

**FORM MDS-4 MATERIAL DATA SHEET — CERAMIC COMPOSITE MATERIAL  
(U.S. CUSTOMARY UNITS)**

**Identification, Classification, and Description**

Design/material specification ID \_\_\_\_\_ Purchase document \_\_\_\_\_  
 Producer/source name or ID \_\_\_\_\_  
 Composite classification (if specified per HHB-A) \_\_\_\_\_  
 Component ID \_\_\_\_\_ Production lot number \_\_\_\_\_  
 Date of manufacture \_\_\_\_\_

**Constituents and Fabrication Description**

Description and pedigree of fiber (carbon/graphite/silicon carbide)

Description and pedigree of fiber architecture

Description and pedigree of fiber coating/interface, if used

Description and pedigree of matrix

Description and pedigree of composite fabrication

Description and pedigree of component seal coating, if used

Meets chemical purity specification?    Yes \_\_\_\_\_ No \_\_\_\_\_ High purity \_\_\_\_\_ Low purity \_\_\_\_\_

Constituent bulk volume fractions: Fiber \_\_\_\_\_ vol. %    Matrix \_\_\_\_\_ vol. %

Bulk density by physical measurement \_\_\_\_\_ lb/ft<sup>3</sup>

Bulk density by immersion \_\_\_\_\_ lb/ft<sup>3</sup>

Apparent porosity by immersion \_\_\_\_\_ %

Orientation/Directional Factors of the Fiber/Fabric Architecture

Direction	Description	Fiber, vol. %
1	_____	_____
2	_____	_____
3	_____	_____

## FORM MDS-4 (Cont'd)

Coefficient of Linear Thermal Expansion,  $^{\circ}\text{F}^{-1}$ , Across Designer-Specified Temperature Ranges

### Temperature Range

Direction	___ $^{\circ}\text{F}$ to ___ $^{\circ}\text{F}$			
1	___ $^{\circ}\text{F}^{-1}$	___ $^{\circ}\text{F}^{-1}$	___ $^{\circ}\text{F}^{-1}$	___ $^{\circ}\text{F}^{-1}$
2	___ $^{\circ}\text{F}^{-1}$	___ $^{\circ}\text{F}^{-1}$	___ $^{\circ}\text{F}^{-1}$	___ $^{\circ}\text{F}^{-1}$
3	___ $^{\circ}\text{F}^{-1}$	___ $^{\circ}\text{F}^{-1}$	___ $^{\circ}\text{F}^{-1}$	___ $^{\circ}\text{F}^{-1}$

Thermal Conductivity,  $\text{Btu/hr}\cdot\text{ft}\cdot^{\circ}\text{F}$ , at Designer-Specified Temperatures and Intervals

Direction	At Room Temp.	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$
1	___ $\text{Btu/hr}\cdot\text{ft}\cdot^{\circ}\text{F}$				
2	___ $\text{Btu/hr}\cdot\text{ft}\cdot^{\circ}\text{F}$				
3	___ $\text{Btu/hr}\cdot\text{ft}\cdot^{\circ}\text{F}$				

Specific Heat (If Specified),  $\text{Btu}\cdot\text{lb}^{-1}\cdot^{\circ}\text{F}^{-1}$ , at Designer-Specified Temperatures and Intervals

At Room Temp.	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$
___ $\text{Btu}\cdot\text{lb}^{-1}\cdot^{\circ}\text{F}^{-1}$				

Electrical Resistivity (If Specified),  $\Omega\cdot\text{in.}$ , at Designer-Specified Temperatures and Intervals

Direction	At Room Temp.	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$
1	___ $\Omega\cdot\text{in.}$				
2	___ $\Omega\cdot\text{in.}$				
3	___ $\Omega\cdot\text{in.}$				

Emissivity/Emittance (If Specified) at Designer-Specified Temperatures and Intervals

At Room Temp.	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$	At ___ $^{\circ}\text{F}$
___	___	___	___	___

Gas Permeability (If Specified),  $\text{in.}^3/\text{in.}^2\cdot\text{s}$

- Direction 1 \_\_\_\_\_  $\text{in.}^3/\text{in.}^2\cdot\text{s}$
- Direction 2 \_\_\_\_\_  $\text{in.}^3/\text{in.}^2\cdot\text{s}$
- Direction 3 \_\_\_\_\_  $\text{in.}^3/\text{in.}^2\cdot\text{s}$

