U.S. CONSUMER PRODUCT SAFETY COMMISSION
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Mr. Carl C. Radcliffe
Principal Engineer, Heating, Cooling, and Ventilation Products
Underwriters Laboratories, Inc.
12 Laboratory Drive
Research Triangle Park, NC 27709-3995

Dear Mr. Radcliffe:

These comments are those of the CPSC staff, have not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.

When the Underwriters Laboratories Standards Technical Panel, UL STP 1042 met in July 2003, a working group was formed to consider flux measurements from radiant electric heaters. At the meeting, I offered to provide some information the U.S. Consumer Product Safety Commission (CPSC) staff has regarding measurements of electric heater radiant flux and ignition of combustibles. Presented below is a summary of the recent work CPSC staff has performed regarding the measurement of the radiant flux from electric heaters. This data is presented as background material for upcoming discussions by STP 1042's working group on radiant flux measurements. Please share the data with the other group members prior to our meeting.

Unlike air heaters, radiant heaters have the possibility of raising the surface temperature of an object in the path of the radiant flux very high. With a heating element temperature of hundreds of degrees Celsius, radiant heaters will continue to transfer energy to objects after they have warmed. Cooling mechanisms (conduction, convection, etc.) are required to keep the object from continuing to heat indefinitely. For materials with low thermal conductivity or high emissivity, there is the possibility of continued heating until ignition temperatures are reached.

Currently, UL 2021 evaluates the potential for radiant heaters to ignite nearby combustibles using a series of draping and wall tests. These tests run for no more than 7 hours. Pass or fail conditions are determined by whether flames, molten metals, or glowing embers escape the product during that period. Only a small number of samples (sometimes only one sample) are evaluated with the draping tests in UL 2021. Further, the white cotton cloth used in

the testing could have a different thermal emissivity than dyed fabrics (towels, upholstered furniture, clothing, etc.) that can be exposed to an installed heater's radiant flux. As defined, the draping tests in UL 2021 do not fully account for the heat transfer mechanisms of radiant heaters.

In 2002, the CPSC report *Final Report on Fixed-Position Radiant Heaters*[i] recommended that radiant heaters have a maximum heat flux of 0.5 W/cm^2 or less at a distance of six inches from any point on the heater.

This recommended value of 0.5 W/cm^2 was based upon two sets of experiments. In 1987, CPSC staff conducted an evaluation of portable electric heaters.[ii] Section 7 of that report dealt with evaluating the flux from a heater as a means of assessing a radiant heater. The testing indicated that heaters with flux values above 0.5 W/cm^2 were more likely to ignite cotton fabrics near the heater front. In the tests described in this report, cotton batting ignited at a six-inch distance from the heater grill. The measured radiant flux was 0.54 W/cm^2.

In the aforementioned 2002 report, draping tests were conducted on two radiant heaters. For one sample heater, the draped material charred but did not flame, or create glowing embers. This heater's radiant flux was measured at about 0.23 W/cm^2 at a 6-inch distance. When a second sample was tested, the draped material (terrycloth or a combination of cotton duck and cheesecloth) ignited in under 30 seconds. This heater's radiant flux was measured at 0.64 W/cm^2, again at a 6-inch distance. Later testing measured over 2 W/cm^2 at a one-inch distance.

Also in 2002, a study was made on the radiant ignition properties of commonly used fire indicators irrespective of the heat source or distance[iii]. The radiant heat fluxes of several appliances (including two radiant heaters) were mapped; and the critical heat flux (the minimum heat flux required to ignite the material) was determined for several common household combustibles. This study reported that the critical heat flux for some materials was less than the maximum radiant flux of one of the heaters. Thus, the possibility exists that the positioning of common materials near a radiant heater could result in the material's ignition. The minimum critical heat flux for a tested material was 1.37 W/cm^2.

Based on these data, specifying an upper heat flux limit for radiant heater designs can be a means of reducing the number of fire incidents attributed to combustibles being too close to the appliance. The maximum heat flux value is independent of heater wattage, and is based on factors under the control of the product designer. Sample-to-sample variability introduced by the draping materials is eliminated when a quantified flux value is substituted for observing the effects of 7 hours of testing.

Equipment for quantifying the maximum flux from a radiant heater is readily available. Evaluation techniques can take the effects of reflectors or heating element geometry into effect when determining the maximum values. Establishing a maximum value independent of distance from the grill allows heater designers to incorporate whatever means they wish to provide effective warming without constraints other than avoiding "hot spots" in the emitted radiant heat pattern.

The UL STP Working Group on Radiant Heater Flux should consider specifying a maximum heat flux for products covered by voluntary standards UL 1278 and UL 2021. Test methodologies and heat flux limits can be defined and evaluated through an examination of the present data or new experiments. Incorporation of a maximum heat flux specification has the potential to reduce the number of fire incidents associated with radiant heaters.

Sincerely,

Randy Butturini

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[i] *Final Report on Fixed-Position Electric Heaters*, Randy Butturini, U.S. Consumer Product Safety Commission, Directorate for Engineering Sciences, January 2002. http://www.cpsc.gov/library/foia/foia02/os/fpheater.PDF

[ii] *Portable Electric Heaters, Engineering Project Report*, Edward W. Krawiec, U.S. Consumer Product Safety Commission, Directorate for Engineering Sciences, September, 1987.

[iii] *Fire Indicators, Engineering Project Report*, Dean L. LaRue, U.S. Consumer Product Safety Commission, Directorate for Engineering Sciences, August 2002. http://www.cpsc.gov/LIBRARY/FOIA/FOIA03/os/fip2003.pdf