



**Federal Aviation
Administration**

Guidance Statement on Hazardous Scenarios

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1.1 Preface

The material in this document is advisory in nature and does not constitute a regulation. This guidance is not legally binding in its own right, and the FAA will not rely upon this guidance as a separate basis for affirmative enforcement action or other administrative penalty. Conformity with this guidance document (as distinct from existing statutes and regulations) is voluntary only, and nonconformity will not affect rights and obligations under existing statutes and regulations. The material in this document does not change or create any additional regulatory requirements, nor does it authorize changes to, or deviations from, existing regulatory requirements.

1.2 Hazardous Scenarios

In accordance with 14 CFR § 450.121(b)(1), a debris analysis must account for each reasonably foreseeable cause of vehicle breakup and intact impact. The type of breakup affects the hazardous debris list and imparted velocities of those hazardous debris. There can be many failure modes for a vehicle, and there can be multiple potential breakup modes for a given failure mode. The hazardous debris list for each vehicle depends on the breakup mode and not the failure mode. Vehicles can break up due to many factors. In accordance with § 450.107(b), for each phase of flight during a launch or reentry, an operator must use a functional hazard analysis to determine a hazard control strategy or strategies that account for all function failures associated with reasonably foreseeable hazardous events that have the capability to create a hazard to the public; safety-critical systems; and a timeline of all safety-critical events.

1.3 Breakup Initiation

Breakup can be initiated by a variety of events. It is common that different initial events will result in essentially the same hazardous debris when considering uncertainty. These common end states are often referred to as breakup modes. To identify each reasonably foreseeable cause of vehicle breakup and intact impact in accordance with §§ 450.121(b)(1), and (d)(1), all functional failures identified in the functional hazard analysis required by § 450.107(b) should be considered. The rationale for the assignment of an initial breakup event to a resulting breakup mode should also be provided. Some of the common events initiating breakup include:

- FTS destruct activated
- FTS thrust termination
- Propellant tank bulkhead failure
- Explosion in engine
- Aerothermal structural weakening
- Exceedance of structural loads in stage N for each N greater than or equal to the current active stage

- Solid propellant case rupture
- Solid propellant nozzle loss

To comply with § 450.121(b)(1) and § 450.121(d)(1), the operator should define the breakup modes for each flight stage and for each vehicle stage. An applicant should consider all the relevant breakup-initiating events and breakup modes for their vehicle even if they are missing from the list above.

1.4 **Trajectory Deviation**

When trajectory deviation occurs, there are many potential breakup mode outcomes. A trajectory deviation may result from loss of thrust (partial or complete), inadvertent separation, or because of a guidance, navigation, or control malfunction. For this, an event tree should be used, showing each condition that could lead to a different outcome in accordance with § 450.121(d)(1). An example is shown in the figure below. The quantitative criteria associated with each conditional should also be developed through engineering analysis and incorporated into the malfunction trajectory analysis in accordance with § 450.119(b)(2).

