

IAF SYMPOSIUM ON COMMERCIAL SPACEFLIGHT SAFETY ISSUES (D6)  
Enabling safe commercial spaceflight: vehicles and spaceports (3)

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ESTABLISHING THE REQUIREMENTS FOR SAFE ROCKET LAUNCHES WITH RESPECT TO  
WEATHER

**Abstract**

Space Concordia is launching the biggest student built Canadian rocket with the aim of passing the Karman Line. Launching from Churchill, Manitoba, a former military airbase used in the 1950s for suborbital sounding rocket launches, the Space Concordia ambition is to reinstate the zone as a launch site. Being the first launch out of Churchill in decades, safety is mandatory and must follow the safety protocols and established regulations for sub-orbital launch vehicles. Space Concordia must structure our own guidelines and requirements leveraging expertise from the FAA and various agreements with local authorities.

To ensure safety, Flight Performance runs wind weighting optimization algorithms using Astos, a 6 degree of freedom software referring to wind data obtained from the Churchill weather Station. The wind data is processed through a combination of Python and Matlab data analysis scripts and the predictions based on historical data will be compared with weather balloon data taken at regular intervals prior to launch to confirm the proper launch rail configuration. Our goal is to orient the launch rail in such a way that the rocket will achieve its nominal theoretical landing point simulated with no winds. The launch rail angle is expected to be 84 degrees for ideal conditions.

Casualty expectation plays a significant role in the launch safety analysis since the launch site is situated next to a national park and multiple small communities. To obtain the results, the LandScan database is referenced, and an impact hazard area has been constructed as the union of a circle around the launch site with a 1 nautical mile radius and a  $3\sigma$  dispersion ellipse of all the impact points obtained as the result of 1000 Monte Carlo Analysis simulations. Furthermore, the probability of casualty is calculated to be  $2.36E-8$ , which is smaller than the  $30E-6$  FAA requirement.

Establishing a strict set of guidelines while building a rocket creates many difficulties in terms of both design and regulations, however they will permit a clearer structure for future launches made by both Space Concordia and other organizations as well a predefined understanding of the weather effect on Churchill suborbital rocket launches.