HITACHI SUBMERSIBLE MOTORS

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SAFETY PRECAUTIONS

For the best results with submersible motors, read this manual and all of the warning sign attached to the motor carefully before installing and operating it, or maintaining and testing it, and follow the instructions exactly.

In this manual, the rank of cautions is distinguished as **WARNING** and **CAUTION**.

⚠ WARNING Indicates a potentially hazardous situation may happen, which, if not avoided, can result in death or serious injury.

⚠ CAUTION Indicates a potentially hazardous situation may happen, which, if not avoided, can result in injury or damage of product.

In some situations, serious results may be caused even by the reason of **⚠ CAUTION**. Please be sure to keep every instruction on this manual. After reading this manual, keep it at hand of end-users for quick reference.

HANDLING AND INSTALLATION

⚠ WARNING This motor is intended for installation by technically qualified personnel.

⚠ WARNING Verify motor is filled with clean water before installing. The warranty is void if this is not done.

⚠ CAUTION This motor and lead assembly are designed only for use submerged in water.

1) Do not use lead wires to pull, lift or handle the motor. The lead wires should be protected during storage, handling, moving and installation of the motor.
2) Inspect the motor to determine that it is the correct HP, voltage and size for the job and that there is no shipping damage.
3) The factory-installed water in the motor is supplied with Propylene Glycol capable of temperatures to -30°C(-22°F). Do not install, transport or store below these temperatures. If storage is necessary below these temperatures, drain the water from the motor.
4) After long periods of idleness and on all new installations, check the electrical resistance and megger the motor with lead wires connected: see table A. Prior to installation, the motor should have an insulation value of at least 50 megohms. After installation, motor and power cable should have a minimum insulation value of 1 megohm. If minimum values are not obtained, contact factory.
5) Check the tightness of drain plugs, mounting bolts and cable connections.
6) Do not hammer the shaft, coupling or slinger since this may damage the thrust bearing. Check the rotation of the shaft by hand to insure that it turns freely.
7) Do not drop the bottom end of the motor in the dirt or mud since this may plug up the diaphragm opening.
8) If motor is to be installed in a horizontal position, make sure that the lead wires are at the 12 o'clock position when facing the motor shaft (in horizontal position).

TROUBLE SHOOTING OF SUBMERSIBLE MOTORS

1) Motor does not start.
 • No power supply.→ Check for loose or corroded connections and motor lead terminals.
 • Defective connections. → Correct connections.
2) Fuses or relay blow when motor starts.
 • Incorrect voltage. → Apply correct voltage (Nameplate).
 • Incorrect fuses or relay.→ Replace with proper fuses and relay.
 • Defective capacitors. → Replace with proper capacitors.
 • Wrong connections. → Correct wrong connections or short circuit.
 • Locked rotor conditions. →Correct pump or well conditions.
 • Insulation resistance down. →Check the line and correct.
3) Motor runs for a while and then blown fuses or relay.
 • Low voltage or high voltage. → Apply rated voltage.
 • Defective capacitors. → Replace with proper capacitors.
 • Different control box for the motor. → Replace with proper control box.
 • Defective starting voltage relay. → Replace with proper relay.
 • Pump is sand clogged. → Pull pump and clean well.
 • Overheated protector. → Shield the control box from heat source.

The following conditions are stated to provide the owner with a list of criteria for maximum motor life and to assure motor warranty.

PRE-INSTALLATION

1) Maximum water temperature:
 A) 35°C(95°F): 6" (5～40HP) motors.
 B) 25°C(77°F): 6" (50 , 60HP), 8", 10", 12" and 14" motors.
2) PH content of the water between: 6.5 -8
3) Maximum chlorine content: 500 PPM
 Maximum Sulfuric acid iron content: 15 PPM
 Maximum Fluorine content: 0.8 PPM
 Maximum Electric conductivity: 118 μMHO/INCH
4) Maximum sand content: 50 PPM
5) Proper approved three-phase overload protection. See TABLE B.
6) Proper fusing for motor circuit protection. See TABLE C.
7) Proper line voltage variation during running conditions:
 60Hz: 460V, 230V ±10% , 50Hz: 380V ±10%
 at motor lead terminal.
 (voltage drop of cable should be considered by user.)
 Combination of voltage and frequency variation: ±10%
 (sum of absolute values of voltage and frequency)
 Current unbalance between legs should not exceed 5% of the average.
8) Proper sizing of motor HP. (current, thrust, voltage, etc.)
9) Motor must be set with minimum 10 feet clearance from the bottom of the well.

