

## **SPACEX DRAGON 1 POST FLIGHT MMOD INSPECTION CAMPAIGN**

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### **ABSTRACT**

#### **Introduction**

The SpaceX Dragon 1 spacecraft performed 20 resupply missions to the International Space Station (ISS) between 2012 and 2020. After each mission, a team from the NASA Johnson Space Center Hypervelocity Impact Technology Group inspected each Dragon 1 capsule 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 micrometeoroid and orbital debris (MMOD) environment predictions.

#### **Scope**

A general description of the areas of the vehicle that were inspected are provided as well as mission details such as exposure duration and launch dates. The paper documents the general inspection procedure for collection of data and the post inspection data analysis process. It also provides details of the observation data collected as well as the results of analysis of intact sam-

ples 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 with the latest MMOD environments are also presented.

## **Findings**

Statistics on the >300 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 dependent on several factors. The paper provides details of each of these variables.

(1) Damage equations

(2) Impact condition assumptions

a. Projectile density

b. Impact speed

c. Impact angle

(3) Analysis results

a. pre-flight vs. on-orbit damage

b. MMOD vs. non-MMOD

## **Conclusions and Recommendations**

The ISS visiting vehicle impact database is an ongoing project. SpaceX provides crew rotations as well as resupply and cargo return with the Dragon 2 spacecraft. Sierra Space is manifested for resupply and cargo return services starting in 2023. Boeing is expected to provide crew rotations as well. All of these spacecraft will provide additional opportunities for post flight MMOD inspections of space exposed hardware.

## **Acknowledgements**

Over the course of the inspection campaign various personnel at the SpaceX Texas Test Site in McGregor and at the SpaceX headquarters in Hawthorne CA provided valuable support to this activity.