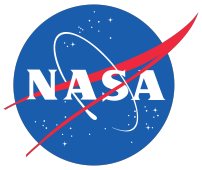
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Multirotor Test Bed Second Wind Tunnel Entry

Data Report

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Ames Research Center
Moffett Field, California

May 2025

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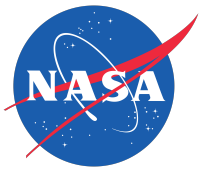
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Summary

In mid-2022, a wind tunnel test of the Multirotor Test Bed (MTB) was carried out in the U.S. Army 7- by 10-Foot Wind Tunnel at NASA Ames Research Center. This was the second wind tunnel test of the MTB, following the initial test entry that was conducted in 2019 shortly after the test stand was built. The first MTB wind tunnel test was essentially a shakedown test, exercising the different capabilities of the test stand. The second test entry, covered by this data report, was intended to be more tightly focused on a quadrotor configuration, with variations across multiple characteristics of the rotor system layout. These multirotor characteristics included rotor spacing, rotor azimuthal phasing, and incidence, in addition to more traditional variables like rotor rpm, vehicle pitch, and windspeed. This data report contains a brief summary of the test objectives, as well as a high-level description of the test hardware design, which is fully detailed in a companion report. The test procedures, test matrix, and results are covered here in a high level of detail, with the intent that these test results can be used as validation data across a broad range of computational tools. In all, over 2,500 data points were collected across a wide range of test conditions.

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Nomenclature

Symbol	Description	Units
c	airfoil/rotor chord length	in
c_d	section drag coefficient	-
c_l	section lift coefficient	-
c_m	section moment coefficient	-
CI_α	confidence interval derived from loads measurements	-
C_T	thrust coefficient	-
C_T/σ	blade loading	-
dz	difference in vertical rotor spacing between the front and back rotors	in
dz/R	change in vertical rotor spacing with respect to rotor radius	-
F	applied load	lb
$\hat{F}$	model predicted load	lb
F_x	force reading from load cell in x-direction	lb
Fx_B	force reading from load cell in x direction in the Balance Coordinate System	lb
Fx_H	force reading from load cell in x direction in the Hub Coordinate System	lb
Fx_M	force reading from load cell in x direction in the Manufacturer Coordinate System	lb
F_y	force reading from load cell in y direction	lb
Fy_B	force reading from load cell in y direction in the Balance Coordinate System	lb
Fy_H	force reading from load cell in y direction in the Hub Coordinate System	lb
Fy_M	force reading from load cell in y direction in the Manufacturer Coordinate System	lb
F_z	thrust force reading from load cell	lb
Fz_B	thrust reading from load cell on the front starboard side in the Balance Coordinate System	lb
Fz_H	thrust reading from load cell on the front starboard side in the Hub Coordinate System	lb
Fz_M	thrust reading from load cell on the front starboard side in the Manufacturer Coordinate System	lb
g	gravitational acceleration	ft/s^2
M	Mach number	-
M_x	roll moment reading from load cell	in-lb
Mx_B	roll moment reading from load cell in the Balance Coordinate System	in-lb
Mx_H	roll moment reading from load cell in the Hub Coordinate System	in-lb
Mx_M	roll moment reading from load cell in the Manufacturer Coordinate System	in-lb
M_y	pitch moment reading from load cell	in-lb
My_B	pitch moment reading from load cell in the Balance Coordinate System	in-lb
My_H	pitch moment reading from load cell in the Hub Coordinate System	in-lb
My_M	pitch moment reading from load cell in the Manufacturer Coordinate System	in-lb
M_z	torque reading from load cell	in-lb
Mz_B	torque reading from load cell in the Balance Coordinate System	in-lb
Mz_H	torque reading from load cell in the Hub Coordinate System	in-lb
Mz_M	torque reading from load cell in the Manufacturer Coordinate System	in-lb
N	number of blades	-
p	number of multivariate parameters	-
P	power	lb-ft/s
P_o	profile power	lb-ft/s
P_i	induced power	lb-ft/s

PI	predictive interval derived from loads measurements	-
r	airfoil profile location along the blade span	in
R	radius of the rotor blade	in
r/R	radial station of the airfoil profile	-
Re	Reynolds number	-
Re/M	Reynolds-Mach proportionality constant	-
X	longitudinal axis	in
Y	lateral axis	in
Z	vertical axis, height	in
$[A]$	conversion matrix	-
$[F]$	matrix of resultant forces and moments	lb
V	input voltage matrix	volts
$\hat{C}$	resultant calibration coefficients derived from applied loads and load cell voltage measurements	-
$\hat{W}$	calibrator matrix derived in load cell calibration at Ames	-
α	angle of attack	deg
β	percentage of confidence interval	-
$\epsilon(\sigma 2)$	Gaussian noise term	-
θ	rotor blade built-in collective	deg
θ_{tw}	rotor blade linear twist angle	deg
σ	blade solidity	-
σ_i	variance term	-
δ_p	change in pitch angle	deg
δ_t	change in twist angle	deg
$\hat{i}, \hat{j}, \hat{k}$	unit vector corresponding to x,y,z directions	-

Acronyms

APC	Advanced Precision Composites
ARC	Ames Research Center
CI	confidence interval
DAQ	Data Acquisition Aystem
E387	Eppler 387
ESC	electronic Speed Controller
EU	Engineering Units
GPR	Gaussian Process Regression
LC	Load Cell Sensor
MCS	MTB Control System
MTB	Multirotor Test Bed
MUAS	Multirotor Unmanned Aerial System
NI	National Instruments
OEM	Original Engineering Manufacturer
OLS	Ordinary Least Squares
PI	Predictive Interval
RSE	root sum error
SBIR	Small Business Innovation Research
SDAS	Standard Data Acquisition System
SOF	Safety of Flight
UIUC	University of Illinois at Urbana Champaign
WLS	Weighted Least Squares

1 Background

The rapid proliferation of small, multirotor unmanned aircraft systems (UAS) in the mid-to-early 2010s, coupled with a subsequent expansion of interest in larger electric vertical take-off and landing (eVTOL) aircraft, has led to a need for improved prediction tools for multirotor aircraft performance. One of the key elements of the development of these prediction tools is comparison with validation data.

Prior to the expansion of interest in multirotor systems, rotor testing both in flight and in wind tunnels consisted almost entirely of 1- and 2-rotor systems, reflecting the only vehicle types that were flying at the time. Very few studies had looked extensively at the performance of small (i.e., less than 15-in diameter) rotors or propellers, with the large database generated by the University of Illinois (Ref. 1) as the primary notable exception.

In 2015, NASA began testing small UAS rotors * and rotor systems, starting with hobby drones manufactured by DJI, 3DRobotics, Straight Up Imaging, and Drone America (Ref. 2). These early tests provided some of the first test data for multirotor systems that were of high enough quality to use for computational tool validation. These wind tunnel tests were followed up in 2017 by additional NASA tests, with a more significant focus on rotor-rotor interactions. The 2017 tests also included other vehicles and measurement techniques that were not present for the 2015 tests and are briefly described in (Ref. 3).

Since those first drone tests were completed, there have been additional non-NASA wind tunnel studies looking at various aspects of multirotor system performance. Staruk et al. conducted a thorough investigation of rigid rotors in edgewise flight, extensively quantifying the vibrations experienced on fixed-pitch, rigid rotors, such as those found on various small UAS and eVTOL vehicles (Ref. 4). Atte, Wylie, and Rauleder have tested various quadrotor configurations, including both '$\times$' and '$+$' rotor layouts (Ref. 5).

After the success of NASA's multirotor UAS wind tunnel tests in 2015/17, a need was recognized for a more capable test platform that could be used to evaluate the performance of rotor systems beyond those that were available off-the-shelf. This led to the development of the Multirotor Test Bed (MTB), which is described in (Ref. 6) along with a selection of results from the first MTB wind tunnel test, conducted in 2019. The mechanical design of the MTB is summarized in (Ref. 7) and more fully detailed in (Ref. 8). The MTB was developed to move beyond the two main limitations of the early multirotor UAS tests:

- Loads were only measured for the entire vehicle, so a full picture of interactional aerodynamics could not be gleaned from the data
- Testing was limited to existing vehicles with no ability to alter the configurations beyond replacing motors and/or rotors

The ongoing MTB test program seeks to build upon the knowledge gained during the multirotor UAS tests and to significantly broaden the multirotor design space available for testing. By measuring individual rotor loads for a multirotor system and allowing for adjustments to rotor position and attitude, the MTB is designed to provide a wealth of data on the aeromechanics of arbitrary multirotor configurations. The test stand is also intended to be "future-proof" since it is modular by design and therefore reconfigurable and will allow for testing of future vehicle concepts that have not yet been developed. Finally, future testing of larger rotor sizes will assist researchers in understanding the effects of scale for multirotor systems.

*The term "rotor" is used throughout this report to refer to the lifting devices present on the various vehicles used for the tests described here. Strictly speaking, the lifting devices may be more accurately referred to as propellers, since they do not contain the collective or cyclic rotor controls present on typical helicopters. The usage of the term "rotor" in this context is currently up for some debate within the VTOL research community.

2 Test Objectives

2.1 MTB1

Because the Multirotor Test Bed was an entirely new test capability, the first test, referred to as MTB1 and conducted in 2019, was largely focused on proving the system capabilities in a wind tunnel environment. The primary systems to be checked out included:

- MTB control systems, including individual rotor tilt, full pitch of the MTB, and rotor RPM control
- MTB hardware, including the strongback attachment system, vertical and lateral adjusting beams, and pitch and tilt mechanisms
- Force measurement systems, primarily consisting of six-axis load cells, located at the base of each of the MTB motors.

The objectives of MTB1 are only briefly summarized here and will be further detailed in a separate report on the MTB1 test. The primary scientific objectives of the MTB1 test were the evaluation of forces and moments experienced by the individual rotors of multirotor systems with 4 or 6 rotors. The MTB allows the adjustment of various rotor positioning parameters, including translation in all three linear axes and rotation about a tilt axis. An example of one of the studies that was done during this test was to examine the effect on steady and dynamic loads of relative vertical placement of the forward and aft rotors in a quadrotor configuration. In broad strokes, the main research goal of the MTB1 test was to provide experimental data to help validate computational performance predictions for multirotor aircraft. Further, the rotor layout parametric variations were not mainly focused on a single configuration.

2.2 MTB2

Since the MTB1 test ensured that the MTB could successfully perform all of its designed functions while installed in the wind tunnel, the focus of the second test entry, MTB2, was to get data for specific configurations, while exploring the highly interactional aerodynamics of a quadrotor system. The main objectives of this test were to obtain experimental data (using individual six-axis load cells underneath each rotor) for:

- A scaled-down version of the concept quadrotor configuration developed under the Revolutionary Vertical Lift Technology Project (RVLT) (Ref. 9). The quadrotor configuration was tested with varying amounts of vertical separation between the forward and aft rotors, because it has been shown computationally that this spacing impacts the rotor system performance, particularly with respect to the aft rotors (Ref. 10).
- Varying degrees of azimuthal rotor phasing. Various studies have suggested that controlling the azimuthal phasing between the rotors may be an effective tool for controlling air frame vibrations and/or noise (Ref. 11, 12).

The main differences between MTB1 and the MTB2 tests were that the MTB2 test incorporated a control system that allowed for azimuthal phasing, the linear actuators controlling the rotor tilt were replaced, and the rotors were replaced with custom rotors whose geometry could be publicly shared.

Measurements for a given configuration of the MTB were made at a range of airspeeds and angles of attack. The following subsections describe the various measurement objectives of the MTB2 test.

2.2.1 Rotor Forces

One major difference between the previous multirotor UAS tests in the U.S. Army 7- by 10-Foot Wind Tunnel and the MTB tests is the ability to measure six forces and moments at each rotor. While the previous MUAS tests had a single six-axis load cell to measure the overall loads on the test vehicles, the MTB has six such load cells (corresponding to the maximum six rotor capability of the MTB) allowing independent loads

measurements at each rotor. With this capability, it is possible to precisely measure the effects of rotor-rotor interference, both on steady (mean) and vibratory loads. Note that the MTB2 test used only four load cells for the quadrotor configuration.

2.2.2 Vibrations

One of the main observations from both NASA and non-NASA tests of rigid rotors operating in edgewise flight is high vibration from the rotors. These vibrations were measured and recorded along with the mean loads for the MTB2 test, with vibrations generates at the hub and in-plane vibratory loads generated from the rotor. The effects of rotor placement on vibrations were a primary measurement of interest for this test entry. There was also a desire to measure the effect of relative rotor phase angle on vibrations, and an updated motor controller with azimuthal control was used successfully for this test.

2.2.3 Aerodynamic Interference

Because the rotors of multirotor aircraft operate in close proximity to each other and to the vehicle airframe, rotor-rotor aerodynamic interference alters each rotor's performance. Single rotors were therefore tested in isolation as well as with other rotors present. Tests with one, two, and four rotors mounted on the MTB were tested in order to gain insight into rotor-rotor interference. With the individual rotor loads measurements available on the MTB, a complete measurement of rotor-rotor interference was possible. The main focus for this test entry was the aerodynamic interference between the front and back rotors at different rotor heights for the quadrotor configuration. The 2-rotor configurations included both tandem (front-and-back) and side-by-side layouts.

3 Test Facility

The MTB2 test was conducted in the U.S. Army 7- by 10-Foot Wind Tunnel at NASA Ames Research Center. This facility has been in continuous operation by either NASA or the Army since 1941 (Ref. 13). This closed-throat, single-return wind tunnel is capable of top speeds of approximately 200 kts, depending on blockage, with power provided by a single, variable-speed, 30-ft fixed-pitch fan drive that draws up to 1,600 HP at maximum power. Due to the large 14:1 contraction ratio and a series of turbulence reduction screens downstream of the fan drive, the wind tunnel has good flow quality, with turbulence intensities of approximately 0.1—0.25% (Ref. 14). The tunnel circuit contains an air exchange to provide temperature stabilization at high windspeeds, but the air exchange was left closed for the tests described here.

Tunnel operations in this wind tunnel require at least two personnel: a Tunnel Operator and a Model/Data Operator. Many tests require more than two personnel at any given time to reduce individual workload. For the MTB2 test, operations typically involved five people: Tunnel Operator, Test Engineer/Director, Safety-of-Flight (SOF) Monitor, Model Operator, and Data Operator. The control room setup is shown in Figure 3.1. All functions of the model and the tunnel are controlled from within the control room, and test section conditions and video of the model are displayed on the large monitors at the front of the room. For a more detailed description of operations/layout in the control room for MTB2, see Section 5.

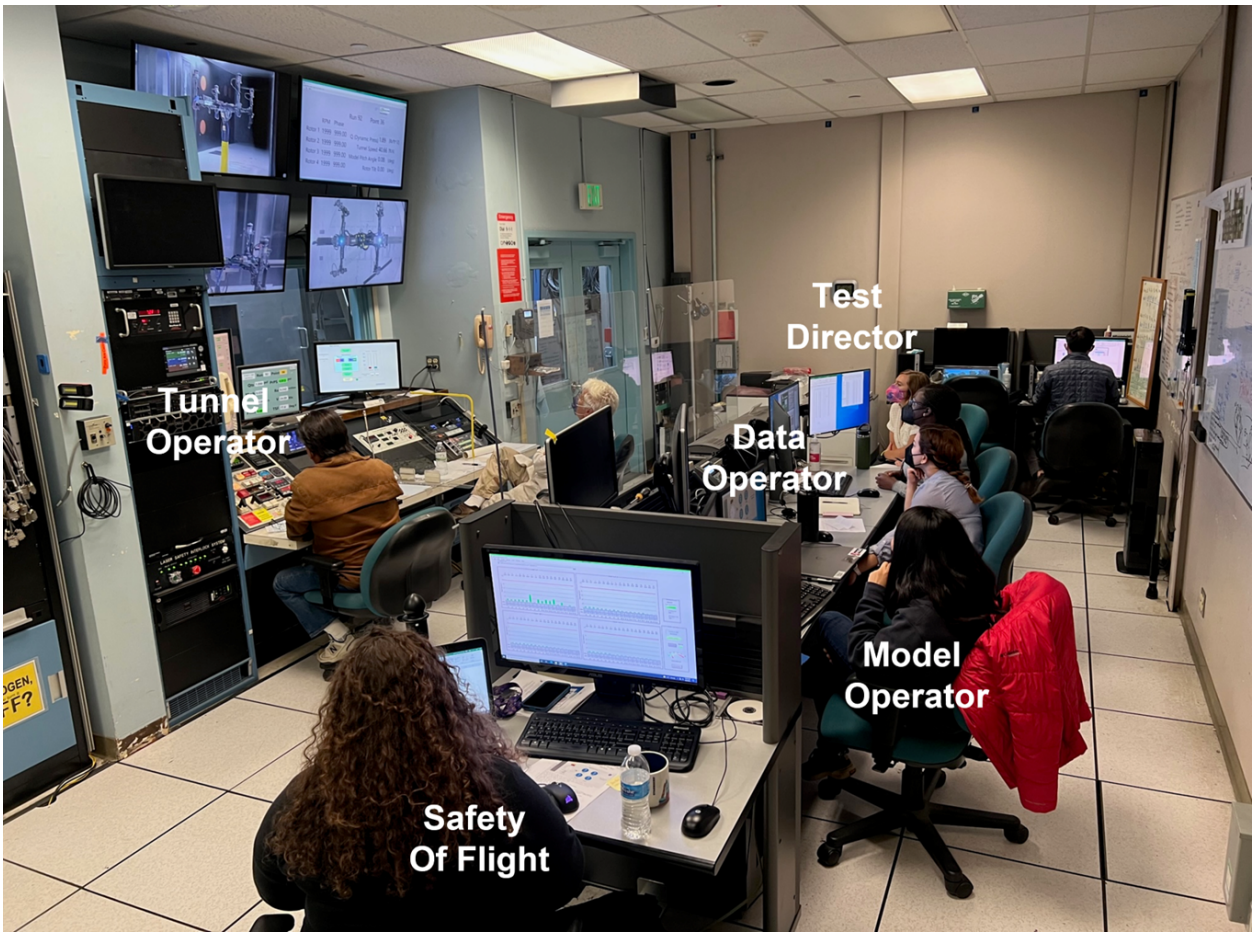


Figure 3.1: 7- by 10-Foot Wind Tunnel control room with MTB2 operator positions identified.

The wind tunnel has an external scale system for measuring model forces and moments, but because the MTB has its own load cells for measuring individual rotor forces and moments, the tunnel scales were left locked out for this test. A turntable sits on the tunnel scales, allowing for ±180 deg of yaw, and the test article is generally mounted to this turntable with a combination of struts or a rotor test stand. Synchronized AC motors drive the upper (non-metric) turntable along with the lower (metric) turntable. The MTB was mounted to the lower turntable on a single strut with a movable pitch rod. See the Test Hardware section for a more thorough description of the MTB hardware.

The primary data acquisition system used for this test was a LabVIEW-based interface called the Standard Data Acquisition System (SDAS). SDAS uses a flexible architecture to acquire a large number of channels – channel count and acquisition speed are based on the data acquisition (DAQ) hardware present at any given time. For the MTB2 test, the key DAQ hardware included a National Instruments (NI) NI-9188 DAQ chassis configured with 4 modules: 2x 16 channel thermocouple, 1x 8-channel single-ended analog, and 1x 8-channel digital input/output modules. In addition, the SDAS included a NI-6031E multifunction DAQ card with 64 single-ended (reconfigured as 32 differential) analog inputs. In addition, a Pacific Instruments PI-6000 signal conditioning system provided strain gauge amplification, excitation, and acquisition for as many as 64 channels, a maximum frequency of 64 kHz, and up to 4.6 M samples/s aggregate acquisition capability. Twenty-four of the PI-6000 channels were used for the MTB2 test – six channels for each of the four rotors, giving all six forces and moments at every rotor. Force and moment data were also fed directly to a safety-of-flight monitor so that maximum loads could be constantly monitored.

4 Test Hardware, Instrumentation, and Data Acquisition

4.1 Design and Analysis

The MTB consists of up to six individual rotor systems, each with its own lateral, longitudinal, vertical, and rotational adjustment systems. Each rotor is 24.5 inches in diameter and can tilt forward –90 deg and backwards 5 deg in its standard configuration. The center of the design features the strongback, which acts as a structural backbone for the assembly. Lateral support beams are held in the strongback and connected to the adjusting L-brackets. The rotor assemblies are connected to the vertical support beams (4.1.1 and 4.1.2 below show the assembly parts along with their labels). The rotation system for the rotors (rotor tilt) uses a linear actuator which is controlled remotely during testing. The rotational adjustment for the strongback (model pitch) is controlled by a stepper motor interfacing with a jackscrew within the single heavy strut. The whole assembly can pitch –30 deg forward (nose down) and 10 deg backward (nose up). There are load cells under each rotor to capture loads and vibrations. The positions for rotors 1, 2, 3, and 4 are shown in Figures 4.1.1 and 4.1.2 below, with rotor 1 being in the front on the starboard side of the test stand.

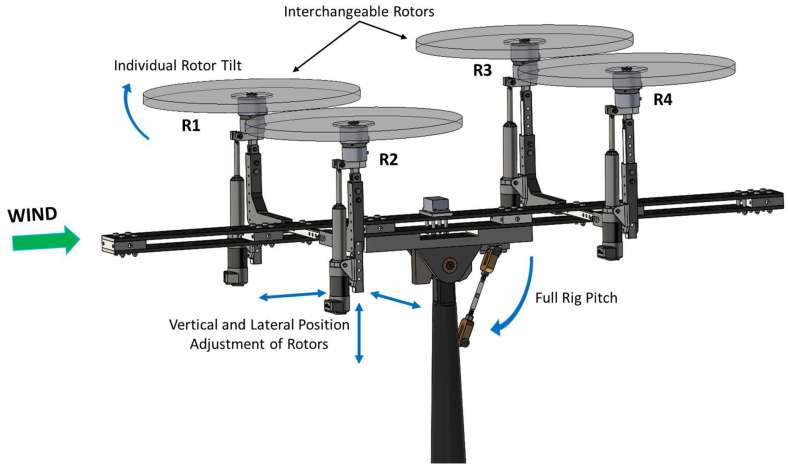


Figure 4.1.1: CAD image of MTB, side view of the assembly.

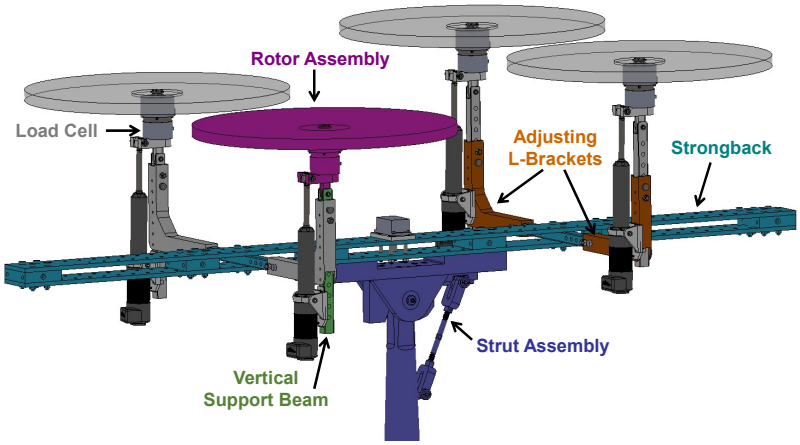


Figure 4.1.2: CAD image of MTB, side view with parts and subassemblies labeled.

The MTB was designed to be an extremely versatile and reconfigurable system. The adjusting L-brackets rest on the lateral support beams, which can move along the strongback to bring the front and back rotors closer or further away from each other (across 72 inches, 1-inch increments). Additionally, the adjusting L-brackets can slide along the lateral support beams to bring the port and starboard rotors closer or further away from each other (24.7 inches to 38.7 inches, 1 inch increment). Finally, the vertical support beams, which hold the rotor assembly at the top, can slide inside of the adjusting L-brackets, which in turn move the rotor assembly up and down relative to the strongback (9 inches of travel, 1 inch increments). Adding the rotor tilt and model pitch to the system allows the rotors to be adjusted up and down, left and right, forward and back, tilted in their own reference frame (rotor tilt), and pitched along with the model (model pitch). The rotors and hubs can easily be removed and replaced to compare the effects of varying the number of blades and to compare different blade sets. Figures 4.1.3 and 4.1.4 shows a complete schematic of a port side rotor and linear actuator subassembly.

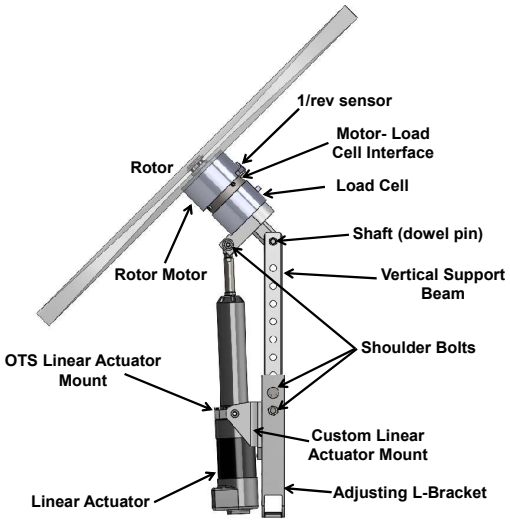


Figure 4.1.3: Labeled CAD image of the port side rotor stack assembly, side view, tilted rotor.

