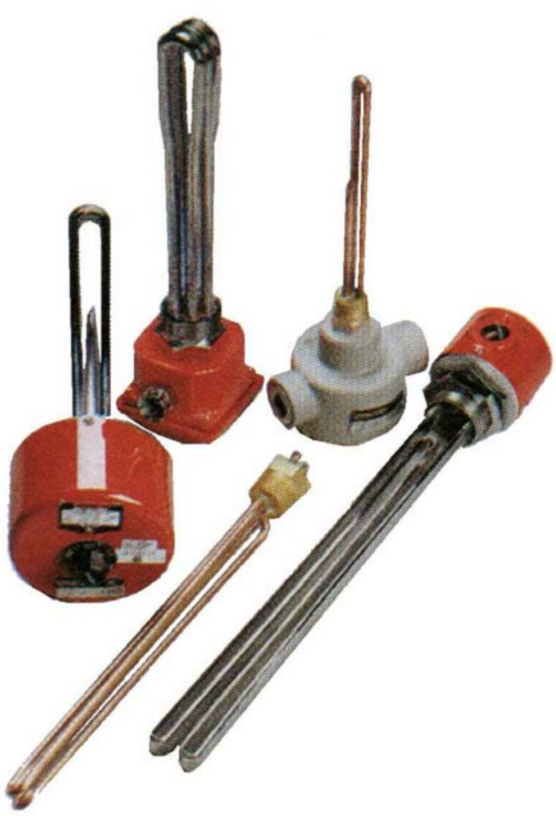
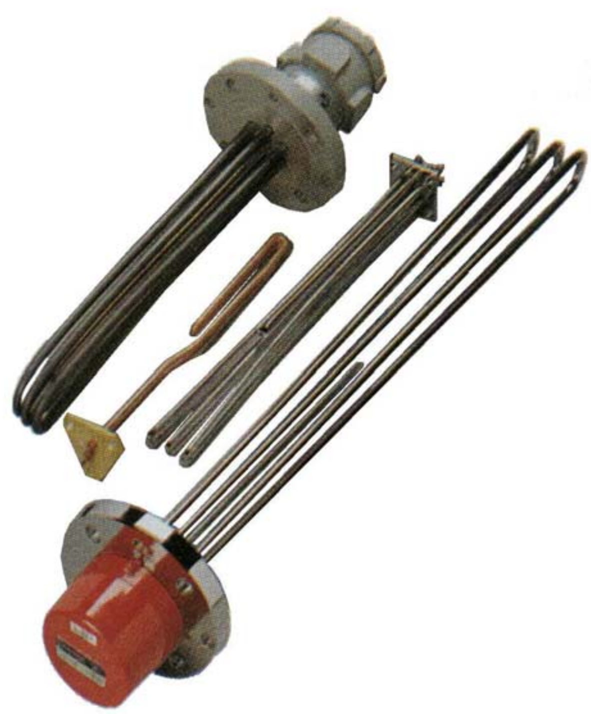
Hubbell™

ELECTRIC HEATER COMPANY
Operating and Maintenance Manual
For Immersion Heating Elements





HUBBELL
ELECTRIC HEATER COMPANY
P.O. BOX 288
STRATFORD, CT 06615

PHONE: (203) 378-2659
FAX: (203) 378-3593
INTERNET: http://www.hubbellheaters.com/

-- IMPORTANT --
Always reference the full model number and serial number when calling the factory.

WARNING / CAUTION

1. The refractory material used in heating elements may absorb some moisture during transit, periods of storage, or when subjected to a humid environment. This moisture absorption results in a cold insulation resistance of less than twenty (20) megohms. If this heater has been subjected to the above condition, each heating element must be checked for insulation resistance before energizing. A low megohm condition can be corrected by removing the terminal hardware and baking the element in an oven at 350°F -700°F for several hours or until the proper megohm reading is obtained.

