An Overview of NASA-STD-1008: Classifications and Requirements for Testing Systems and Hardware to be Exposed to Dust in Planetary Environments. K. K. John[1], D. C. Barker[2], C. R. Buhler[3], W. A. Chambers[4], P. H. Dunlap[5], A. M. Fritz[1], A. H. Garcia[2], K. M. Hurlbert[1], G. O. Jayne[6], M. R. Johansen[3], J. E. Kleinhenz[5], K. L. Gordon[7], M. Mehta[4], M. E. Meyer[5], E. N. Montbach[5], K. M. Montt de Garcia[6], J. N. Pulia[6], M. C. Sico[1], B. J. Sumlin[8]. [1]NASA Johnson Space Center, kristen.k.john@nasa.gov; [2]Jacobs Technology, NASA Johnson Space Center, [3]NASA Kennedy Space Center, [4]NASA Marshall Space Flight Center, [5]NASA Glenn Research Center, [6]NASA Goddard Space Flight Center, [7]NASA Langley Research Center, [8]USRA, NASA Glenn Research Center.

Introduction: As we return to the Moon with Artemis, hardware will inevitably be exposed to lunar dust. Encountering the surface of a dusty planetary body brings significant hazards to the hardware. A team of subject matter experts across NASA were brought together to create a standard for addressing the best means of performing ground testing of hardware and systems to guard against the expected negative effects that dust may bring. This effort resulted in NASA-STD-1008: Classifications and Requirements for Testing Systems and Hardware to be Exposed to Dust in Planetary Environments. The NASA Technical Standard went through an Agency wide review and was approved for public release in September 2021.

Purpose: The purpose of NASA-STD-1008 is to establish minimum requirements and provide effective guidance regarding methodologies and best practices for testing systems and hardware to be exposed to dust in dust laden and generating environments. The intent is to facilitate consistency and efficiency in testing space systems, subsystems, or components with operations and missions in dusty environments.

Overview of Document:

Section 1 of the document provides information on applicability and tailoring of the standard. This NASA Technical Standard allows for broad usage for missions to the Moon, Mars, and small bodies (e.g., asteroids) when working with dust or regolith. However, section 4.2 (Sources of Dust) and section 5.4 (Simulants) have been broken into Lunar, Martian, and Small Bodies sections, with the Martian and Small Bodies sections currently marked as reserved.

Section 2 provides information on Applicable Documents and Section 3 provides Acronyms, Abbreviations, Symbols, and Definitions.

The core of the document can be found in Section 4 (Dust Requirements and Standards) and Section 5 (Testing Methodologies and Best Practices), with more information provided below.

Appendices include: Context for Testing the Effects of Dust on Hardware and Systems, Dust Impact Assessment Process Examples, References, and Requirements Compliance Matrix.

Dust Requirements and Standards: Section 4 outlines the Dust Impact Assessment Process and the Sources of Dust. The Dust Impact Assessment Process guides the user through the steps necessary to test hardware/system(s) appropriately against the effects of dust. The Sources of Dust tables help the user understand and define the surface and dust environments for the hardware/system(s).

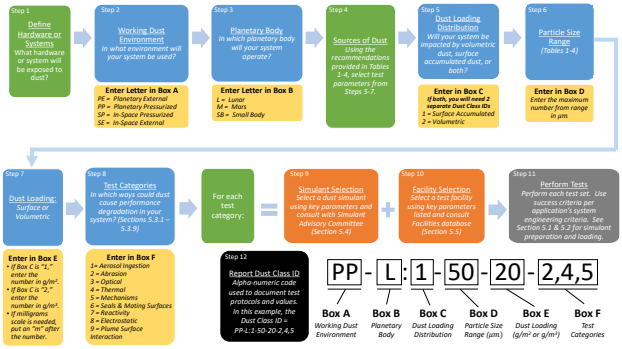

Figure 1: Dust Impact Assessment Process – Higher Resolution Graphic Available in NASA-STD-1008.

Testing Methodologies and Best Practice: Section 5 provides requirements and guidelines for hardware/system(s) testing, including how to prepare simulant for testing and how to load/distribute the simulant onto the hardware/system(s). This section includes testing methodologies and best practices for several different types of tests. For each type of test, recommended simulant characteristics and facility capabilities are provided. The section concludes with information and guidelines on how to select appropriate simulants and facilities that can be tailored to user needs.

Simulant Preparation and Storage: This section provides information on particle separation, bake-out, and simulant storage.

Simulant Loading Definitions: The section provides information on surface-accumulated loading and volumetric loading.

Types of Testing: All hardware/system(s) exposed to planetary dust could experience performance degra-

dation. Various types of testing are necessary to evaluate the performance of the system. It is necessary to determine the type(s) of dust exposure testing applicable to hardware/system(s) from the following nine testing types:

- Aerosol Ingestion Testing
- Abrasion Testing
- Optical Testing
- Thermal Testing
- Mechanisms Testing
- Seals and Mating Surfaces Testing
- Reactivity Testing
- Electrostatic Properties
- Plume Surface Interaction Testing

Simulants: Simulant guidance, inquiries, recommendations, and procurement are facilitated through the NASA LSII Simulant Advisory Committee. To contact the NASA Simulant Advisory Committee, go to the following website: https://ares.jsc.nasa.gov/projects/simulants/.

Facilities: The facility selection process involves understanding the options available for testing. Facilities are available at NASA Centers, universities, industry, and other government facilities. To become familiar with dust testing facilities, visit https://lsic-wiki.jhuapl.edu/x/HINf.

Accessing the Document: The document is available publicly at standards.nasa.gov. Click on "NASA Technical Standards," click "1000" link, then click on the document number. You will see the Summary Page. Scroll down to "Download Current Revision" and click the link below it. Or go directly to: standards.nasa.gov/standard/nasa/nasa-std-1008. Future revisions of this document will also be located here.

Future Work: The environmental conditions defined in this NASA Technical Standard (sources of dust, particle sizes, system surface, and/or volumetric loading) are based on estimates from current data sets or studies. Future insight into these environments through missions, technology demonstrations, laboratory studies, modeling, or analyses may unveil new definitions, at which time this NASA Technical Standard will be revised.

References: [1] NASA-STD-1008.