

can cause impacts uprange or well away from the intended flight line, and (2) some vehicle failures cannot logically be classified as Response Modes 1, 2, 3, or 4.

In keeping with the above, the Mode-5 impact-density function was developed with the characteristics listed below. The function, which fills the void left by Modes 1 through 4, is sufficiently robust to include all possible impacts, yet seemingly comports with observed test results.

- (1) Impacts can occur in any direction from the launch point and at any range within the vehicle's energy capabilities.
- (2) At any given impact range from the launch point, the likelihood of impact decreases as the angular deviation from the flight line increases, becoming least likely in the uprange direction. For any fixed angular deviation from the flight line, the likelihood of impact decreases as the impact range increases.
- (3) At fixed impact ranges near the launch point, the impact density function changes gradually as the impact direction swings 180° from downrange to uprange. As the impact range increases, the decrease in the density function becomes progressively more and more rapid with change in impact direction. In other words, the greater the impact range, the more rapidly the density function changes with angular deviation from the flight line.

As modeled in DAMP, the effects of destruct action on the Mode-5 density function are accounted for in the launch area by supplementing impacts inside the impact limit lines with those that would occur outside the impact limit lines if no destruct action were taken.

The Mode-5 failure-response methodology was fully developed in an earlier RTI report⁽¹⁾. As pointed out there, the shape of the impact density function can be controlled somewhat through the selection of shaping constants that appear in the defining equation. Intuition suggests that the constants should be vehicle dependent, since (1) ruggedly built missiles would, after a malfunction, be more likely to impact well away from the flight line than would a fragile space vehicle that tends to break up before deviating significantly; and (2) certain vehicles, after a malfunction, tend to stabilize and continue thrusting at large angles of attack, while other vehicles that experience similar malfunctions tend to tumble. Hit probabilities computed by program DAMP for targets located more than two miles or so uprange from the pad or more than a few miles from the flight line, are due almost entirely to the Mode-5 impact-density function. Thus, the assumed probability of occurrence of a Mode-5 response as well as the selected Mode-5 constants are of considerable importance.

The tasking for this study is set forth as Task No. 10/95-77, Paragraph 2.0, of Contract FO4703-91-C-0112. The primary purpose of the tasking is: "Perform a study to determine the best values for Mode-5 failure probability and the Mode-5 density-function shaping constant A." Although not explicitly included in the statement of work, the study also develops absolute failure probabilities for Atlas, Delta, and Titan, and