - PE (main)
PT100 DE - PE (spare)
PT100 NDE - PE (main)
PT100 NDE - PE (spare)

Riso(MΩ)

Auxiliaries Heater phase-ground

heater L1 - PE
-
-

Riso(MΩ)

Auxiliaries

-
-
-

Riso(MΩ)

Insulation resistance (hot)			
Pass	Fail	N.T.	N.A.

3.22 RTD PT-100 Hot

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Tambient
Fault class

Ω

IEC 60751

R0	100	Ω	Fault class	0,1	0,0017	
A	3,91E-03	-	F0,1	0,10	0,0017	F0,1 class B 1/3 DIN
B	-5,78E-07	-	F0,15	0,15	0,0020	F0,15 class A
C, t < 0 °C	-4,18E-12	-	F0,3	0,30	0,0050	F0,3 class B
C, t >= 0 °C	0	-	F0,6	0,60	0,0100	F0,6 class 2B

Temperature measurement	R Measured (Ω)	T Calculated ($^{\circ}\text{C}$)	Tolerance ($^{\circ}\text{C}$)	Tolerance ($^{\circ}\text{C}$)	PT-100 Test			
					Pass	Fail	N.T.	N.A.
PT100 U ₁		-246,86	0,100000	-246,96/-246,76				
PT100 U ₂		-246,86	0,100000	-246,96/-246,76				
PT100 V ₁		-246,86	0,100000	-246,96/-246,76				
PT100 V ₂		-246,86	0,100000	-246,96/-246,76				
PT100 W ₁		-246,86	0,100000	-246,96/-246,76				
PT100 W ₂		-246,86	0,100000	-246,96/-246,76				
PT100 DE ₁		-246,86	0,100000	-246,96/-246,76				
PT100 DE ₂		-246,86	0,100000	-246,96/-246,76				
PT100 NDE ₁		-246,86	0,100000	-246,96/-246,76				
PT100 NDE ₂		-246,86	0,100000	-246,96/-246,76				

RTD = Resistance Temperature Detector

Annex 1.1 Spec. Machine

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Machine type

Manufacture	
Machine Type	
International Standard	NEN-EN-IEC 60034-1
AC or DC machine	AC
Number of phases	3
Speed rotor	Synchronous / Asynchronous
Type of Motor	

Location

Installation machine	indoor
Min. ambient temperature	-20 °C
Max. ambient temperature	40 °C
Max. attitude above sealevel	1000 m
Humidity	< 95 %

Mechanical machine data

Rated speed		rpm
Rated torque (full load)		Nm
Starting torque	110	%
Break-down torque	130	%
Direction of rotation	both ways	-
Moment of inertia		Kgm ²
Weight rotor (approx.)		Kg

ATEX

ATEX class	No
------------	----

Efficiency machine

Efficiency, 100% load	94,00	%
Efficiency, 75% load	93,00	%
Efficiency, 50% load	92,00	%
Efficiency, 25% load	91,00	%
Efficiency Class	n.a.	

Electrical machine data

Rated power		kW
Rated voltage	500	V
Rated frequency		Hz
Pole pairs		pp.
Angular velocity		rad/s
Rated stator current		A
Starting current		%
BEMF (cold)		V@1000rpm
BEMF (cold)		V@ rpm
Number of poles		poles
Rs, cold		mΩ (phase)
Ld, cold		mH (phase)
Lq, cold		mH (phase)
Stator connection		-
Stator winding material (Cu or Al)	Cu	-
Insulation system	VPI system	-
Line voltage	500	V
Line frequency	50	Hz

Temperature Rise

Insulation class	F => 155	°C
Temperature rise class	B => 130	°C

Powerfactor (PF)

PF, 100% load		-
PF, 75% load		-
PF, 50% load		-
PF, 25% load		-

Annex 1.2 Spec. Machine

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Frame

Frame material		mm
Frame size H		
Flange size		
Foot size	n.a.	
Mouting arrangement (new)	IM-3011	
Mouting arrangement (old)	IM-V1	
Motor protection	>=IP-23	
Terminal box protection	>=IP-55	

Cable Glands

Main power cable glands	drawing....
Auxiliary cable glands	drawing....