10) In the case of horizontal installation, the motor is to be rigidly aligned with the pump and firmly mounted to prevent any load on the shaft and bearings and to avoid any damaging vibrations to the motor.
11) The motor must always be immersed in water so that a flow velocity of cooling water at a rate of 0.5 feet per second flows past any and all parts of the motor. The motor will not operate in mud or sand.
12) Hitachi motor leads are sized for operation while submerged in water at the maximum rated ambient water temperature. The factory motor leads must be fully submerged at all times during operation to avoid damage or failure.
13) The power cables shall be sized large enough so that at rated current there will be less than a 5% voltage drop. See TABLE C. Cables must be waterproof submersible type.
14) For three-phase motors a balanced and properly sized transformer bank shall be provided. Improper electrical supply (for example, phase converter, V-connection transformer, etc.) or connections will void the warranty.
15) Single-phase protection is recommended for protection of the installation. Any failure due to single phasing of the incoming voltage causing the motor to fail will void the warranty.
16) Surge suppressors are recommended in the interest of protecting the control panel, as well as the insulation system of the motor. Any motor failure due to lightning or other natural disasters will void the warranty.
17) Provide waterproof insulation splices between all lead wires and well cables.
18) In the event that a reduced voltage starter is used to start the motor, the following should be verified:

A. Correct quick trip, class 10 or better, ambient compensated overloads are incorporated.
B. Proper short circuit protection is utilized.
C. The torque required by the motor and pump package is attainable by this type starter.
D. The lead arrangement of the motor is acceptable with the proposed starter load connections.
E. Verify that if any time delay relays are used in switching contactors in and out, that the time settings do not exceed 2 seconds; this could damage the motor.
F. If a manual auto-transformer starter is used, voltage should be minimum 60% of rated voltage, and switched to "Run" condition within 2 seconds. Double check TABLE B and C for correct protection.

19) Single-Phase Motors (5-15HP)
Proper connections and correct capacitors and relays are necessary for single-phase motor starting and running.
Connection diagram: See Fig. 1.
Performance and recommendable capacitors: See TABLE D.
20) VFD (Inverter)
Please contact Hitachi for VFD(inverter) usage on Hitachi Submersible Motors

MAINTENANCE

There are no bearings that need oil or grease. The motor, being inaccessible, should be monitored through its electrical connections.

1) Measure and record operating current and voltage.
2) Measure and record the motor insulation resistance. Any resistance of less than 50 megohm for a new motor should be evaluated or checked further by a qualified service shop.
3) Lightning arrestors and/or surge capacitors will help prevent damage to the control box, cables, and motor.
4) Single-phase protection will help in preventing motor failure due to adverse incoming primary power.
5) Based on the values obtained in A and B above and the output flow rates and pressures of the pump, a complete picture of total performance can be obtained. This can be used to determine any pump and motor maintenance and overhauling which might be required.
6) If the motor is to be stored, protect the unit from freezing by storing in an area with a temperature higher that -30°C(-22° F).

OPERATION

1) After energizing the motor, check the flow and pressure of the pump to make sure that the motor is rotating in the correct direction. To correct a wrong rotation, switch any two of the three cable connections. (Three-phase motor only)
2) When starting the pump for the first time, inspect the water for sand. If sand appears, then continue to pump till the water clears up; otherwise, sand will accumulate in the pump stages and will bind or freeze the moving parts if water is allowed to flow back down the well.
3) During testing or checking rotation (such as "bumping" or "inching") the number of "starts" should be limited to 3, followed by a full 15 minutes cooling-off period before any additional "starts" are attempted. Depending on the depth of the well and/or method of checking, these rotational checks or "starts" may actually be full-fledged starts. If this is the case, then a full cooling-off period of 15minutes is required between this type of start.
4) For automatic (pilot device) operation, the motor should be allowed to cool for 15 minutes between starts.
5) Input voltage, current and insulation resistance values should be recorded throughout the life of the installation and should be used as a from of preventive maintenance.