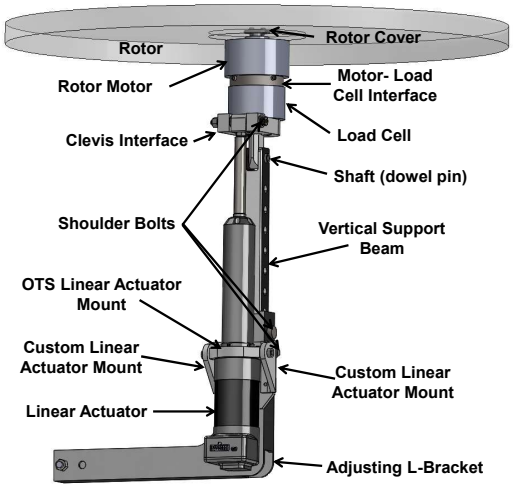


Figure 4.1.4: Labeled CAD image of the port side rotor stack assembly, front view, helicopter mode.

Figure 4.1.5 is an example of MTB capabilities, and shows the model pitched nose down -5 deg and the rotors all tilted in various positions in a non-testing configuration. Note that the angle for model pitch and rotor tilt is defined as negative angles being nose down and positive angles being nose up. This may differ from previous tunnel conventions. In this image, the left side is upstream, and the rotor 2 and 4 are on the port side.

The total weight of the assembly is just under 240 lb, not including the strut. The maximum dimensions are 80.625 inches long by 60.2 inches wide by 27.8 inches tall (not including the strut; from model pitch point; in tallest, widest, and untilted configuration). For more dimensions, see Figure 4.1.6 and Figure 4.1.7. Table 4.1.1 details the spacing, speed, tilt, and pitch limitations for the MTB.

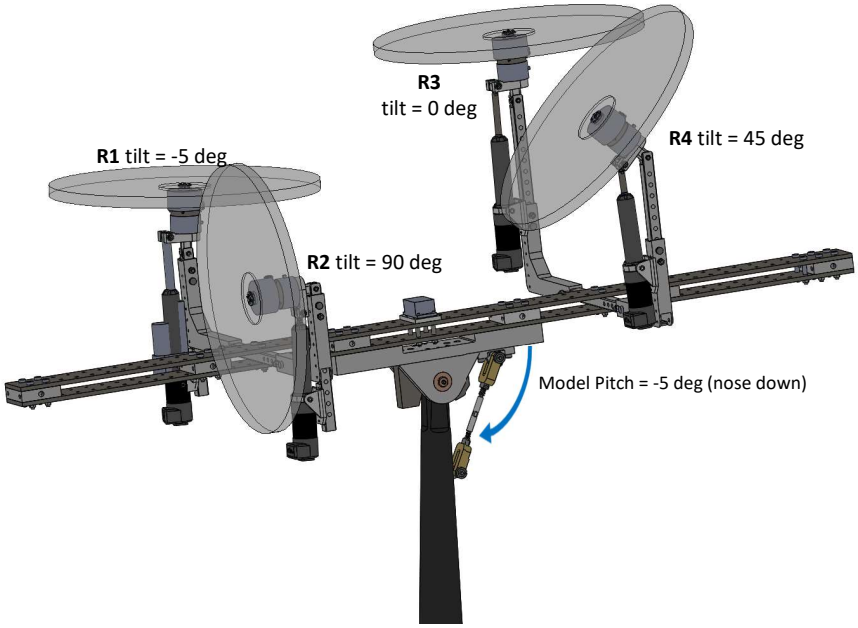


Figure 4.1.5: CAD image of MTB demonstrating pitch and tilt capabilities, non-testing configuration.

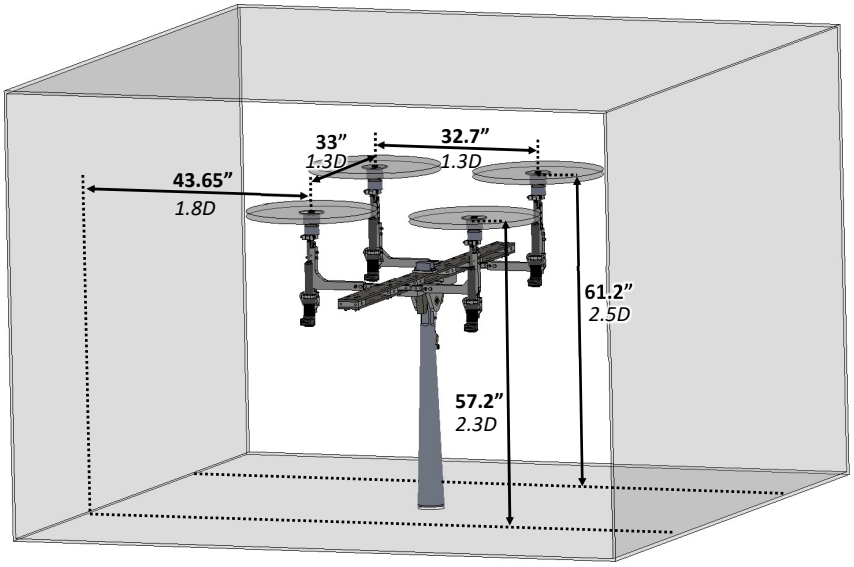


Figure 4.1.6: CAD isometric view of MTB in the 7- by 10-Foot Wind Tunnel test section, concept quadrotor configuration.

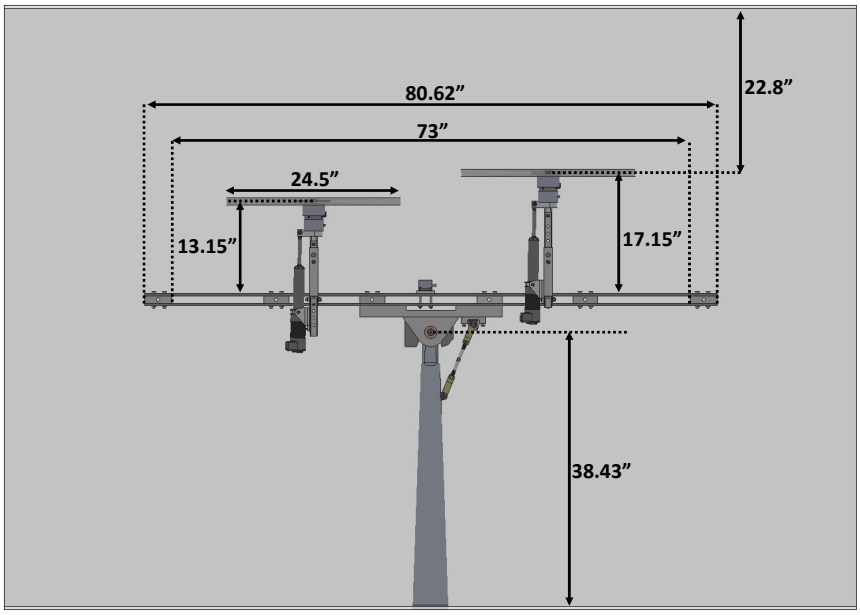


Figure 4.1.7: CAD port side view of MTB in the 7- by 10-Foot Wind Tunnel test section, concept quadrotor configuration.

Table 4.1.1: MTB capabilities and limits.

Characteristic	**Range**
max. rotor size	24.5 inches (same as the KDE-CF245-DP rotors of MTB1)
max. rotor RPM	4,500 (for 24.5 inch rotor)
lateral spacing	24.7 inches - 38.7 inches, adjustable in 1-inch increments (2 inches if keeping symmetry about centerline)
longitudinal spacing	25.5 inches – 72 inches, adjustable in 1.5 inch increments
vertical position	9 inches of travel, adjustable in 1 inch increments
individual rotor tilt	-90 deg forward to 5 deg aft, adjustable in arbitrary increments
full MTB pitch	-30 deg forward to 10 deg aft, adjustable in arbitrary increments
max. wind speed*	40 ft/s

For the stress analysis, the maximum thrust load limits from the rotors were set to 30 lbs, with ± 34 lb in plane vibratory loads. The maximum allowable loads used for the analysis and for the Safety of Flight are given in Table 4.1.2. The MTB was designed to withstand testing conditions (with considerable margin) in the 7-by 10-Foot Wind Tunnel and to enable accurate measurements. All custom-made parts were designed with a minimum safety factor of 5 on yield strength for testing conditions. In order to be approved for the wind tunnel, a minimum safety factor of 3 on yield strength and 4 on ultimate strength is required (this was met). A blade out analysis was performed, and all parts showed a minimum safety factor of 1 on yield. For more details about the design and the loads and stress analysis of the MTB, see (Ref. 7, 8).

Table 4.1.2: MTB capabilities and limits.

	F_x **[lb]**	F_y **[lb]**	F_z **[lb]**	M_x **[in-lb]**	M_y **[in-lb]**	M_z **[in-lb]**
Load Limit	±34	±34	±30	±86.6	±86.7	60

4.2 Data Acquisition System

4.2.1 Load Cells

Each load cell produced a 6-signal output that was routed to a 44-pin connector via a 30 ft cable. Then, a 5-ft adapter cable went from the 44-pin connector to a 55-pin connector on the 7- by 10-Foot Wind Tunnel junction box, which provided the excitation voltage that powered the load cells. The signal went through the facility junction boxes to the amplifier installed at the front-end of the DAS. At the amplifiers, the signal was buffered, low-pass filtered at 1 kHz, and had a gain applied. The signal was converted from raw voltages into engineering units (EU) via 6x6 matrices and was recorded in SDAS. The signal was also sent to Safety of Flight for loads monitoring during testing. For more information on the matrix conversions, see the Coordinate System overview in Section 6. The load cells did not go through a traditional R-Cal conversion/correction. The excitation at the load cell was adjusted to match the calibration excitation, and then an R-Cal was taken at the beginning and end of each run to monitor the health of the gauges.

4.2.2 RPM Sensors

Rotor speed, or RPM, was measured by a 1/rev Hall effect sensor mounted under the motor. The resulting pulse train from the 1/rev sensor was routed to the MCS (Multirotor Test Bed Control System), which computed the individual RPM values. These signals were T-ed off with one cable going to the MCS and the other going directly to Dynamic Raw Storage (wide band, not filtered). The signal that was routed to the MCS went through the SDAS buffer and was then displayed on the Test Director Display. The other signal that came out of the SDAS buffer was sent to Data Storage (recorded in voltages, EU, and statistics). Thus, the Data Storage received both the 1/rev signal and the computed RPM.

4.2.3 Thermocouples

The thermocouple signals were routed directly to the MCS DAQ, and a rolling average was computed. The MCS then sent the rolling average to SDAS via the RS-232 line. The thermocouples on the load cells were Standard J Type thermocouples, and the thermocouples in the power bus were K Type thermocouples.

4.2.4 Accelerometers

There were three signals for each of the four tri-axial accelerometers (one for each of the four rotors of the quadrotor model). The three signals traveled along a 25-ft cable to the accelerometer amplifier, the Kistler 5124A. The amplifier provided power to the accelerometers and output BNCs which fed into the 1 kHz filters with a gain of 1. These signals then went directly to Dynamic Raw Storage. The accelerometers went through a linear conversion from volts to g's. Note: no zero-subtract was needed. These were piezo-electric sensors, so they only measured acceleration change, not steady-state motion.

4.2.5 Inclinometer

The inclinometer was calibrated in place, in the tunnel. The signal went through a linear single order polynomial engineering conversion with no zero subtract.

4.2.6 Rotor Tilt

Rotor tilt was controlled indirectly by an analog voltage sent to the linear actuators for the different rotors. There was an in-place calibration performed for each actuator to determine a polynomial conversion of actuator analog input to rotor tilt.

4.3 Data Sampling

The data from this test was recorded and stored in four files, which are listed below:

- Average file (all channels in EU)
- Raw Average file (all channels prior to EU conversion, in volts)
- Dynamic Pacific Instruments (PI) data (all channels coming through PI that were being sampled at 4kHz, in EU)
- Statistics file (all channels, in EU, showing max, min, and half peak-to-peak (HPP) data)

The low-speed measurement channels were sampled at 10 Hz. The tunnel parameters, tunnel scales, wind speed, barometric pressure, dew point temperature, total tunnel temperature, pitch and yaw angle were all sampled at low speed, see Table 5.2.3 in Section 5.2. The high-speed measurement channels were sampled at 4 kHz and recorded for 5 seconds during testing. All load cells and the accelerometers were sampled at 4 kHz, and the load cells had a low-pass filter of 1 kHz.

If additional data that is not present in this data report is needed, please contact the authors. All data has been zero subtracted and temperature corrections have been applied to the the load cell data. Aerodynamic and weight tares were also applied to the data.

- The Average file contained the load cell forces and moments in the hub axis; these parameters also listed on Table 5.2.1 in Section 5.2, Recorded Parameters.
- Table 5.2.1 lists the recorded parameters that were originally captured in the MCS and then transferred to SDAS via a RS232 line to be recorded. This includes measured model operating parameters: Pitch, Tilt, R#RPM, R#Phase (where R# indicates the rotor number). The bit rate was 9600. The data frequency or update rate was 10 Hz for the RS232 parameters.
- Finally, none of the data files, including the average file (AVG), had the data with the weight/aero tares applied. The weight/aero tares were applied during post-processing. The raw data (BCK) was in volts.

5 Overall Test Setup

5.1 Procedure

The wind tunnel test was conducted in the U.S. Army 7- by 10-Foot Wind Tunnel at NASA Ames Research Center and data was acquired for several different quadrotor configurations. For each configuration, three main types of runs were performed:

1. Aerodynamic and weight tares
2. Isolated rotor testing
3. Multirotor testing (*concept quadrotor, equal height quadrotor, tall quadrotor*)

The above runs were not necessarily performed in this order. The order in which the runs were performed is outlined in the Section 12 test timeline. The *concept quadrotor* configuration was the MTB configuration closest to a scaled down version of the RVLT concept quadrotor vehicle (Ref. 9). The distance between the front and back rotors along the x axis (longitudinal) was 33 inches or 2.7R. The distance between the left and right (port and starboard) rotors along the y axis (lateral) was 32.7 inches or roughly 2.7R. The distance between the front and back rotors along the z axis (height) was 4 inches or dz/R = 0.33. The axis directions were parallel with those of the Balance Coordinate System (see section 6, Coordinate Systems). To change the model to the *equal height* quadrotor configuration, the back rotors were lowered to the same height as the front rotors (dz/R = 0), while keeping the lateral and longitudinal placement the same. To change the model to the *tall quadrotor* configuration, the back rotors were raised so they were 7 inches taller than the front rotors (dz/R = 0.57). For a full table of rotor positions within the tunnel, see Appendix A. Note that for this table, the coordinate system has the origin at the center of the floor in the test section – x is positive downstream, y is positive towards starboard, and z is positive up.

For the first configuration, the concept quadrotor, isolated rotor testing was performed for each rotor in every condition. Specifically for the concept quadrotor configuration, additional isolated rotor tests were performed in which the counterclockwise rotors (rotors 1 and 4) were swapped with each other. This was to help determine the uncertainty between the rotor blade measurements. For the subsequent multirotor configurations, only a handful of isolated rotor testing conditions were included. For each multirotor testing configuration, two rotors (rotors 1 and 2) were tested in the side-by-side configuration, two rotors (1 and 3) were tested in the tandem configuration, and then the four rotors were tested in the quadrotor configuration at each testing condition (varying pitch, tilt, RPM, phase, and tunnel speed). Note that rotors 1 and 4 spin counterclockwise and rotors 2 and 3 spin clockwise (when viewed from above).

The functionality of the system was monitored throughout the buildup process to ensure that all systems were operating properly and that loads were within acceptable limits. A small number of wind-on points were repeated a couple of times during the test entry. Additionally, static points (0 RPM) and standard housekeeping points (2000 RPM), with the wind off and tilt and pitch set to zero degrees, were taken at the beginning and end of each run. These repeat points can help to verify that data quality was maintained for the duration of the test.

The intent of the test was to measure steady and vibratory forces and moments as a function of wind speed, attitude, MTB configuration, rotor phase, and rotor RPM. The general strategy for testing was to vary RPM at a given tunnel speed and model pitch angle and configuration. Pitch was then changed, and RPM was varied again for multiple tilt angles. Depending on how long a pitch and RPM sweep took at a given wind speed, multiple wind speeds could be tested in a single run. A typical run would start off with taking a zero point, then an R-Cal (to verify the health of the load cells), and then a static point was taken (no rotor rotation, no tunnel speed). Next, the RPM was brought up to the housekeeping speed, 2000 RPM, and the "housekeeping wind off" point was taken. The tunnel speed was then increased to 20 ft/s, corresponding to

a dynamic pressure of 0.48 lbf/ft^2, and the "housekeeping wind on" point was taken. Next, the RPM was varied from 2000 to 2500 to 3000 (collecting data points at each speed), and then the tilt angle was adjusted from 0 deg to –3 deg. Then, starting at 3000 RPM, the RPM was brought back down to 2500 RPM and then to 2000 RPM. Next, the model pitch angle was adjusted. This process was repeated until all the points were taken at each model pitch angle. The tunnel speed was then adjusted to 40 ft/s, corresponding to a dynamic pressure of 1.90 lbf/ft^2 (if high speeds were required for that run) and the process repeated, this time starting from –10 deg model pitch and going down to 0 deg, in order to make the process the most efficient. Finally, a "housekeeping wind on" and a "housekeeping wind off" point were taken. Then a static point, a zero point, and a R-cal (again, to verify that the load cells were healthy and properly functioning). Taking the housekeeping and static points allows for comparison between different runs as well as within the same run to ensure the complete test setup is behaving correctly and that there are no changes in the test apparatus.

5.2 Recorded Parameters

For each data point, several measured and calculated parameters were recorded. Tables 5.2.1 – 5.2.4 list and describe the parameters that were recorded in each data point. Note that some of these parameters are used in intermediate calculations and are not reported.

Table 5.2.1: Measured model operating parameters. Note: The Manufacturer, Balance, Hub, and wind tunnel coordinate systems are explained in the Coordinate Systems Section.

Parameter	Description	Notes
Pitch	model pitch angle measured from inclinometer [deg]	-
Tilt	rotor tilt angle [deg]	rotors 1, 2, 3, and 4 have the same value
R1_RPM	RPM revolutions per minute, for rotor 1	values repeated for rotors 2, 3, and 4. Ex: R2_RPM for rotor 2
R1_Phase	phase angle for rotor 1 [deg]	values repeated for rotors 2, 3, and 4. Ex: R2_Phase for rotor 2
Yaw	yaw angle from turn table [deg]	zero for this test
A1_X	accelerometer on rotor stack 1 measuring along x-axis in the wind tunnel coordinate system [g]	
A1_Y	accelerometer on rotor stack 1 measuring along y-axis in the wind tunnel coordinate system [g]	
A1_Z	accelerometer on rotor stack 1 measuring along z-axis in the wind tunnel coordinate system [g]	repeated for rotor stacks 2, 3, and 4
Fx1_H	force (F_x) reading from load cell 1 in x direction on the front starboard side [lb]	measurement in Hub Coordinate System, value goes through a zero subtract and matrix conversion
Fy1_H	force (F_y) reading from load cell 1 in y direction on the front starboard side [lb]	measurement in Hub Coordinate System, value goes through a zero subtract and matrix conversion
Fz1_H	force (F_z) reading from load cell 1 on the front starboard side [lb]	measurement in Hub Coordinate System, value goes through a zero subtract and matrix conversion

Continued on next page

Table 5.2.1 continued

Parameter	Description	Notes
Mx1_H	roll moment (M_x) reading from load cell 1 on the front starboard side [in-lb]	measurement in Hub Coordinate System, value goes through a zero subtract and matrix conversion
My1_H	pitch moment (M_y) reading from load cell 1 on the front starboard side [in-lb]	measurement in Hub Coordinate System, value goes through a zero subtract and matrix conversion
Mz1_H	torque (M_z) reading from load cell 1 on the front starboard side [in-lb]	measurement in Hub Coordinate System, value goes through a zero subtract and matrix conversion
Fx2_H	force (F_x) reading from load cell 2 in the x direction on the front port side [lb]	measurement in Hub Coordinate System, value goes through a zero subtract and matrix conversion

Number denotes the load cell: remaining forces and moments are the same for load cells 2, 3, and 4.

Table 5.2.2: Calculated model operating parameters.

Parameter	Description	Equations/Tolerances
OMR_R1	rotor tip speed for rotor 1 [ft/s]	= RPM_1_EU *PI*ROTRAD/30.0
MTIP_R1	hover tip Mach number for rotor 1	= OMR_R1/CSND
MU_R1	rotor advance ratio for rotor 1	= VFPS/OMR_R1
CT_R1	coefficient of thrust for rotor 1	= Fz1_H/(RHO*ROTORAREA*OMR_R1^2)

Note: All above values are repeated for each rotor. The number after "R" denotes the rotor number.

Table 5.2.3: Measured standard tunnel parameters.

Parameter	Description	Notes/Tolerances
BARO	barometric pressure outside the tunnel [psia]	direct measurement (±0.0015)
DPT	dew point temperature [deg F]	direct measurement (±0.36)
PRPS	reference pressure minus static pressure [psi (differential)]	direct measurement (±0.0002)
PRPA	reference pressure minus atmospheric pressure [psi (differential)]	direct measurement (±0.0002)
TTF	total temperature [deg F]	direct measurement (± 1)
BETA	yaw angle of the model in the test section [deg]	direct measurement
ALPHA	pitch angle of the MTB in the test section, as measured from the inclinometer [deg]	direct measurement

Note: BETA was not adjusted during the test but was recorded as a check.

Table 5.2.4: Calculated standard tunnel test section parameters.

Parameter	Description	Equations/Tolerances
QU	uncorrected dynamic pressure [psf]	= PRPS * 144
DELPTR	total pressure adjustment [psf]	= -4.96150x10^{-3}*QU
PA	atmospheric pressure at tunnel centerline [psf]	= BARO – SPAIR * DH
VPDP	dew point vapor pressure [psf]	= 2.0901+3.46x10^{-6}*PA*6.1121* exp((17.502*DPT-560.064)/(401.62+DPT))
TTR	total temperature [Rankine]	= TTF + 459.67
QCLU1	corrected centerline Q [psf]	= QU–(CQ1[0]+CQ1[1]QU+ CQ1[2]QU^2 +CQ1[3]QU^3)
PT	test section total pressure at tunnel centerline [psf]	= PA + PRPA + DELPTR
PS	test section static pressure at tunnel centerline [psf]	= PT - QCLU1
MTUN	tunnel Mach number *Note: if PT/PS < 1.00000001, then MTUN = 0*	= $\sqrt{(5.0 * (((PT/PS) * (2.0/7.0)) - 1.0))}$
TSR	static temperature [Rankine]	= TTR/(1 + 0.2 * MTUN * MTUN)
TSF	static temperature [deg F]	= TSR - 459.67
VPDB	dry bulb vapor pressure [psf]	= 2.0901 + 3.46x10^{-6} * PA * 6.1121 * exp((17.502*TSF–560.064)/(401.62+TSF))
RH	relative humidity [%]	= VPDP/VPDB*100
CSND	speed of sound [ft/s]	= 49.0223 * $\sqrt{TSR}$
RHO	static air density [slug/ft^3]	= 0.00058256*(PS –0.378*VPDP)/TSR
Q	corrected dynamic pressure [psf]	= 0.7*PS*MTUN*MTUN
VFPS	tunnel speed [ft/s]	= $\sqrt{2.0 * Q/RHO}$)
VKTS	tunnel speed [kt]	= VFPS * 0.5925
VMPH	tunnel speed [mph]	= VFPS * 0.681818
VISC	dynamic viscosity [slug/ft]	= 2.27x10^{-8} * (TSR * 1.5/(TSR + 198.6))
REYN	Reynolds number/million [1/ft]	= (RHO * VFPS * C / VISC) / 1.0x10^6

5.3 Physical Setup

The MTB was assembled in the test section of the U.S. Army 7- by 10-Foot Wind Tunnel, as shown in Figure 5.3.1. Note that this figure presents a downstream view of the test section, where the left of the image is the starboard side, and the right of the image is the port side. The MTB rested on a turntable that is underneath the tunnel floor (shown in Figure 5.3.2). The yaw angle was not varied for this tunnel entry. The cabling was routed underneath the tunnel floor through the opening at the strut (by the yellow tape in Figure 5.3.1) and was either routed directly below the turntable or through the floor to the control room. A strobe light and camera were placed on the outside of the plexiglass skylight on the ceiling of the test section (see Figure 5.3.3), which allowed for verification of the phase angle.



Figure 5.3.1: Front view of the MTB in the 7- by 10-Foot Wind Tunnel.