2. KEEP AWAY FROM LIVE ELECTRICAL CIRCUITS.
   Do not perform any maintenance, make any adjustments, or replace any components inside the control panel with the high voltage power supply turned on. Under certain circumstances, dangerous potentials may exist even when the power supply is off. To avoid casualties, always turn the power supply safety switch to off, turn the charge or ground the circuit before performing any maintenance or adjustment procedure.

3. Generalized instructions and procedures cannot anticipate all situations. For this reason, only qualified installers should perform the installations. A qualified installer is a person who has licensed training and a working knowledge of the applicable codes regulation, tools, equipment, and methods necessary for safe installation of an electric resistance water heater. If questions regarding installation arise, check your local plumbing and electrical inspectors for proper procedures and codes. If you cannot obtain the required information, contact the company.

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Section I: Physical Damage and Prevention

Physical and mechanical damage usually occurs when high velocity fluids, turbulence from agitators, etc. cause vibration, shock and metal erosion. Metal fatigue from constant flexing of the sheath, abrasion caused by rubbing supports and sheath erosion caused by the wearing away of the sheath material by the heated media all represent different types of physical damage. This type of damage can be prevented if the potentially damaging conditions are known when the equipment and system are designed. Extra bracing and supports can be added to provide additional support and protection to the elements. Unfortunately, when the physical damage occurs in the field, there is little that can be done except to inspect the heater to see if repair or replacement is necessary.

Section II: General Maintenance and Routine Service

When a heating service problem develops or is suspected, it is usually necessary to conduct fundamental electrical tests to determine the condition of the heating elements. All industrial elements and assemblies are tested 100% electrically prior to leaving the factory. In addition to the continuity and megohm checks, the elements are subjected to a high potential (hi-pot) test. In this test, a high potential AC voltage is applied between the live parts and ground. This potential is typically calculated by the following equation:

$2 \times E + 1000$ (Volts), where E is the line voltage rating of the heater

These tests insure that no contaminants are present in the insulation, the resistance coil wire is properly centered, the refractory has suitable density, and any wiring is properly insulated from ground.

While it is normally not practical to conduct hi-pot tests in the field, other electrical tests will usually identify the problem. These tests consist of checking the element continuity, (electrical resistance in ohms terminal to terminal) and the insulation resistance, (megohm values between terminals and ground). It is recommended that qualified personnel who are familiar with the test equipment and can properly interpret the results perform these tests.

If the heating elements are operational, the best way to check proper heater operation is to measure the current with a clamp on ammeter. If all circuits are drawing proper current, it can be assumed that all heater elements have continuity. If this test method is not possible, then it will be necessary to measure individual circuits or elements for continuity and proper resistance. MAKE SURE THE POWER IS DISCONNECTED FROM THE HEATER WHEN CONDUCTING THESE TESTS. Hand held ohmmeters, digital VOM’s and resistance measuring bridges, while usable, may not give accurate readings due to the low voltages involved and the possibility of oxide coatings on the terminals. If the ohm readings are higher than the calculated values for the terminal-to-terminal or the phase-to-phase resistance on multiple element assemblies, then it can be assumed that some, but not all elements are open circuited. In this situation, it will be necessary to unbuss and isolate each element to test them individually. Infinite megohm readings terminal-to-terminal or phase-to-phase indicate open circuits.

The line-to-line cold resistance of a three phase balanced heater system can be calculated for service checking as follows:

$\frac{E^2}{W_C}$,where E equals the line voltage and W_C equals the total wattage divided by the number of circuits

On 3 phase Delta connected circuits, the resistance line to line is equal to 2/3 the rated per phase resistance and Wye connected loads it is twice (2x) the rated per phase resistance. For further assistance, see Section VII.

To determine the insulation resistance, it is recommended that a 500 VDC megohm meter (Megger) be used. Apply the leads from the megger to the heater terminals or circuit bussbars and the ground or heater chassis. This should be a cold or unenergized test. Heater assemblies having multiple elements per phase may have very low (cold test) insulation values. When bussed together, one low element will cause the whole assembly to read low due to parallel resistance.

