however, involve the quantity $\dot{R}$ which is expressed explicitly as a function of R and only implicitly as a function of time. Values of R from the nominal trajectory are differenced to compute $\dot{R}$.

The secondary Mode-5 impact-density function is circular normal in form and expressed by the equation

$$f(d) = \frac{1}{2\pi\sigma_c^2} e^{-\frac{1}{2}\left(\frac{d}{\sigma_c}\right)^2} \qquad (2)$$

where d is the distance from the impact point of the mean piece to the center of the target, and σ_c is the standard deviation (dispersion) for the debris class. The fact that the center of the secondary impact-density function (or secondary MPI for a debris class) lies on some population center does not necessarily mean that pieces in the class hit the center. The probability that one or more pieces actually hits the pop center is determined by integrating the secondary impact-density function over the center and combining results for all pieces in the class. The dispersions for the secondary function are computed by root-sum-squaring individual dispersions* arising from the effects of winds, vehicle-breakup velocities, and drag uncertainties for the class. They are computed from the nominal trajectory, and can be explicitly expressed as a function of impact range. Since the pop center can also be hit if the MPI of the secondary density function lies outside the pop center, all possible mutually-exclusive locations of the secondary function that can result in impact on the pop center must be considered. For each mutually-exclusive location, the probability that one or more class pieces impacts on the pop center is calculated, and the results combined to obtain the total hit probability for the class.

The Mode-5 primary impact-density function is modeled so it is independent of how the impact point arrives at a particular location. For example, there are myriad paths that a vehicle can travel to impact at a location two miles crossrange left from the launch pad. Figure 1 shows one such way for a Joust vehicle that failed at 15 seconds, but four seconds later had moved the impact point uprange and crossrange to a position two miles crossrange left from the launch point. Another way to place the impact point two miles crossrange left is for the vehicle to fly in the wrong direction (north instead of east) from liftoff.

Although numerous failure mechanisms and vehicle behaviors can lead to a Mode-5 response and impact in a particular area, the exact mechanism and behavior are irrelevant. All such possibilities are assumed to be accounted for by Eq. (1). Four specific failures that produce Mode-5 responses are easily described: (1) a re-orientation of the guidance platform, (2) insertion of an erroneous spatial target into the guidance system, (3) locking of the engine nozzle in a fixed position near null thus producing a near-constant angular

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* These dispersions are a subset of the Mode-4 impact dispersions.