TABLE A. RESISTANCE DATA
Single Phase 2 Pole 230V/60Hz

MOTOR SIZE & TYPE	HP	RESISTANCE (Ω)		
		R − Y	B − Y	R − B
6", C	5	2.143	0.482	2.597
"	7.5	1.372	0.371	1.715
"	10	1.022	0.286	1.280
"	15	0.648	0.200	0.821

Three Phase 2 Pole

MOTOR SIZE & TYPE	HP	VOLT	RESISTANCE (Ω)
6", C	5	230	0.776
"	5	460	3.021
"	7.5	230	0.621
"	7.5	460	2.400
"	10	230	0.418
"	10	460	1.590
"	15	230	0.282
"	15	460	1.044
"	20	230	0.229
"	20	460	0.832
"	25	230	0.180
"	25	460	0.636
"	30	230	0.147
"	30	460	0.530
"	40	460	0.358
"	50	"	0.308
"	60	"	0.308
8" , C	40	"	0.278
"	50	"	0.202
"	60	"	0.202
8", W	40	"	0.372
"	50	"	0.331
"	60	"	0.278
"	75	"	0.218
"	100	"	0.164
"	125	"	0.132
"	150	"	0.115
10", W	175	"	0.121
"	200	"	0.0929
"	250	"	0.0776
12", W	300	"	0.0386

Three Phase 4 Pole

MOTOR SIZE & TYPE	HP	VOLT	RESISTANCE (Ω)
8", W	7.5	230	0.564
"	7.5	460	2.178
"	10	230	0.564
"	10	460	2.178
"	15	230	0.399
"	15	460	1.519
"	20	230	0.399
"	20	460	1.519
"	25	230	0.242
"	25	460	0.888
"	30	230	0.242
"	30	460	0.888
10", W	40	460	0.408
"	50	"	0.408
"	60	"	0.288
"	75	"	0.257
"	100	"	0.171
"	125	"	0.171
12", W	150	"	0.138
"	175	"	0.119
"	200	"	0.0826
14", W	250	"	0.0552
"	300	"	0.0517

Values are for normal temp.68°F (20℃) and with motor lead wires resistance.
LEAD WIRE COLOR
R: Red , Y: Yellow, B: Black , G: Green (6"C , 8"C)
MOTOR TYPE
C : CANNED , W : WATER TIGHT

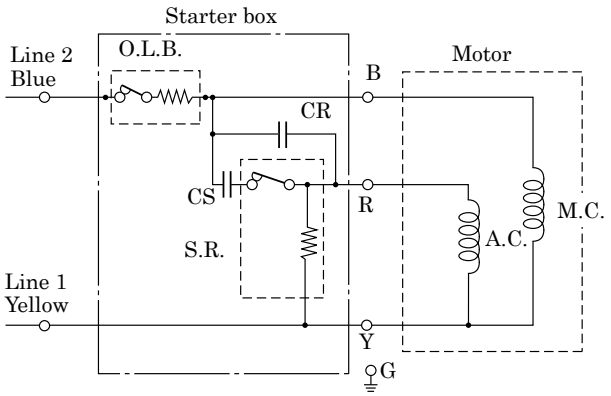
TABLE B. SELECTION TABLE OF OVERLOAD PROTECTION