In order to properly test heaters with multiple elements, it is may be necessary to separate the circuits and check each element individually. Interpretation of megohm readings must be done on an individual element basis to be of any practical value. If each element has a satisfactory megohm value, then you need not be concerned about the combined circuit values. Individual element readings of 0.25 megohms (250,000 Ohms) or higher should be considered satisfactory in most applications.

Section III: Service Problems, Comments and Suggestions

Hubbell factory engineers are trained to evaluate and solve all types of problems in the application, control and service of electric heating equipment. If the customer has qualified maintenance and electrical personnel, then servicing of the equipment can frequently be handled efficiently right on site. Otherwise, the products can be returned to Hubbell for evaluation, repair or replacement. When requested, Hubbell service engineers will conduct failure analysis and make recommendations for equipment changes to meet specific application problems or conditions.

One of the most frequent field complaints and service problems is that the heaters have low megohms or insulation resistance, and the customer's electricians are reluctant to energize them. This complaint is the result of absorption of moisture by the MgO causing the insulation resistance to drop to a level unacceptable to the customer. This situation occurs when the heaters have been in storage or left installed in the process equipment for long periods of time without being energized.

For the safest and most reliable operation, it is recommended that any heating element or assembly with insulation resistance of less than 0.25 megohms (250,000 ohms) to ground be dried out before energizing. The easiest and simplest method of drying out wet heaters is to remove the unit and bake the assembly in an oven. Heaters should be baked at 350°F, overnight, where possible. Care should be taken not to exceed the temperature rating of any controls or wiring materials installed as part of heater assembly.

In some instances baking the unit in an oven is probably the only cure. It is very difficult to drive the moisture out of units with large flanges, long cold pins or special configurations using other methods because there is usually insufficient heat in the cold pin areas to drive moisture out. The moisture tends to migrate from the heated section and condense in the cold pin area, which makes the problem worse.

When it is not possible or practical to remove the heating units from the installation, it may be possible to dry the elements out using alternative methods. The application of low (1/2) voltage for an extended period of time (usually 24 to 48 hours) is frequently successful in driving the moisture from the element. Another alternative is to operate the element assembly at very low wattage initially, gradually raising the wattage to full power over a period of time.

This is most easily accomplished with SCR controls since the power input can be precisely controlled in small increments for short time periods (seconds). The SCR should be set for 25% duty cycle of the process until satisfactory megohm values are restored. It may also be possible to operate the smallest circuit of a multiple circuit heater at full process to bake out the rest of the assembly.

Despite the above recommendations, the question frequently arises as how low can the megohm readings be and still permit the heater to be energized at full power. A general rule of thumb is that it is usually safe to energize heaters at full power if the megohm readings, in ohms, are 1000 times the rated voltage, i.e. a 120 volt heater should have 120,000 ohms to ground. However, under certain conditions, electric heating elements have been safely energized with virtually no insulation resistance. When properly grounded, the high leakage currents that occur at start up will normally not damage the heater and will quickly dissipate as the heaters dry out in operation without creating a safety hazard. Please note that the preferred procedure is to restore the proper insulation values before applying power.

All electric heaters must be wired and properly grounded in accordance with the National Electrical Code and other state and local regulatory agencies. Provisions for ground connections are provided on all Hubbell industrial heaters. Normal safety precautions should be observed and a qualified electrician should supervise any electrical work. Factory start up for supervision is available from Hubbell for a reasonable charge.

If the heater assembly appears to be operational and control problems are suspected, then it is recommended that the controls be disconnected from the heating equipment and checked independently. Controls should be checked for calibration, accuracy, and function in accordance with procedures given in the instruction and service literature. Electronic controls can occasionally be repaired either on site or at the factory. Damaged mechanical controls such as bulb and capillary assemblies are not repairable, and replacements must be obtained.

