Moog SureFly® Hover Test Update

Revolutionary Vertical Lift Technology Project
Advanced Air Vehicles Program

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NASA Acoustics Technical Working Group
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Objectives

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- Determine location of far-field
- Measure sound pressure levels for vehicle in hover
- Acquire data to use in electric motor efforts
- Acquire dataset for future predictive tool validation

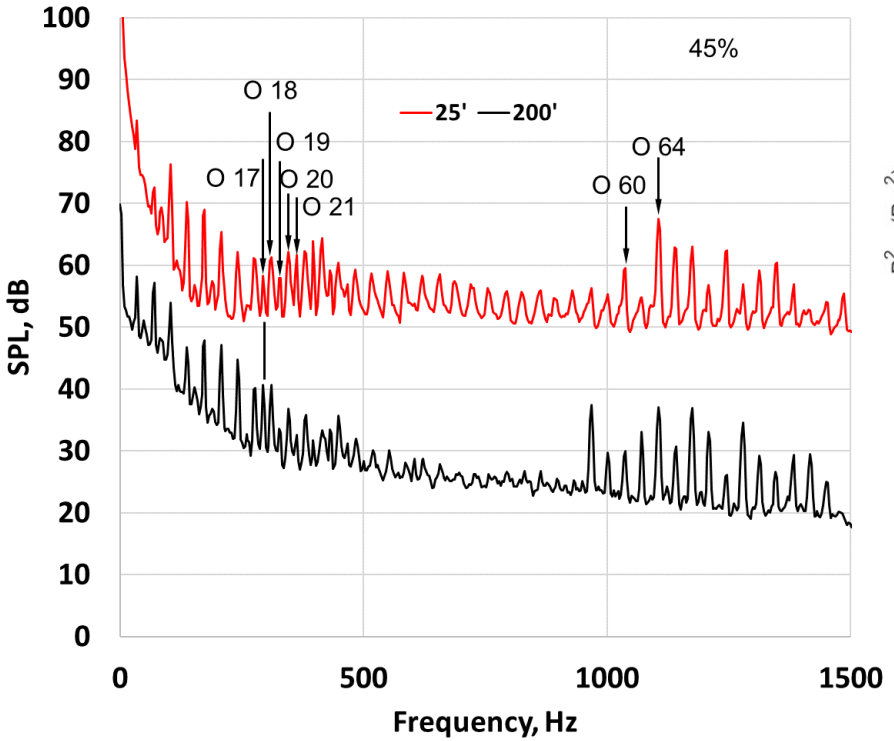
Test Constraints

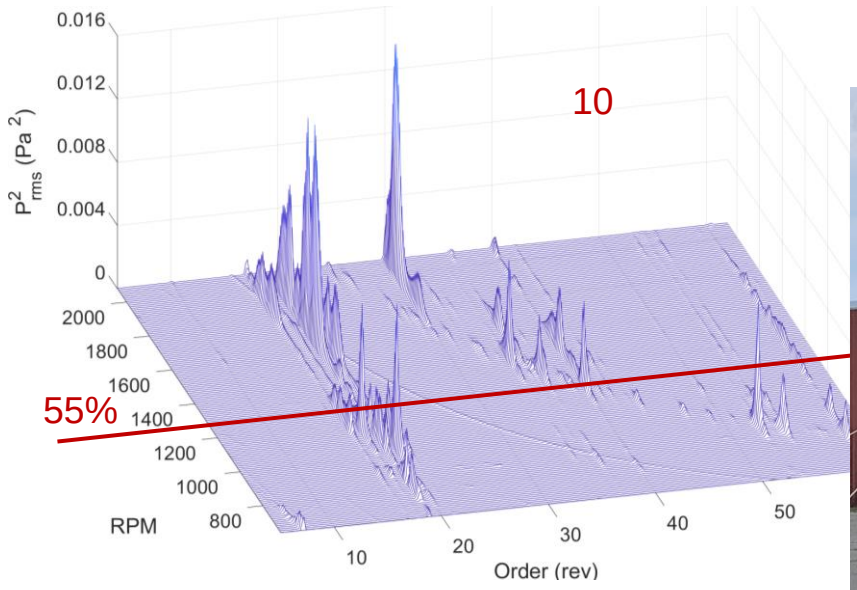
- Lunken Field
  - 15’ maximum hover
  - Limited testing area
  - Fog!
- ~10 minutes flight time
- Altitude (z coordinate) part of control loop, x and y coordinates maintained visually by pilot
  - x and y box was approximately equivalent to that expected from the control system
- Needed to post process GPS data for accuracy