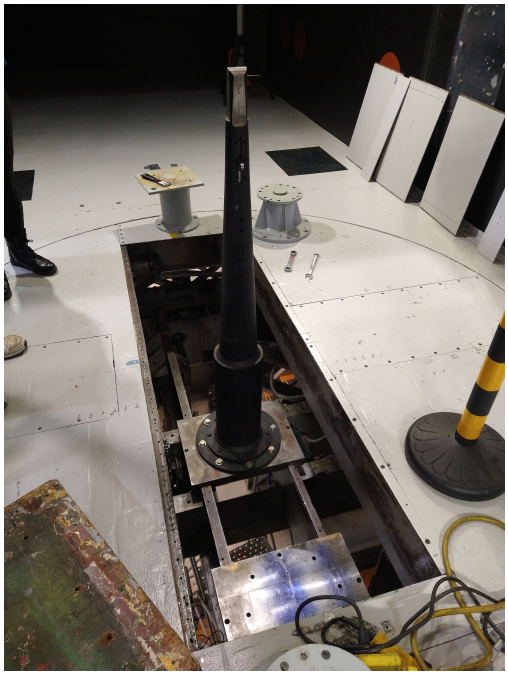


Figure 5.3.2: Installation of the strut onto test section turntable.



Figure 5.3.3: Test section ceiling and test crew working on model.

The control room is past the wall on the starboard side of the model, shown in Figure 3.1 (also shown in Figure 5.3.1). The right Model Operator screen is shown on the bottom left of Figure 5.3.4. There is an additional screen for the Model Operator on the left, which is not shown. Left of the Model Operator (shown in Figure 3.1) is the SOF station, where the load cell readouts were monitored by the SOF Monitor. To the right of the Model Operator are three additional screens for the Data Operator station (Figure 5.3.4). The Data Operator records data, visualizes data, and can respond to messages from the SDAS. Right of the Data Operator is where the Test Director was normally stationed.

During a test, the Test Director often moved around the control room to check in with different team members. The Test Director displays were in the very front of the control room for easy visibility across the control room. The Test Director displays showed the key parameters that were being set: RPM, phase, dynamic pressure, tunnel speed, model pitch angle, and rotor tilt angle. The Tunnel Operator displays and the Tunnel Operator station were also at the very front of the control room and where the tunnel speed is controlled.

On the back panel of the Model Operator and Data Operator stations were several panels. These panels contained wiring from the MTB Control System (MCS) below the turntable to the model in the test section. The power supply rack, shown in Figure 5.3.5, and the load cell amplifiers rested below the turntable (underneath the tunnel test section).

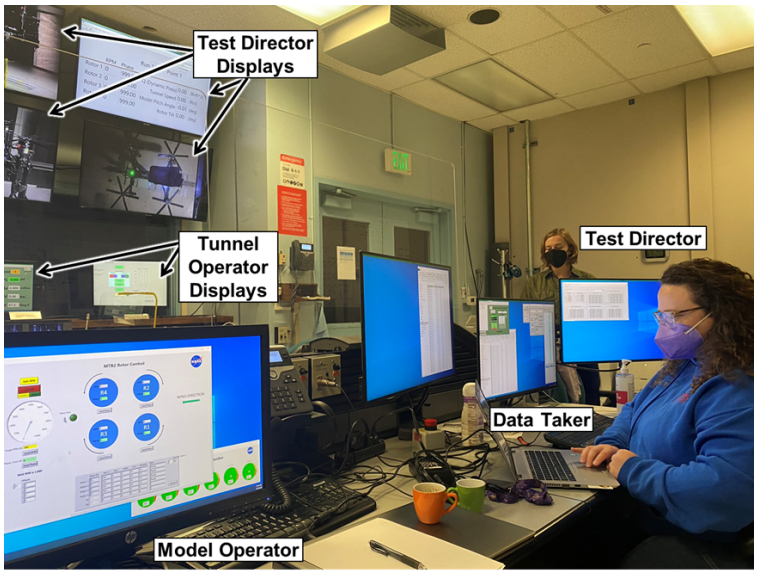


Figure 5.3.4: View of control room in the 7- by 10-Foot Wind Tunnel.

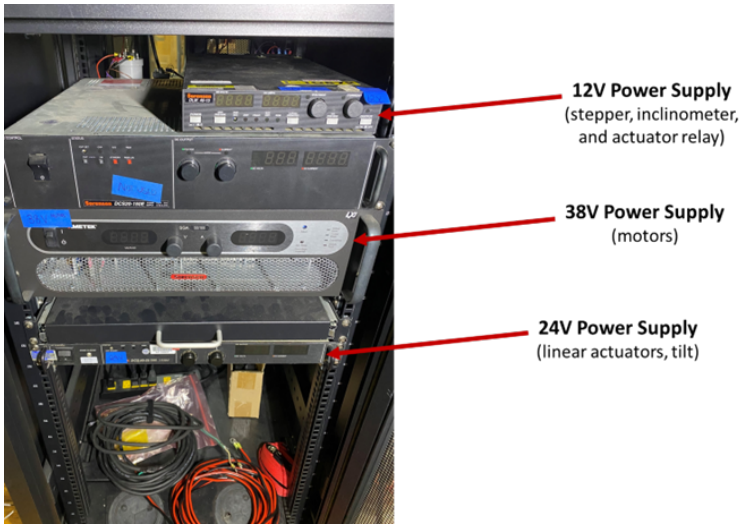


Figure 5.3.5: MTB power supply rack.

6 Coordinate Systems

There are a total of three coordinate systems in which the load cell data was recorded: the Manufacturer Coordinate System, the Balance Coordinate System, and the Hub Coordinate System. The data is only given in the Hub Coordinate System. The first coordinate system, the Manufacturer Coordinate System, is shown in Figure 6.1. The axes are defined as follows:

Fx_M towards control room
Fy_M upstream
Fz_M up
Mx_M positive pitch up
My_M positive roll right
Mz_M positive torque CCW (as viewed from above)

The suffix "M" indicates that it is the Manufacturer Coordinate System. The load cell x-axis is oriented orthogonally to the streamwise direction in order to position the connector, shown in Figure 6.1, behind the load cell in order to minimize potential disruption of the airflow. Note that the manufacturer defined the moment center of the load cell at the top surface of the load cell, in the center. The Manufacturer Coordinate System was only used for initial load checks, not for wind tunnel testing.

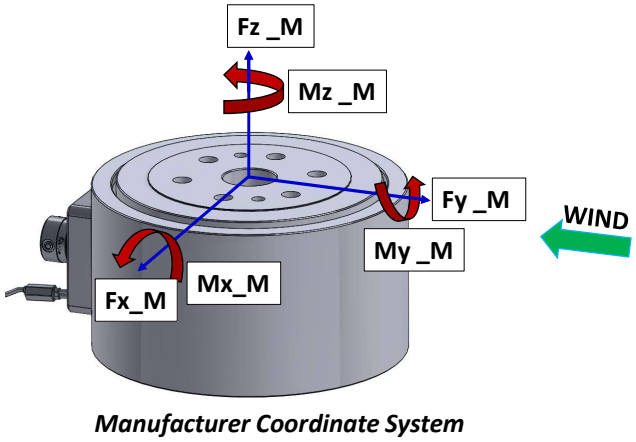


Figure 6.1: Interface load cell axes as defined by the manufacturer.

The next coordinate systems are the Balance Coordinate System and the Hub Coordinate System, shown in Figure 6.2. These axes are identical to each other except that they are displaced a distance of "HUB_DIST" along the z axis (2.783 inches). This is the distance from the moment center of the Manufacturer Coordinate System (the top of the load cell) to the center of the hub (in the rotor plane). The Balance axes are defined as follows:

Fx_B downstream
Fy_B towards the control room
Fz_B up
Mx_B positive pitch up
My_B positive roll right
Mz_B positive torque CCW (as viewed from above)

The "B" here indicates that it is for the Balance Coordinate System. Note that the Balance Coordinate System rotates with the rotor tilt, so it is only aligned with the flow at 0 deg rotor tilt and 0 deg MTB pitch. The Hub axes are defined exactly the same except with an "H" instead of a "B" as shown in Figure 6.2. Note that this coordinate system obeys the right-hand rule and may differ from other reported wind tunnel experimental or flight data.

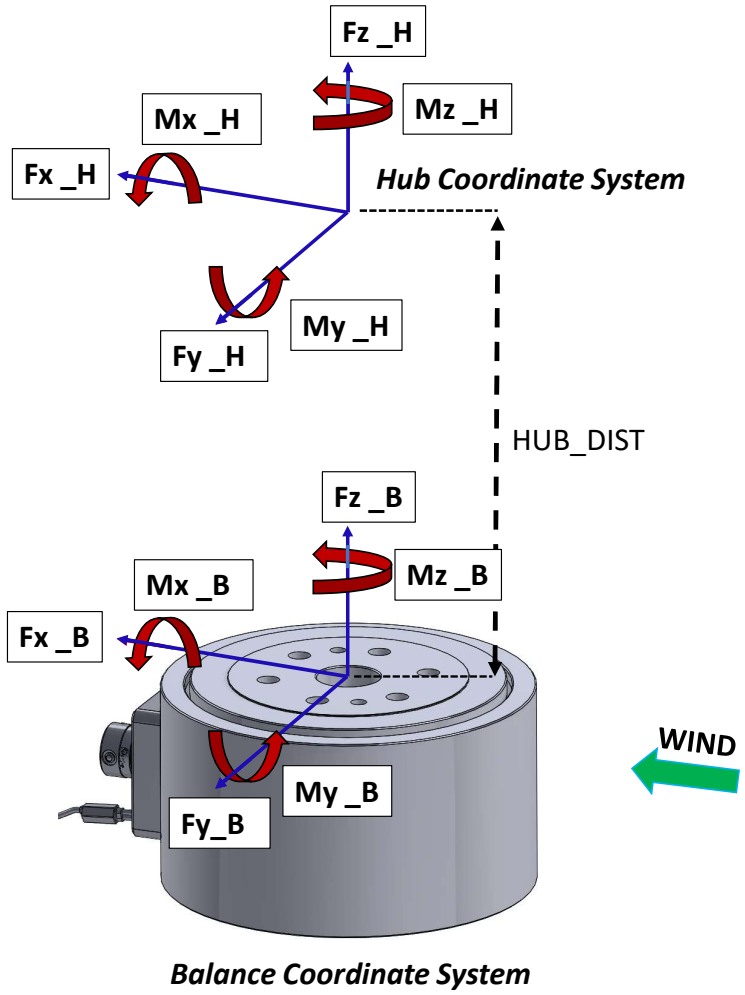


Figure 6.2: The load cell forces and moments in the Balance Coordinate System and in the Hub Coordinate System.

The load cell signals go through the following matrix conversion in order to convert the raw voltages into engineering units. [F] = [A]*V, where [F] is the resultant forces and moments, [A] is the calibration matrix, and V is the input voltage matrix. LC1_L is the first signal from load cell 1 in volts. After all the raw voltages go through a zero subtract and then through the matrix multiplication with the calibration matrix, the signals are converted to the forces and moments in the Hub Coordinate System. For example, Fx1_H_u is the force for load cell 1 in the x-axis of the Hub Coordinate System. The underscore "u" marks that it is uncorrected and still needs to undergo further data corrections and tares, discussed in Section 10.

It should be noted that this process is slightly different than what was used in the tunnel. The new calibrated load cell matrices were derived for the forces and moments in the Hub Coordinate System. The forces and moments were measured in the AeroLab facility at a distance 2.75 inches from the top of the load cell. The measured distance from the top of the load cell to the rotor plane in the tunnel was 2.783 inches The resulting difference in load cell force and moment values from a height of 2.783 inches versus 2.75 inches was within the error margin. The calibration matrix was thus derived using the 2.75 inch distance.

The original load cell matrices were calibrated for loads at the surface of the load cell in the Manufacturer Coordinate System, and thus needed a transformation matrix to go from the manufacturer to the Balance Coordinate System, and then a translation matrix to go from the balance to the Hub Coordinate System. These new calibrated load cell matrices skip those steps since they were calibrated for the Hub Coordinate System. One note is that the Hub Coordinate System was redefined, so the resulting Mx1_H_u value does need to be multiplied by -1 to be aligned with the new coordinate system. The full calibrated load cell matrices are given in Appendix C, with a detailed process for the calibration discussed in Section 9.1.1.

An example matrix conversion for load cell 1 (rotor 1) forces and moments to EU in the hub axes is provided in Equation 1:

$$\begin{bmatrix} Fx1_H_u \\ Fy1_H_u \\ Fz1_H_u \\ Mx1_H_u \\ My1_H_u \\ Mz1_H_u \end{bmatrix} = \begin{bmatrix} \text{Load Cell 1} \\ \text{6 x 6 Matrix} \\ \textit{See Appendix C} \end{bmatrix} \begin{bmatrix} LC1_1 \\ LC1_2 \\ LC1_3 \\ LC1_4 \\ LC1_5 \\ LC1_6 \end{bmatrix} \tag{1}$$

7 Rotor Design

The rotor design process consisted of identifying an airfoil for the rotor blade, generating a corresponding airfoil table at the expected atmospheric and flight conditions, and using CAMRAD II, a rotorcraft comprehensive analysis code (Ref. 15), to investigate rotor performance for various combinations of linear twist distribution and built-in collective pitch. The MTB2 rotor blades were designed with the intent that the geometry and blade characteristics be readily shareable and available for public distribution. Advanced Precision Composites (APC) Propellers was selected to manufacture the rotor blades. Some characteristics of the first test entry's KDE rotor blades were kept the same, primarily the blade radius and the rotor solidity.

7.1 Airfoil Tables

The Eppler 387 (E387) airfoil was selected for the rotor blades due to its favorable characteristics at low Reynolds numbers (Ref. 16). For simplicity, a constant-chord blade was selected. The ideal E387 airfoil coordinates were obtained from the University of Illinois at Urbana Champaign (UIUC) airfoil database (Ref. 1). Due to manufacturing thickness constraints, some modifications to the airfoil trailing edge geometry were required by the manufacturer, APC, prior to blade production. A comparison of the ideal E387 airfoil used for airfoil table generation and the APC modified geometry is included in Figure 7.1.1. The E387 airfoil properties are provided in Table 7.1.1. Note that the comprehensive analysis detailed in Section 7.2 was based on the ideal E387 airfoil and not the APC modified airfoil.

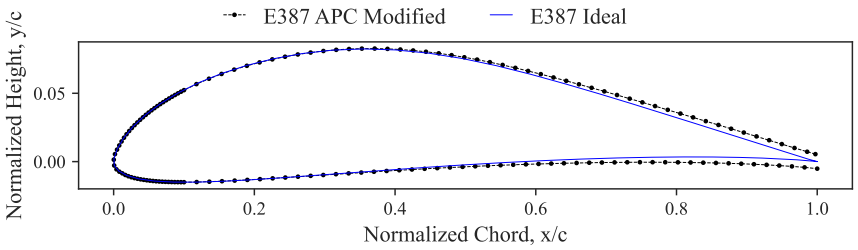


Figure 7.1.1: Ideal (UIUC) and APC modified airfoil profiles. Additional nodes were added to the leading edge to improve mesh refinement.

Table 7.1.1: Eppler 387 airfoil characteristics.

Parameter	Value
maximum camber, x/c	3.2% at 44.8% chord
maximum thickness, y/c	9.1% at 31.1% chord
chord length	1.54 inches

Atmospheric conditions, operating conditions, and blade chord length were used to calculate expected Reynolds numbers across the blade span for expected wind tunnel test speeds. Airfoil Table Generator (AFTGen) is a software tool developed by Sukra Helitek (Ref. 17) that provides a graphical user interface (GUI) for several different flow solvers, from low-fidelity solvers such as XFOIL (Ref. 18) to high-fidelity flow solvers such as the Computational Fluid Dynamics (CFD) code OVERFLOW 2.3d (Ref. 19, 20). AFTGen allows the user to input the airfoil coordinates, angle of attack and Mach number ranges, flow conditions, and various simulation settings (dependent on the flow solver selected) to run simulations and produce an airfoil table (in C81 file format) that provides the section lift, drag, and moment coefficients. AFTGen with OVERFLOW was used to generate the section aerodynamic coefficients for the E387 airfoil at the conditions provided in Table 7.1.2.

Table 7.1.2: AFTGen inputs for the E387 airfoil table.

Parameter	Value	Units
Re/M	911,292	-
angle of attack range	–20 to 20, Δ 1	deg
Mach number range	0.0 to 0.5, Δ 0.1	-

The Reynolds-Mach ratio, Re/M, shown in Table 7.1.2 is an input used to scale the Reynolds number with Mach number. This value was calculated using standard sea level conditions and is based on the chord length of the airfoil. Aerodynamic coefficients outside of the ±20 deg angle of attack range were obtained from the NACA 0012 airfoil table included in AFTGen. AFTGen with OVERFLOW simulations were completed using the resources provided by the NASA Ames Research Center High-End Computing (HEC) Program through the NASA Advanced Supercomputing (NAS) Division.

7.2 Comprehensive Analysis

A design study was performed using CAMRAD II to determine desired settings for the blade's linear twist distribution and built-in collective pitch. Assessments of two performance metrics, power (P, defined as profile power P_o + induced power P_i) and blade loading (C_T/σ), were used to determine the acceptable values for twist and built-in collective. Table 7.2.1 highlights key parameters of the rotor model as it was created in CAMRAD II. Radius, mean chord, mass, and RPM were based on the rotor used in the first MTB tunnel entry.

CAMRAD II simulations were run for 20 and 40 ft/s wind speeds and rotor tilt angles from 0 deg to –15 deg in increments of –5 deg. Using the parameters in Table 7.2.1 and these wind speeds and rotor tilt angles, the linear twist of the blades was swept from –30 deg to 0 deg. For these twist sweeps, C_T/σ was trimmed to a predetermined value of 0.1 by varying collective pitch of the blades. A linear twist of –17 deg was found optimal (yielded minimum power) for the baseline case of 40 ft/s wind speed, 2000 RPM, and –5 deg rotor tilt angle, as shown in Figure 7.2.1. The corresponding trimmed collective was approximately 6.22 deg.

Table 7.2.1: Key rotor model parameters, with the E387 airfoil used for the entire span.

Parameter	Inputs	Units
blade mass	0.0024	slug
chord	0.1283	ft
Lock number	2.2745	-
number of blades	2	-
radius	1.021	ft
rotor speed	2000	RPM
solidity	0.08	-
sweep	-	deg
taper	-	-

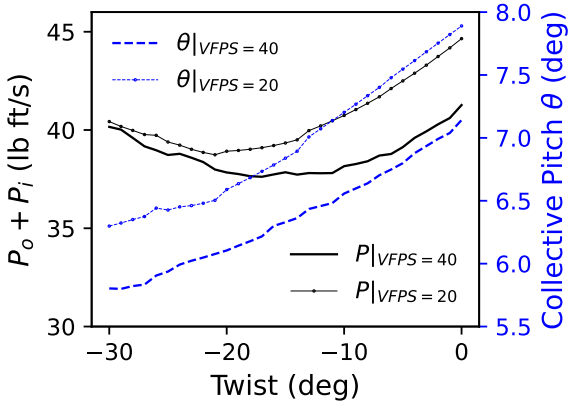


Figure 7.2.1: Power and collective pitch vs twist at 20 and 40 ft/s, rotor pitch = –5 deg.

With the selected linear twist distribution, sweeps of blade collective pitch were simulated for rotor pitch angles of 0, –5, –10, and –15 deg. The blade loading and power are plotted against the blade collective in Figure 7.2.2 through Figure 7.2.5.

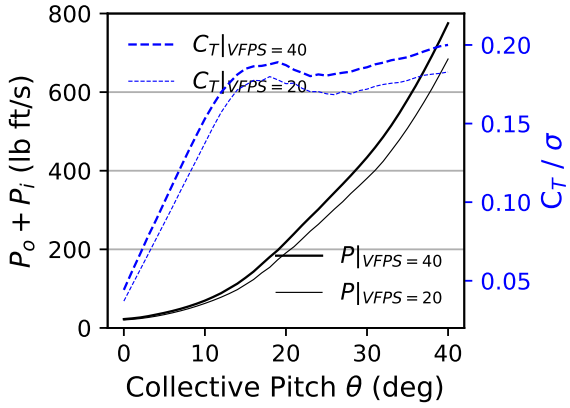


Figure 7.2.2: C_T/σ and power vs collective pitch, speeds of 20 and 40 ft/s, rotor pitch = 0 deg.

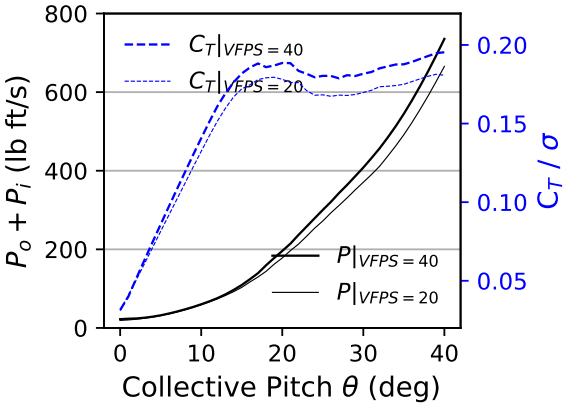


Figure 7.2.3: C_T/σ and power vs collective pitch, speeds of 20 and 40 ft/s, rotor pitch = –5 deg.

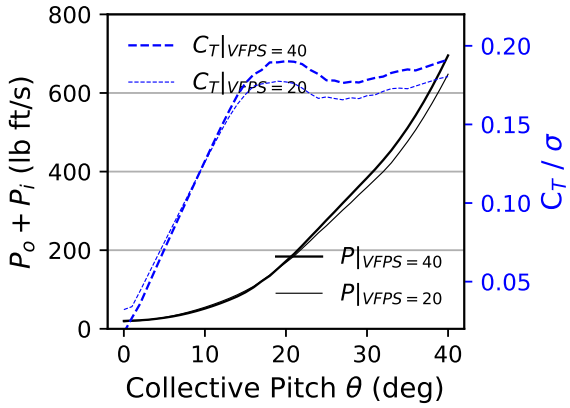


Figure 7.2.4: C_T/σ and power vs collective pitch, speeds of 20 and 40 ft/s, rotor pitch = –10 deg.

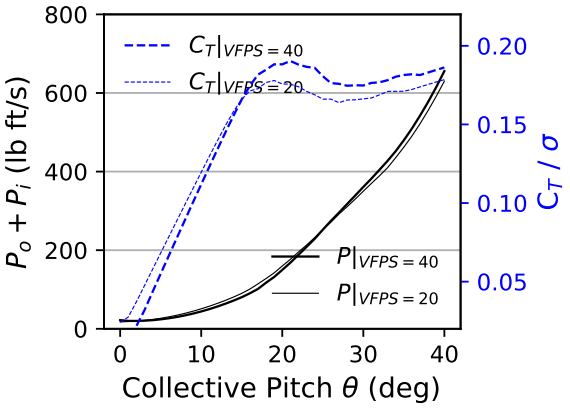


Figure 7.2.5: C_T/σ and power vs collective pitch, speeds of 20 and 40 ft/s, rotor pitch = –15 deg.

It was determined that a C_T/σ of 0.09 was likely a better target value, due to the proximity of $C_T/\sigma = 0.1$ to the stall boundary. Limited cases were run with C_T/σ trimmed to 0.09 while sweeping linear twist. Only conditions at 40 ft/s, 2000 RPM, and –5/–10 deg rotor tilt were analyzed, as these were deemed the most representative of the tests that would eventually be conducted in the wind tunnel.

Figure 7.2.6 shows the results of the twist sweep with 2000 RPM, 40 ft/s, and –10 deg rotor tilt. The optimum twist (–16 deg) and the corresponding built-in collective (6.7 deg) from the sweep in Figure 7.2.6 were selected for blade manufacturing. The overall MTB2 blade geometry is detailed in Table 7.2.2, including the selected settings of linear twist and built-in blade collective pitch.

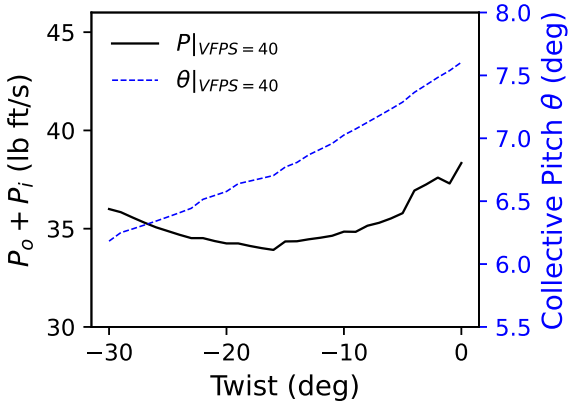


Figure 7.2.6: Power and collective pitch vs twist, speed = 40 ft/s, rotor tilt = -10 deg

Table 7.2.2: MTB2 blade geometry

Parameter	Value	Units
overall rotor diameter	24.5	inches
rotor radius	12.245	inches
chord length	1.54	inches
airfoil name	Eppler 387	-
blade twist	-16, linear from root to tip	deg
built-in blade collective pitch	6.7 deg at 75% radius	deg
maximum rotor speed	4500	RPM
trailing edge thickness	0.020	inches
	Sharp corners at the trailing edge rounded to radius of 0.020 inches	

The blade was designed in SolidWorks as shown in Figure 7.2.7 and modified by APC to account for manufacturing requirements. Notably, when the MTB2 blades were manufactured, the twist was applied about the centroid and not about the ¼ chord location as was done in the CAMRAD II modeling. It is not believed that a slight change in twist axis would significantly affect the results of the CAMRAD II rigid blade analysis.