Section IV: Routine Service Format

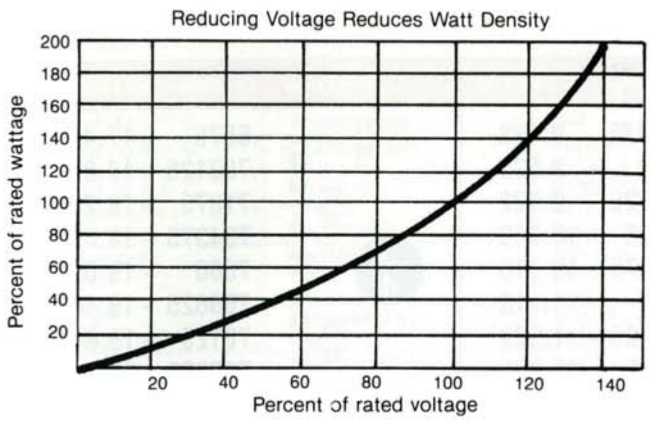
While heating elements do have a long service life in most applications, the possibility of ultimate failure must be considered. Provisions should be made for ready replacement if the potential down time will be expensive or critical to production or other operations. Replacement parts should be stocked as necessary so that a failed element can be replaced in a short period of time without completely stopping or disrupting the process.

Section V: Helpful Suggestions and Practices

1. Keep the equipment clean, particularly around the terminals, wiring enclosure, and heater itself through a regular maintenance program. In highly contaminating environments or in hazardous atmospheric conditions, special attention should be directed to the terminal boxes and electrical enclosures. Heater terminal enclosures can be designed with special fittings to use positive nitrogen gas pressure to prevent the entrance of contaminants or explosive gases. Purging is a low cost solution to many terminal problems where local codes permit the use of continuous purging.
2. Use field wiring suitable for the temperatures involved. Heater terminal boxes and enclosures usually get quite warm during operation and may require special wiring techniques. For field terminal connections inside the heater enclosure, alloy wire with high temperature insulation is recommended unless the instruction sheet specifically states that copper or low temperature insulated wire may be used. Never use rubber, wax impregnated or thermoplastic insulated wire on high temperature heater applications since these materials will deteriorate very quickly with heat. Some insulating materials may give off fumes that could cause injury or damage to the heating equipment. Always check local electrical codes for proper wiring requirements.
3. Use thermal insulation wherever possible to reduce heat losses from piping, tanks or vessels. Insulation is relatively inexpensive and will pay for itself in a short time by reducing heat losses and operating costs. It is also desirable from the standpoint of personnel comfort and safety.

Section VI: Electrical Data

Wattage Change with Voltage Change



PERCENT RATED WATTS ON REDUCED VOLTAGE

230-volt heater on 208 volts—82%
240-volt heater on 208 volts—75%
480-volt heater on 277 volts—33%
480-volt heater on 440 volts—84%
480-volt heater on 318 volts—44%
550-volt heater on 480 volts—76%

$$W_2 = W_1 \times \left(\frac{e_2}{e_1}\right)^2$$

Where:

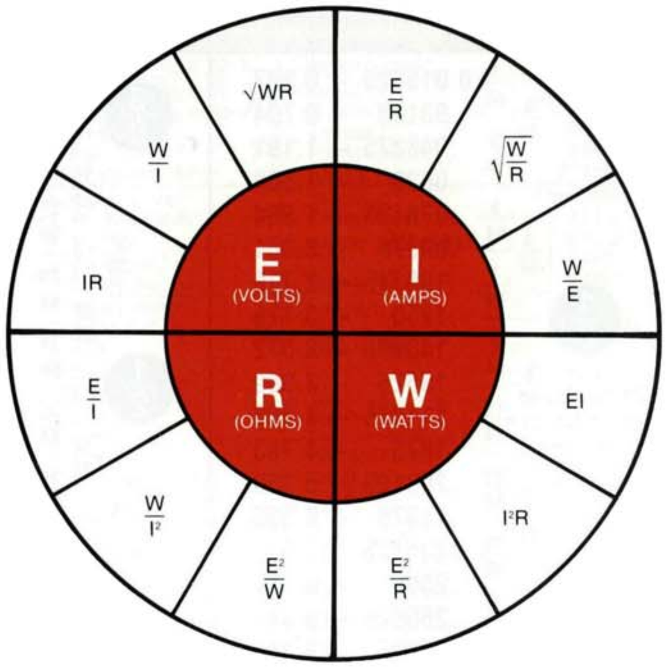
w_2 = New wattage output

w_1 = Rated wattage

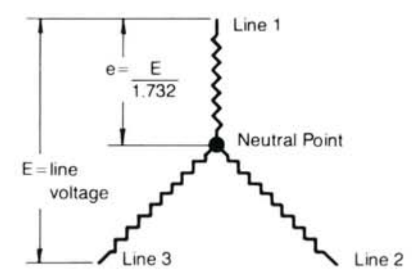
e_2 = Applied voltage

e_1 = Rated voltage

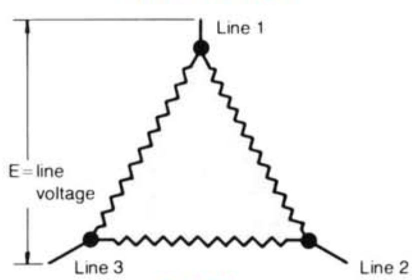
ohms Law



Three Phase Circuits



WYE OR STAR



DELTA

If elements are designed for 3-phase Delta connection, wattage output may be reduced to 1/3 by reconnecting to 3-phase WYE

For current in 3-phase circuits $I = \frac{W}{E \times 1.732}$

For resistance in 3 phase circuit (across any two terminals)

$$\mathbf{R} = \frac{E^2}{\frac{1}{2}W}$$

Amperage Conversion Table

	Volts, Single Phase			Volts 3 Phase Balanced Load		
Watts	120	240	480	240	480	Watts
100	.83	.42	.21	.24	.13	100
150	1.25	.63	.31	.36	.18	150
200	1.67	.83	.42	.49	.25	200
250	2.08	1.04	.52	.61	.30	250
300	2.50	1.25	.63	.73	.37	300
350	2.92	1.46	.73	.85	.43	350
400	3.33	1.67	.84	.97	.49	400
450	3.75	1.88	.93	1.10	.55	450
500	4.17	2.08	1.04	1.20	.60	500
600	5.00	2.50	1.25	1.45	.73	600
700	5.83	2.92	1.46	1.70	.85	700
800	6.67	3.33	1.67	1.93	.97	800
900	7.50	3.75	1.87	2.17	1.09	900
1000	8.33	4.17	2.10	2.41	1.21	1000
1100	9.17	4.58	2.30	2.65	1.33	1100
1200	10.0	5.00	2.51	2.90	1.45	1200
1250	10.4	5.21	2.61	3.10	1.55	1250
1300	10.8	5.42	2.71	3.13	1.57	1300
1400	11.7	5.83	2.91	3.38	1.69	1400
1500	12.5	6.25	3.12	3.62	1.82	1500
1600	13.3	6.67	3.34	3.86	1.93	1600
1700	14.2	7.08	3.54	4.10	2.05	1700
1800	15.0	7.50	3.75	4.34	2.17	1800
1900	15.8	7.92	3.96	4.58	2.29	1900
2000	16.7	8.33	4.17	4.82	2.41	2000
2200	18.3	9.17	4.59	5.30	2.65	2200
2500	20.8	10.4	5.21	6.10	3.05	2500
2750	23.0	11.5	5.73	6.63	3.32	2750
3000	25.0	12.5	6.25	7.23	3.62	3000
3500	29.2	14.6	7.30	8.45	4.23	3500
4000	33.3	16.7	8.33	9.64	4.82	4000
4500	37.5	18.8	9.38	10.84	5.42	4500
5000	41.7	20.8	10.42	12.1	6.1	5000
6000	50.0	25.0	12.50	14.50	7.25	6000
7000	58.3	29.2	14.59	16.9	8.5	7000
8000	66.7	33.3	16.67	19.3	9.65	8000
9000	75.0	37.5	18.75	21.7	10.85	9000
10000	83.3	41.7	20.85	24.1	12.1	10000

NOTES

THE ELECTRIC HEATER COMPANY
P.O. BOX 288
STRATFORD, CT 06615-0288
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FAX: (203) 378-3593
INTERNET: http://www.hubbellheaters.com/