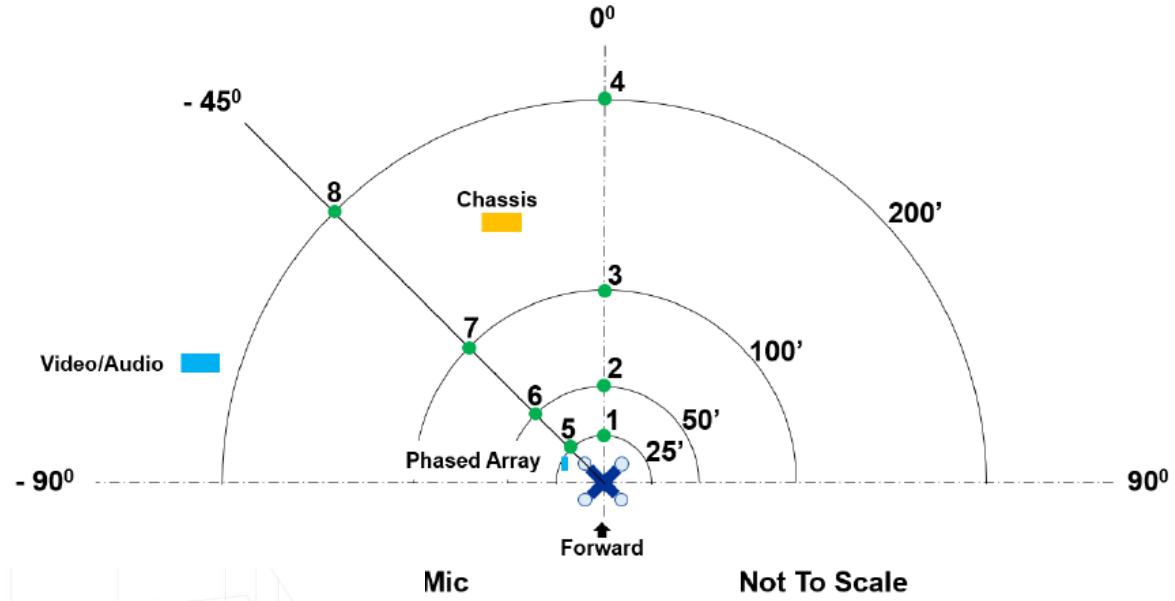
Test Date – 6/29/2022

Previous Results

- Ground Runups in November 2019 with sparse microphone array (NASA/TM-20210015042) and constrained to 55% throttle
- Electric motor noise measurements in August 2021 (NASA ATWG Spring 2022)
- RotCFD calculations 2022 in preparation for hover test