Bearing data

Bearing manufacturer		kN
Bearing type Drive End		
Bearing code Drive End		
Lubrication bearings (amount of grease/operating hours)		
Bearing type Non Drive End		
Bearing code Non Drive End		
Lubrication bearings (amount of grease/operating hours)		
Bearing NDE insulated	yes	
Bearing lubrication		
Axial load on Drive End		
Radial load on Drive End		
Shaft groundig ring	Aegis	

Vibration & noise

Vibration severity	1,50	V rms (mm/s)
Vibration class	B	
Noise Level LpA at 1 m on VSD <	78,00	dB(A)

Annex 1.3 Spec. Machine

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Machine Load data

Application machine	centrifugal pump	
Connection with application	rigid / flexible coupling	
Torque characterisitic	quadratic	
Starting methode	Variable Speed Drive (VSD)	
Operation methode	Variable Speed Drive (VSD)	
Number of starts (cold)	15	x/h
Number of starts (hot)	15	x/h
Load class	S1	

Auxiliaries

Fan

Coolant medium	air	
Cooling type	IC-416	
Cooling type description	Totally Enclosed Forced Ventilation (TEFV)	
Voltage Fan	500	V
Current Fan		A
Power Fan		W

Heating

Anti-condensation heater		
Voltage heater		V
Power heater		W

Temperature Protection PTC

Stator winding U, V, W, STOP	PTC (2x 3x in series) T= 155	°C
Stator winding U, V, W, Warning	PTC (2x 3x in series) T= 140	°C

Statorwinding Temperature Measurement

U, V, W, (hotspot, main, winding end), main	PT100
U, V, W, (hotspot, main, winding end), spare	PT100

Painting

Painting system	Corrosivity cat. C3
Painting RAL-color	RAL-1005
Painting color	Honey Yellow

Variabel Speed Drive (VSD)

Prefered control mode sensorless	vector or scalar
Min. switching frequency	3,6 kHz
Max. switching frequency	6 kHz

Temperature measurement bearings

ND Bearing PT100	PT100
ND Bearing PT100 (spare)	PT100
NDE Bearing PT100	PT100
NDE Bearing PT100 (spare)	PT100

Vibration monitoring

ND, axes: Hor., Vert. , Axiaal	No
NDE, axes: Hor., Vert. , Axiaal	No

Additional specifications for predictive maintenance

nr. slots	-
nr. rotor bars	-
nr. permanent magnets	-
nr. rows of PM magnets	-
type permanent magnets (PM)	-
PM maximum temperature	°C
PM Currie temperature	°C
PM mounting intern / surface	-
PM mounting line / skewed	-

Annex 2

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx

List of used instruments



Tag	Serial Number	Measurement	Instrument	Type	Calibration	Accuracy	Test	Remarks
					certificate + expiration date			
		Power analyser 1						
		U, I, f, PF, S, P, Q						
		Current clamp L1						
		Current clamp L2						
		Current clamp L3						
		Power analyser 2						
		suitable for PWM						
		U, I, f, PF, S, P, Q						
		Current clamp U						
		Current clamp V						
		Current clamp W						
		Power analyser 3						
		suitable for PWM						
		U, I, f, PF, S, P, Q						
		Current clamp U						
		Current clamp V						
		Current clamp W						
		Temperature datalogger PT100						
		Multi meter 1						
		Multi meter 2						
		Mili ohmmeter Rs						
		Multi meter						
		4-wire terminal						
		Insulation (Megger)						
		Insulation (PI+DAR)						
		Dielectric strength tester						
		Torque transducer						
		Speed transducer						

Annex 2

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx

List of used instruments



Tag	Serial Number	Measurement	Instrument	Type	Calibration	Accuracy	Test	Remarks
					certificate + expiration date			
		Clock (time)						
		Temperature						
		Sound meter						
		Vibration meter						

Annex 3.1 Specifications VSD

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Description	Value	Unit	Remarks
Fabricaat	Danfoss-VACON		Vectorcontrol
Bescherming omhuizing	IP-00	-	in cabinet IP-54
Bouwworm	2x NXN-0650-6-X0T0-NSV 1x NXI-1150-5-A0T0-ISG	-	12-pulsige brug
Serie nr.		-	
Nominale netspanning	500	V	500vac
Nominale ingangstroom	2x 461	A	Dd0Dy5
Max. voorbeveiliging	2x 461	A	
Nominale stroom (normaal)	909	A	(normaal bedrijf)
Nominaal vermogen (normaal)	630	kW	
Overbelasting (normaal)	110	%	1 min. elke 10 min.
Nominale stroom (zwaar)		A	
Nominaal vermogen(zwaar)	630	kW	
Overbelasting (zwaar)	110	%	1 min. elke 10 min.
Maximale uitgangsstroom	1150	A	bij 40°C omgeving
Nominale ingangsfrequentie	50	Hz	
Schakelfrequentie uitgang	3,6	kHz	max. 6kHz
Control algoritme	Vector control or Scalar control	-	closedloop sensorless or V/Hz
Bedieningspaneel	ja	-	
EMC filter	ja	-	
Common Mode Filter	ja	-	
Optiekaart	ja	-	IO