Phase	MOTOR Size & Type Pole	HP	Volts	Hz	AMPS		Overload Protection	
					Rated AMPS	S.F=1.15 AMPS	STARTER Size	HEATER CODE (Furnas AMB.COMP.)
Three Phase	6", C 2Pole	5	230	60	15	17	1	K58
			460	60	7.5	8.5	0	K43
			380	50	9	—	0	K49
		7.5	230	60	22	26	1	K64
			460	60	11	13	1	K54
			380	50	13	—	1	K55
		10	230	60	29	33	1-3/4	K68
			460	60	14.5	16.5	1	K58
			380	50	17	—	1	K58
		15	230	60	42	46	2	K74
			460	60	21	23	1-3/4	K63
			380	50	25	—	1-3/4	K64
		20	230	60	54	60	2-1/2	K77
			460	60	27	30	2	K67
			380	50	32	—	2	K69
		25	230	60	68	76	3	K83
			460	60	34	38	2	K72
			380	50	41	—	2	K73
		30	230	60	82	94	3	K86
			460	60	41	47	2-1/2	K74
			380	50	48	—	2-1/2	K75
		40	460	60	53	60	3	K76
			380	50	62	—	3	K76
		50	460	60	70	79	3	K83
			380	50	83	—	3	K85
		60	460	60	82	94	3-1/2	K86
	8", C 2Pole	40	460	60	54	61	3	K76
			380	50	64	—	3	K77
		50	460	60	67	75	3	K78
			380	50	78	—	3	K85
		60	460	60	79	89	3-1/2	K86
			380	50	94	—	3-1/2	K87
	8", W 2Pole	40	460	60	56	63	3	K76
			380	50	65	—	3	K77
		50	460	60	65	73	3	K78
			380	50	78	—	3	K85
		60	460	60	80	90	3-1/2	K86
			380	50	95	—	3-1/2	K87
		75	460	60	96	109	3-1/2	K88
			380	50	115	—	4	K89
		100	460	60	127	145	4	K92
			380	50	152	—	4-1/2	K26
		125	460	60	161	180	4-1/2	K28
			380	50	192	—	4-1/2	K28
		150	460	60	197	220	4-1/2	K31
			380	50	235	—	5	K32
	10", W 2Pole	175	460	60	205	230	5	K31
			380	50	261	—	6	K23
		200	460	60	235	270	5	K33
			380	50	295	—	6	K24
		250	460	60	295	340	6	K27
			380	50	370	—	6	K28
	12", W 2Pole	300	460	60	350	396	6	K29
			380	50	420	—	6	K31
	8", W 4Pole	7.5	230	60	26	29	1-3/4	K68
			460	60	13	14	1	K56
		10	230	60	32	36	1-3/4	K70
			460	60	16	18	1	K60
		15	230	60	46	52	2-1/2	K75
			460	60	23	26	1-3/4	K64
		20	230	60	58	66	2-1/2	K77
			460	60	29	33	2	K69
		25	230	60	76	86	3	K85
			460	60	38	43	2	K73
		30	230	60	88	100	3	K87
			460	60	44	50	2-1/2	K75
	10", W 4Pole	40	460	60	62	71	3	K77
		50	460	60	73	83	3	K83
		60	460	60	91	104	3-1/2	K87
		75	460	60	106	121	3-1/2	K89
		100	460	60	145	166	4-1/2	K26
		125	460	60	175	200	4-1/2	K29
	12", W 4Pole	150	460	60	190	218	4-1/2	K29
		175	460	60	220	250	5	K32
		200	460	60	255	293	6	K24
	14", W 4Pole	250	460	60	305	350	6	K27
		300	460	60	370	425	6	K29
Single Phase	6", C 2Pole	5	230	60	24	27.5		
		7.5	230	60	36	41		
		10	230	60	50	58		
		15	230	60	72	85		

Recommended Adjustable Overload Relays
Siemens : Class/Type 3UA5,3UA6,3UA7
Furnas : Class/Type US/15 48AG,UA/15 48BG

