IPC-1331

Voluntary Safety Standard for Electrically Heated Process Equipment

IPC-1331
March 2000
A standard developed by IPC

ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

2215 Sanders Road, Northbrook, IL 60062-6135
Tel. 847.509.9700 Fax 847.509.9798 www.ipc.org
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**Standards Should:**
- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

**Standards Should Not:**
- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

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Adopted October 6, 1998

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Thank you for your continued support.
IPC-1331

Voluntary Safety Standard for Electrically Heated Process Equipment

Developed by the Health and Safety Subcommittee (4-32) of the Environmental Health and Safety Committee (4-30) of IPC

Users of this standard are encouraged to participate in the development of future revisions.

Contact:

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Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the Health and Safety Subcommittee (4-32) of the Environmental Health and Safety Committee (4-30) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

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**Health and Safety Subcommittee**

Collingham, Mark E., Griffin Ltd.
Girard, Joan, Electrotek Corp.
Heth, Michael, Allied Signal
Hoium, Brad, Advanced Flex Inc.

Lundquist, Robert, MNTAP (MN Technical Assistance Prog.)
Scott, Tim, Tyco Printed Circuit Group

Sella, Alon, Micro-Swiss
Tremblay, Russell J., M/A-COM Inc.
Voluntary Safety Standard for Electrically Heated Process Equipment

1 SCOPE
This voluntary standard establishes minimum requirements for the design, installation, operation and maintenance of electrically heated process equipment in order to minimize electrical hazards and prevent fires that may occur in combustible tanks, tank liners and drying equipment. It is intended to cover both liquid and gas (e.g., air) process heaters used in the manufacture of printed wiring boards (PWBs) and printed wiring assemblies (PWAs). Minimum requirements are indicated by the use of the term “shall.”

Please note: This standard does not purport to address all safety issues associated with its use. Users should establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to standard’s use.

2 REFERENCE DOCUMENTS

2.1 This Standard is intended to be compliant with the following regulations and codes:

29 CFR 1910 Subpart S-Electrical
NFPA 70 National Electrical Code, Article 427 of National Electric Code
NFPA 79 National Fire Prevention Association
UL 499 Electric Heating Appliances
CSA C22.2 No. 88-1958 Industrial Heating Equipment
CEmark

3 GENERAL APPLICATION AND USE

3.1 Electric immersion heaters are generally used to heat aqueous or semi-aqueous solutions. They are not recommended for use with flammable solutions and shall not be used with class 1 or 2 flammable liquids.

3.2 Users shall verify with equipment and/or heater manufacturer and chemical supplier(s) that heater sheath material is compatible with the intended solution before installation and use. If user changes chemical composition, user shall ensure that heater sheath material is compatible with the new solution by checking with equipment and/or heater manufacturer.

3.3 Electric immersion heaters may ignite combustible tanks or liners. To prevent ignition, heating elements shall be securely mounted in a manner that prohibits direct contact with the tank or tank liner. Heating elements shall be located at least 25 mm [0.984 in] from the tank bottom and sidewalls or minimum distance recommended by manufacturer.

3.4 Electric heating elements, used in both liquid and gas process heating applications, shall be equipped with appropriate and adequate supports to prevent contact with combustible surfaces as a result of heating element deflection or sag due to use.

3.5 Electric immersion heaters shall be protected from physical damage. They shall be shielded or located to prevent physical damage from contact with other items entering tanks such as anodes, cathodes, racks, product, concentrated chemicals, and/or electrically charged components. Protection shall be accomplished by proper placement or appropriate guarding.

3.6 Heater elements shall be allowed to cool before they are removed from equipment for service or replacement.

3.7 Tanks shall not be drained until heater element has cooled.

3.8 Electric heating devices shall be built and tested to comply with a nationally recognized independent testing laboratory specification, Underwriters Laboratories (UL) and Factory Mutual (FM), for their intended application.

4 DESIGN AND INSTALLATION REQUIREMENTS

Electrically heated process equipment shall comply with the following design and installation requirements:

4.1 Control Circuit Design

4.1.1 A corrosion-resistant temperature-sensing element, such as a thermocouple, thermistor, or resistance thermal device (RTD), shall be used in conjunction with a temperature-indicating controller (see 4.1.2). The use of a thermostat with set point indication is also permitted. All sensing elements shall be compatible with the environment in which they are used (i.e., bath chemistry, fumes, or vapors) or be housed in a chemically compatible thermowell.
4.1.2 A temperature-indicating controller with both sensor break and short protection that provides an indication of process set point shall be used to provide temperature sensor open and short circuit protection. The controller shall allow the power control device (see 4.1.3) to be switched off when the tank temperature reaches the set point or when the system is not being used. A controller that displays the set point and the actual temperature at the same time is preferable because it allows an immediate evaluation of the system condition.

4.1.3 An appropriately sized power control device, such as a contactor relay, solid state relay (SSR), or silicon controlled rectifier (SCR), shall be used for controlling the availability or the amount of electrical power to the process heater.