Surface area by BET analysis (if specified) \_\_\_\_\_  $\text{ft}^2/\text{lb}$

## FORM MDS-4 (Cont'd)

### Tensile, Flexure, Compression, and Shear Properties [Notes (1) and (2)]

#### Tensile Properties at Designer-Specified Temperatures and Intervals

#### Mean/Standard Deviation/Count of Tensile Property Measurements

Direction	At Room Temp.	At ____°F	At ____°F	At ____°F	At ____°F
<b>Ultimate Stress, <math>S_{tU}</math></b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain, <math>\epsilon_{tU}</math></b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
<b>Proportional Limit Stress, <math>S_{tPL}</math></b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain, <math>\epsilon_{tPL}</math></b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___

**NOTES:**

(1) As defined and to the extent required by the Designer.

(2) Test methods are per the Designer, Mandatory Appendix HHB-III, and ASTM C1783 and ASTM C1793.

## FORM MDS-4 (Cont'd)

### Flexure Properties at Designer-Specified Temperatures and Intervals

#### Mean/Standard Deviation/Count of Flexure Property Measurements

Direction	At Room Temp.	At ___°F	At ___°F	At ___°F	At ___°F
<b>Ultimate Stress, <math>S_{fU}</math></b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain, <math>\epsilon_{fU}</math></b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
<b>Proportional Limit Stress, <math>S_{fPL}</math></b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain, <math>\epsilon_{fPL}</math></b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___

## FORM MDS-4 (Cont'd)

### Compression Properties at Designer-Specified Temperatures and Intervals

#### Mean/Standard Deviation/Count of Compression Property Measurements

Direction	At Room Temp.	At ___°F	At ___°F	At ___°F	At ___°F
<b>Ultimate Stress, <math>S_{cU}</math></b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain, <math>\epsilon_{cU}</math></b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
<b>Proportional Limit Stress, <math>S_{cPL}</math></b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain, <math>\epsilon_{cPL}</math></b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___

## FORM MDS-4 (Cont'd)

### Shear Properties at Designer-Specified Temperatures and Intervals

#### Mean/Standard Deviation/Count of Shear Property Measurements

Direction	At Room Temp.	At ___°F	At ___°F	At ___°F	At ___°F
<b>Ultimate Stress, <math>S_{TU}</math></b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain, <math>\epsilon_{TU}</math></b>					
1	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___
2	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___
3	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___
<b>Proportional Limit Stress, <math>S_{TPL}</math></b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain, <math>\epsilon_{TPL}</math></b>					
1	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___
2	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___
3	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___	___ / ___ / ___

## FORM MDS-4 (Cont'd)

### Design Strength and Material Reliability Curve Values

For the selected failure mode:  $S_{C0.05}$  \_\_\_\_\_ ksi       $m_{0.05}$  \_\_\_\_\_  
 $S'$  \_\_\_\_\_ ksi       $S'_{C0.05}$  \_\_\_\_\_ ksi       $m'_{0.05}$  \_\_\_\_\_  
 $S_{gm}(10^{-4})$  \_\_\_\_\_ ksi       $S_{gm}(10^{-3})$  \_\_\_\_\_ ksi       $S_{gm}(10^{-2})$  \_\_\_\_\_ ksi  
 $S_{gm}(5 \times 10^{-2})$  \_\_\_\_\_ ksi  
 Ultimate strength,  $S_{um}$  \_\_\_\_\_ ksi

### Young's Modulus and Shear Modulus [Notes (1) and (2)]

Young's Modulus by Mechanical Loading in Tension at Designer-Specified Temperatures and Intervals

#### Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At _____°F	At _____°F	At _____°F	At _____°F
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				

Young's Modulus (If Specified) by Mechanical Loading in Compression at Designer-Specified Temperatures and Intervals

#### Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At _____°F	At _____°F	At _____°F	At _____°F
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				

Young's Modulus (If Specified) by Sonic Resonance, Impulse Excitation, or Sonic Velocity at Designer-Specified Temperatures and Intervals

#### Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At _____°F	At _____°F	At _____°F	At _____°F
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				

## FORM MDS-4 (Cont'd)

Shear Modulus (If Specified) by Sonic Resonance, Impulse Excitation, or Sonic Velocity at Designer-Specified Temperatures and Intervals

### Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At ____°F	At ____°F	At ____°F	At ____°F
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				

Poisson's Ratio (If Specified),  $\mu$ , at Room Temperature

Direction 1-2 \_\_\_\_\_  
 Direction 1-3 \_\_\_\_\_  
 Direction 2-3 \_\_\_\_\_

### Crack Growth [Note (2)]

Crack Growth Resistance (If Specified) in the Selected Mode(s) at Designer-Specified Temperatures

### Mean/Standard Deviation/Count of Measurements

Mode	At ____°F	At ____°F	At ____°F	At ____°F
_____	___ ft-lb/in. <sup>2</sup> /___ ft-lb/in. <sup>2</sup> /___			
_____	___ ft-lb/in. <sup>2</sup> /___ ft-lb/in. <sup>2</sup> /___			
_____	___ ft-lb/in. <sup>2</sup> /___ ft-lb/in. <sup>2</sup> /___			

Defined plane \_\_\_\_\_

Selected opening mode \_\_\_\_\_

Crack length \_\_\_\_\_

## FORM MDS-4 (Cont'd)

### Geometric Feature Properties [Note (2)]

The mechanical properties to be detailed in the following tables are "geometric feature" properties, which are geometry and component specific. The Designer may call for one or more of these properties in specific directions and test and temperature conditions, depending on the design requirements.

Open-Hole Tensile Strength (If Specified) at Designer-Specified Temperatures and Intervals

#### Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At ___°F	At ___°F	At ___°F	At ___°F
<b>Ultimate Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
<b>Proportional Limit Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___

## FORM MDS-4 (Cont'd)

Open-Hole Compression Strength (If Specified) at Designer-Specified Temperatures and Intervals

### Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At ___°F	At ___°F	At ___°F	At ___°F
<b>Ultimate Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
<b>Proportional Limit Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___

## FORM MDS-4 (Cont'd)

Notch Tensile Strength (If Specified) at Designer-Specified Temperatures and Intervals

Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At ___°F	At ___°F	At ___°F	At ___°F
<b>Ultimate Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
<b>Proportional Limit Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___

## FORM MDS-4 (Cont'd)

Notch Compression Strength (If Specified) at Designer-Specified Temperatures and Intervals

Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At ___°F	At ___°F	At ___°F	At ___°F
<b>Ultimate Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
<b>Proportional Limit Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___

## FORM MDS-4 (Cont'd)

Pin-Bearing Strength (If Specified) at Designer-Specified Temperatures and Intervals

### Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At ___°F	At ___°F	At ___°F	At ___°F
<b>Ultimate Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
<b>Proportional Limit Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___

## FORM MDS-4 (Cont'd)

Hoop Strength for Tubes (If Specified) at Designer-Specified Temperatures and Intervals

Mean/Standard Deviation/Count of Measurements

Direction	At Room Temp.	At ___°F	At ___°F	At ___°F	At ___°F
<b>Ultimate Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Ultimate Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
<b>Proportional Limit Stress</b>					
1	___ ksi/___ ksi/___				
2	___ ksi/___ ksi/___				
3	___ ksi/___ ksi/___				
<b>Proportional Limit Strain</b>					
1	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
2	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___
3	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___	___ /___ /___

## FORM MDS-4 (Cont'd)

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### Durability and Reliability Requirements [Note (2)]

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The following durability and reliability requirements are specified in detail by the Designer, based on performance conditions and durability requirements. The Designer may call for one or more of the following properties, depending on the Design Specification. Time, temperature, environment, stress, and orientation conditions for each performance factor are defined by the Designer.

Fast-fluence irradiation effects on dimensions (if specified)

Fast-fluence irradiation effects on thermal properties in selected directions (if specified)

Fast-fluence irradiation effects on mechanical properties in selected directions (if specified)

Chemical-attack/oxidation weight change at selected temperatures and times (if specified)

Chemical-attack/oxidation effects on physical properties in selected directions (if specified)

Chemical-attack/oxidation effects on mechanical properties in selected directions (if specified)

Creep rates and stress rupture in selected directions (if specified)

Slow crack growth, damage, and stress rupture life in selected directions (if specified)

Fatigue life in selected directions (if specified)

Impact damage on selected mechanical properties in selected directions (if specified)

Thermal shock effects on selected mechanical properties in selected directions

Wear, erosion, and abrasion effects on weight loss and physical and mechanical properties in selected directions (if specified)