**The Current MEPAG Representation of Potential Dust-related Hazards as they may Relate to the Human Exploration of Mars.** J. W. Ashley[1], D. Banfield[2], D. W. Beaty[1], J. E. Bleacher[3], B. L. Carrier[1], V. E. Hamilton[4], R. J. Whitley[5], and R. W. Zurek[1] (james.w.ashley@jpl.nasa.gov); [1]Mars Program Office, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109; [2]Cornell University, 420 Space Sciences Building Ithaca, NY 14853; [3]NASA Goddard Space Flight Center, Greenbelt, MD 20771; [4]Southwest Research Institute, 1050 Walnut St. #300, Boulder, CO 80302; [5]NASA Johnson Space Center, 2101 NASA Parkway, Houston, TX 77058.

**Introduction:** Planning successful human exploration of Mars will require the thorough identification and characterization of all acceptable and unacceptable risks to human health and mission operations. Suspended atmospheric (aerosol) dust and dust on the Martian surface could pose hazards to crews and/or surface assets of potential future Mars missions.

The Mars Exploration Program Analysis Group (MEPAG) Goals Document [1] presents as Goal IV - *Prepare for Human Exploration*. Objectives A and B within Goal IV provide a framework for addressing open questions regarding risks related to dust on Mars. Specifically, Objective A directs that we "*Obtain knowledge of Mars sufficient to design and implement a human mission to Mars orbit with acceptable cost, risk, and performance*;" and Objective B stipulates that we "*Obtain knowledge of Mars sufficient to design and implement a human mission to the Martian surface with acceptable cost, risk, and performance*." The following list of Goal IV Investigations presents our current understanding of each possible dust-related risk and its respective priorities (parenthesized). High-priority listings are likely to associate with unacceptable risks. Investigations are categorized by risks related to 1) atmospheric modeling for weather-forecasting and EDL simulations, and 2) understanding the impact of dust on humans and human operations. Additional information on the rationale for priority rankings is available in the Goals Document.

We are interested in receiving input from the science and engineering communities on the content and priority ranking of each Investigation, and also whether additional Investigations addressing these or other risks should be outlined in future drafts of the Goals Document.

**Atmospheric Modeling Investigations**

**Goal IV Investigation #A1-2; (High):** At all local times, make long-term (> 5 Martian year) global measurements of the vertical profile of aerosols (dust and water ice) between the surface and > 60 km with a vertical resolution ≤ 5 km. These observations should include the optical properties, particle sizes and number densities.

**Goal IV Investigation #B1-1; (High):** Globally monitor the dust and aerosol activity, especially large dust events, to create a long-term dust activity climatology (> 10 Martian years) capturing the frequency of all events (including small ones) and defining the duration horizontal extent and evolution of extreme events.

**Goal IV Investigation #B1-2 (High):** Make temperature and aerosol profile observations under dusty conditions (most importantly within the core of a global dust storm) from the surface to ~40 km with a vertical resolution of < 5 km.

**Goal IV Investigation #A1-3; (Medium)**: Make long-term (> 5 Martian year) observations of global winds and wind direction with a precision ≤ 5 m/s at all local times from 15 km to an altitude > 60 km. The global coverage would need observations with a vertical resolution of ≤ 5 km and a horizontal resolution ≤ 300 km. The record needs to include a planetary scale dust event.

**Humans/Human Operation Investigations**

**Goal IV Investigation #B2-1 (High)**: Determine if extant life is widely present in the Martian near-surface regolith, and if the air-borne dust is a mechanism for its transport. If life is present, assess whether it is a biohazard.

**Goal IV Investigation #B4-1 (High)**: Test ISRU atmospheric processing system to measure resilience with respect to dust and other environmental challenge performance parameters that are critical to the design of a full-scale system.

**Goal IV Investigation #B1-6 (Low)**: Combine the characterization of atmospheric electricity with surface meteorological and dust measurements to correlate electric forces and their causative meteorological source for more than 1 Martian year, both in dust devils and large dust storms.

**Goal IV Investigation #B6-3 (Low)**: Assay for chemicals with known toxic effect on humans, particularly oxidizing species (e.g., Cr(VI)), in samples containing dust-sized particles that could be ingested. Of particular interest is a returned sample of surface regolith that contains airfall dust, and a returned sample of regolith from as great a depth as might be affected by surface operations associated with human activity (EVA, driving, mining, etc.).

**Goal IV Investigation #B6-5 (Low)**: Analyze the shapes of Martian dust grains with a grain size distri-

bution (1 to 500 microns) sufficient to assess their possible impact on human soft tissue (especially eyes and lungs).

**Goal IV Investigation #B7-1 (Low)**: Analyze regolith and surface aeolian fines (dust), with a priority placed on the characterization of the electrical and thermal conductivity, triboelectric and photoemission properties, and chemistry (especially chemistry of relevance to predicting corrosion effects), of samples of regolith from a depth as large as might be affected by human surface operations.

**Goal IV Investigation #B7-2 (Low)**: Determine the charge on individual dust grains.

**Goal IV Investigation #B7-3 (Low)**: Determine the column abundance and size-frequency distribution, resolved at less than scale height, of dust particles in the Martian atmosphere.

**About the MEPAG Goals Document:** The MEPAG Goals Document [1] is a living document that is revised regularly (~every 2 yrs) in light of new results from Mars and changes in NASA's strategic direction. It is organized into a hierarchy of goals, objectives, and investigations. The four Goals are not prioritized and are organized around major areas of scientific knowledge: "Life", "Climate", "Geology", and "Preparation for Human Exploration".

**References:** [1] MEPAG (2015) *Mars Scientific Goals, Objectives, Investigations, and Priorities: 2015*, 74 p., http://mepag.nasa.gov/reports.cfm.