Figure 7.2.7: MTB2 rotor blade CAD model using revised E387 airfoil.

The blades were manufactured by APC from a 40% long carbon fiber reinforced Nylon 6 thermoplastic composite (Ref. 21). The blade was designed for compatibility with the KDE DPAHL-ML rotor hub, with a flat root and a 4 mm diameter pin hole for securing the blade to the blade grip.

8 RPM and Phasing Control

One of the major changes between the MTB1 and MTB2 tests was the addition of a motor control system capable of azimuthal phase control. This system was developed by Launchpoint Electric Propulsion Solutions under a Phase III NASA SBIR (Small Business Innovation Research) contract, and it uses a similar architecture to the one described in Ref. 22.

In short, the system uses a Hall effect sensor to provide a 1/rev signal to the controller. The timing of the 1/rev signals of the different rotors is used by the controller to determine the relative azimuthal phase angles of the rotors, with a capability of controlling up to 6 rotors. For the MTB2 test, phase-controlled test points were collected for 2- and 4-rotor configurations. The phase angle was verified visually by pointing a stroboscope at the rotor system from above and noting the positions of retroreflective targets added on the surface of the rotor blades, near the tips.

The phase control system was interfaced with the MTB Control System (MCS) via Controller Area Network (CAN) bus, and the LabVIEW control software for the phase control system was integrated into the MCS control console so that rotor RPM and phase could be controlled alongside the other model parameters, including model pitch, rotor tilt, and power bus control.

9 Instruments

Table 9.1 lists the instruments used in the test with model numbers and the manufacturer. Appendix B lists the condensed instrumentation requirements for the test. Not mentioned in the tables is the related parameter, the sample rate, which is 4 kHz for the model instrumentation and the tunnel conditions, but not for the instrumentation coming in through the RS-232 connection (RS-232 parameters indicated in Appendix B). Note that the inclinometer pitch calibration was an in-place calibration. For more information on data capture, see section 4.3.

Table 9.1: List of instruments used in the MTB2 test campaign..

Instrument	Name/Model Number	Manufacturer	Quantity
Load Cell	Interface 6AR70A-S11	Interface	4
Motor	KDE7215XF-135	KDE Direct	4
Accelerometer	Type 8763B Triaxial Accelerometer	KISTLER	4
Stepper Motor	SY57STH76-2804A	Changzhou Songyang Machinery & Electronics	1
Linear Actuator	Ultra Motion Series A1 Servo Cylinder A1NU8B-B0M2E2	Ultra Motion	4
Bus Thermocouples	Type K	Omega	2
Load Cell Thermocouples	Type J	Omega	4
Inclinometer	Analog MEMS Inclinometer AMI-1-30-V1-ATP	Jewell Instruments	1
Electronic Speed Controller	Custom	LaunchPoint	4

The load cells were chosen for their small size (which both reduced the moment arm from the rotor and minimized any possible aerodynamic interference) and their load capacity relative to the expected loads. The calibration of these load cells provided some difficulties, due to their non-linear response. The load cell calibration was found to be dependent on the combination of applied loads, making data reduction difficult. The updates made to the load cell calibration are detailed in section 9.2. Future MTB tests will use a 6-axis load cell that does not exhibit this type of non-linear behavior.

The KDE motors were the same as those used for the MTB1 test. For that test, the rotor size was selected based on the test section size constraints of the 7- by 10-Foot Wind Tunnel. The motor and electronic speed controller (ESC) were then chosen based on manufacturer-recommended pairings of those components with the 24.5-inch diameter rotors. The ESCs used for MTB1 were replaced for the MTB2 test with a phase-controlled motor drive built by Launchpoint Electric Propulsion Solutions and discussed above in Section 8, RPM and Phasing Control.

A stepper motor drives the jack screw at the bottom of the support strut to control the pitch of the MTB. The requirements on this motor were fairly minimal. Essentially, all that was required was a small physical footprint and an operating voltage that was compatible with the available DC power already being used for the test – in this case 12 V. The linear actuators were selected because they could handle sufficiently large forces, could not be back driven, and had negligible backlash. The linear actuators behaved well throughout the test.

The bus and load cell thermocouples were intended to be used to help with both monitoring of these MTB components as well as to make temperature corrections to any observed thermal drift. These thermocouples were directly wired over a long ($\sim$ 75 ft) cable run from the MTB to the NI DAQ card in the control room without amplification. This arrangement led to a large amount of electrical noise any time the motors were

energized, and the temperature data was mostly unusable. The static points at the beginning and end of each run with the motors turned off were the only data points with usable temperature measurements from the thermocouples. Future tests will use a thermocouple amplifier placed closer to the MTB to help reduce the problematic interference. The inclinometer was chosen for its precision and resistance to thermal forces.

9.1 Load Cells

The primary scientific measurements for the MTB2 test were made using a set of Interface 6AR70A-S11 six-axis load cells and recorded by the 7-by 10-Foot Wind Tunnel's SDAS. The SDAS recorded both steady (mean) and dynamic loads. The load cells used for this test have overload ranges that are 3 times the standard measurement range. The specifications of the four load cells are contained in Table 9.1.1. The measuring capacities and load limits are in the first three rows, and the following four rows list the manufacturer-reported uncertainties for each load cell by serial number. The Nominal Range is the range at which the load cell can most accurately measure a load/moment. The Safe Overload Range is the limit to which the load cell would not be damaged but would have less accurate measuring capability. The Ultimate Overload Range is the value at which, if exceeded, the load cell would be permanently damaged and would require replacement.

Table 9.1.1: Load cell ratings. The measure of signal to noise (S/N) is quantified in terms of the 95% measurement uncertainty.

	F_x [lb]	F_y [lb]	F_z [lb]	M_x [in-lb]	M_y [in-lb]	M_z [in-lb]
Nominal Range	75	75	75	115	115	115
Safe Overload Range	113	113	113	173	173	173
Ultimate Overload Range	225	225	225	345	345	345
Measurement Uncertainty (95%)						
S/N R100842	0.23	0.97	0.18	1.07	0.80	4.04
S/N R100843	0.27	0.99	0.17	1.02	0.36	0.65
S/N R100844	0.24	1.28	0.15	1.51	0.64	2.95
S/N R100845	0.26	1.34	0.16	1.32	0.38	2.92

The load cell systems contain their own power supply and amplification provided by an Interface BX8-HD44 amplifier which provides a calibrated voltage with a full-scale output of approximately ± 10 volts, which was used with mixed success in the MTB1 test. Given the difficulties encountered during that test with the BX8 amplifiers, the MTB2 test entry used the more traditional Wheatstone bridge amplification system provided by the facility's PI6000 system.

9.1.1 Calibration

To accurately represent Load Cell Sensor (LC) responses, a new calibration matrix and its associated uncertainties were developed. A new math model was derived since LC gage voltages (and consequently, the loads) demonstrated significant signal responses in off-diagonal elements. The error has been quantified by post-calibration dataset analysis and estimated with uncertainty intervals. New calibrations maximized the model likelihood resulting in a new matrix that optimally fits a linear response. Each load cell was subjected to an array of static load tests according to this schedule:

- Combined F_x and M_y
- Combined F_y and M_x
- Sole F_z
- Sole M_x
- Sole M_y
- Sole M_z

Each run started with a zero to full-scale loading (performed twice) to remove any stiction from the system. This was followed by loading to full scale in 10% increments and then unloading back down to zero in the same 10% steps to capture hysteresis. Three runs were performed for each load case to establish the uncertainty distribution. It was noted that the LC sensitivity varied as a function of the fixture height. A 2.75 inch fixture height was chosen to emulate the MTB2 aparatus which had a 2.783 inch elevation from the top of the load cell to the rotor plane.

Initial linear models for each load cell were derived by Ordinary Least Squares (OLS) which seeks to minimize the difference between applied loads and calculated loads predicted by a linear math model, described in 2, where F represents the loads, V represents the voltages, and $\hat{C}$ represents resultant calibration coefficients.

$$\min_{\hat{w}} \|F - V\hat{C}\| \tag{2}$$

The voltage array $V \in R^{(n,6)}$ is composed of n rows of load cell gage measurements $\vec{v_0} = [v_1, v_2, \ldots, v_6]$ for gages 1 through 6. The applied loads are represented by $F \in R^{(n,6)}$ where each row is composed of vector $\vec{f_0} = [f_x, f_y, f_z, M_x, M_y, M_z]$.

The calibration procedure consists of partitioning the complete calibration dataset into two randomized sets. The first partition is 80% of the total data and is used in calibration, while the remaining 20% is used to estimate the error and validate the calibrated math-model. The OLS fit minimizes Equation 2 via the least squares projection, representing the best possible solution for linear models (Ref. 23). The minimization procedure results in an array of coefficients $\hat{C} \in R^{(6,6)}$.

An additional optimization step is performed to ensure the model coefficients capture the error frequency distribution, thereby finding the best possible solution for normal linear models. The residual errors given by the OLS solution contribute towards estimating the covariance. The Weighted Least Squares (WLS) method uses the covariance to derive updated coefficients in which the chi-squared distribution is minimized. It is well known that the WLS model represents the maximum likelihood for normal linear distributions (Ref. 24). Thus, all weighted linear matrices presented here are the optimal solutions for linear load cell behavior. The calibration conversion matrices developed for each load cell are provided in Appendix C.

9.1.2 Uncertainty Quantification

Two essential sources of independent uncertainties are derived and computed from quasi-static and dynamic MTB2 data sources. Those sources are random uncertainty (e.g. precision) due to calibration $u_{\text{ci}}(f_i)$, and transient uncertainty $u_{\text{dyn}}(f_i)$. The first uncertainty source comes from uncertainties embedded within calibration coefficients. For instance, it is well known that the covariance matrix (of the fitting/calibration data) can be used to estimate the variance of each matrix coefficient in $\hat{C}$ (Ref. 25). This measurement is then used in the confidence interval (CI), as will be demonstrated herein. Further details on transient uncertainties will be given in this section.

Noise due to uncertainties in the calibration weights (matrix coefficients), or Gaussian noise contributions to the linear model can be re-written as equation 3.

$$\hat{F} = V\hat{C} + \varepsilon(\sigma^2) \tag{3}$$

A Gaussian noise term $\varepsilon(0, \sigma^2)$ is added to the mean to estimate the error distribution in the voltage responses. There is no bias term in the linear model since this has been removed in the zero-subtraction step. In this calibration, the uncertainty quantification is expressed by the confidence interval (CI) defined in equation 4. This relation identifies a region of possible load values due to random noise in the measurement data.

$$u_{CI,\beta} = \pm t_{n-p,1-\beta/2}\sigma_j \sqrt{\|v_0^T (V^T V)^{-1} v_0\|} \text{ for } j = (1, 2, ...6) \tag{4}$$

The variance σ_i and $(V^TV)^{-1}$ terms are saved from the calibration dataset since those are the only cases where the residual can be computed with known loads. The variance is computed as $\|F-\hat{F}\|^2/(n-p))$ where p is the number of multivariate parameters (i.e., 6 axis responses correspond to 6 parameters). Finally, the variable $t_{n-p,1-\beta/2}$ represents the t-distribution for some quantile $1-\beta/2$ (where β is the confidence interval percentage). Applying the CI can be used to estimate the error due to random noise in measurements v_0. However, a step further establishes a predictive interval (PI) that infers the region of possible loading predictions, defined in 5 (Ref. 23).

$$u_{PI,\beta} = \pm t_{n-p,1-\beta/2}\sigma_j\sqrt{1+v_0^T(V^TV)^{-1}v_0} \tag{5}$$

Either the resulting value $u_{CI,\beta=0.05}$ (for a 95% confidence interval) or $u_{PI\beta=0.05}$ may be added to the mean loads to establish a bounded interval of valid solutions. This analysis is in line with recommended practices given by the 2020 AIAA Balance Calibration Handbook (Ref. 26).

An additional, independent source of uncertainty found by estimating the variance in the mean oscillatory behavior gives a sense of the repeatability over time. By partitioning M number of sections within a single run-point index, the time-resolved statistics or variation of each partition's mean $u_j = \sum_i^N f_{jik}$ may be computed like so[†] .

$$\mu = \frac{1}{M}\sum_{j=1}^{M}\mu_j \qquad\qquad u_{\text{dyn}} = \sqrt{\frac{1}{M}\sum_{j}^{M}(\mu_j-\mu)^2} \tag{6}$$

For each j^th partition there are $N = N_{\text{periods}} \cdot N_{\text{samples-per-period}}$ samples. For an equal number of periods across each run-point index, $M = 10$ segmented partitions and $N_{\text{periods}} = 5$ were chosen to reasonably accommodate the range of increased sampling statistics depending on the RPM. An example is shown in Figure 9.1.1, where the variance between each curve may be computed.

Finally the precision uncertainties may be combined with the mean loads to provide error bars.

$$\tilde{F} = V\hat{C} \pm \sqrt{u_{\text{CI}}(\beta)^2 + u_{\text{dyn}}^2} \tag{7}$$

9.1.3 Accuracy

The maximum residual differences found in the validation dataset are represented in Tables 9.1.2 to 9.1.5. Each individual table shows the residual loading error associated with a particular load cell. Each row corresponds to results for a single applied loading case/direction. The first six columns (Fx_H, Fy_H, etc.) indicate the applied load that corresponds to the worst residuals. The last six columns show the maximum residual loading error for each loading case and direction. The deviation from the ground truth or known applied load is represented by the residual computed like so:

$$\Delta F = |F - \hat{F}| \tag{8}$$

Tables 9.1.2 to 9.1.5 represent the maximum error that occurred in the validation set. Recall that the smaller subset of AeroLab data (set B, 20% of the total calibration loads) are used here to compute the error. The F_x and F_y loading cases are categorized as combined loading conditions, since they both induce a moment due to the 2.75 inch application height. The only pure loads are F_z, M_x, M_y, M_z.

[†]the k^{th} index indicates the dimension F_x, F_y, F_z, M_x, M_y, M_z.

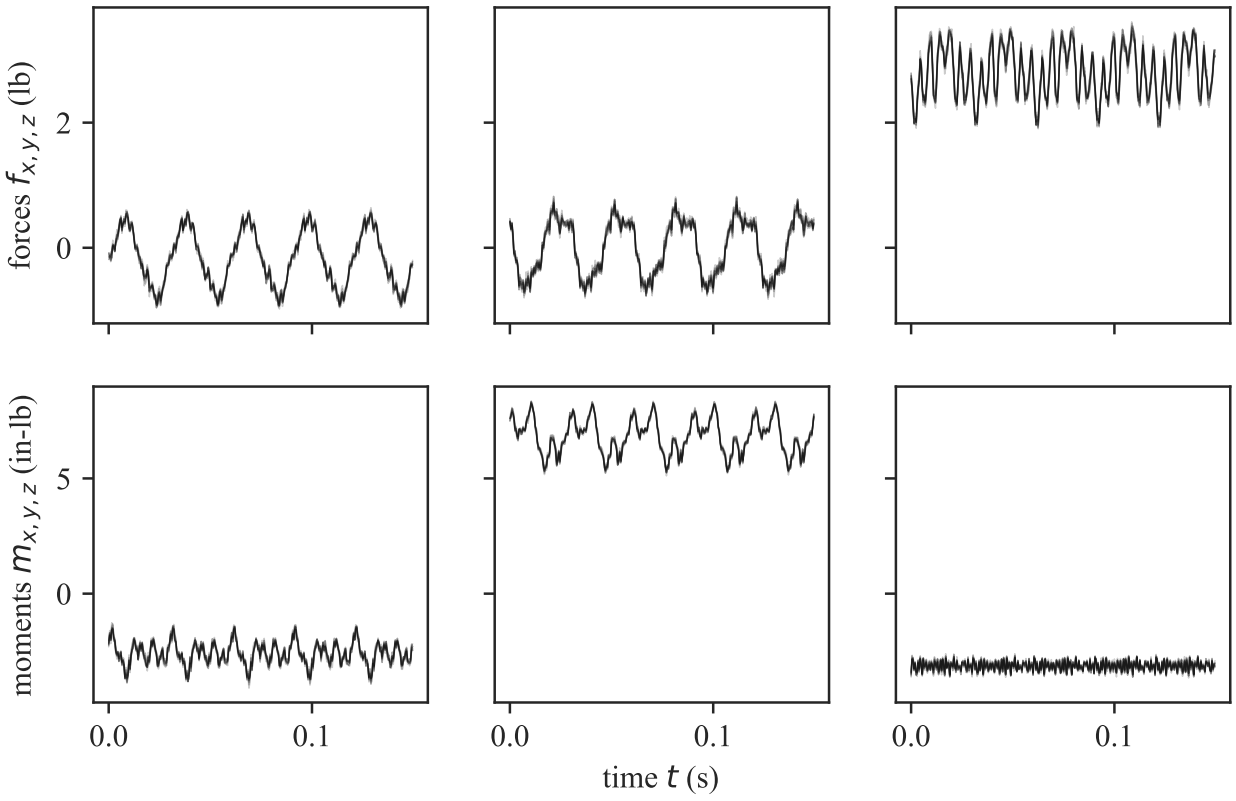


Figure 9.1.1: Overlapping representation of partitioned segments of dynamic data for Run 128, Point 26. Shown here are ten partitions (M=10) and 5 periods for each partition. For clarity each period is a complete revolution.

Table 9.1.2: Maximum residual errors in load predictions (given by LC1/R100842 conversions).

Category	Fx_H [lb]	Fy_H [lb]	Fz_H [lb]	Mx_H [in-lb]	My_H [in-lb]	Mz_H [in-lb]	ΔF_x [lb]	ΔF_y [lb]	ΔF_z [lb]	ΔM_x [in-lb]	ΔM_y [in-lb]	ΔM_z [in-lb]
F_xM_y	51.73	0.00	0.00	0.00	142.25	0.00	1.58	1.31	0.87	1.28	1.44	1.56
F_yM_x	0.00	46.73	0.00	128.50	0.00	0.00	3.97	1.02	1.70	2.19	3.33	2.64
F_z	0.00	0.00	45.73	0.00	0.00	0.00	0.70	1.57	2.28	4.09	1.69	0.32
M_x	0.00	0.00	0.00	120.00	0.00	0.00	0.62	0.58	0.60	0.94	0.91	1.45
M_y	0.00	0.00	0.00	0.00	100.00	0.00	1.55	0.79	0.91	0.74	1.96	0.73
M_z	0.00	0.00	0.00	0.00	0.00	120.00	1.40	0.58	0.59	1.11	0.58	1.53

Table 9.1.3: Maximum residual errors in load predictions (given by LC2/R100843 conversions).

Category	Fx_H [lb]	Fy_H [lb]	Fz_H [lb]	Mx_H [in-lb]	My_H [in-lb]	Mz_H [in-lb]	ΔF_x [lb]	ΔF_y [lb]	ΔF_z [lb]	ΔM_x [in-lb]	ΔM_y [in-lb]	ΔM_z [in-lb]
F_xM_y	50.00	0.00	0.00	0.00	137.50	0.00	0.49	0.31	0.39	0.34	0.93	0.43
F_yM_x	0.00	50.00	0.00	137.50	0.00	0.00	1.24	0.68	0.53	0.72	0.59	0.37
F_z	0.00	0.00	45.17	0.00	0.00	0.00	0.22	0.23	5.01	1.27	0.60	0.03
M_x	0.00	0.00	0.00	100.00	0.00	0.00	0.94	0.13	0.36	0.73	0.89	0.08
M_y	0.00	0.00	0.00	0.00	80.00	0.00	0.20	0.04	0.40	0.05	1.52	0.12
M_z	0.00	0.00	0.00	0.00	0.00	100.00	0.07	0.19	0.88	0.53	2.03	4.85

Table 9.1.4: Maximum residual errors in load predictions (given by LC3/R100844 conversions).

Category	Fx_H [lb]	Fy_H [lb]	Fz_H [lb]	Mx_H [in-lb]	My_H [in-lb]	Mz_H [in-lb]	ΔF_x [lb]	ΔF_y [lb]	ΔF_z [lb]	ΔM_x [in-lb]	ΔM_y [in-lb]	ΔM_z [in-lb]
F_xM_y	50.00	0.00	0.00	0.00	137.50	0.00	0.81	1.30	0.64	0.97	0.60	0.36
F_yM_x	0.00	45.00	0.00	123.75	0.00	0.00	2.27	1.26	0.59	0.83	0.52	0.46
F_z	0.00	0.00	50.17	0.00	0.00	0.00	0.37	0.33	0.76	0.94	1.50	0.03
M_x	0.00	0.00	0.00	60.00	0.00	0.00	0.60	0.49	0.40	1.15	0.22	0.24
M_y	0.00	0.00	0.00	0.00	80.00	0.00	0.37	0.12	0.45	0.17	1.03	0.42
M_z	0.00	0.00	0.00	0.00	0.00	100.00	0.39	0.53	0.35	0.32	1.17	1.24

Table 9.1.5: Maximum residual errors in load predictions (given by LC4/R100845 conversions).

Category	Fx_H [lb]	Fy_H [lb]	Fz_H [lb]	Mx_H [in-lb]	My_H [in-lb]	Mz_H [in-lb]	ΔF_x [lb]	ΔF_y [lb]	ΔF_z [lb]	ΔM_x [in-lb]	ΔM_y [in-lb]	ΔM_z [in-lb]
F_xM_y	35.00	0.00	0.00	0.00	96.25	0.00	0.73	1.04	0.59	1.31	0.58	0.84
F_yM_x	0.00	40.00	0.00	110.00	0.00	0.00	1.27	0.82	0.64	0.58	0.88	0.40
F_z	0.00	0.00	50.17	0.00	0.00	0.00	0.14	0.22	0.17	1.64	1.50	0.04
M_x	0.00	0.00	0.00	60.00	0.00	0.00	0.33	0.18	0.44	1.34	0.11	0.24
M_y	0.00	0.00	0.00	0.00	80.00	0.00	0.64	0.05	0.43	0.43	2.44	0.20
M_z	0.00	0.00	0.00	0.00	0.00	100.00	0.18	0.34	0.35	0.32	0.16	1.21

Tables 9.1.2 to 9.1.5 indicate significant errors in the off-axis directions, meaning there are sometimes residuals in directions where loads were not applied. This is partially because the load cell was constructed in a way in which the load cell matrix cannot be diagonal (gage placement not orthogonal with loading directions). Because of the load cell sensor's variance, we demonstrate the residuals ΔF in each direction. Thus, all theoretical comparison with experimental data must consider using error bounds.

9.2 Load Cell Check Loads

Four load cells were used for the MTB2 wind tunnel entry, calibrated at Ames Research Center. After the MTB was built up in the 7- by 10-Foot Wind Tunnel's test section, check loads were performed both at the surface of the load cell and then again at the hub prior to testing. The purpose of the check loads was to identify any change to the load cells' sensitivity or readings due to improper installation or handling, or possible changes of force or moment path loads. Each load cell was examined for force in the x direction (F_x), force in the y direction (F_y), thrust (F_z), roll (M_x), pitch (M_y), and yaw moment (M_z) at the surface of the load cell and at the hub. Note that the yaw moment was only checked at the surface of the load cell, not at the hub. The Balance and Hub Coordinate Systems, shown in Section 6, Figure 6.2, define the positive coordinate for F_x downstream, F_y towards the control room, and F_z up when tilt and pitch angle are zero. The positive moment is defined as roll left, pitch up, and counter-clockwise yaw. See the Coordinate System overview in section 6 for more details.

Many of the check loads were performed using the Check Load System shown in Figure 9.2.1. The Check Load System is equipped with two pulleys capable of moving left/right and up/down in the main frame of the Check Load System. The whole Check Load System sits on four wheels that can be locked in place, allowing more accessible transport and location adjustment.

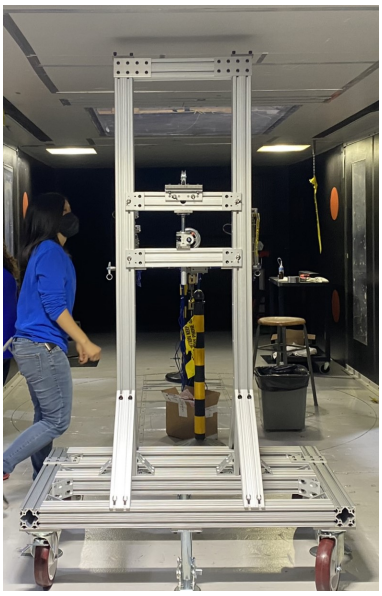


Figure 9.2.1: The Check Load System in 7- by 10-Foot Wind Tunnel test section.

After setting up the check load system, a hanging bubble line level (see Figure 9.2.2) was attached to the wire cable to ensure the wire cable between the load cell and the pulley was level. If the bubble inside the level was not at the center, the pulley location was adjusted. Note that the pan's weight allows the string to stay taut during this adjustment. The two hooks at the end of this line level connected to the wire cable. In addition, it was ensured that the wire cable from the center of the load cells directly met the center of the pulley by standing eye level with the pulley and tracking the direction of the wire. If the center of the pulley and the load cells were not lined up, the pulley was moved to the left or right to make the necessary adjustment. Since this measurement was prone to human error, two personnel verified the setup for each measurement.