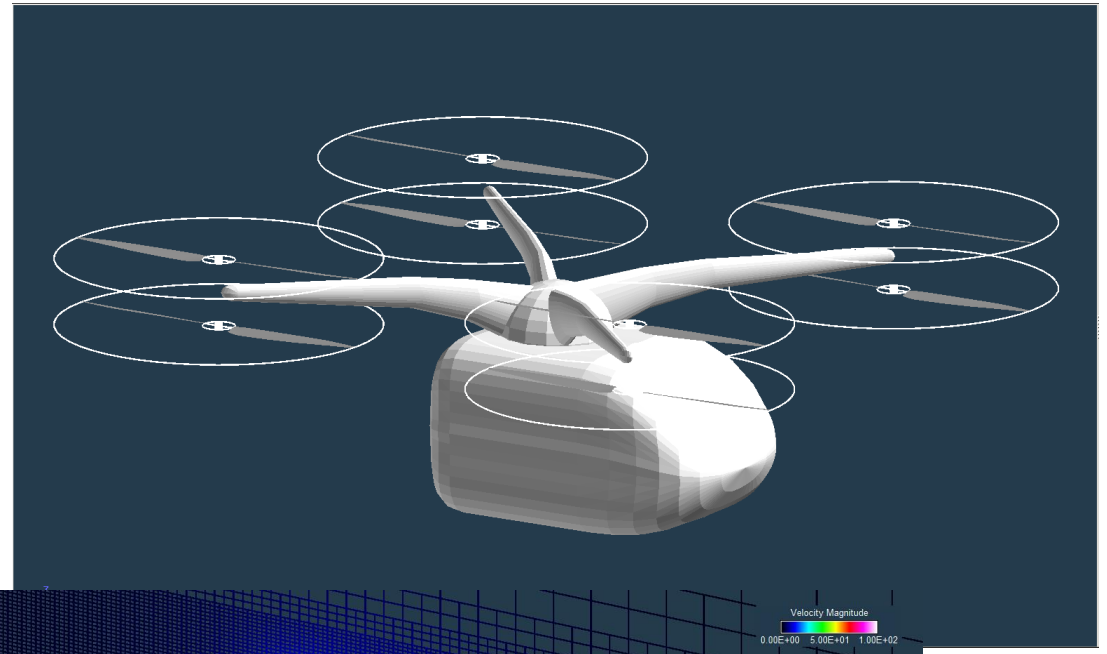


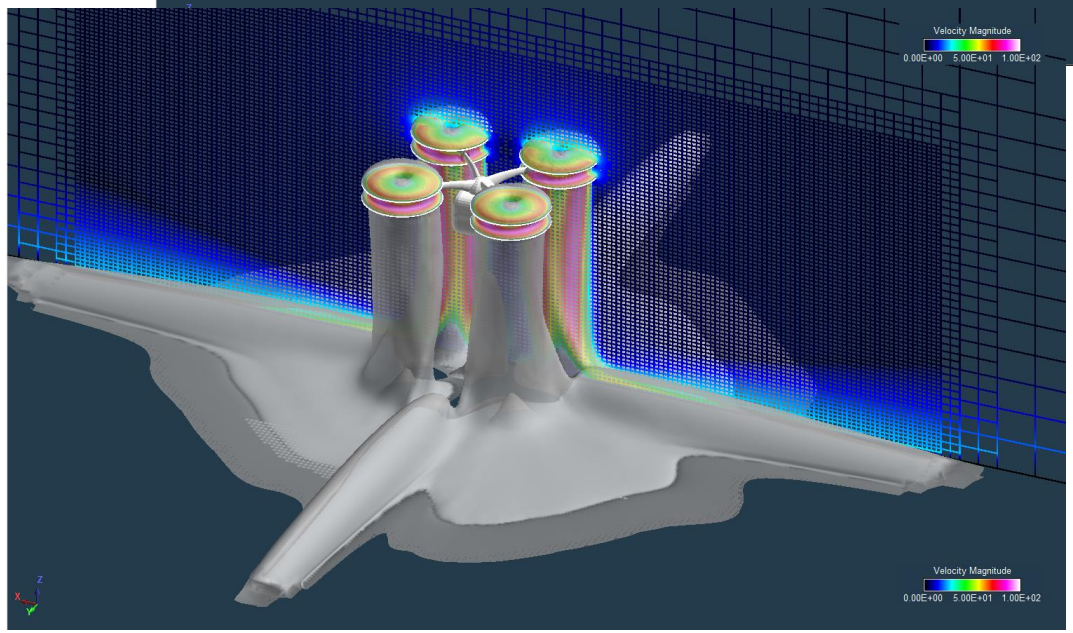


Mic Not To Scale

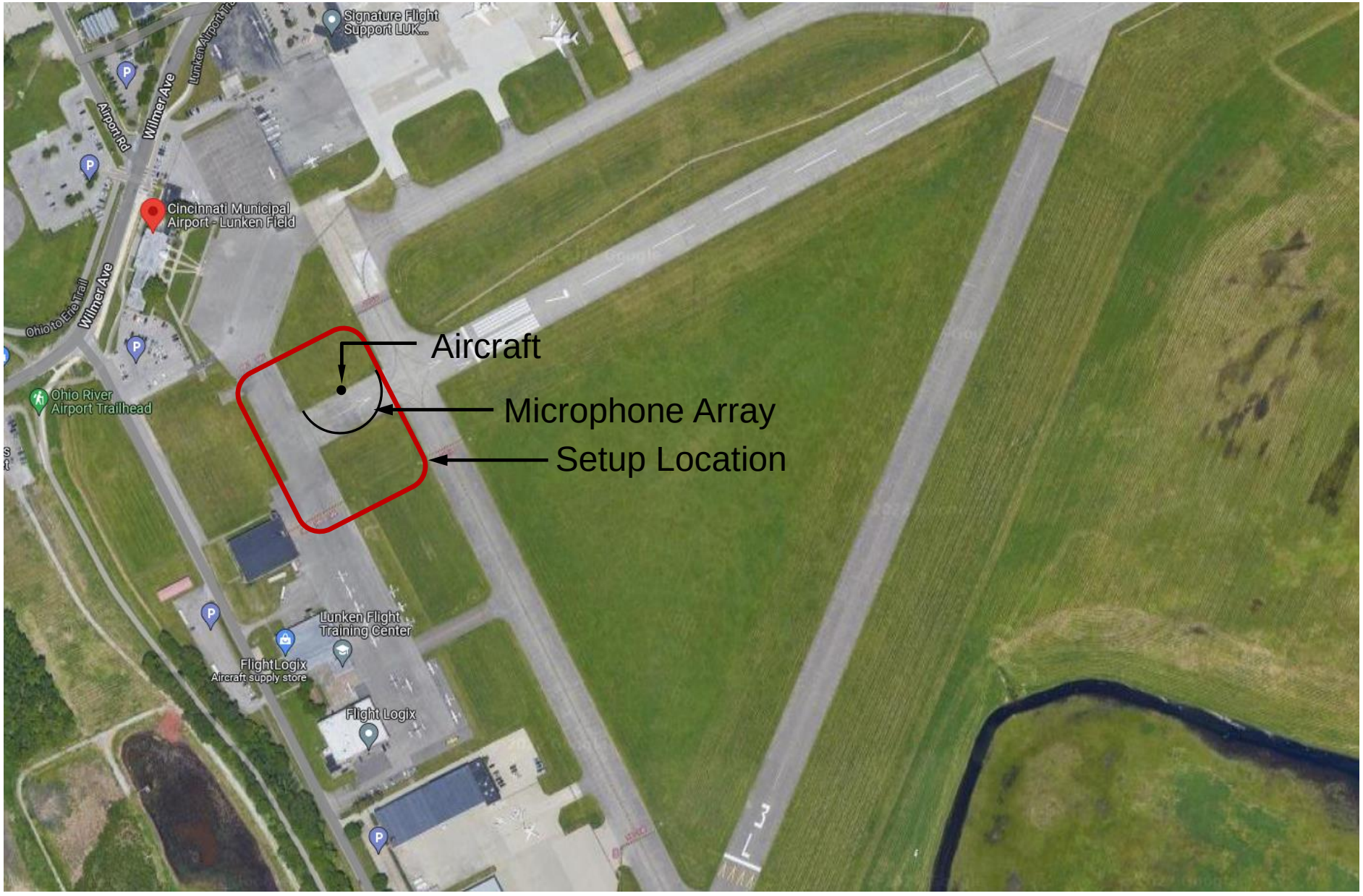
Moog SureFly – RotCFD

- GOAL
  - Preliminary analysis to protect ground plate microphones and assess hover test results
- APPROACH
  - Hover In Ground Effect (HIGE)
  - Actuator disk rotors
  - At estimated power and uniform RPM
- RESULTS
  - Strong ground plumes avoided for some angles
  - Minimum time on condition estimated
- FUTURE
  - Use actual rotor power and RPM
  - Predict rotor tones