TABLE C. FUSE AND COPPER CONDUCTIOR CABLE

Phase	MOTOR Size & Type Pole	HP	Volts	Hz	FUSE		Copper Cable Size from Control Box to MOTOR (FEET) Conductor Size AWG,MCM COND.TEMP:80℃																	
					STD Size	Dual-Element Size	12	10	8	6	4	2	0	00	000	0000	250	300	350	400	500	600
Three Phase	6", C 2Pole	5	230	60	45	30	240	380	610	970	1500	2380										
			460	60	25	15	960	1520	2420													
			380	50	30	17.5	670	1060	1670	2690												
		7.5	230	60	70	40	160	260	410	650	1010	1610	2430									
			460	60	35	20	660	1050	1670	2660												
			380	50	40	25	450	710	1130	1800	2790											
		10	230	60	90	60		200	320	500	780	1240	1880									
			460	60	45	30	490	780	1250	1990												
			380	50	60	30	340	540	850	1360	2110											
		15	230	60	150	80			210	340	530	840	1270	1590	2020							
			460	60	70	40	340	540	860	1370	2120											
			380	50	80	45		360	580	920	1430	2260										
		20	230	60	175	100				260	400	640	970	1220	1550	1940						
			460	60	90	50		410	650	1040	1620	2570										
			380	50	100	60		280	440	710	1090	1740	2620									
		25	230	60	225	125					330	520	780	980	1240	1560	1800					
			460	60	110	60			530	840	1300	2060										
			380	50	125	80			350	550	860	1370	2060									
		30	230	60	250	150						430	650	810	1030	1300	1490	1790				
			460	60	125	80			430	690	1070	1700	2570									
			380	50	150	90			300	480	740	1170	1770	2220								
		40	460	60	175	100				520	810	1290	1940									
			380	50	200	125				360	560	890	1350	1700	2150							
		50	460	60	225	125					650	1030	1560	1960								
			380	50	250	150					440	690	1040	1310	1660	2090						
		60	460	60	250	150						850	1290	1610	2050							
	8", C 2Pole	40	460	60	175	100				520	810	1280	1930									
			380	50	200	125				360	550	870	1320	1660	2100							
		50	460	60	200	125					670	1060	1600	2010								
			380	50	250	150					450	710	1070	1350	1710	2150						
		60	460	60	250	150						860	1310	1640	2080							
			380	50	300	175						590	880	1110	1410	1770	2040					
	8", W 2Pole	40	460	60	175	100				520	810	1280	1930									
			380	50	200	125				360	550	870	1320	1660	2100							
		50	460	60	200	125					670	1060	1600	2010								
			380	50	250	150					450	710	1070	1350	1710	2150						
		60	460	60	250	150						860	1310	1640	2080							
			380	50	300	175						590	880	1110	1410	1770	2040					
		75	460	60	300	175						710	1080	1360	1720	2160						
			380	50	350	225						480	730	910	1160	1460	1680	2010				
		100	460	60	400	225							810	1020	1300	1630	1880					
			380	50	500	300							550	690	870	1100	1270	1510	1760			
		125	460	60	500	300								820	1040	1310	1510	1800				
			380	50	600	350									700	880	1020	1220	1420	1620	2030	
		150	460	60	600	350										1090	1250	1500	1750			
			380	50	700	450										740	850	1010	1180	1350	1690	2030
	10", W 2Pole	175	460	60	700	400										950	1090	1300	1520	1740		
			380	50	800	500											700	840	970	1110	1390	1670
		200	460	60	800	450												1130	1320	1510	1889	
			380	50	900	600													870	1000	1250	1500
		250	460	60	900	600														1210	1510	1810
			380	50	1200	650															990	1190
	12", W 2Pole	300	460	60	1200	650															1270	1520
			380	50	1300	750																1050
	8", W 4Pole	7.5	230	60	80	50		270	420	670	1050	1660	2510									
			460	60	40	25	670	1060	1690	2700												
		10	230	60	100	60		200	310	500	770	1230	1850									
			460	60	50	30	490	780	1250	1990												
		15	230	60	150	90				340	520	830	1250	1570	1990							
			460	60	70	45	330	530	840	1340	2080											
		20	230	60	175	110				250	390	610	930	1160	1480	1860						
			460	60	90	60		390	620	1000	1540	2450										
		25	230	60	250	150					320	510	770	970	1230	1540	1780					
			460	60	125	70			520	830	1280	2040										
		30	230	60	300	175						420	640	800	1010	1270	1470	1760				
			460	60	150	80			430	680	1060	1680	2540									
	10", W 4Pole	40	460	60	200	110					830	1310	1980	2490								
		50	460	60	225	150					670	1060	1590	2000								
		60	460	60	300	175						890	1350	1690	2150							
		75	460	60	350	200							1090	1370	1740	2190						
		100	460	60	450	300								1020	1300	1640	1880	2250				
		125	460	60	600	350									1030	1300	1490	1790	2080			
	12", W 4Pole	150	460	60	600	350										1100	1270	1510	1760	2020		
		175	460	60	700	400											1100	1310	1530	1750	2190	
		200	460	60	800	450												1150	1330	1530	1910	
	14", W 4Pole	250	460	60	1000	600														1230	1540	1850
		300	460	60	1200	650																1550
Single Phase	6", C 2Pole	5	230	60	80	45		190	300	470	730	1170										
		7.5	230	60	110	70			190	300	470	750	1130									
		10	230	60	175	90				220	340	550	830	1040								
		15	230	60	225	150					240	380	570	720	920							