Figure 9.2.2: The hanging bubble level was attached to the wire cable between the load cells and the pulleys to ensure the wire cable was level.

After ensuring the check load setup was ready, a Zero data point was taken to account for any existing load applied to the load cells. The Zero data point was taken when the weight pan was connected and stationary. Then, the beginning baseline data point was taken (static point before applying any weight). Next, the weight was loaded on the weight pan, and the data point was recorded for every weight added. After the max weight was reached, the weight was offloaded in the same increments, and data was recorded until no weight was left on the weight pan. Note that before taking the data, it was ensured that the weight pan was steady and not swinging. The run finished by taking the last baseline, Zero data point, and R-Cal. Note that each load cell has a maximum load capacity, and exceeding that value could damage the load cell. These load limits were shown previously in Table 9.1.1. The loads applied to the load cells for the check loads, including the 5 lb weight pan and moment arms, are shown in Tables Tables 9.2.1 and 9.2.2. The total load from the applied weight, in addition to the weight pan, did not exceed the load cell load limits.

Table 9.2.1: The total load used during the check loads at the load cell, including the 5 lb weight pan, increments, and moment arm length.

Force	Incremental weight applied (no weight pan) [lb]	Σ Applied Load +weight pan [lb]	Moment Arms [in]
F_x	5, 10, 15, 20	25	-
F_y	5, 10, 15, 20	25	-
F_z	2, 4, 6, 8, 10, 15, 20	25	-
M_x	2, 4, 6, 8, 10, 15	20	3.5
M_y	5, 10, 15, 20	25	2.5
M_z	2, 4, 6, 8, 10	15	3.5

Table 9.2.2: The total load used during the check loads at the hub, including the 5 lb weight pan, increments, and moment arm length.

Force	Incremental weight applied (no weight pan) [lb]	Σ Applied Load +weight pan [lb]	Moment Arms [in]
F_x	5, 10, 15, 20	25	2.783
F_y	5, 10, 15, 20	25	2.783
F_z	2, 4, 6, 8, 10, 15, 20	25	-
M_x	2, 4, 6, 8	20	5.65
M_y	2, 4, 6, 8	25	5.65
M_z	2, 4, 6, 8	15	5.65

While loading and offloading, the load cell reading was monitored in the control room before taking any data points. In some cases, the load cell reading differed much from the actual weight, indicating possible friction in the load cells or at pulleys. To release the friction or tension, the pulley was tapped slightly with a mallet. If the reading still had low accuracy, the load cell was slightly tapped to release the tension. Often tapping the pulley or load cell helped increase the accuracy of the reading.

9.2.1 Check Loads at the Surface of the Load Cells

Check load for F_x and F_y at the surface of the load cells

To perform the check load for F_x and F_y at the load cells, a custom-made plate was first secured with six screws to one of the load cells. Then, a zip tie was looped around the lower edge of the plate, close to the top surface of the load cells, shown in Figure 9.2.3.

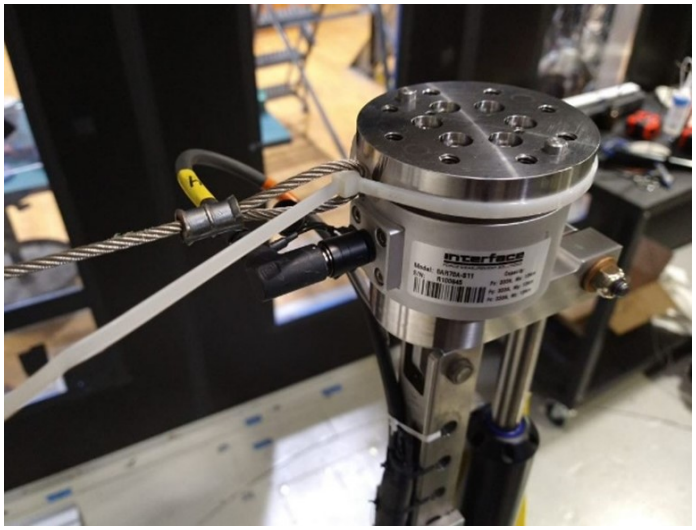


Figure 9.2.3: Customized plate attached with six screws on top of the load cells was used for performing check loads for F_x and F_y at the load cells.

This zip tie connects to the wire cable, which goes over the pulleys, which are part of the Check Load System. On the other side of the wire cable is a weight pan. Figure 9.2.4 shows the components involved in measuring F_x, and F_y at the load cells. To simplify the diagram, only the pulleys from the Check Load System are shown.

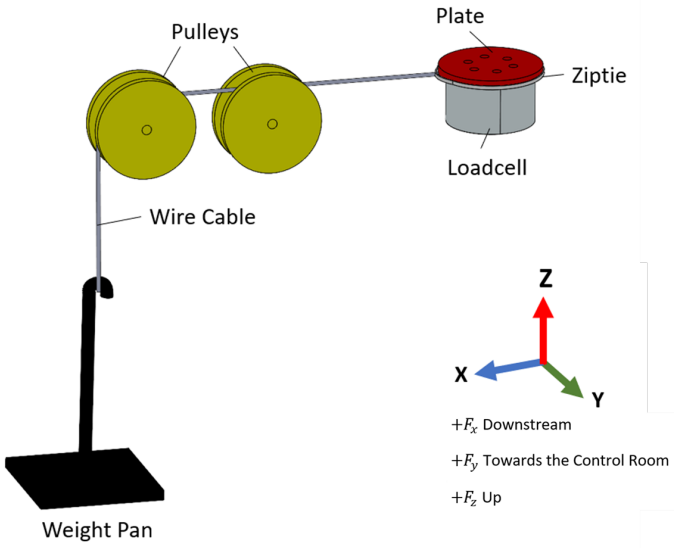


Figure 9.2.4: Schematic for F_x check load at the load cells in the Balance Coordinate System.

The Check Load System was still being assembled when these first check loads started, which is why a different pulley was used in this section than the others. For these check loads, a pulley was attached to the Load System structure using two C-clamps as shown in Figure 9.2.5. Since these check loads are not used for calibration and only for checks, this discrepancy is inconsequential.

To measure F_x for rotor 4's load cell (back port rotor), the Check Load System was placed downstream of the model. One end of the wire cable was already attached to the load cells using a zip tie. The wire cable's other end extended towards +x (downstream), went over the pulley, and connected to a weight pan, also shown in Figure 9.2.5.

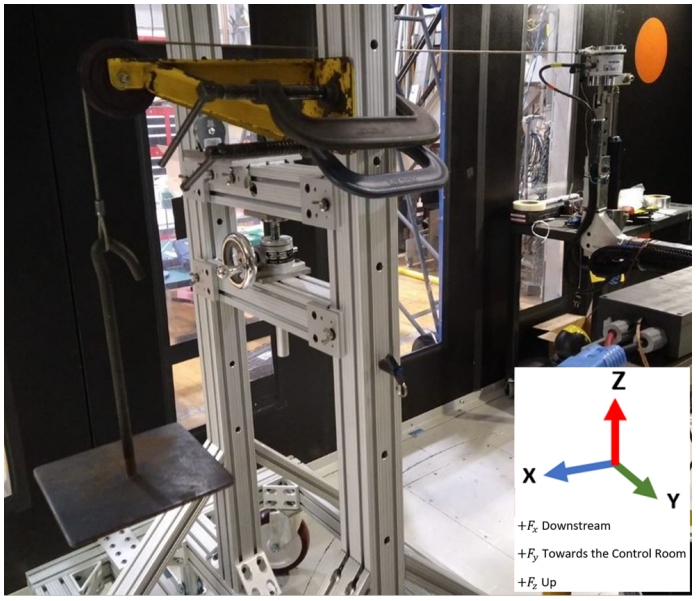


Figure 9.2.5: The setup of check load for rotor 4's load cell in the 7- by 10-Foot Wind Tunnel's test section in the Balance Coordinate System.

This process was also used for performing check loads for F_y. Instead of bringing the Check Load System upstream or downstream of the model, the Check Load System was placed port or starboard of the model. The wire cable was assembled the same way, only pulling either +y (starboard, towards control room) or -y (port, away from control room). The check load of F_x and F_y at the load cells were loaded and offloaded up to 20 lb with 5-lb increments.

Check load for F_z at the load cells To perform the check loads in the F_z direction, the loads were applied at $+F_z$ direction. This is because the sensitivity of $+F_z$ and -F_z of the load cells were not the same, and $+F_z$ is more important since it corresponds to the thrust measurement.

To apply the load at $+F_z$ the calibration cylinder, shown in Figure 9.2.6, was connected to the load cell, and the Check Load System was placed near the load cell of interest. A pendulum (plumbob) connected to a string was used to locate the center of the load cell. The string was placed on pulleys, and the other end of the string was fixed to the Check Load System. The location of the Check Load System and pulleys were adjusted to ensure the plumbob lined up with the center of the calibration cylinder, and therefore the center of the load cell, 9.2.7.

When the plumbob was centered, the Check Load System was fixed in place and the string was replaced by the wire cable. The weight pan was connected to one end of the cable, and the other end was attached to the hoop of the calibration cylinder using a zip tie, Figure 9.2.8. F_z was measured in 2-lb increments until it reached the total of 10 lb, and then the load was increased by an increment of 5 lb until it reached the total of 20 lb.



Figure 9.2.6: Custom-made calibration cylinder for MTB load cells.

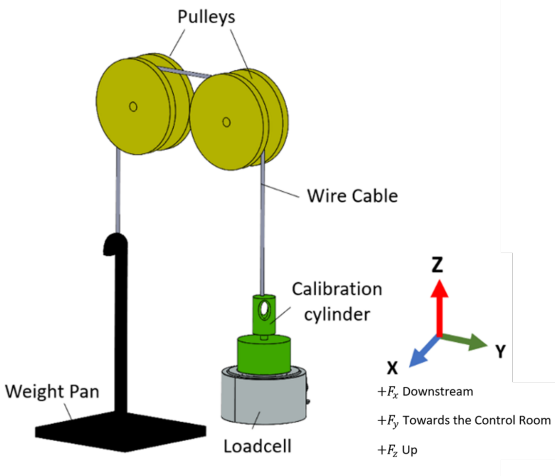


Figure 9.2.7: Schematic showing process for lining up to the center of the load cell for F_z check loads at the load cell in the Balance Coordinate System.

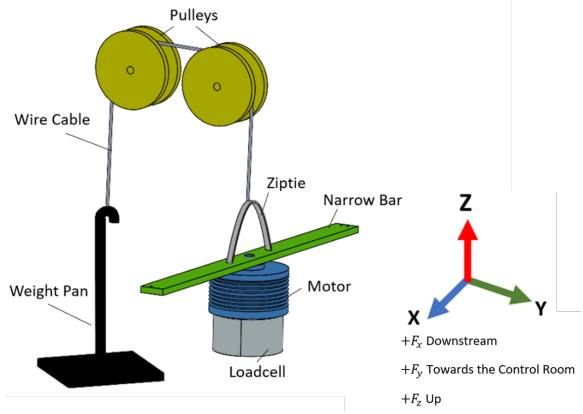


Figure 9.2.8: Assembly used to perform F_z check loads at the load cell in the Balance Coordinate System.

Check load for yaw moment M_z at the load cells

To check the yaw moments, M_z, a wide bar was attached to the load cells to act as the moment arm, and the wire cable was attached to the wide bar using a zip tie. The other end of the wire cable passed through the pulley and connected to the weight pan, Figure 9.2.9. Figure 9.2.10 shows the wide bar connected to load cell number 3, which provides a 3.5-inch moment arm to help with check load measurements at the load cell.

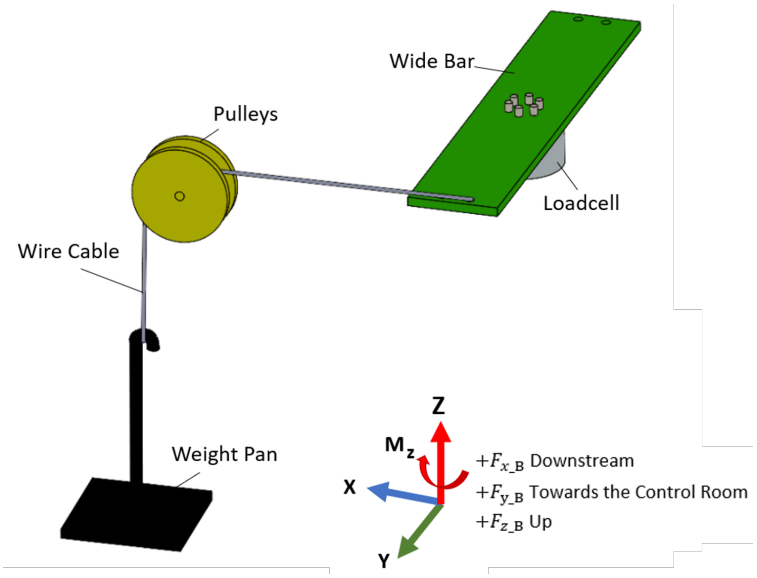


Figure 9.2.9: Assembly for M_z check loads at the load cell in the Balance Coordinate System.

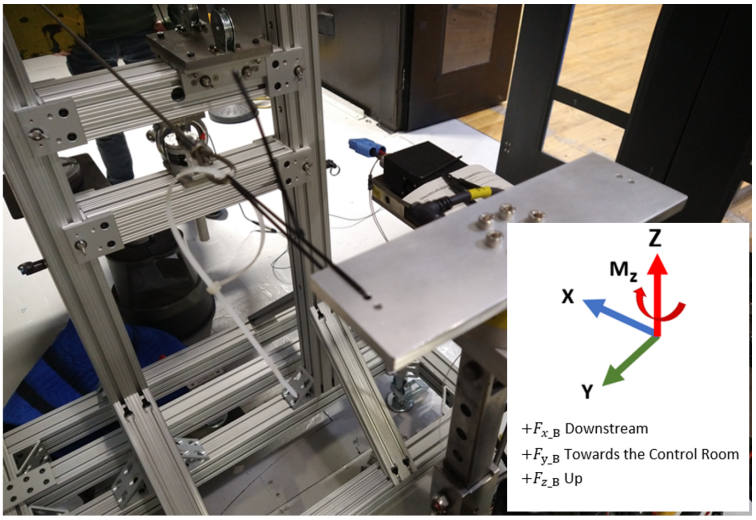


Figure 9.2.10: Check loads set up for M_z at rotor 3's load cell in the Balance Coordinate System, downstream view.

The moment arm of 3.5 inches was measured from the center of the load cell to the center of the wide bar's hole that connects to the wire. Before taking any data, the angle between the moment arm and the wire cable was adjusted to ensure it was ∼90 deg angle (in the horizontal plane).

For the M_z check load, the weight pan was loaded in increments of 2 lb up to 10 lb, and then unloaded in increments of 2 lb back to 0 lb. Figure 9.2.11 shows the M_z check load on rotor 3's load cell with 6 lb of weight on top of the weight pan. With a moment arm of 3.5 inches on +Y axis and the total weight of 11 lb (including the 5 lb weight pan) this resulted in a 38.5 in-lb yaw moment.

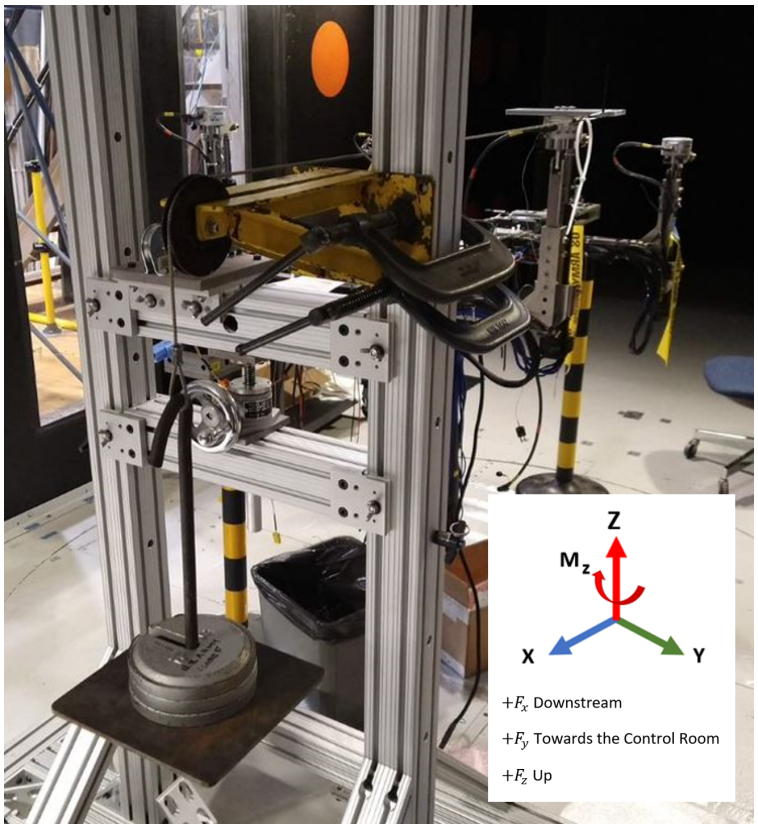


Figure 9.2.11: Check loads set up for M_z at rotor 3's load cell in the Balance Coordinate System, upstream view.

The enhanced performance metrics related to the check load on load cells are detailed in Appendix D.

9.2.2 Check Loads on the Hubs

Check load for F_z at the Hub

To check the loads for F_z at the hub, the motor was secured at the top of the load cells, and the narrow bar was secured to the top of the motor via screws. The narrow bar had two holes in the middle of the bar through which a zip tie was secured that then connected to the wire cable, as shown Figure 9.2.12. The process for identifying the center of the load cell was the same process described in 9.2.1 for check loads in the F_z direction. After the desired location was achieved, the plumbob was replaced with the wire cable and secured as shown in Figure 9.2.13.

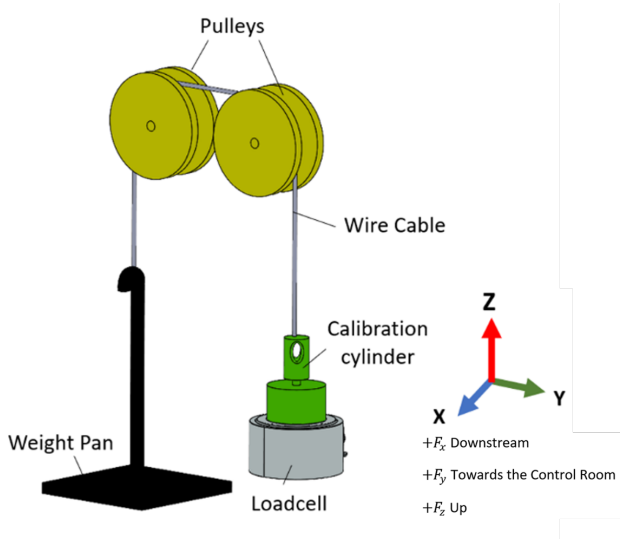


Figure 9.2.12: System diagram for identifying the center of the load cell for check load measurement of F_z at the hub in the Hub Coordinate System.

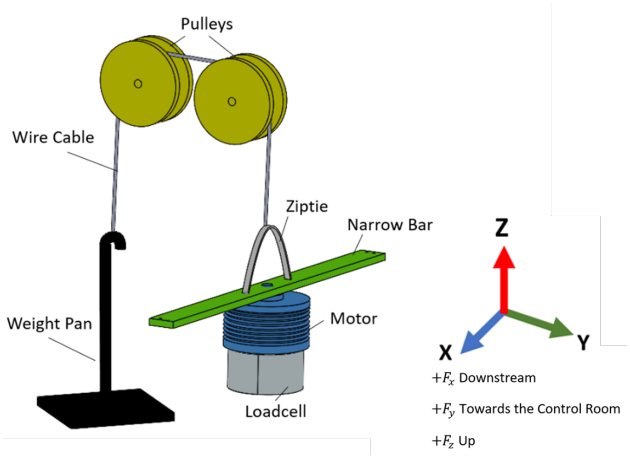


Figure 9.2.13: The set-up diagram for the check load measurements of F_z at the hub in the Hub Coordinate System.

Loading the weight pan with increments of 2 lb up to 10 lb and continued up to 20 lb with an increment of 5 lb. Figure 9.2.14 shows the setup for F_z check loads at hub number 2 (front port rotor 2) inside the 7- by 10-Foot Wind Tunnel test section.

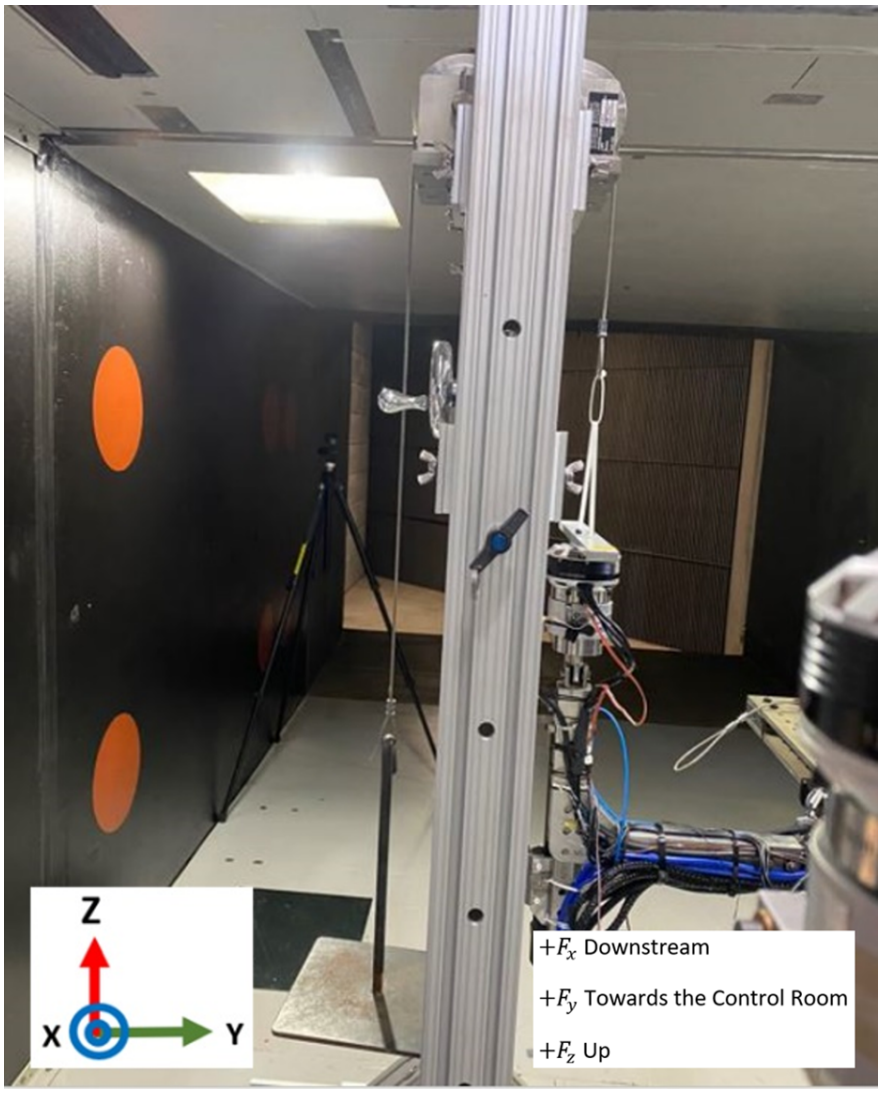


Figure 9.2.14: The F_z check loads at hub number 2 in the test section in the Hub Coordinate System.

For brevity the remainder of the check loads are not included in the main text of this document but are described in Appendix D.

10 Post-Processing

A series of post-processing steps were performed on the data to remove biases. Corrected load cell responses considered effects due to zero offset, drift, baseline aerodynamic interactions, and weight contributions. Each data table is indexed per run and point, enabling easier post-processing analysis by leveraging pivoting. Particular points of a run type (i.e. Zero Point, R-Cal, or Data point) are utilized at certain stages of generating corrected value columns. Corrected values are added as new columns to preserve initial data sources. The following sections describe necessary steps to the data processing involved herein.

10.1 Initial Load Tares

Loads which are recorded at the beginning and ending of every run, are considered a *Zero Point*. These points represent the condition in which no loads were applied to the rotor (RPM = 0, wind tunnel speed = 0, tilt = 0 deg, pitch = 0 deg). A *Zero Point* is leveraged in removing biases in load recordings. Any offset or load that exists at these points must be removed from all gage voltages. Initial tares are applied using the first zero point, meaning the initial offset is subtracted from all subsequent values. Once the initial tares are performed on the raw voltage data, the data is multiplied by the calibration matrix and converted into engineering units (see Coordinate Systems Section 6). The subsequent tares are performed on the data after it has been converted into engineering units, when it is in the form Fx1_H_u, where "u" signifies that the data is uncorrected (see Coordinate Systems Section 6). After all tares and corrections are applied to the data, it takes the form Fx1_H.