4.1.4 All liquid process heater elements shall contain a thermal limit device, such as a fusible link, bimetallic thermostat, or other temperature regulating device, to detect an over-temperature condition in all installations where the possibility of combustion exists. The device shall disable power flow to the heating elements in the event of an over-temperature condition. This device may be non-resettable, manually reset, or automatically reset. If the device automatically resets, power flow to the heating elements shall be restricted from automatically resuming by the use of a manual latching circuit. Please note that the type of thermal limit device used will depend upon the technologies employed.

4.1.5 A temperature-sensing device shall be provided to protect electrically heated process equipment from over-temperature conditions. This device shall disable power flow to all heating elements in the event of an over-temperature condition. This device shall be unique to and redundant with the temperature-sensing element specified in 4.1.1. This device may be a pre-set temperature switch or a temperature-sensing element, such as a thermocouple, thermistor, or resistance thermal device (RTD) and its attendant hi-limit controller. The set point of this over-temperature device shall be set at a temperature value that is less than the maximum temperature limit of the equipment (i.e., when reached, no damage will occur to the chamber, lining, vessel or any other component contained within).

4.1.6 If an adjustable device or controller is used, the maximum adjustment position that is available shall be no greater than the equipment’s maximum temperature limit (i.e., when reached, no damage will occur to the chamber, lining, vessel or any other component contained within).

4.1.7 If exothermic chemistries are present in the process vessel, the over-temperature device and associated cooling equipment shall be set at a temperature value to ensure that the exothermic action is controlled. The over-temperature set point for such chemistries shall be lower than the maximum temperature limit dictated by the materials of construction of the vessel or chamber used (i.e., when reached, no damage will occur to the chamber, lining, vessel or any other component contained within). Please note that the over-temperature limit shall be non-resettable to prevent resetting to an unsafe temperature, such as a temperature that is above an exothermic temperature.

4.1.8 An over-temperature controller for the over-temperature sensing device specified in 4.1.5 shall disable power flow to all heating elements in the event of an over-temperature condition. This over-temperature controller may be non-resettable, manually reset, or automatically reset. If the controller automatically resets, power flow to the heating elements shall be restricted from automatically resuming by the use of a manual latching circuit. The over-temperature controller shall activate a visible light and/or audible alarm to signal that an over-temperature condition exists.

4.1.9 For liquid tank heaters, a low-level switch shall be included in the electrical control circuit to disable the heater circuit power whenever the process liquid level drops to less than 25 mm [0.984 in] above the heater elements’ hot zone. This switch shall also be equipped with a visible light and/or audible alarm to indicate that the switch has been activated. It is recommended that users choose low-voltage control circuits for monitoring low-level liquid sensors to prevent risk of shock.

4.1.10 For gas (e.g., air) process heaters, a low-flow switch shall be included in the electrical control circuit to disable the heater circuit power whenever the process gas (e.g., air) flow drops to a value just above the minimum flow required by the heating elements’ manufacturer for gas (e.g., air) process heaters. This switch shall also be equipped with a visible light and/or audible alarm to indicate that the switch has been activated.

4.1.11 A separate safety interrupt contactor shall be included in the electrical control circuit and be wired in series with the thermally-used heater elements specified in 4.1.4 and activated by the temperature-sensing device specified in 4.1.5, the over-temperature controller specified in 4.1.6, the low liquid level switch specified in 4.1.9, or the low-flow switch specified in 4.1.10. This contactor shall be separate from the power control device specified in 4.1.3 to interrupt power flow to all heating elements in the case of an over-temperature condition.

4.1.12 An enable switch or process set point shall be included in the electrical control circuit to disable the heating control (not the safety interrupt controls) if process cooling is utilized in addition to process heating.
4.1.13 Where an exhaust fan is used to prevent the buildup of a flammable or toxic vapor, a safety interlock sensor such as a flow switch shall be included so as to interrupt power to the heaters in the event of fan malfunction. For a flammable vapor, the sensor should be set to actuate at not greater than 25 percent of the lower flammability limit."

4.1.14 For liquid process heaters, Ground Fault Circuit Interrupters shall be employed with baths where solutions are known to be electrically charged.

4.1.15 Electric heater elements shall be equipped with a ground wire of sufficient size to carry any fault current. The construction of both heater and ground wire should be approved by a nationally recognized testing laboratory.

4.2 Control System Installation

4.2.1 For open-top tanks, the low-level switch sensing element shall be mounted in a way that allows the low-level setting to be tested without draining the contents of the tank. This will facilitate periodic testing of the liquid low level switch. For conveyorized equipment, the low-level switch shall be mounted to allow testing of the low-level switch sensing element without draining the sump level whenever possible.

4.2.2 The temperature-sensing element for the thermal over-temperature switch shall be mounted to facilitate testing without draining the tank or sump contents on liquid heaters. Thermostat temperature indicating sensors and hi-limit sensing devices shall be secured in a location below the minimum liquid level and above the bottom of the heating element.

