



Standard Test Method for Heat of Ablation¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers determination of the heat of ablation of materials subjected to thermal environments requiring the use of ablation as an energy dissipation process. Three concepts of the parameter are described and defined: cold wall, effective, and thermochemical heat of ablation.

1.2 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

E285 Test Method for Oxyacetylene Ablation Testing of Thermal Insulation Materials

E422 Test Method for Measuring Heat Flux Using a Water-Cooled Calorimeter

E457 Test Method for Measuring Heat-Transfer Rate Using a Thermal Capacitance (Slug) Calorimeter

E459 Test Method for Measuring Heat Transfer Rate Using a Thin-Skin Calorimeter

E511 Test Method for Measuring Heat Flux Using a Copper-Constantan Circular Foil, Heat-Flux Transducer

E617 Specification for Laboratory Weights and Precision Mass Standards

3. Terminology

3.1 Descriptions of Terms Specific to This Standard:

3.1.1 *heat of ablation*—a parameter that indicates the ability of a material to provide heat protection when used as a sacrificial thermal protection device. The parameter is a func-

tion of both the material and the environment to which it is subjected. In general, it is defined as the incident heat dissipated by the ablative material per unit of mass removed, or

$$Q^* = q/m \quad (1)$$

where:

Q^* = heat of ablation, kJ/kg,
 q = incident heat transfer rate, kW/m², and
 m = total mass transfer rate, kg/m²·s.

3.1.2 The heat of ablation may be represented in three different ways depending on the investigator's requirements:

3.1.3 *cold-wall heat of ablation*—The most commonly and easily determined value is the cold-wall heat of ablation, and is defined as the incident cold-wall heat dissipated per unit mass of material ablated, as follows:

$$Q_{cw}^* = q_{cw}/m \quad (2)$$

where:

Q_{cw}^* = cold-wall heat of ablation, kJ/kg,
 q_{cw} = heat transfer rate from the test environment to a cold wall, kW/m², and
 m = total mass transfer rate, kg/m²·s.

The temperature of the cold-wall reference for the cold-wall heat transfer rate is usually considered to be room temperature or close enough such that the hot-wall correction given in Eq 8 is less than 5 % of the cold-wall heat transfer rate.

3.1.4 *effective heat of ablation*—The effective heat of ablation is defined as the incident hot-wall heat dissipated per unit mass ablated, as follows:

$$Q_{eff}^* = q_{hw}/m \quad (3)$$

where:

Q_{eff}^* = effective heat of ablation, kJ/kg,
 q_{hw} = heat transfer rate from the test environment to a nonablating wall at the surface temperature of the material under test, kW/m², and
 m = total mass transfer rate, kg/m²·s.

3.1.5 *thermochemical heat of ablation*—The derivation of the *thermochemical heat of ablation* originated with the simplistic surface energy equation employed in the early 60s to describe the effects of surface ablation, that is:

$$q_{hw} - q_{rr} = q_{cond} + q_{abl} + q_{block} \quad (4)$$

¹ This test method is under the jurisdiction of ASTM Committee E21 on Space Simulation and Applications of Space Technology and is the direct responsibility of Subcommittee E21.08 on Thermal Protection.

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² 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.