10.2 Drift Tares

As mentioned in the previous section, there are *Zero Points* taken at the beginning and the end of each run. Since hysteretic, thermal, and interference effects may contribute to loading errors linearly in time, the end point offset may be used in defining a linear interpolation function. For each run and load cell, a linear interpolator (derived from the beginning/ending "data" points) is used to subtract each hub load measurement. Note that the points are classified as a "zero point", a "R-Cal point", or a "data point" where the first and last "data point" are referred to as the "wind-off housekeeping points". Thus, the drift tares were derived from linear interpolation between the first and last "wind-off housekeeping points" for each run. The drift corrections are not always drastic reductions. As illustrated by Figure 10.2.1, run 123, the corrected starting / ending load points for load cell 1, in red, reach the expected zero load condition. The unaltered data in black is off slightly at the beginning of the run (not quite zero) and at the end of the run (does not come back to initial loading condition). Depending on the final offset from the "wind-off housekeeping point", interstitial points corrected by the interpolated line will force other point-loads to deviate from the unaltered cases. It is in this case that corrections less than a half pound can be seen.

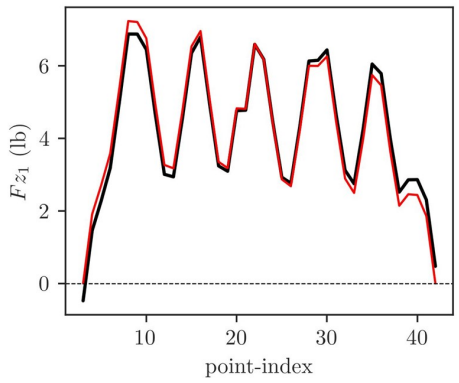


Figure 10.2.1: Demonstration of corrected loading with drift removed shown in red and unaltered load signal shown in black for run 123 load cell 1.

10.3 Aerodynamic Tares

To account for inertial and aerodynamic influences on the rotor hub without blades (due to wind, pitch, and tilt) a series of aerodynamic (aero) tares were applied. Aero tares were taken for each of the three model configurations:

- Concept quadrotor (dz/R = 0.33): aero tare run 154
- Equal height quadrotor (dz/R = 0): aero tare run 145
- Tall quadrotor (dz/R = 0.57): aero tare run 146

The concept, equal height, and tall quadrotor aero tares were applied to these groups of runs (101-135, 155, 156), (136-144, 152, 153), and (147-151) respectively. For each of these configurations, the load relationship for discrete wind, tilt, and pitch inputs were observed, and some non-unique biases existed for some cases (example shown in Figure 10.3.1).

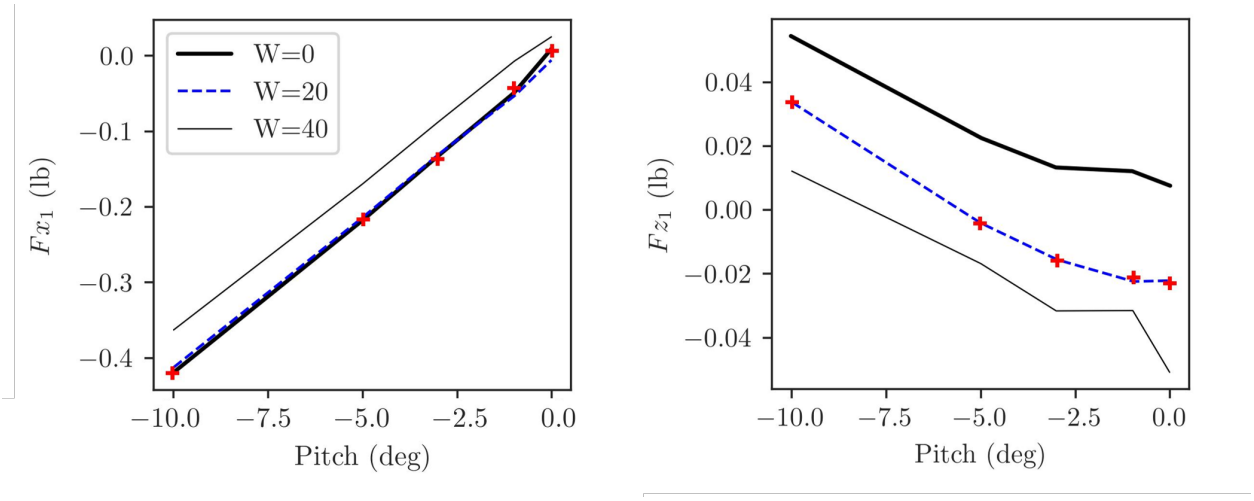


Figure 10.3.1: Concept quadrotor aero tare loads for various wind conditions for load cell 1. Non uniqueness seen by overlap in W=0 and W=20. Model points are shown in red.

Thus, it was necessary to develop multiple independent models that were functions of pitch for:

- VFPS $\approx$ 0, tilt = 0, pitch variable
- VFPS $\approx$ 0, tilt = -3, pitch variable
- VFPS = 20, tilt = 0, pitch variable
- VFPS = 20, tilt = -3, pitch variable
- VFPS = 40, tilt = 0, pitch variable
- VFPS = 40, tilt = -3, pitch variable

for each of the three quadrotor configurations. The three configurations and six wind/tilt configurations amounted to 18 different simple polynomial models.

Relegating the aero tares to simple functions of pitch, accurately predicted linear behavior in F_x and quadratic/cubic behavior in F_z. Despite noisy responses in F_z, each model had exceptionally low residuals and were essential in taking input (wind, tilt, pitch) and correctly returning the aero tare load. Aero tares were only applied to F_x, M_y, and F_z.

10.4 Weight Tares

Since the hub and the blades were not assembled on the model for the aero tares, their weights were not included in the aero tare data correction. However, the weight of all the other components between the load cell and the hub were included in the aero tares since they were assembled on the model. Weight tares were taken during testing; however, it was determined that it would be more accurate to weigh the hubs and blades separately after the test. Equation 9 demonstrates how the weights are applied in the F_x and F_z loading directions commensurately in blade configurations.

$$F_{weight} = \{ \begin{matrix} -S_N \sin(\text{pitch} + \text{tilt}) & (x - \text{direction}, N_{\text{bladed assembly}}) \\ -S_N(-\cos(\text{pitch} + \text{tilt}) + 1) & (z - \text{direction}, N_{\text{bladed assembly}}) \end{matrix} \tag{9}$$

The corresponding magnitude in weight depends on the number of blades, N_b=2, 3,and 6 as shown in Table 10.4.1.

Table 10.4.1: Weight magnitudes for equation 9

s_2	=	0.259 lb
s_3	=	0.354 lb
s_6	=	0.639 lb

Since these components are assembled on top of the load cell prior to taking the *Zero Point*, the weight contribution is removed. A rudimentary check of equation 9 at zero angles of pitch and tilt $\delta_p = \delta_t = 0$ will show that the added F_x and F_z values are zero. The equation corrects for the weight that is removed during the *Zero Point* at nonzero pitch and tilt angles (i.e. at pitch of –10 degrees, the initial load tare from the *Zero Point* still takes out all of the weight from the hub and blades, however the act of pitching the model transfers some of that weight from the z axis into the x axis, thus the equation provided corrects this).

10.5 Summary

Processing the data begins with raw voltages that were tared and then converted (via our calibrated model) into engineering units. This initial set of loads are considered unaltered at this point and denoted as Fx1_H_u; while the finalized loads in the hub frame, Fx1_H, account for drift, aero, and weight tares. The expression for computing the finalized loads is shown in equation 10:

$$F_{final_loads} = F_{initial_values} - F_{drift} - F_{aero_tare} + F_{weight_tare} \tag{10}$$

11 Test Matrix

Table 11.1 is the condensed version of the test matrix detailing the test parameters varied for each rotor configuration. Appendix E provides both a configuration sorted list and a chronological list of every run that was performed, and provides full details on the specific model pitch, RPM, phase, tilt, and rotor/blade numbers used for each run and the respective configuration. Note that some runs contained both forward flight and hover conditions and needed two rows in order to properly call out all of the conditions from the run.

Table 11.1: Test matrix summarizing model configuration and test conditions.

Configuration	**Concept**	**Equal Height**	**Tall**
dz/R	0.33	0	0.57
dynamic pressure [psf]	0, 0.48, 1.90	0, 0.48, 1.90	0, 0.48, 1.90
model pitch [deg]	0, -1, -3, -5, -10	0, -1, -3, -5, -10	0, -1, -3, -5, -10
phase [deg]	0, -30, -60, -90	0, -90	0, -90
number of rotors	1, 2 (SBS), 2 (Tandem), 4	1, 2 (Tandem), 4	1, 2 (Tandem), 4
number of blades	2, 3, 6*	2	2
rotor tilt [deg]	0, -3	0, -3	0
RPM	2000, 2500, 3000	2000, 2500, 3000	2000, 2500, 3000

**Note: 3 and 6 bladed runs in the concept quadrotor configuration were not performed for all listed testing conditions.*

12 Test Timeline

Table 12.1 is a timeline of the events since the condensed test matrix does not necessarily reflect the order in which the runs took place. The order in which the runs were tested was determined by priority, feasibility, and efficiency. For a list of all the runs that were performed in chronological order, see Appendix E.

Table 12.1: Timeline of Events for MTB2.

Date(s)	Description
July 18^{th} 2022	Moved into the 7- by 10-Foot Wind Tunnel
July 18^{th} – August 8^{th}	Built up the model in the tunnel, hooked up instrumentation and cabling, got SDAS working, held safety briefing, updated SOF, performed check loads, safety checks, rap test
August 8^{th}	Initial spinning of rotors, checked data system was recording correctly, verified phase control system function
August 9^{th} – August 18^{th}	Concept quadrotor: isolated, SBS, SBS Hover, Tandem, Tandem Hover, and 4 rotor runs (forward flight and hover)
August 22^{nd} – August 23^{rd}	Equal height quadrotor: 4 rotor hover, weight tare with blades, single rotor runs (rotor 4 and 3), Tandem, Aero and weight tare run (no blades)
August 24^{th} – August 25^{th}	Tall quadrotor: aero and weight tare run (no blades), isolated rotor (rotor 3 and 4), 4 rotor runs, tandem
August 25^{th}	Equal height quadrotor: 4 rotor runs forward flight
August 25^{th} – August 26^{th}	Concept quadrotor: aero and weight tares, Uncertainty and Transients, and airplane mode run. Finished up the short quadrotor configuration testing
August 26^{th} and 31^{st}	Single rotor: at tilt of -90 deg. Took VSTAR Measurements, hand measurements, and disassembled and cleared out of the tunnel

13 Sample Results

During the MTB2 wind tunnel test campaign, isolated rotor, two-rotor, and quadrotor performance data was collected for three primary quadrotor configurations: concept quadrotor, equal height quadrotor, and tall quadrotor. As described in Section 5, data was acquired for a variety of rotor spacing, azimuthal phase angles, and incidence angles at each configuration. Each run provides individual rotor load measurements for a specified configuration for various RPMs, model pitch angles, rotor tilt angles, and wind speeds. This data report is not intended to provide an in-depth analysis of all the test campaign results but to provide a high-level overview of the test campaign and to present sample results. The objective of this section is to present a few ways of plotting and organizing the data to allow for the comparison of different configurations and testing conditions.

The calibration matrix developed at Ames Research Center used to convert the load cell voltages into loads is detailed in section 9.1.2. Additional corrections for drift and aerodynamic and weight tares are described in Section 10. The data tables, detailed in Appendix F, provide the dynamic pressure, density, tunnel temperature, tunnel speed, model pitch, rotor tilt, and individual rotor RPM, as well as the corrected and tared forces and moments for each load cell. Sections 13.1 and 13.2 provide sample results for the concept quadrotor, equal height quadrotor, and tall quadrotor configurations.

13.1 Example Comparison of Differently Phased Rotors for Concept Quadrotor Configuration

Figures 13.1.1 and 13.1.2 show thrust vs RPM for differently phased rotors in the concept quadrotor configuration for Runs 121 and 122. Both runs show varying RPM for a pitch of –5 deg, a tilt angle of –3 deg, and a wind tunnel speed of 20 ft/s. Run 121 has zero phase difference between the rotors and Run 122 has a phase lag of –90 deg on rotors 2 and 3 (compared to rotors 1 and 4). Points for both runs are for wind tunnel speeds of approximately 20 ft/s.

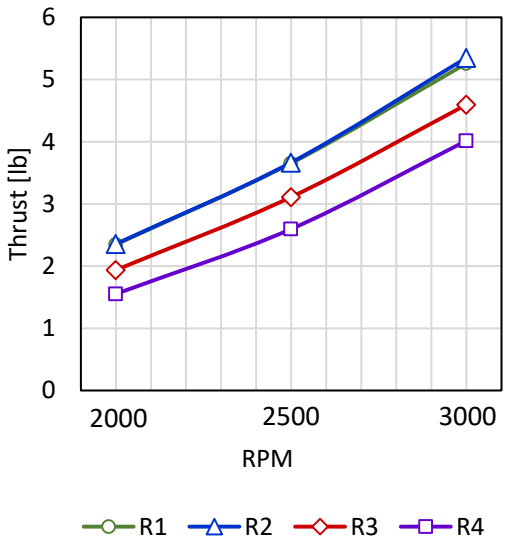


Figure 13.1.1: Concept quadrotor, Run 121. Thrust vs RPM for all rotors, –3 deg tilt, –5 deg pitch, rotor phase of zero, and a 20 ft/s wind tunnel speed.

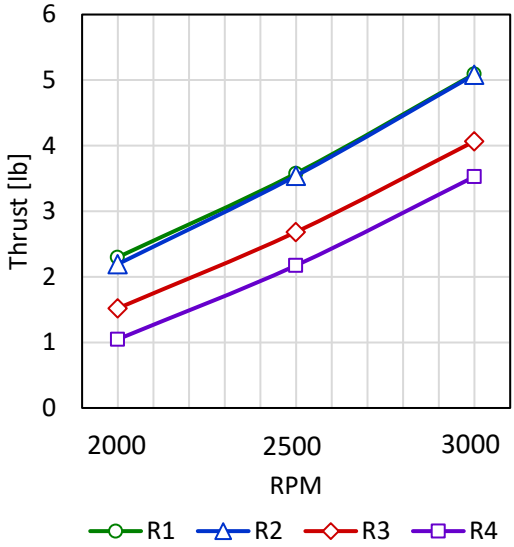


Figure 13.1.2: Concept quadrotor, Run 122. Thrust vs RPM for all rotors, –3 deg tilt, –5 deg pitch, –90 deg phase lag on R2 and R3, and a 20 ft/s wind tunnel speed.

Figures 13.1.1 and 13.1.2 show that the back rotors (3 and 4) have a decrease in thrust measurement when rotors 2 and 3 are subjected to a –90 deg phase lag for this specific testing condition and configuration. The data also includes –90 deg phase lag for other testing conditions and configurations as well as different angles of phase lag. As such, many trends can be investigated to observe how phase affects performance.

13.2 Example Comparison of Front And Back Rotors in the Concept, Equal Height, and Tall Quadrotor Configurations

Runs 121, 152, and 149 contain data at similar testing conditions for the concept quadrotor, equal height quadrotor, and tall quadrotor configurations, respectively. Figures 13.2.1 and 13.2.2 provide thrust vs RPM comparisons of rotor 1 (front starboard) and 3 (back starboard) for each quadrotor configuration. The data shown is for 2000, 2500, and 3000 RPM at a wind tunnel speed of ~~4~~0 ft/s, 0 deg rotor phase, 0 deg rotor tilt, and –5 deg model pitch.

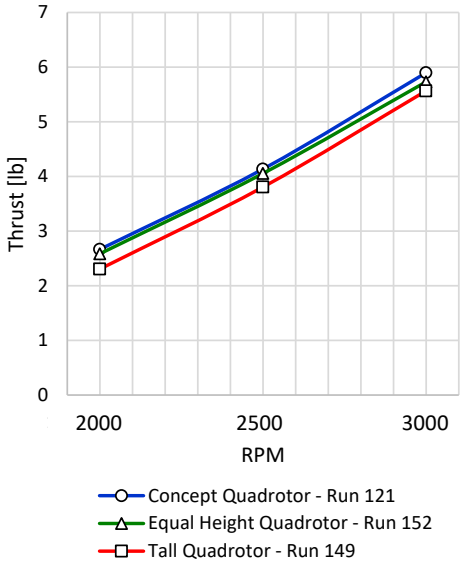


Figure 13.2.1: Thrust vs RPM for R1 in each quadrotor configuration at –5 deg pitch, 0 deg tilt, 0 deg phase, and 40 ft/s wind tunnel speed.

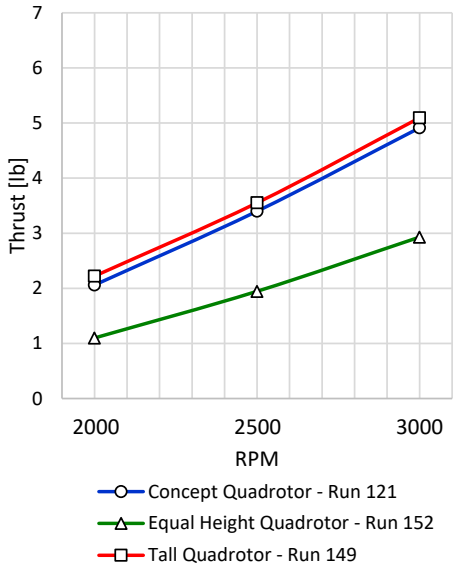


Figure 13.2.2: Thrust vs RPM for R3 in each quadrotor configuration at –5 deg pitch, 0 deg tilt, 0 deg phase, and 40 ft/s wind tunnel speed.

Figure 13.2.1 shows very little change in thrust for rotor 1 for varying RPM in each quadrotor configuration, although there is a slightly lower thrust for the concept quadrotor configuration for rotor speeds of 2000 and 2500 RPM. Figure 13.2.2, however, shows that rotor 3 has a significant decrease in produced thrust when the front and rear rotors are at equal heights. There is a slight increase in thrust for rotor 3 when in the tall configuration compared to the concept configuration.

The figures presented provide examples of rotor load comparisons that can be made for different rotor configurations, rotor tilt, model pitch, wind speed, RPM, and rotor phase conditions. Appendix A provides a list of the different rotor positions for the concept, equal height, and tall quadrotor configurations. Appendix E provides the complete run summary (the detailed test matrix) used in the wind tunnel test campaign. Appendix F contains the tabulated data for each run. For specific, comprehensive data from the test campaign and rotor geometry details, an information request can be sent to the contact(s) listed in this data report. An in-depth analysis of the test results will be published at a later date (Ref. 27).

14 References

1. University of Illinois at Urbana-Champaign Applied Aerodynamics Group, "UIUC Airfoil Data Site," https://m-selig.ae.illinois.edu/ads/coord_database.html, Accessed October 2020.

2. Russell, C., Theodore, C., Jung, J., and Glanser, B., "Wind Tunnel and Hover Performance Test Results for Multicopter UAS Vehicles," NASA/TM–2018–219758, Moffett Field, CA, February 2018.

3. Russell, C. R., Theodore, C. R., and Sekula, M. K., "Incorporating Test Data for Small UAS at the Conceptual Design Level," American Helicopter Society Technical Meeting on Aeromechanics Design for Vertical Lift, San Francisco, CA, January 2018.

4. Staruk, W., Butt, L., Hennig, G., Bonny, E., Gray, C., Represa, D., and Toner, R., "Wind Tunnel Testing and Analysis of a Rigid, Variable Speed Rotor for eVTOL Applications," *Journal of the American Helicopter Society*, Vol. 68, (3), 2023, pp. 32003–32012.

5. Atte, A., Wylie, D., and Rauleder, J., "Experimental Evaluation of Multi-Rotor Aerodynamic Interactions," Vertical Flight Society 78th Annual Forum, Fort Worth, TX, May 2022.

6. Russell, C., and Conley, S., "The Multirotor Test Bed – A New NASA Test Capability for Advanced VTOL Rotorcraft Configurations," Vertical Flight Society 76th Annual Forum & Technology Display, virtual, October 2020.

7. Conley, S., and Russell, C., "Mechanical Design of the Multirotor Test Bed," Vertical Flight Society Aeromechanics for Advanced Vertical Flight Technical Meeting, San Jose, CA, January 2020.

8. Conley, S., "Multirotor Test Bed Load and Stress Analysis," NASA/TM-2023-0000313, Moffett Field, CA, February 2023.

9. Silva, C., and Johnson, W., "Practical Conceptual Design of Quieter Urban VTOL Aircraft," Vertical Flight Society 77th Annual Forum & Technology Display, Virtual, May 2021.

10. Diaz, P. V., and Yoon, S., "Computational Study of NASA's Quadrotor Urban Air Taxi Concept," AIAA SciTech Forum, Orlando, FL, January 2020.

11. Smith, B., and Gandhi, F., "Quadcopter Noise Variation Due to Relative Rotor Phasing," Vertical Flight Society 80th Annual Forum & Technology Display, Montreal, Quebec, Canada, May 2024.

12. Niemiec, R., Gandhi, F., and Kopyt, N., "Relative rotor phasing for multicopter vibratory load minimisation," *The Aeronautical Journal*, Vol. 126, (1298), 2022, pp. 710–729. DOI: 10.1017/aer.2021.94.

13. Hartman, E. P., *Adventures in research : a history of Ames Research Center, 1940-1965*, NASA-SP-4302, NASA Scientific and Technical Information Division, Washington, D.C, 1970.

14. Schatzman, D., "Tunnel Survey and Calibration Report - 7- x 10-ft Wind Tunnel," Technical Report A215-00-R0006, US Army, 2019.

15. Johnson, W., "Technology Drivers in the Development of CAMRAD II," American Helicopter Society Aeromechanics Specialist Meeting, San Francisco, CA, January 1994.

16. Selig, M., *Summary of Low Speed Airfoil Data*, Volume 1, SoarTech Publications, 1995, pp. 19,20,84–87.

17. Sukra Helitek, "AFTGen Final Report," SBIR Final Report 80NSSC18C0206, 2020.

18. Drela, M., "XFOIL: An Analysis and Design System for Low Reynolds Number Airfoils," Low Reynolds Number Aerodynamics, edited by T. J. Mueller, 1989.

19. Nichols, R., and Buning, P. G., "User's Manual for OVERFLOW 2.3," NASA Langley Research Center, August 2010.

20. "OVERFLOW Module for AFTGen Application User Manual," Sukra Helitek, Inc., September 2021.

21. Knowde, "Complēt LCF40-PA6," https://www.knowde.com/stores/plasticomp/products/complet-lcf40-pa6, Accessed October 2024.

22. Asper, M., Sirohi, J., Ricci, M., and Brewer, J., "Electromechanical Modeling and Testing of a Phase-Controlled Stacked Rotor," Vertical Flight Society's 78th Annual Forum & Technology Display, Fort Worth, TX, May 2022.

23. Kroese, D. P., Botev, Z. I., Taimre, T., and Vaisman, R., *Data science and machine learning : mathematical and statistical methods*, Chapman & Hall/CRC machine learning & pattern recognition, CRC Press, Taylor & Francis Group, Boca Raton, 2020.

24. Bishop, C. M., *Pattern recognition and machine learning*, Information science and statistics, Springer Science + Business Media, New York, NY, corrected at 8th printing 2009. edition, 2009 - 2006.

25. Hogg, D. W., Bovy, J., and Lang, D., "Data analysis recipes: Fitting a model to data," *ArXiv e-prints*, August 2010. DOI: 10.48550/arXiv.1008.4686.

26. AIAA Ground Testing Technical Committee, *Recommended Practice: Calibration and Use of Internal Strain-Gage Balances with Application to Wind Tunnel Testing*, AIAA R-091A-2020, American Institute of Aeronautics and Astronautics, April 2020. DOI: 10.2514/4.106019.001.

27. Conley, S., and Russell, C., "Qualitative Analysis of the Multirotor Test Bed Second Wind Tunnel Test Campaign Results," Vertical Flight Society 81st Annual Forum & Technology Display, Virginia Beach, VA, May 2025.

Appendices

Appendix A Rotor Locations

This appendix provides details for each configuration tested in during the MTB2 test campaign in the 7- by 10-Foot Wind Tunnel. Section A.1 provides details on the concept quadrotor configuration, Section A.2 provides details on the equal height quadrotor configuration, and Section A.3 provides details on the tall quadrotor configuration.

The tables provide the coordinates for each rotor for various rotor heights (dz/R), rotor tilt angles, and model pitch angles. The Corrected Tunnel Coordinate System includes the offset of the MTB in the wind tunnel 3/8" closer to the control room (in +y direction) and 5/32" forward (-x direction). The tunnel coordinate system origin is at center of floor in test section. For reference use these conventions: X+ = downstream; Y+ = towards starboard; and Z+ = up.

A.1 Concept Quadrotor

Table A.1.1: Concept quadrotor configuration $dz/R = 0.33$, pitch angle = 0.0.

