

STATUS OF THE POST FLIGHT MMOD INSPECTION CAMPAIGN FOR THE SPACE X CARGO DRAGON

James L. Hyde¹, Eric L. Christiansen² and Dana M. Lear³

¹ Barrios Technology, 2101 NASA Parkway, Code XI4, Houston, TX 77058, james.l.hyde@nasa.gov

² NASA/JSC, 2101 NASA Parkway, Code XI411, Houston, TX 77058, eric.l.christiansen@nasa.gov

³ NASA/JSC, 2101 NASA Parkway, Code XI411, Houston, TX 77058, dana.m.lear@nasa.gov

ABSTRACT

Introduction

The SpaceX Cargo Dragon has been flying supply missions for NASA to the International Space Station (ISS) since 2012. At the time of this writing, SpaceX has completed 14 missions to ISS with each returning to Earth via water landing. After each mission, a team from the NASA Johnson Space Center performs an inspection of the exterior surfaces of the Cargo Dragon spacecraft for hypervelocity impact damage features. Data from these inspections are collected into a database that includes impact feature dimensions as well as the location on the vehicle. Additional details on the type and size of particle that produced the damage site are provided when sampling data and definitive spectroscopic analysis results are available. Observation data can be compared with impact estimates from risk assessment codes as a check on the micro-meteoroid and orbital debris (MMOD) environment predictions.

Scope

A general description of the spacecraft and its thermal protection system will be provided. Mission details such as exposure duration and launch dates are also planned. The paper will document the general inspection procedure for collection of data and the post inspection data analysis process. It will also provide details on the observation data collected to date as well as

the number of intact samples collected for spectroscopic analysis to discern the source of the impacting particle. A comparison between observed impacts and the expected number of damage features calculated by Bumper 3 will also be presented.

Findings

Statistics on the 223 impact features documented in the database will provide insight into the depth to diameter ratios and other relationships. The quality of the comparison between the observations and code predictions are dependant on several factors. The paper will discuss of each of these variables.

- (1) Damage equations
- (2) Impact condition assumptions
 - a. Projectile density
 - b. Impact speed
 - c. Impact angle
- (3) Observational certainty
 - a. pre-flight vs. on-orbit damage
 - b. MMOD vs. non-MMOD

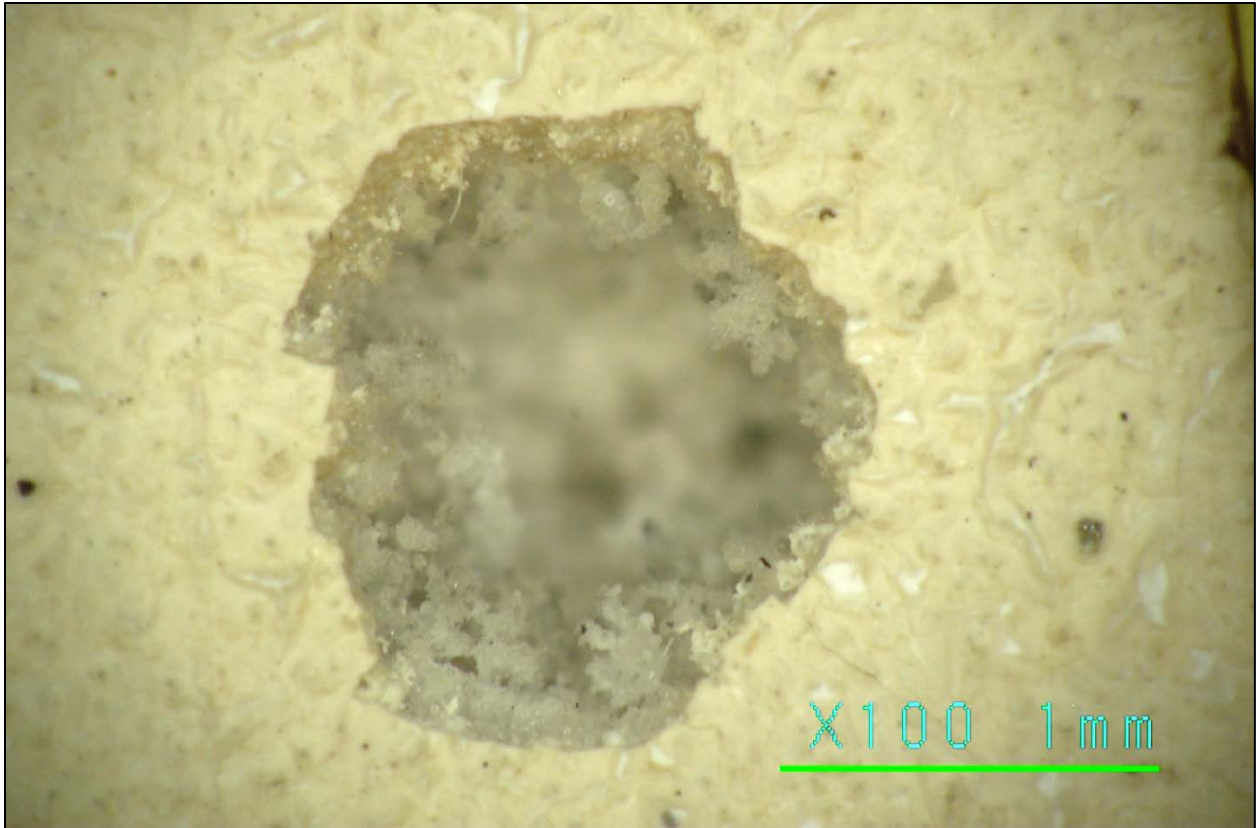


Figure 1. Example of impact feature in Cargo Dragon thermal protection system

Conclusions and Recommendations

With six flights to ISS remaining on the manifest, the Cargo Dragon impact database is an ongoing project. Two of the three companies in the upcoming Commercial Resupply Services (CRS 2) contract for ISS, SpaceX and Sierra Nevada Corporation will have reusable vehicles that present additional opportunities for post flight MMOD inspections.