8. Summary

In RTI's risk-computation program DAMP, vehicle failures per se are not considered. Instead each catastrophic failure is assumed to produce one of five failure responses, and it is these response modes that are modeled in DAMP. Although most catastrophic failures result in impacts near the flight line, less likely malfunctions may cause debris to fall either uprange or well away from the flight line. In DAMP, vehicle failures with this potential are, for the most part, classified as Mode-5 failure responses. The resulting impacts are modeled by a rather formidable-looking density function that includes two shaping constants (A and B) that strongly influence the nature of the impact-density function. To obtain absolute probabilities (or risks), the function must be multiplied by a probability-of-occurrence factor (p_5). The primary purpose of this study was to determine the best values for A, B, and p_5 for various vehicle programs. Other objectives not explicitly included in the statement of work were to develop absolute failure probabilities for Atlas, Delta, and Titan and to derive relative probabilities of occurrence for the five failure-response modes in DAMP.

Although some risk analyses may ignore unlikely failure-response modes, Section 2 demonstrates the need for a Mode-5 response – or some similar response – through brief descriptions of actual vehicle flights. Section 3 and Appendix B provide the reader with a fuller understanding of the nature and intricacies of the Mode-5 impact-density function. Together, they show how density-function shaping is affected by values of A and B, and in particular how the Atlas IIAS launch-area risk contours change if the value of A is changed.

Section 4 is a philosophical discussion of methods of assessing vehicle failure probability (or reliability). Two approaches are discussed, one strictly empirical, the other a parts-analysis method that involves the assignment of failure probabilities to individual parts, components, and systems. Although difficulties exist with both approaches, the empirical method was chosen to estimate both absolute and relative failure probabilities.

As the first step in estimating failure probabilities empirically, performance histories were gathered, summarized, and tabulated (Appendix D) by launch date for Atlas, Delta, and Titan vehicle launches from the Eastern and Western Ranges, and for Thor launches from the Eastern Range. Obtaining this information, and assigning response modes and associated flight phases for each failure consumed a large portion of the effort expended on this task.

A filtering (i.e., data weighting) technique was selected (see Section 5.1 and Appendix C) and applied to the launch failure data to estimate overall failure probabilities by flight phase (see Section D.1.3) for Atlas, Delta, and Titan vehicles. The recommended failure probabilities are based on test results involving only those vehicle configurations that are considered to be representative of current launch