Tilt	Rotor	x	y	z
0.00	1	-16.60	16.73	57.19
0.00	2	-16.60	-15.98	57.19
0.00	3	16.40	16.73	61.19
0.00	4	16.40	-15.98	61.19
-3.00	1	-16.92	16.73	57.18
-3.00	2	-16.92	-15.98	57.18
-3.00	3	16.08	16.73	61.18
-3.00	4	16.08	-15.98	61.18

Table A.1.2: Concept quadrotor configuration, $dz/R = 0.33$, pitch angle = –5.0.

Tilt	Rotor	x	y	z
0.00	1	-18.17	16.73	55.68
0.00	2	-18.17	-15.98	55.68
0.00	3	14.36	16.73	62.54
0.00	4	14.36	-15.98	62.54
-3.00	1	-18.49	16.73	55.64
-3.00	2	-18.49	-15.98	55.64
-3.00	3	14.03	16.73	62.50
-3.00	4	14.03	-15.98	62.50

Table A.1.3: Concept quadrotor configuration, $dz/R = 0.33$, pitch angle = –10.0.

Tilt	Rotor	x	y	z
0.00	1	-19.60	16.73	54.04
0.00	2	-19.60	-15.98	54.04
0.00	3	12.20	16.73	63.71
0.00	4	12.20	-15.98	63.71
-3.00	1	-19.92	16.73	53.97
-3.00	2	-19.92	-15.98	53.97
-3.00	3	11.88	16.73	63.64
-3.00	4	11.88	-15.98	63.64

A.2 Equal Height Quadrotor

Table A.2.1: Equal height quadrotor configuration $dz/R = 0$, pitch angle = 0.0.

Tilt	Rotor	x	y	z
0.00	1	-16.60	16.73	57.19
0.00	2	-16.60	-15.98	57.19
0.00	3	16.40	16.73	57.19
0.00	4	16.40	-15.98	57.19
-3.00	1	-16.92	16.73	57.18
-3.00	2	-16.92	-15.98	57.18
-3.00	3	16.08	16.73	57.18
-3.00	4	16.08	-15.98	57.18

Table A.2.2: Equal height quadrotor configuration $dz/R = 0$, pitch angle = -5.0.

Tilt	Rotor	x	y	z
0.00	1	-18.17	16.73	55.68
0.00	2	-18.17	-15.98	55.68
0.00	3	14.71	16.73	58.55
0.00	4	14.71	-15.98	58.55
-3.00	1	18.18	16.73	55.64
-3.00	2	18.18	-15.98	55.64
-3.00	3	14.38	16.73	58.52
-3.00	4	14.38	-15.98	58.52

Table A.2.3: Equal height quadrotor configuration, $dz/R = 0$ at pitch angle = −10.0.

Tilt	Rotor	x	y	z
0.00	1	19.29	16.73	54.04
0.00	2	19.29	-15.98	54.04
0.00	3	12.90	16.73	59.77
0.00	4	12.90	-15.98	59.77
-3.00	1	19.61	16.73	53.97
-3.00	2	19.61	-15.98	53.97
-3.00	3	12.57	16.73	59.70
-3.00	4	12.57	-15.98	59.70

A.3 Tall Quadrotor

Table A.3.1: Tall quadrotor configuration $dz/R = 0.57$, pitch angle = 0.0.

Tilt	Rotor	x	y	z
0.00	1	-16.60	16.73	57.19
0.00	2	-16.60	-15.98	57.19
0.00	3	16.40	16.73	64.19
0.00	4	16.40	-15.98	64.19
-3.00	1	-16.92	16.73	57.18
-3.00	2	-16.92	-15.98	57.18
-3.00	3	16.08	16.73	64.18
-3.00	4	16.08	-15.98	64.18

Table A.3.2: Tall quadrotor configuration $dz/R = 0.57$, pitch angle = –5.0.

Tilt	Rotor	x	y	z
0.00	1	-18.17	16.73	55.68
0.00	2	-18.17	-15.98	55.68
0.00	3	14.10	16.73	65.53
0.00	4	14.10	-15.98	65.53
-3.00	1	-18.49	16.73	55.64
-3.00	2	-18.49	-15.98	55.64
-3.00	3	13.77	16.73	65.49
-3.00	4	13.77	-15.98	65.49

Table A.3.3: Tall quadrotor configuration $dz/R = 0.57$, pitch angle = -10.0.

Tilt	Rotor	x	y	z
0.00	1	-19.60	16.73	54.04
0.00	2	-19.60	-15.98	54.04
0.00	3	11.68	16.73	66.66
0.00	4	11.68	-15.98	66.66
-3.00	1	-19.92	16.73	53.97
-3.00	2	-19.92	-15.98	53.97
-3.00	3	11.36	16.73	66.60
-3.00	4	11.36	-15.98	66.60

Appendix B Instrumentation Requirements

This appendix provides details on the instrumentation requirements defined for the wind tunnel test campaign, and was used to set

- DAS Tagname
- Description
- Serial Number
- Zero (digital)
- Dynamic Data [Volts]
- Type
- Engineering Units (EU)
- Sensitivity @ Fixed Excitation (EU/V)
- Fixed Excitation Type
- Excitation Level
- Limit EU
- Gain
- Low-Pass (LP) Filter [Hz]
- Max EU @ 10 V
- R-Cal Ω
- Δ RCal [mV], (+/+) after gain R-Cal Spec
- Conversion Type

The DAS Tagname specified is consistent with the nomenclature described in Section 5.2.

B.1 Model Requirements

Table B.1.1: Model Instrumentation Requirements.

DAS Tag-name	Description	Serial Number	Zero (digital)	Dynamic Data (Volts)	Type	EU	Sensitivity @ Fixed Ex (EU/V)	Fixed Excitation Type	Excitation Level	Limit EU	Gain	Filter LP (Hz)	Max EU @ 10 V	R-Cal Ω	ΔRCal** (mV)	Conversion Type
Yaw	Turntable Yaw					deg	TBD				10					
PI Spare	PI Spare Channel															
LC1_1	Front Starboard Axial Force LC	S/N R100842	X	X	1000Ω Bridge	mV	1000	Voltage	5	34	500	1K	20	174K	3600.962644	matrix
LC1_2	Front Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	34	500	1K	20	174K	3594.841954	matrix
LC1_3	Front Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	30	500	1K	20	174K	3602.399425	matrix
LC1_4	Front Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	86.6	500	1K	20	174K	3593.448276	matrix
LC1_5	Front Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	86.7	500	1K	20	174K	3600.057471	matrix
LC1_6	Front Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	60	500	1K	20	174K	3598.08908	matrix
LC2_1	Front Port Axial Force LC	S/N R100843	X	X	1000Ω Bridge	mV	1000	Voltage	5	34	500	1K	20	174K	3599.698276	matrix
LC2_2	Front Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	34	500	1K	20	174K	3596.637931	matrix
LC2_3	Front Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	30	500	1K	20	174K	3599.899425	matrix
LC2_4	Front Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	86.6	500	1K	20	174K	3593.204023	matrix
LC2_5	Front Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	86.7	500	1K	20	174K	3597.16954	matrix
LC2_6	Front Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	60	500	1K	20	174K	3600.215517	matrix
LC3_1	Aft Starboard Axial Force LC	S/N R100844	X	X	1000Ω Bridge	mV	1000	Voltage	5	34	500	1K	20	174K	3596.364943	matrix
LC3_2	Aft Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	34	500	1K	20	174K	3594.856322	matrix
LC3_3	Aft Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	30	500	1K	20	174K	3599.683908	matrix
LC3_4	Aft Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	86.6	500	1K	20	174K	3593.132184	matrix
LC3_5	Aft Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	86.7	500	1K	20	174K	3595.488506	matrix
LC3_6	Aft Starboard Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	60	500	1K	20	174K	3599.252874	matrix
LC4_1	Aft Port Axial Force LC	S/N R100845	X	X	1000Ω Bridge	mV	1000	Voltage	5	34	500	1K	20	174K	3600.58908	matrix
LC4_2	Aft Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	34	500	1K	20	174K	3593.017241	matrix
LC4_3	Aft Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	30	500	1K	20	174K	3601.494253	matrix
LC4_4	Aft Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	86.6	500	1K	20	174K	3592.974138	matrix
LC4_5	Aft Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	86.7	500	1K	20	174K	3597.744253	matrix
LC4_6	Aft Port Axial Force LC		X	X	1000Ω Bridge	mV	1000	Voltage	5	60	500	1K	20	174K	3598.333333	matrix

Continued on next page

Table B.1.1. Model Instrumentation Requirements continued

DAS Tag-name	Description	Serial Number	Zero (digital)	Dynamic Data (Volts)	Type	EU	Sensitivity @ Fixed Ex (EU/V)	Fixed Excitation Type	Excitation Level	Limit EU	Gain	Filter LP (Hz)	Max EU @ 10 V	R-Cal Ω	ΔRCal** (mV)	Conversion Type
A1_X	Front Starboard LC Accelerometer signal (X)	6058949	X	X	3-axis	g	9.4251	-	-	-	1	1K	50	-	-	polynomial
A1_Y	Front Starboard LC Accelerometer signal (Y)		X	X	3-axis	g	9.4787	-	-	-	1	1K	50	-	-	polynomial
A1_Z	Front Starboard LC Accelerometer signal (Z)		X	X	3-axis	g	9.2507	-	-	-	1	1K	50	-	-	polynomial
A2_X	Front Port LC Accelerometer signal (X)	6058950	X	X	3-axis	g	8.9206	-	-	-	1	1K	50	-	-	polynomial
A2_Y	Front Port LC Accelerometer signal (Y)		X	X	3-axis	g	9.3809	-	-	-	1	1K	50	-	-	polynomial
A2_Z	Front Port LC Accelerometer signal (Z)		X	X	3-axis	g	8.9686	-	-	-	1	1K	50	-	-	polynomial
A3_X	Aft Starboard LC Accelerometer signal (X)	6058951	X	X	3-axis	g	9.4877	-	-	-	1	1K	50	-	-	polynomial
A3_Y	Aft Starboard LC Accelerometer signal (Y)		X	X	3-axis	g	9.3633	-	-	-	1	1K	50	-	-	polynomial
A3_Z	Aft Starboard LC Accelerometer signal (Z)		X	X	3-axis	g	9.1324	-	-	-	1	1K	50	-	-	polynomial
A4_X	Aft Port Axial LC Accelerometer signal (X)	6056159	X	X	3-axis	g	9.0334	-	-	-	1	1K	50	-	-	polynomial
A4_Y	Aft Port Axial LC Accelerometer signal (Y)		X	X	3-axis	g	9.4251	-	-	-	1	1K	50	-	-	polynomial
A4_Z	Aft Port Axial LC Accelerometer signal (Z)		X	X	3-axis	g	9.0334	-	-	-	1	1K	50	-	-	polynomial
R1_1P	1/rev timing signal Rotor #1		X	X	encoder	on/off	1	-	-		1	WB	10	-	-	polynomial
R2_1P	1/rev timing signal Rotor #2		X	X	encoder	on/off	1	-	-		1	WB	10	-	-	polynomial
R3_1P	1/rev timing signal Rotor #3		X	X	encoder	on/off	1	-	-		1	WB	10	-	-	polynomial
R4_1P	1/rev timing signal Rotor #4		X	X	encoder	on/off	1	-	-		1	WB	10	-	-	polynomial

*Note: ** indicates (+/+) after gain RCalSpec*

B.2 Tunnel Conditions

Table B.2.1: Tunnel Condition Requirements.

DAS Tagname	Description	Serial Number	Zero (digital)	Dynamic Data (Volts)	Type	EU	Sensitivity @ Fixed Ex (EU/V)	Fixed Excitation Type	Excitation Level	Limit U	Gain	Filter LP (Hz)	Max EU @ 10 V	R-Cal Ω	ΔRCal** (mV)	Conversion Type
TTF	Tunnel total temperature				Tunnel Conditions	deg F	-	-	-	-	-	-	-	-	-	-
BARO	Barometric pressure				Tunnel Conditions	psia	-	-	-	-	-	-	-	-	-	-
PR-PS	Differential pressure from settling chamber to atmospheric		X		Tunnel Conditions	psf	-	-	-	-	-	-	-	-	-	-
PR-PA	Differential pressure across contraction		X		Tunnel Conditions	psf	-	-	-	-	-	-	-	-	-	-
DPT	Dew point temperature from humidity meter				Tunnel Conditions	deg F	-	-	-	-	-	-	-	-	-	-
UDP Spare	UDP Spare Channel															

*Note: ** indicates (+/+) after gain RCalSpec*

B.3 vis RS-232

Table B.3.1: Requirements via RS_232.

DAS Tagname	Description	Serial Number	Zero (digital)	Dynamic Data (Volts)	Type	EU	Sensitivity @ Fixed Ex (EU/V)	Fixed Excitation Type	Excitation Level	Limit EU	Gain	Filter LP (Hz)	Max EU @ 10 V	R-Cal Ω	ΔRCal** (mV)	Conversion Type
Bus Temp 1	Power Bus temperature 1					deg C										
Bus Temp 2	Power Bus temperature 2					deg C										
LC1_Temp	LC 1 Temperature					deg C										
LC2_Temp	LC 2 Temperature					deg C										
LC3_Temp	LC 3 Temperature					deg C										
LC4_Temp	LC 4 Temperature					deg C										
Pitch	deg	S/N 21080072	-	-	Inclinometer	deg	0.01196172	Voltage	24V @ 28mA	30	-	-	-	-	-	-
Tilt_Comm	deg					deg										
Tilt_Input	deg					deg										
Bus Voltage	Volts					Volts										
Bus Current	Amps					Amps										
R1_RPM	UL					UL										
R2_RPM	UL					UL										
R3_RPM	UL					UL										
R4_RPM	UL					UL										
R1_Phase	deg					deg										
R2_Phase	deg					deg										
R3_Phase	deg					deg										
R4_Phase	deg					deg										

*Note: ** indicates (+/+) after gain RCalSpec*

Appendix C Conversion Matrices

The matrices provided in C.1 through C.4 contain the coefficients used in matrix conversions necessary to transform the test data from voltages into engineering units.

Table C.1: Load Cell 1 (R100842) matrix $\hat{w}$ elements expressed in units $[V]^{-1}$.

-7.60	12.72	33.57	-25.89	21.22	-4.97
17.74	-38.19	3.25	28.39	18.31	14.96
-2.57	-4.58	32.66	-11.46	-28.43	-2.49
19.91	34.05	0.52	-27.38	16.92	15.92
3.00	0.44	32.54	30.26	3.16	-1.26
-34.97	2.15	0.57	-0.48	-30.22	14.01

Table C.2: Load Cell 2 (R100843) matrix $\hat{w}$ elements expressed in units $[V]^{-1}$.

-0.15	-0.75	-16.69	-7.04	13.31	0.17
9.39	-19.27	-0.29	14.73	7.21	7.46
-1.45	-3.18	-16.76	-5.41	-14.82	-1.36
10.56	19.30	-0.49	-14.70	8.26	7.90
0.13	0.55	-16.59	15.16	-0.13	0.00
-19.54	1.03	0.00	-0.93	-15.21	7.42

Table C.3: Load Cell 3 (R100844) matrix $\hat{w}$ elements expressed in units $[V]^{-1}$.

-0.42	0.36	16.36	-8.20	12.39	-0.17
9.67	-18.75	0.00	13.18	8.58	7.11
0.16	-0.33	16.44	-7.34	-13.57	-0.12
8.97	17.24	0.15	-13.59	5.58	8.06
1.04	0.32	16.45	14.86	0.68	-0.45
-18.80	1.08	-0.07	0.53	-14.35	7.48

Table C.4: Load Cell 4 (R100844) matrix $\hat{w}$ elements expressed in units $[V]^{-1}$.

-2.52	4.33	-16.34	-11.24	11.35	-1.85
9.97	-19.19	-0.66	14.87	9.24	7.95
-3.27	-6.42	-16.79	-3.55	-15.74	-2.76
9.97	19.17	-1.04	-14.73	6.21	7.69
3.20	0.00	-16.49	15.33	2.40	-1.15
-18.46	1.18	-0.74	-1.20	-14.45	7.75

Appendix D Additional Load Cell Check Loads Overview

D.1 Check Loads at the Surface of the Load Cells

Check load for rolling moment M_x at the load cells

To test the M_x reading at the load cell, the same wide bar was used, as in the previous section. A zip tie was looped through both holes at one end of the bar and connected to the wire cable from which the small weight pan was hung. The moment arm was the same as before, 3.5 in from the center of the load cell to the centerline of the holes through which the zip tie was connected. The resulting moment was created by hanging weights off the weight pan from that moment arm. The wide bar was lined up with the moment arm parallel to the y-axis. The weight pan was loaded up to 10 lb with an increment of 2 lb, and then loaded up to 15 lb with an increment of 5 lb. The weight increments were then reversed for unloading. Also, prior to testing, the same type of zip tie was tested for up to 25 lb to ensure no failure could happen due to using the zip tie. Still, a blanket was placed underneath the weight pans to protect the test section floor in the case of a zip tie failure. Figure D.1.1 shows the setup for the M_x check loads at the load cells with a moment arm of 3.5 in along the +Y axis direction with the weigh pan hanging at the end of the moment arm creating a negative roll moment.

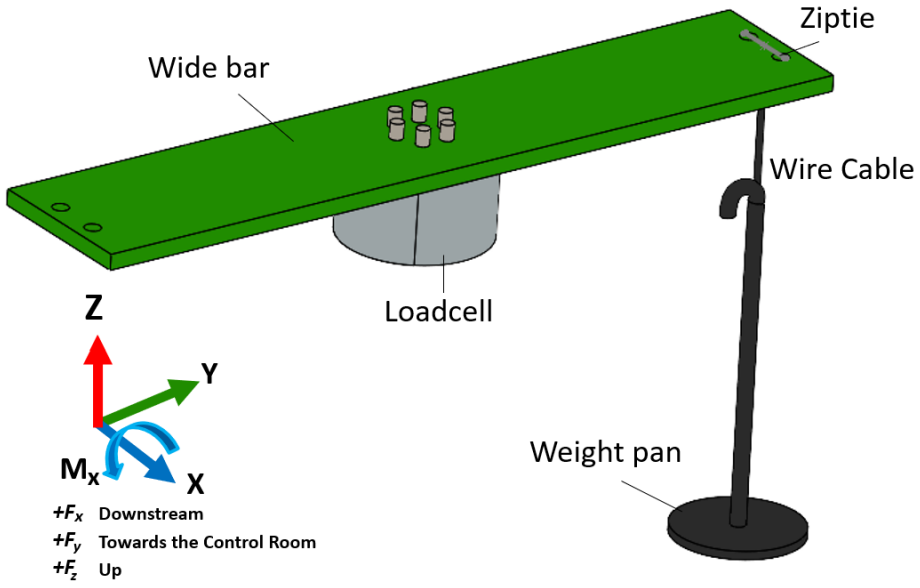


Figure D.1.1: The M_x check loads at the load cell with the moment arm at +Y direction creating negative roll moment in the Balance Coordinate System.

Check load for Pitching moment (M_y) at the load cells

To measure the M_y at the load cell, the same method that was described in the previous section for measuring the rolling moment could be used if the moment arm was aligned with the X-axis instead of the Y-axis. Another method for performing the M_y check loads is described below. In this case, the calibration cylinder was used as the moment arm in the +Z direction and the wire cable was pulled in the +X direction to create the positive pitching moment. The wire cable was connected around the calibration cylinder hoop via a zip tie, and after passing over the pulley, the weight pans were connected at the other end of the wire cable, Figure D.1.2 and Figure D.1.3. The moment arm starts from the top of the load cell to the hoop where the wire cable was connected and measured as 2.5 inches The weight pan got loaded up to 20 lb with increments of 5 lb, then offloaded while data was collected between increments.

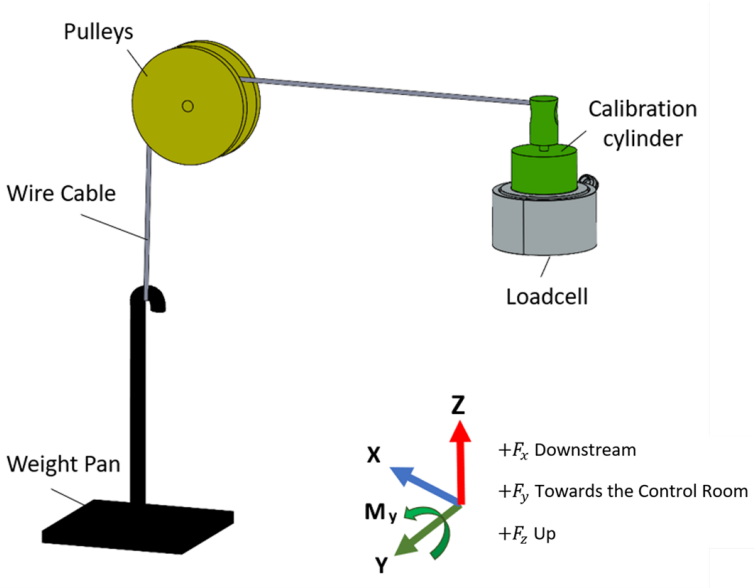


Figure D.1.2: The setup for check load of M_y at the load cell with the moment arm at +Z direction creating positive pitch moment in the Balance Coordinate System.

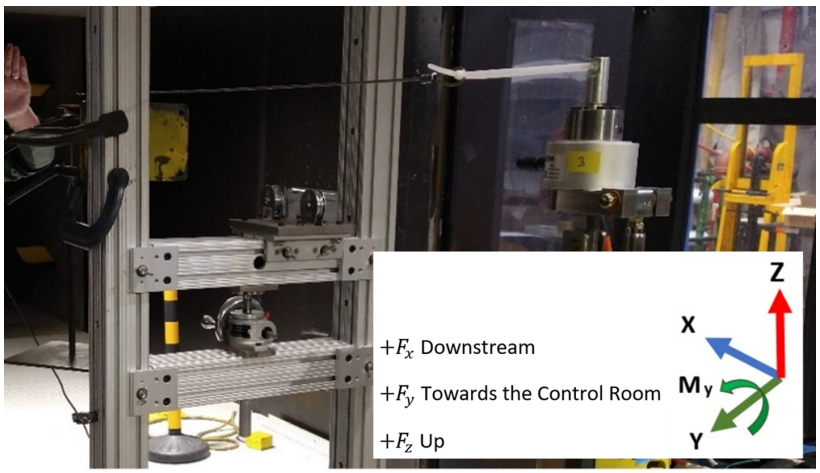


Figure D.1.3: The M_y check loads at rotor 3's load cell with the moment arm of 2.5 in at +Z direction, created positive pitch moment in the Balance Coordinate System.

D.1.1 Check Loads on the Hubs

Check load for F_x and F_y at the Hub

For check loads of F_x, and F_y at the hub, first, the motor was secured on top of the load cell, then a rotor hub without the blades connected to the motor. One end of the wire cable connected to the rotor's hub passed through the pulley and was attached to the weight pan. Note that having a motor on top of the load cell will act as a moment arm; therefore, while checking the loads at F_x, and F_y at the hub, the moments of M_y and M_x can be measured as well. Figure D.1.4 and Figure D.1.5 show the setup of the check loads at the hub for the F_x. For these check loads, the motor acted as a 2.8-in moment arm measured from the top of the load cell to the center of the hub where the wire cable was connected. These setups generate a negative F_x and positive M_y moment at the hub. The weights were increased by increments of 5 lb to a total of 20 lb while data was acquired.

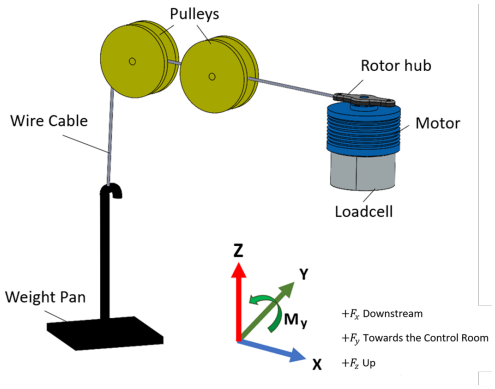


Figure D.1.4: The setup diagram for check loads of F_x and F_y at the hub in the Hub Coordinate System.

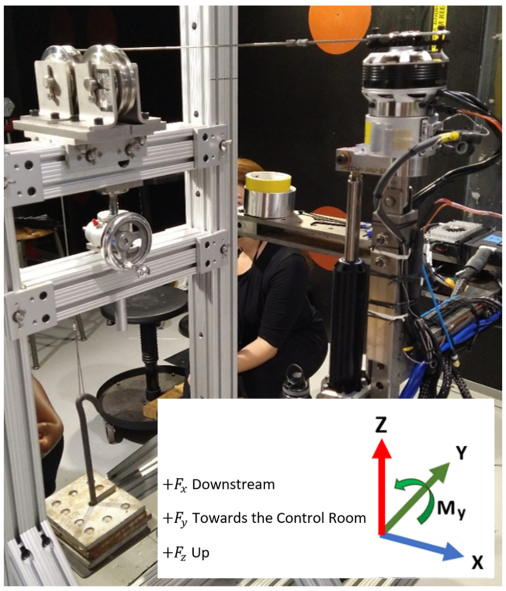


Figure D.1.5: The setup of check load for F_x at hub number 2 (Hub Coordinate System) in the 7- by 10-Foot Wind Tunnel's test section.