Annex 3.2 Specifications VSD

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Settings machine data

Description	Parameter	Value	Unit	Remarks
Taal				1e Dutch, 2e English
Motor Selectie				
Aandrijfmodus				Vacon
Rotatie		rechtsom + linksom		rechtsom
Netspanning		500	V	
Motor spanning		500	V	
Motor frequentie			Hz	
Motor vermogen		630	kW	Standaard Pnom x 1 – 110%
Motor stroom			A	Standaard Inom x 25 – 110%
Motor toerental			rpm	40 - 80 rpm
Motor polen			polen	
Motor geluid			kHz	
PWM schakelfrequentie		3,6	kHz	max. 6kHz
Fase volgorde			-	normal U, V, W

Settings PM-machine

Description	Parameter	Value	Unit	Remarks
Encoder		off	-	uitgeschakeld
Motor type			-	
Tegen EMK			V	@.... rpm
Rs			Ohm/fase	
Lsd			mH/fase	
Lsq			mH/fase	

Annex 4 PT100

Testplan Machine Pump 1 Pumpstation De Helsdeur HHNK Rev. 0.2.xlsx



Temperature (°C)	0	1	2	3	4	5	6	7	8	9
-40	84,271	84,667	85,063	85,458	85,853	86,248	86,643	87,038	87,433	87,828
-30	88,222	88,617	89,011	89,405	89,799	90,193	90,587	90,98	91,374	91,767
-20	92,16	92,553	92,946	93,339	93,732	94,125	94,517	94,91	95,302	95,694
-10	96,086	96,478	96,87	97,262	97,653	98,045	98,436	98,827	99,218	99,609
0	100	100,391	100,781	101,172	101,562	101,953	102,343	102,733	103,123	103,513
10	103,902	104,292	104,681	105,071	105,46	105,849	106,238	106,627	107,016	107,404
20	107,793	108,181	108,57	108,958	109,346	109,734	110,122	110,509	110,897	111,284
30	111,672	112,059	112,446	112,833	113,22	113,607	113,994	114,38	114,767	115,153
40	115,539	115,925	116,311	116,697	117,083	117,469	117,854	118,24	118,625	119,01
50	119,395	119,78	120,165	120,55	120,934	121,319	121,703	122,087	122,471	122,855
60	123,239	123,623	124,007	124,39	124,774	125,157	125,54	125,923	126,306	126,689
70	127,072	127,454	127,837	128,219	128,602	128,984	129,366	129,748	130,13	130,511
80	130,893	131,274	131,656	132,037	132,418	132,799	133,18	133,561	133,941	134,322
90	134,702	135,083	135,463	135,843	136,223	136,603	136,982	137,362	137,741	138,121
100	138,5	138,879	139,258	139,637	140,016	140,395	140,773	141,152	141,53	141,908
110	142,286	142,664	143,042	143,42	143,797	144,175	144,552	144,93	145,307	145,684
120	146,061	146,438	146,814	147,191	147,567	147,944	148,32	148,696	149,072	149,448
130	149,824	150,199	150,575	150,95	151,326	151,701	152,076	152,451	152,826	153,2
140	153,575	153,95	154,324	154,698	155,072	155,446	155,82	156,194	156,568	156,941
150	157,315	157,688	158,061	158,435	158,808	159,18	159,553	159,926	160,298	160,671
160	161,043	161,415	161,787	162,159	162,531	162,903	163,274	163,646	164,017	164,388
170	164,76	165,131	165,501	165,872	166,243	166,614	166,984	167,354	167,724	168,095
180	168,465	168,834	169,204	169,574	169,943	170,313	170,682	171,051	171,42	171,789
190	172,158	172,527	172,895	173,264	173,632	174	174,368	174,736	175,104	175,472
200	175,84	176,207	176,575	176,942	177,309	177,676	178,043	178,41	178,777	179,143
210	179,51	179,876	180,242	180,609	180,975	181,34	181,706	182,072	182,438	182,803
220	183,168	183,534	183,899	184,264	184,628	184,993	185,358	185,722	186,087	186,451
230	186,815	187,179	187,543	187,907	188,271	188,634	188,998	189,361	189,724	190,088
240	190,451	190,813	191,176	191,539	191,901	192,264	192,626	192,988	193,35	193,712
250	194,074	194,436	194,798	195,159	195,521	195,882	196,243	196,604	196,965	197,326
260	197,686	198,047	198,407	198,768	199,128	199,488	199,848	200,208	200,568	200,927
270	201,287	201,646	202,006	202,365	202,724	203,083	203,442	203,8	204,159	204,517
280	204,876	205,234	205,592	205,95	206,308	206,666	207,024	207,381	207,739	208,096