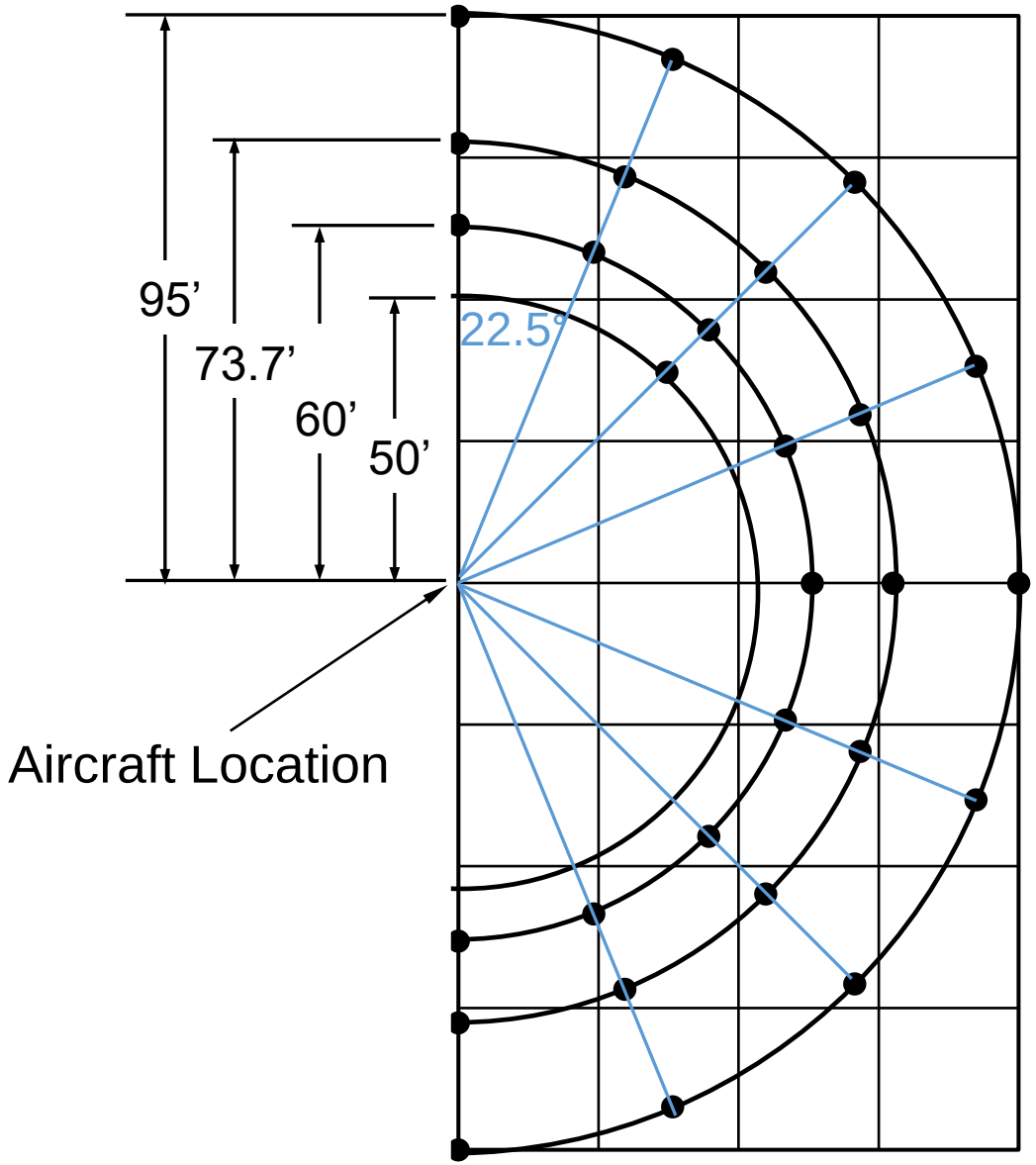


Test Location - Lunken Field in Cincinnati



Array Layout

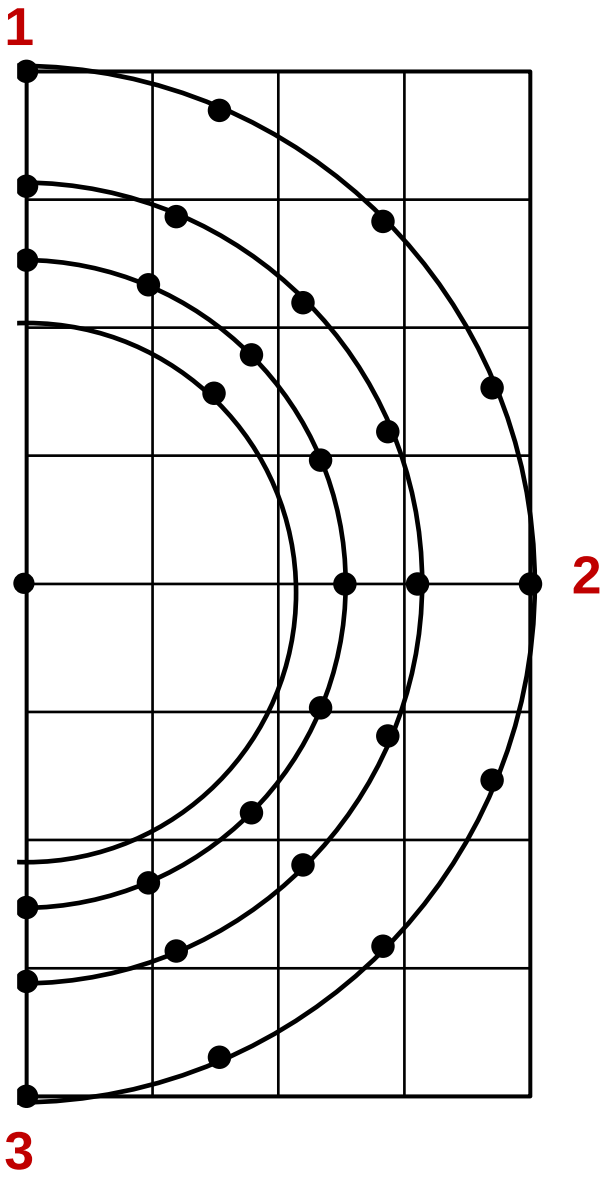
- 28 Ground plate microphones
- Maximum distance from the aircraft in the test location was 95’ (100’ to aircraft at 15’)
- Array allowed for determination of directivity and distance to the far field



Test Procedure

- Align with microphone 1 and hold for 20 sec
- Rotate to microphone 2 and hold for 20 sec
- Rotate to microphone 3 and hold for 20 sec
- Repeat in opposite rotational direction
- Land, liftoff, repeat procedure

- Acoustic data was acquired continuously to record steady hover and yaw conditions
- Humidity, temperature, pressure, wind speed were recorded at roughly 10’ above ground



Requested Vehicle Data

- GPS for vehicle position
  - L1 Capable
  - Distance to nearest base station - 14.7 km
- Vehicle attitude from inertial measurement unit (pitch, yaw, roll)
- Motor speeds
- Electric motor input (at least one leg)
- Shaft power
- Weight
- Center of gravity
- Rotor blade angle settings

Summary

- Preliminary RotCFD complete. Final analysis will be completed once vehicle data is incorporated
- In the process of obtaining RINEX files needed for GPS post processing – needed for far-field determination
- Electric motor noise assessment planned for Spring ATWG
- Exercise acoustic predictive tools in Spring
- Hover test at higher altitude is planned for Springfield-Beckley Municipal Airport airport in Spring