SYMBOL

Motor	:	Single-Phase Induction Motor
M.C.	:	Main Coil
A.C.	:	Auxiliary Coil
B	:	Motor Lead Black
R	:	Motor Lead Red
Y	:	Motor Lead Yellow
G	:	Motor Ground Lead Green
CR	:	Running Capacitor
CS	:	Starting Capacitor
S.R	:	Starting Voltage Realy
O.L.B.	:	Overload Protection Circuit Breaker

Fig. 1 Connection Diagram for Single-Phase Motors

TABLE D. PERFORMANCE DATA OF SINGLE-PHASE SUBMERSIBLE MOTOR

2P FOR 6" DEEP WELL																					
Output		(HP)	5					7.5					10					15				
Voltage-Frequency			230V 60Hz					230V 60Hz					230V 60Hz					230V 60Hz				
No Load Current		(A)	8.8					8.3					12.0					16.1				
No Load Loss		(W)	1184					1428					1544					2050				
Load Characteristics	Load	(%)	25	50	75	100	125	25	50	75	100	125	25	50	75	100	125	25	50	75	100	125
	Current	(A)	11.5	14.6	18.9	23.8	30.2	13.6	19.5	26.7	35.2	45.6	18.0	25.5	35.5	48.0	59.0	25.5	38.1	52.7	70.8	96.8
	Efficiency	(%)	47.8	66.2	72.2	74.8	72.8	51.1	67.6	72.5	72.9	70.8	54.0	67.8	73.1	73.6	71.5	57.5	70.8	74.7	73.7	69.2
	Power Factor	(%)	73.5	84.0	89.0	91.2	92.3	87.8	92.5	94.5	94.9	94.2	81.8	88.9	91.8	93.2	93.7	82.9	90.2	92.7	93.2	90.8
	Slip	(%)	0.8	1.5	2.2	3.0	4.2	0.8	1.8	2.9	4.2	5.8	0.7	1.7	2.8	4.1	5.6	1.0	2.1	3.3	4.9	7.3
Full Load Torque		(ft•lbs)	7.53					11.42					15.23					23				
Break Down Torque		(ft•lbs)	15.5					22.0					27.4					45				
Locked Rotor Torque		(ft•lbs)	12.5					18.3					21.3					34				
Locked Rotor Current		(A)	124					167					202					275				
Locked Rotor Code			G					F					E					D				
Rated Input		(W)	4987					7675					10135					15180				
Current of SF 1.15		(A)	27.5					41					58					85				
Input of SF 1.15		(W)	5735					8950					11830					18050				
Spec. of Running Capacitor			440VAC 30μFD					440VAC 40μFD					440VAC 50μFD					440VAC 70μFD				
Spec. of Starting Capacitor			330VAC 200μFD					330VAC 250μFD					370VAC 350μFD					370VAC 450μFD				