

Degra accounts for the gradual deterioration of performance attributable primarily to decay of the radioactive source and secondarily to gradual deterioration of the thermoelectric material. To provide guidance to an RTG designer, given a minimum of input,

Degra computes the dimensions, masses, and thermal conductances of important internal structures as well as the overall external dimensions and total mass.

*This program was written by Eric G. Wood, Richard C. Ewell, Jagdish Patel, David R.*

*Hanks, Juan A. Lozano, G. Jeffrey Snyder, and Larry Noon of Caltech for NASA's Jet Propulsion Laboratory.*

*This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-45252.*

## Calculations for Calibration of a Mass Spectrometer

*NASA's Jet Propulsion Laboratory, Pasadena, California*

A computer program performs calculations to calibrate a quadrupole mass spectrometer in an instrumentation system for identifying trace amounts of organic chemicals in air. In the operation of the mass spectrometer, the mass-to-charge ratio ( $m/z$ ) of ions being counted at a given instant of time is a function of the instantaneous value of a repeating ramp voltage waveform applied to electrodes. The count rate as a function of time can be converted to an  $m/z$  spectrum (equivalent to a mass spectrum for singly

charged ions), provided that a calibration of  $m/z$  is available.

The present computer program can perform the calibration in either or both of two ways: (1) Following a data-based approach, it can utilize the count-rate peaks and the times thereof measured when fed with air containing known organic compounds. (2) It can utilize a theoretical proportionality between the instantaneous  $m/z$  and the instantaneous value of an oscillating applied voltage. The program can also

estimate the error of the calibration performed by the data-based approach. If calibrations are performed in both ways, then the results can be compared to obtain further estimates of errors.

*This program was written by Seungwon Lee of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

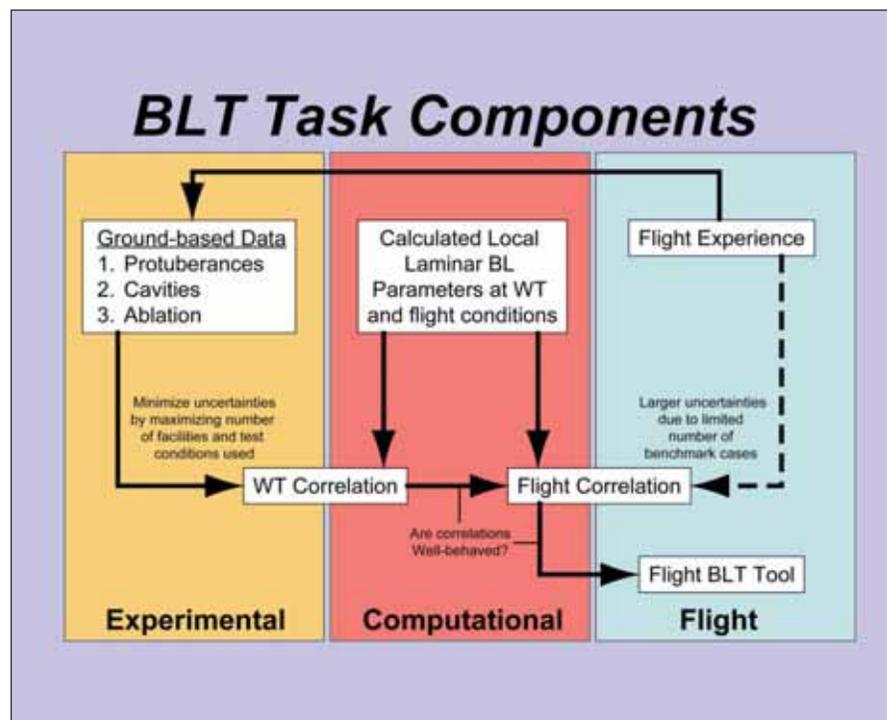
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## Predicting Boundary-Layer Transition on Space-Shuttle Re-Entry

*Langley Research Center, Hampton, Virginia*

The BLT Prediction Tool ("BLT" signifies "Boundary Layer Transition") is provided as part of the Damage Assessment Team analysis package, which is utilized for analyzing local aerothermodynamics environments of damaged or repaired space-shuttle thermal protection tiles. Such analyses are helpful in deciding whether to repair launch-induced damage before re-entering the terrestrial atmosphere. Given inputs that include re-entry trajectory and attitude parameters, air density, air temperature, and details of each damage or repair site, the BLT Prediction Tool calculates expected times of laminar-to-turbulent transition onset of the boundary-layer flow during re-entry. (These times help to define the proper aerothermodynamic environment to use in subsequent thermal and stress analyses of local structural components.)

