**Supplemental Application Guidance for Unguided Suborbital Launch Vehicles**

**Attachment 4 - Wind Weighting**

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**General**

1. A wind weighting procedure shall be conducted in accordance with the following specified definitions, input, methodology, and output.
2. As part of the launch countdown process, a wind weighting analysis is used to predict the wind effect on impact point displacement during the thrusting phases of flight as well as the ballistic phase of each launch vehicle stage until impact.
3. The wind weighting system produces solution errors which are a function of the method used to measure the winds, the method used to compute the effects of winds, and the frequency of wind measurements. The resulting sum of these error components shall be no greater than those used as the wind error component in the launch vehicle dispersion analysis defined in Attachment 1.
4. The procedures must consider parachute recovery, if applicable. The applicant may wind weight for a parachute impact or for a ballistic impact of the final stage. If a ballistic impact method is used for wind weighting, the applicant shall perform a wind drift analysis to determine the parachute impact point.
5. The wind weighting procedures shall list needed assets, such as a wind tower, balloons, a GPS system, and a 6 DOF trajectory program.

**Definitions**

1. Ballistic Wind - A constant wind value acting from the ground to the top of the effective atmosphere that would produce the same effect on a trajectory of an unguided suborbital launch vehicle as the actual winds (direction and magnitude) encountered in flight.
2. Impact Point Displacement - A distance measured from the predicted, nominal, no-wind impact point to the impact point which is produced by the unguided suborbital launch vehicle's flight through winds.
3. Wind Weighting - A technique used to predict launcher azimuth and elevation settings for unguided launch vehicles such that a rocket's flight through a forecasted wind field will produce the predicted nominal drag impact point for the final launch vehicle stage.

**Input**

1. The wind weighting analysis below requires a six degree-of-freedom (DOF) computer program that can target an impact point. The minimum data requirements for the 6 DOF computer simulations shall be those sufficient to perform an analysis with winds.
2. The wind weighting analysis below requires inputs necessary to produce a 6-degree-of-freedom trajectory. Trajectory data computed with commercially available software products should consider the parameters used in the trajectory computations in Attachment 1. The data should also include launch day wind direction and wind magnitude vs. altitude measured to a height up to a maximum of 90,000 ft..
3. The wind weighting analysis below requires a computer program or method of editing wind data, recording the time the data was obtained, and recording the balloon number for each wind altitude layer.

**Methodology**

On launch day, the wind weighting processes shall include:

1. Using a wind measuring system, such as balloons with GPS, determine launch day wind velocity and direction. A wind measurement is required every 200 feet from ground level to the maximum altitude.
2. Measure winds to a "maximum altitude" not less than the altitude at vehicle burnout. If a parachute is employed, the balloon shall be sized to measure winds to the altitude at parachute deployment or 90,000 feet, whichever is less. Maximum altitude winds are required to be remeasured at least once every 6 hours, whenever a weather front passes the launch site, or whenever the top levels of a lower altitude balloon do not agree with the wind data measured by the "maximum altitude" balloon.
3. Measure winds to a "medium altitude" not less than 50,000 ft.. This measurement is required every 4 hours, whenever a weather front passes the launch site, or whenever the top levels of a lower altitude balloon do not agree with the wind data measured by the "medium altitude" balloon.
4. Measure winds to a "low altitude" not less than 5000 ft. This measurement is required twice within 30 minutes of launch.
5. Using the six DOF computer program with launch day winds and targeting for final stage impact, compute the launcher elevation and azimuth settings to achieve the nominal no wind impact point.
6. Using the trajectory produced in 5 above, compute the impact point which results from wind drift for all intermediate stages/ejected components. This is accomplished by performing a trajectory simulation, with the launch angles determined in 5 above, through the wind field until the applicable stage burnout.
7. If a parachute is used for the final or any intermediate stage/component, a trajectory simulation shall predict the wind drifted impact point. The change in aerodynamics at parachute ejection shall be modeled in the simulation. This simulation is in addition to any simulation of spent stages without parachutes. The requirement is to predict the impact location, for all impacting bodies, which results from flight through the winds.
8. Verify launcher settings are within established limits. The launcher adjustment due to wind weighting shall not exceed: a. � 5o for elevation, not to exceed 86o, and b. � 30o for azimuth.
9. Verify that the actual launcher settings are the same as computed by the wind weighting program.
10. Monitor and verify wind variations and maximum wind limits are within launch constraints.

**Output**

1. An applicant's wind weighting procedure shall determine the following:
   1. Launcher azimuth and elevation settings which are derived from a trajectory simulation through launch day winds that achieve a final launch vehicle stage impact at the nominal no wind impact point.
   2. Wind drifted impact locations for each stage/ejected component.
2. Output data from wind weighting operations may be required in printed, plotted, or computer medium format for each impacting body. The output shall include:
   1. Wind data for each balloon.
   2. The results of each computer run made on each wind weighting balloon. Data includes but is not limited to, launcher settings, and impact locations for each stage or component.
   3. Anemometer data, recorded
   4. Final launcher settings, recorded.
3. In the applicants application, provide a description of operational wind weighting methods including method and schedule of determining wind speed and wind direction for each altitude layer, and provide qualifications of the lead wind weighting person and each member of the team.