4.2.3 Electrical wiring shall be designed and installed so as to minimize condensation and facilitate drainage of condensation away from electrical connections to prevent arcing, bridging and corrosion on the electrical connections.

4.2.4 All installation work shall be implemented in accordance with the latest edition of the National Electric Code.

4.3 Testing

4.3.1 Testing of all temperature sensing elements, limit controls and liquid level devices shall be performed by trained personnel on a periodic basis to ensure that all components are working properly and to assure the integrity of the safety interrupt circuit. Any failure shall be addressed by the user’s corrective action policy.

4.3.2 All testing shall be documented. Records including corrective action shall be retained for a minimum of one year or per the record retention policy of the user.

4.3.3 Any replacement of a temperature-controlled circuit element shall be calibrated and proper operation shall be verified prior to placing into operation.

4.3.4 Calibration of the temperature controller specified in 4.1.2 should be performed per the manufacturer’s recommendation, but no less than semiannually initially. It is recommended that facilities include this calibration requirement in the plant’s calibration program.

4.3.5 Calibration of the over-temperature controller in 4.1.6 shall be performed as recommended by the manufacturer, but no less than annually.

4.4 Heating System Maintenance

4.4.1 All heater elements shall be periodically inspected and cleaned or as required per manufacturer recommendations to remove any deposits, which may inhibit heat transfer. Heaters used in additive operations may warrant more frequent inspection and maintenance.

4.4.2 All electrical power shall be turned off and locked out in accordance with site lock, tag and try procedures, and proper personal protection equipment worn prior to removing and inspecting heating elements.

4.4.3 The interchanging of parts, which were not included in the original heating system design, shall be limited unless advised by the equipment/heating manufacturer. Alternate parts can lead to failures resulting in either fire or physical injury.
The purpose of this form is to keep current with terms routinely used in the industry and their definitions. Individuals or companies are invited to comment. Please complete this form and return to:

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This is a NEW term and definition being submitted.
This is an ADDITION to an existing term and definition(s).
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IEC Classification

Terms and Definition Committee Final Approval Authorization:
Committee 2-30 has approved the above term for release in the next revision.
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For more information, contact Hugo Scaramuzza
tel 847/790-5312 fax 847/509-9798
e-mail: scarhu@ipc.org www.ipc.org/html/forum.htm
**Education and Training**

IPC conducts local educational workshops and national conferences to help you better understand emerging technologies. National conferences have covered Ball Grid Array and Flip Chip/Chip Scale Packaging. Some workshop topics include:

- Printed Wiring Board Fundamentals
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- Choosing the Right Base Material
- Acceptability of Printed Boards
- High Speed Design
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- Acceptability of Printed Boards
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- New Design Standards

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For more information on programs, contact John Riley
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For information on how to get involved, contact:
Jeanette Ferdman, Membership Manager
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To help IPC serve your member site in the most efficient manner possible, please tell us what your facility does by choosing the most appropriate member category.

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Our facility manufactures and sells to other companies, printed wiring boards or other electronic interconnection products on the merchant market.

**WHAT PRODUCTS DO YOU MAKE FOR SALE?**

- [ ] One-sided and two-sided rigid printed boards
- [ ] Multilayer printed boards
- [ ] Flexible printed boards
- [ ] Flat cable
- [ ] Hybrid circuits
- [ ] Discrete wiring devices
- [ ] Other interconnections

Name of Chief Executive Officer/President

### INDEPENDENT PRINTED BOARD ASSEMBLERS EMSI COMPANIES

Our facility assembles printed wiring boards on a contract basis and/or offers other electronic interconnection products for sale.

**WHAT PRODUCTS DO YOU MAKE FOR SALE?**

- [ ] Turnkey
- [ ] SMT
- [ ] Through-hole
- [ ] Mixed Technology
- [ ] Consignment
- [ ] BGA
- [ ] Chip Scale Technology

Name of Chief Executive Officer/President

### OEM – MANUFACTURERS OF ANY END PRODUCT USING PCB/PCAS OR CAPTIVE MANUFACTURERS OF PCB/PCAS

Our facility purchases, uses and/or manufactures printed wiring boards or other electronic interconnection products for our own use in a final product. Also known as original equipment manufacturers (OEM).

**IS YOUR INTEREST IN:**

- [ ] purchasing/ manufacture of printed circuit boards
- [ ] purchasing/manufacturing printed circuit assemblies

What is your company’s main product line?

### INDUSTRY SUPPLIERS

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What products do you supply?

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The purpose of this form is to provide the Technical Committee of IPC with input from the industry regarding usage of the subject standard.

Individuals or companies are invited to submit comments to IPC. All comments will be collected and dispersed to the appropriate committee(s).

If you can provide input, please complete this form and return to:
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1. I recommend changes to the following:

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___ Test Method number ______, paragraph number ______

The referenced paragraph number has proven to be:
___ Unclear  ___ Too Rigid  ___ In Error
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