The BLT Prediction Tool includes a database of computed boundary-layer parameters that cover a range of nominal re-entry trajectories and uses an interpolation program for estimating local boundary-layer properties during flight



Critical Elements for development of new BLT tool for on-orbit assessments.



Space Shuttle Model in wind tunnel tests.

along a specific trajectory. Boundary-layer-transition criteria used in the BLT Prediction Tool were developed from ground-based measurements to account for effects of both protuberances and cavities, and have been calibrated against flight data. Version 1 of this BLT prediction tool was developed in time for the first Return-to-Flight mission STS-114.

*This work was done by Scott Berry, Tom Horvath, Ron Merski, Derek Liechty, Frank Greene, Karen Bibb, and Greg Buck of Langley Research Center; Harris Hamilton and Jim Weilmuenster, Contractors with Langley Research Center; Chuck Campbell, Stan Bouslog, Ben Kirk, Garry Bourland, Amy Casady, and Brian Anderson of Johnson Space Center; Dan Reda and James Reuther of Ames Research Center; Gerry Kinder, Dennis Chao, Jay Hyatt, Maria Barnwell, and K. C. Wang of The Boeing Co.; and Steve Schneider of Purdue University. For more information, contact the Langley Innovative Partnerships office at (757) 864-4015. LAR-17337-1*

## 2D/3D Synthetic Vision Navigation Display

Langley Research Center, Hampton, Virginia

Flight-deck display software was designed and developed at NASA Langley Research Center to provide two-dimensional (2D) and three-dimensional (3D) terrain, obstacle, and flight-path perspectives on a single navigation display. The objective was to optimize the presentation of synthetic vision (SV) system technology that permits pilots to view multiple perspectives of flight-deck display symbology and 3D terrain information. Research was conducted to evaluate the efficacy of the concept. The concept has numerous unique implementation features that would permit enhanced operational concepts and efficiencies in both current and future aircraft.

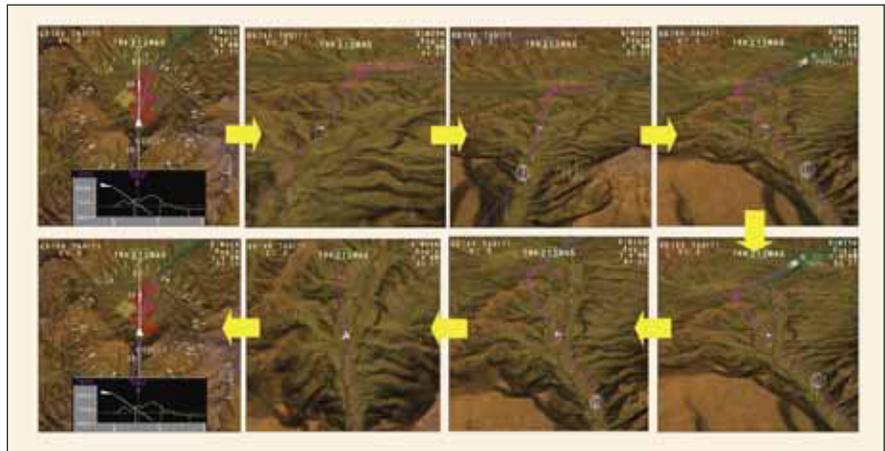
One innovative feature, shown in the figure, was the ability of the flight crew to select among several modes that present a dynamic 3D perspective of aircraft within the flight environment. The study focus was to uncover the developments and benefits of using the 2D and 3D exocentric SV information with regard to primary flight displays (PFDs) and navigational displays (NDs) for reducing accidents and damage for commercial aircraft. The investigated technologies aim toward elimi-

nating low visibility conditions as a causal factor in civil aircraft accidents, while replicating the operational benefits of clear-day flight operations, regardless of actual outside visibility conditions. The concepts also form the basis of revolutionary electronic flight bag applications that utilize these technological enhancements.

The results showed that SV on the PFD was pivotal for pilot use in terrain avoidance and situation awareness,

while SV terrain on the 2D co-planar navigational display was not found to provide much benefit. However, pilots noted that the 3D exocentric display of synthetic terrain, with key implementation features, added significantly to flight-crew situation awareness and substantially enhanced the pilot's ability to detect and avoid controlled-flight-into-terrain situations.

Conclusions reached indicate that SV depicted on PFD is essential for terrain



**Dynamic 3D Exocentric Navigation Display:** Examples show several available display modes selected by pilots that dynamically present an immersed moving 3D perspective of the aircraft in relation to terrain, flight path, and aviation hazards (represented here as static images).