Designation: C1055 – 20

# Standard Guide for Heated System Surface Conditions that Produce Contact Burn Injuries[1]

This standard is issued under the fixed designation C1055; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This guide covers a process for the determination of acceptable surface operating conditions for heated systems. The human burn hazard is defined, and methods are presented for use in the design or evaluation of heated systems to prevent serious injury from contact with the exposed surfaces.

1.2 The maximum acceptable temperature for a particular surface is derived from an estimate of the possible or probable contact time, the surface system configuration, and the level of injury deemed acceptable for a particular situation.

1.3 For design purposes, the probable contact time for industrial situations has been established at 5 s. For consumer products, a longer (60-s) contact time has been proposed by Wu (1)[2] and others to r
children, the elderly, or t



1.4 The maximum leve
causing first degree burns
injury is reversible and causes no permanent tissue damage. For cases where more severe conditions are mandated (by space, economic, exposure probability, or other outside considerations), this guide is used to establish a second, less desirable injury level (second degree burns), where some permanent tissue damage is permitted. At no time, however, are conditions that produce third degree burns recommended.

1.5 This guide addresses the skin contact temperature determination for passive heated surfaces only. The guidelines contained herein are not applicable to chemical, electrical, or other similar hazards that provide a heat generation source at the location of contact.

1.6 A bibliography of human burn evaluation studies and surface hazard measurement is provided in the list of references at the end of this guide (1-16).

1.7 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.9 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

eat Gain or Loss and the Surface Temperatures of Insulated Flat, Cylindrical, and Spherical Systems by Use of Computer Programs

C1057 Practice for Determination of Skin Contact Temperature from Heated Surfaces Using a Mathematical Model and Thermesthesiometer

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *skin:*

3.1.2 *epidermis*—the outermost layer of skin cells. This layer contains no vascular or nerve cells and acts to protect the skin layers. The thickness of this layer averages 0.08 mm.

3.1.3 *dermis*—the second layer of skin tissue. This layer contains the blood vessels and nerve endings. The thickness of this layer averages 2 mm.

3.1.4 *necrosis*—localized death of living cells. A clinical term that defines when permanent damage to a skin layer has occurred.

3.1.5 *burns:*

[1] This guide is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.30 on Thermal Measurement.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this guide.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.6 *first degree burn*—the reaction to an exposure where the intensity or duration is insufficient to cause complete necrosis of the epidermis. The normal response to this level of exposure is dilation of the superficial blood vessels (reddening of the skin).

3.1.7 *second degree burn*—the reaction to an exposure where the intensity and duration is sufficient to cause complete necrosis of the epidermis but no significant damage to the dermis. The normal response to this exposure is blistering of the epidermis.

3.1.8 *third degree burn*—the reaction to an exposure where significant dermal necrosis occurs. Significant dermal necrosis has been defined in the literature **(3)** as 75% destruction of the dermis. The normal response to this exposure is open sores that leave permanent scar tissue upon healing.

3.1.9 *contact exposure*—the process by which the surface of skin makes intimate contact with a heated surface such that no insulating layer, film, moisture, etc., interferes with the rapid transfer of available energy.

3.1.10 *insulation system*—the combination of an insulation material or jacket, or both that forms a barrier to the rapid loss of energy from a heated surface. The insulation system potentially involves a broad range of types and configurations of materials.

3.1.11 *jacket*—the prot
side of an insulation to pr
or abuse. The jacket ma
plastic, metal, canvas clo
similar materials.



3.1.12 *thermesthesiometer*—a probe device developed by Marzetta **(13)** that simulates the thermal physical response of the human finger to contact with heated surfaces.

## 4. Summary of Guide

4.1 This guide establishes a means by which the engineer, designer, or operator determine the acceptable surface temperature of an existing system where skin potentially contacts a heated surface.

4.2 The process used in the analysis follows the outline listed below:

4.2.1 The user must first establish the acceptable contact exposure time and the level of acceptable injury for the particular system in question.

4.2.2 Secondly, the user determines the maximum operating surface temperature. This determination is made either by direct measurement (if possible) or by use of a calculation at design conditions using a method conforming to Practice C680.

4.2.3 Next, utilizing the contact time (4.2.1), the maximum surface temperature (4.2.2), and the graph, Fig. 1, the user determines the potential injury level. If the operating point falls below the injury level specified (4.2.1), then no further analysis is required. (See Note 1.)

NOTE 1—The following equations have been developed from the original data used to generate Fig. 1 for easier use of this figure.

$$T_A = 15.005 + 0.51907 \times Ln\,(\text{time} \times 1000) + 352.97/(Ln\,(\text{time} \times 1000)) \quad (1)$$

000) + 190.60/(*Ln* (time (2)

$T_A$ = critical contact temperature for complete transepidermal necrosis, °C.
$T_B$ = critical contact temperature for reversible epidermal injury, °C.
*time* = elapsed contact time, s.
*Ln* = natural logarithm.

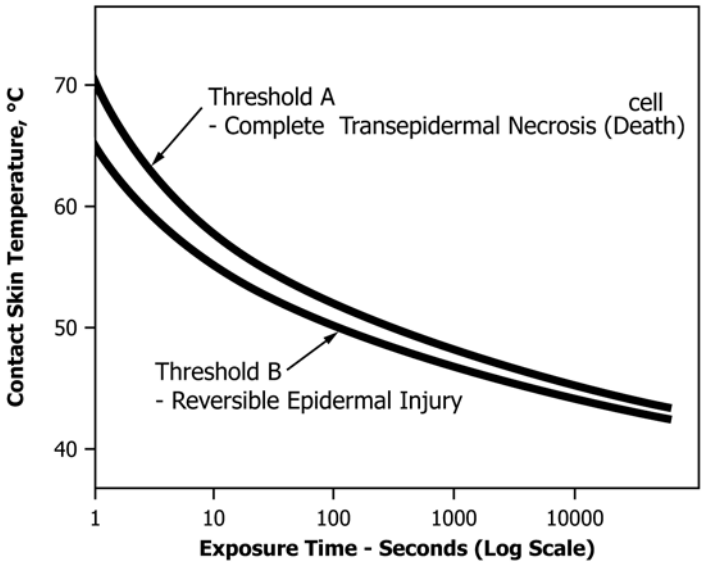


**FIG. 1 Temperature-Time Relationship for Burns**