Check load for M_x and M_y at the Hub

For check loads of M_x and M_y at the hub, the narrow bar was secured to the motor, and a small weight pan was hung on the wire cable secured to the zip tie at one end of the narrow bar, Figure D.1.6. The narrow bar acted as a 5.65 in moment arm during the M_x and M_y check loads. When measuring the M_x, the bar was adjusted parallel to the Y axis, and when measuring M_y, the bar was adjusted parallel to the X-axis.

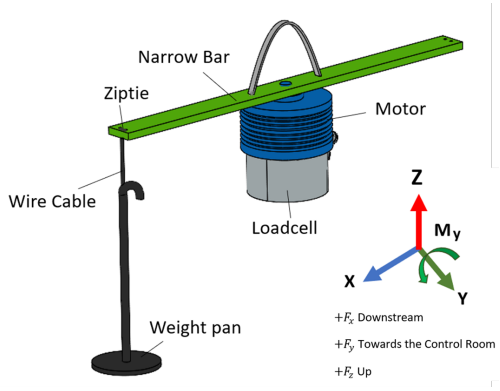


Figure D.1.6: The setup diagram for M_y check loads at the hub, creating a positive pitch moment in the Hub Coordinate System.

Note that setting the bar on pure X or Y axes required more patience since the top of the motor could rotate. Before any data points were taken, the position of the narrow bar and the stationary position of the weight pan were confirmed to minimize human error. M_x and M_y were loaded up to 8 lb in increments of 2 lb. Figure D.1.7 shows the setup for M_y check loads at hub number 4 with a moment arm of 5.65 in at +X direction, creating a positive pitch moment.

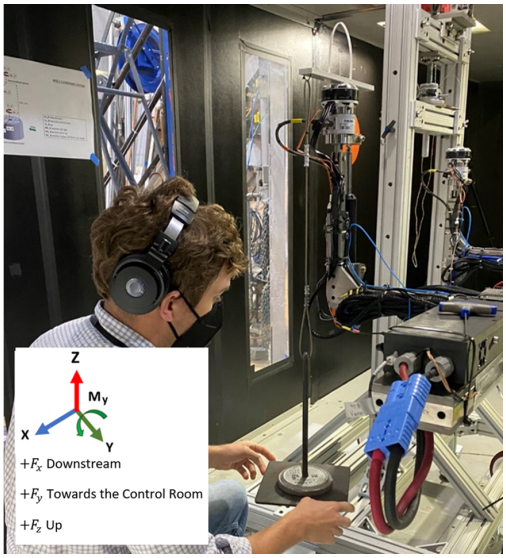


Figure D.1.7: A setup image of the M_y check loads at hub number 4, with the moment arm of 5.65 in in X direction, created a positive pitch moment in the Hub Coordinate System.

Appendix E Test Matrix

This appendix provides a list of all of the runs that were performed during this test campaign. The first table, F1, lists all of the runs sorted by configuration. The second table, F2, provides a chronological list of the runs performed.

Table E.1: MTB2 test matrix sorted by configuration.

Run	Quadrotor Configuration	Description	dz/R	q	Model Pitch	RPM	Phase	# rotors	Rotors	Tilt	# blades
154	Concept	Aero & Weight Tare	0.327	0, 0.48, 1.90	0, -1, -3, -5, -10	0	none	0	0	0, -3	0
101, 102, 103, 104	Concept	Single Rotor	0.327	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R1, R2, R3, R4	0, -3	2
106, 107, 108, 109, 112	Concept	SBS	0.327	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0, -30, -60, -90	2	R1, R2	0, -3	2
105	Concept	SBS Hover	0.327	0	0	2000, 2500, 3000	0, -30, -60, -90	2	R1, R2	0	2
107, 111	Concept	SBS Hover	0.327	0	0	3000 to 200 (Δ200)	0, -90	2	R1, R2	0	2
113, 116, 117, 119	Concept	Tandem	0.327	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0, -30, -60, -90	2	R1, R3	0, -3	2
120	Concept	Tandem Hover	0.327	0	0	3000 to 200 (Δ200)	0, -90	2	R1, R3	0	2
121, 122, 123, 124, 125, 125, 127	Concept	-	0.327	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0, -30, -60, -90	4	all	0, -3	2
128	Concept	-	0.327	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500	0	4	all	0, -3	3
129, 130	Concept	-	0.327	0.48, 1.90	0, -1, -3	2000, 2500	-30, -60	4	all	0	3
132	Concept	-	0.327	0.48	0, -1, -3, -5, -10	1500, 2000	0	4	all	0, -3	6
135	Concept	-	0.327	1.9	0, -1, -3, -5, -10	1500	0	4	all	0, -3	6
134	Concept	-	0.327	0.48	0, -1, -3	1500, 2000	-30	4	all	0, -3	6
122, 124	Concept	Hover	0.327	0	0	3000 to 200 (Δ200)	0, -90	4	all	0, -3	2
155	Concept	Uncertainty	0.327	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R4 on R1	0	2
155	Concept	Uncertainty & transient	0.327	0.48, 1.90	0, -1, -3, -5, -10	2000-3000, 3000-2000	none	1	R4 on R1	0	2
156	Concept	Total -90 deg, upside-down rotor	0.327	1.9	-11.3	500-3000	none	1	R1	-78.7	2
137	Equal Height	Weight Tare	0	0	0, -1, -3, -5, -10	0	0	4	all	0, -3	2
145	Equal Height	Aero & Weight Tare	0	0, 0.48, 1.90	0, -1, -3, -5, -10	0	none	0	0	0, -3	0
140, 141	Equal Height	-	0	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R3, R4	0, -3	2
143, 144	Equal Height	Tandem	0	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0, -90	2	R1, R3	0, -3	2
152, 153	Equal Height	-	0	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0, -90	4	all	0	2
136	Equal Height	Hover	0	0	0	3000 to 200 (Δ200)	0, -90	4	all	0	2
146	Tall	Aero & Weight Tare	0.571	0, 0.48, 1.90	0, -1, -3, -5, -10	0	none	0	0	0	0
147, 148	Tall	-	0.571	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R3, R4	0	2
151	Tall	Tandem	0.571	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0, -90	2	R1, R3	0	2
149, 150	Tall	-	0.571	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0, -90	4	all	0	2

Table E.2: MTB2 test matrix sorted chronologically.

Run	q	Model Pitch	RPM	Phase	# rotors	Rotors	Tilt	Quadrotor Configuration	dz/R	Description	Blades
101	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R2	0, -3	Concept	0.327		2
102	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R1	0, -3	Concept	0.327		2
103	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R3	0, -3	Concept	0.327		2
104	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R4	0, -3	Concept	0.327		2
105	0	0	2000, 2500, 3000	0, -30, -60, -90	2	R1, R2	0	Concept	0.327	SBS Hover	2
106	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0	2	R1, R2	0, -3	Concept	0.327	SBS	2
107	0.48	0, -1, -3, -5, -10	2000, 2500, 3000	-90	2	R1, R2	0, -3	Concept	0.327	SBS	2
107	0	0	3000 to 200 (Δ200)	-90	2	R1, R2	0	Concept	0.327	SBS Hover	2
108	1.9	0, -1, -3, -5, -10	2000, 2500, 3000	-90	2	R1, R2	0, -3	Concept	0.327	SBS	2
109	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	-30	2	R1, R2	0, -3	Concept	0.327	SBS	2
111	0	0	3000 to 200 (Δ200)	0	2	R1, R2	0	Concept	0.327	SBS Hover	2
112	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	-60	2	R1, R2	0, -3	Concept	0.327	SBS	2
113	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0	2	R1, R3	0, -3	Concept	0.327	Tandem	2
116	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	-90	2	R1, R3	0, -3	Concept	0.327	Tandem	2
117	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	-30	2	R1, R3	0, -3	Concept	0.327	Tandem	2
119	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	-60	2	R1, R3	0, -3	Concept	0.327	Tandem	2
120	0	0	3000 to 200 (Δ200)	0, -90	2	R1, R3	0	Concept	0.327	Tandem Hover	2
121	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0	4	all	0, -3	Concept	0.327		2
122	0.48	0, -1, -3, -5, -10	2000, 2500, 3000	-90	4	all	0, -3	Concept	0.327		2
122	0	0	3000 to 200 (Δ200)	-90	4	all	0, -3	Concept	0.327	Hover	2
123	1.9	0, -1, -3, -5, -10	2000, 2500, 3000	-90	4	all	0, -3	Concept	0.327		2
124	0.48	0, -1, -3, -5, -10	2000, 2500, 3000	-30	4	all	0, -3	Concept	0.327		2
124	0	0	3000 to 200 (Δ200)	0	4	all	0, -3	Concept	0.327	Hover	2
125	1.9	0, -1, -3, -5, -10	2000, 2500, 3000	-30	4	all	0, -3	Concept	0.327		2
126	0.48	0, -1, -3, -5, -10	2000, 2500, 3000	-60	4	all	0, -3	Concept	0.327		2
127	1.9	0, -1, -3, -5, -10	2000, 2500, 3000	-60	4	all	0, -3	Concept	0.327		2
128	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500	0	4	all	0, -3	Concept	0.327		3
129	0.48, 1.90	0, -1, -3	2000, 2500	-60	4	all	0	Concept	0.327		3
130	0.48, 1.90	0, -1, -3	2000, 2500	-30	4	all	0	Concept	0.327		3
132	0.48	0, -1, -3, -5, -10	1500, 2000	0	4	all	0, -3	Concept	0.327		6
134	0.48	0, -1, -3	1500, 2000	-30	4	all	0, -3	Concept	0.327		6
135	1.9	0, -1, -3, -5, -10	1500	0	4	all	0, -3	Concept	0.327		6
136	0	0	3000 to 200 (Δ200)	0, -90	4	all	0	Equal Height	0	Hover	2
137	0	0, -1, -3, -5, -10	0	0	4	all	0, -3	Equal Height	0	Weight Tare	2

Continued on next page

Table E.2: MTB2 test matrix sorted chronologically.

Run	q	Model Pitch	RPM	Phase	# rotors	Rotors	Tilt	Quadrotor Configuration	dz/R	Description	Blades
140	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R4	0, -3	Equal Height	0		2
141	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R3	0, -3	Equal Height	0		2
143	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0	2	R1, R3	0, -3	Equal Height	0	Tandem	2
144	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	-90	2	R1, R3	0, -3	Equal Height	0	Tandem	2
145	0, 0.48, 1.90	0, -1, -3, -5, -10	0	none	0	0	0, -3	Equal Height	0	Aero & Weight Tare	0
146	0, 0.48, 1.90	0, -1, -3, -5, -10	0	none	0	0	0	Tall	0.571	Aero & Weight Tare	0
147	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R3	0	Tall	0.571		2
148	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R4	0	Tall	0.571		2
149	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0	4	all	0	Tall	0.571		2
150	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	-90	4	all	0	Tall	0.571		2
151	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0, -90	2	R1, R3	0	Tall	0.571	Tandem	2
152	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	0	4	all	0	Equal Height	0		2
153	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	-90	4	all	0	Equal Height	0		2
154	0, 0.48, 1.90	0, -1, -3, -5, -10	0	none	0	0	0, -3	Concept	0.327	Aero & Weight Tare	0
155	0.48, 1.90	0, -1, -3, -5, -10	2000, 2500, 3000	none	1	R4 on R1	0	Concept	0.327	Uncertainty	2
155	0.48, 1.90	0, -1, -3, -5, -10	2000-3000, 3000-2000	none	1	R4 on R1	0	Concept	0.327	Uncertainty & transient	2
156	1.9	-11.3	500-3000	none	1	R1	-78.7	Concept	0.327	Total -90 deg, upside-down rotor	2

Appendix F Rotor Loads Data

The following sections provide the loads and testing conditions by point for each run in the MTB2 wind tunnel test campaign. Some data points have not been included in the data tables because they were:

- a housekeeping, R-Cal, or zero point
- redundant
- erroneous
- not on condition (i.e., not at an accurate pitch or tunnel speed condition)

The operational settings tables that precede the data tables provide a summary of the conditions tested and the total number of points (including the points omitted for the one or more of the above reasons).

Run 101: Concept Quadrotor, Isolated Rotor

Table F.1: Run 101 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R2
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	none

Table F.2: Testing conditions and rotor 2 loads in the hub coordinate system for run 101.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.013	0.000	0.004	0.000	-0.014	0.000	0.0	0.000	0.00226	0.0	0.0	0	-	82.9
4	-0.182	-0.099	0.060	0.363	0.196	0.884	1.2	0.002	0.00226	0.0	0.0	999	-	82.9
5	-0.198	-0.096	1.728	0.961	0.001	2.722	2.8	0.009	0.00226	0.0	0.0	1999	-	83.0
6	-0.207	0.061	2.299	1.715	6.767	2.471	20.7	0.486	0.00226	0.0	0.0	1999	-	83.7
7	-0.159	0.074	3.563	1.563	9.597	3.659	20.7	0.486	0.00226	0.0	0.0	2499	-	83.8
8	-0.115	0.088	5.177	0.848	12.159	5.127	20.4	0.470	0.00226	0.0	0.0	2999	-	83.8
9	-0.058	0.126	5.091	0.995	11.503	5.225	20.7	0.484	0.00226	0.0	-3.0	2999	-	83.9
10	-0.152	0.124	3.538	1.744	8.856	3.726	20.7	0.486	0.00226	0.0	-3.0	2500	-	84.0
11	-0.273	0.116	2.240	1.992	6.184	2.549	20.6	0.478	0.00226	0.0	-3.0	1999	-	84.5
12	-0.267	0.114	2.300	2.019	6.073	2.557	20.8	0.486	0.00226	-1.0	-3.0	1999	-	84.7
13	-0.220	0.108	3.526	1.796	8.642	3.798	20.7	0.484	0.00226	-1.0	-3.0	2499	-	84.8
14	-0.108	0.114	5.087	1.005	11.240	5.300	20.6	0.478	0.00226	-1.0	-3.0	2999	-	84.9
15	-0.119	0.059	5.144	1.119	11.979	5.173	20.7	0.481	0.00225	-1.0	0.0	3000	-	84.9
16	-0.181	0.064	3.558	1.733	9.426	3.703	20.9	0.491	0.00225	-1.0	0.0	2500	-	84.9
17	-0.307	0.057	2.385	1.889	6.586	2.530	20.5	0.474	0.00225	-1.0	0.0	2000	-	85.1
18	-0.313	0.048	2.342	2.014	6.236	2.566	20.6	0.478	0.00225	-3.0	0.0	2000	-	85.4
19	-0.262	0.056	3.619	1.787	8.847	3.765	20.7	0.481	0.00225	-3.0	0.0	2499	-	85.4
20	-0.182	0.062	5.204	1.047	11.411	5.266	20.5	0.473	0.00225	-3.0	0.0	2999	-	85.4
21	-0.085	0.096	5.026	0.975	10.775	5.377	20.4	0.468	0.00225	-3.0	-3.0	2999	-	85.3
22	-0.167	0.080	3.464	1.724	8.197	3.848	20.4	0.467	0.00225	-3.0	-3.0	2500	-	85.4
23	-0.230	0.068	2.180	1.966	5.715	2.608	20.5	0.472	0.00225	-3.0	-3.0	1999	-	85.4
24	-0.257	0.062	2.170	1.968	5.496	2.659	20.9	0.492	0.00225	-5.0	-3.0	1999	-	85.4
25	-0.204	0.075	3.468	1.730	7.938	3.911	20.9	0.492	0.00225	-5.0	-3.0	2499	-	85.5
26	-0.109	0.089	5.001	1.059	10.472	5.445	20.9	0.489	0.00225	-5.0	-3.0	2999	-	85.5
27	-0.134	0.039	5.132	0.995	11.010	5.337	20.6	0.479	0.00225	-5.0	0.0	2999	-	85.6
28	-0.248	0.026	3.590	1.763	8.328	3.824	20.5	0.472	0.00225	-5.0	0.0	2500	-	85.7
29	-0.300	0.019	2.308	2.015	5.866	2.584	20.5	0.472	0.00225	-5.0	0.0	1999	-	85.7
30	-0.226	0.002	2.090	1.991	5.161	2.710	20.8	0.489	0.00225	-10.0	0.0	2000	-	85.7
31	-0.164	0.010	3.355	1.755	7.485	3.979	20.9	0.492	0.00225	-10.0	0.0	2499	-	85.7
32	-0.073	0.020	4.894	1.131	9.966	5.518	20.9	0.494	0.00225	-10.0	0.0	2999	-	85.8
33	-0.111	0.066	4.820	1.213	9.235	5.548	20.9	0.490	0.00225	-10.0	-3.0	2999	-	85.9
34	-0.184	0.058	3.288	1.831	6.811	4.001	21.0	0.496	0.00225	-10.0	-3.0	2500	-	85.9

Continued on next page

Table F.2: Testing conditions and rotor 2 loads in the hub coordinate system for run 101.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
35	-0.233	0.048	2.007	1.944	4.641	2.717	20.9	0.493	0.00225	-10.0	-3.0	1999	-	85.9
36	-0.158	0.095	2.030	4.386	5.535	2.785	41.0	1.893	0.00225	-10.0	-3.0	2000	-	86.3
37	-0.094	0.111	3.405	4.408	8.450	4.044	41.2	1.903	0.00225	-10.0	-3.0	2499	-	86.4
38	0.047	0.131	5.077	3.774	12.035	5.566	41.2	1.905	0.00225	-10.0	-3.0	2999	-	86.5
39	0.095	0.090	5.382	3.726	13.248	5.478	41.1	1.899	0.00225	-10.0	0.0	2999	-	86.6
40	-0.006	0.067	3.684	4.532	9.467	3.966	41.0	1.888	0.00225	-10.0	0.0	2499	-	86.7
41	-0.088	0.056	2.181	4.613	6.104	2.726	41.0	1.885	0.00225	-10.0	0.0	1999	-	86.8
42	-0.105	0.084	2.597	4.900	7.453	2.598	41.0	1.884	0.00224	-5.0	0.0	1999	-	87.1
43	-0.004	0.116	4.097	4.659	10.908	3.740	41.2	1.900	0.00224	-5.0	0.0	2499	-	87.2
44	0.164	0.141	5.843	3.694	15.211	5.130	41.3	1.914	0.00224	-5.0	0.0	3000	-	87.2
45	0.166	0.142	5.555	3.514	14.033	5.323	41.2	1.902	0.00224	-5.0	-3.0	3000	-	87.2
46	0.048	0.132	3.839	4.630	9.886	3.828	41.1	1.894	0.00224	-5.0	-3.0	2500	-	87.2
47	-0.051	0.112	2.372	4.821	6.670	2.627	41.1	1.890	0.00224	-5.0	-3.0	2000	-	87.2
48	-0.078	0.119	2.511	4.919	7.084	2.584	41.0	1.889	0.00224	-3.0	-3.0	1999	-	87.4
49	0.030	0.153	4.015	4.711	10.694	3.732	41.1	1.891	0.00224	-3.0	-3.0	2499	-	87.4
50	0.176	0.181	5.744	3.554	14.949	5.162	41.2	1.898	0.00224	-3.0	-3.0	2999	-	87.5
51	0.220	0.120	5.946	3.477	15.981	5.077	41.0	1.887	0.00224	-3.0	0.0	3000	-	87.6
52	0.075	0.078	4.241	4.547	11.488	3.710	41.1	1.890	0.00224	-3.0	0.0	2500	-	87.7
53	-0.036	0.058	2.709	4.981	7.501	2.564	41.1	1.891	0.00224	-3.0	0.0	1999	-	87.7
54	-0.056	0.063	2.934	5.017	7.754	2.487	41.0	1.887	0.00224	-1.0	0.0	2000	-	87.8
55	0.061	0.085	4.447	4.446	12.005	3.648	41.1	1.892	0.00224	-1.0	0.0	2499	-	87.9
56	0.238	0.112	6.168	2.752	16.921	5.042	40.9	1.877	0.00224	-1.0	0.0	3000	-	87.9
57	0.231	0.171	5.864	3.460	15.536	5.037	41.0	1.887	0.00224	-1.0	-3.0	2999	-	87.9
58	0.089	0.132	4.183	4.577	11.350	3.667	41.2	1.900	0.00224	-1.0	-3.0	2500	-	88.1
59	-0.026	0.105	2.651	4.922	7.531	2.531	41.1	1.895	0.00224	-1.0	-3.0	2000	-	88.0
60	-0.040	0.106	2.733	4.982	7.501	2.520	41.0	1.885	0.00224	-0.0	-3.0	2000	-	88.1
61	0.065	0.132	4.258	4.656	11.522	3.669	41.2	1.897	0.00224	-0.0	-3.0	2499	-	88.1
62	0.232	0.181	5.947	3.425	15.977	5.048	41.3	1.908	0.00224	0.0	-3.0	3000	-	88.1
63	0.268	0.111	6.267	2.670	17.245	4.990	41.1	1.891	0.00224	0.0	0.0	3000	-	88.2
64	0.107	0.066	4.534	4.263	12.206	3.586	41.0	1.878	0.00224	0.0	0.0	2500	-	88.2
65	-0.023	0.035	2.989	4.972	7.821	2.440	41.3	1.908	0.00224	0.0	0.0	2000	-	88.3
66	-0.033	-0.028	2.215	1.781	6.594	2.361	20.8	0.483	0.00224	0.0	0.0	2000	-	88.2
67	-0.142	-0.099	1.820	0.790	1.643	2.660	3.3	0.012	0.00224	0.0	0.0	1999	-	88.0

Continued on next page

Table F.2: Testing conditions and rotor 2 loads in the hub coordinate system for run 101.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
68	0.018	-0.009	0.004	0.002	-0.004	-0.010	1.4	0.002	0.00224	0.0	0.0	0	-	88.0
69	0.003	0.000	0.010	0.000	-0.006	0.000	1.0	0.001	0.00224	-0.0	0.0	0	-	87.8

Run 102: Concept Quadrotor, Isolated Rotor

Table F.3: Run 102 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R1
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	none

Table F.4: Testing conditions and rotor 1 loads in the hub coordinate system for run 102.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.017	0.000	-0.010	0.000	-0.007	0.000	0.0	0.000	0.00225	-0.0	0.0	0	-	86.5
4	0.006	0.182	1.844	-0.903	0.039	-2.392	2.5	0.007	0.00225	-0.0	0.0	1999	-	86.5
5	0.441	0.067	2.277	-1.670	6.597	-1.967	20.6	0.478	0.00224	-0.0	0.0	1999	-	86.7
6	0.610	0.068	3.523	-1.494	9.439	-3.111	20.7	0.480	0.00224	-0.0	0.0	2499	-	86.7
7	0.849	0.069	5.016	-0.865	11.912	-4.538	20.4	0.467	0.00224	-0.0	0.0	2999	-	86.8
9	0.826	0.029	5.035	-1.107	11.443	-4.623	20.9	0.492	0.00224	-0.0	-3.0	3000	-	87.0
10	0.611	0.028	3.497	-1.657	8.749	-3.156	20.9	0.491	0.00224	-0.0	-3.0	2500	-	87.1
11	0.451	0.033	2.255	-1.893	6.141	-1.980	20.9	0.487	0.00224	-0.0	-3.0	2000	-	87.3
12	0.431	0.044	2.243	-1.895	5.979	-1.996	20.8	0.484	0.00224	-1.1	-3.0	2000	-	87.4
13	0.556	0.048	3.502	-1.653	8.484	-3.182	20.7	0.482	0.00224	-1.1	-3.0	2499	-	87.5
14	0.760	0.051	5.046	-1.031	11.164	-4.657	20.7	0.478	0.00224	-1.1	-3.0	2999	-	87.5
16	0.808	0.091	5.043	-1.050	11.781	-4.533	20.7	0.479	0.00224	-1.0	0.0	2999	-	87.6
17	0.594	0.082	3.530	-1.546	9.245	-3.096	20.9	0.487	0.00224	-1.1	0.0	2500	-	87.6
18	0.443	0.085	2.329	-1.828	6.592	-1.947	21.2	0.503	0.00224	-1.1	0.0	2000	-	87.6
19	0.422	0.085	2.235	-1.952	6.102	-1.977	20.7	0.479	0.00224	-3.0	0.0	2000	-	87.7
20	0.565	0.088	3.476	-1.647	8.633	-3.136	20.5	0.472	0.00224	-3.0	0.0	2499	-	87.7
21	0.769	0.101	4.980	-1.088	11.121	-4.618	20.4	0.466	0.00224	-3.0	0.0	3000	-	87.7
22	0.746	0.060	4.998	-1.064	10.772	-4.763	20.8	0.486	0.00224	-3.0	-3.0	3000	-	87.8
23	0.547	0.063	3.463	-1.632	8.142	-3.275	20.8	0.485	0.00224	-3.0	-3.0	2500	-	87.8
24	0.414	0.049	2.194	-1.913	5.754	-2.064	21.0	0.495	0.00224	-3.0	-3.0	2000	-	87.8
25	0.383	0.060	2.150	-1.893	5.401	-2.130	20.9	0.489	0.00224	-5.0	-3.0	1999	-	87.8
26	0.497	0.070	3.423	-1.627	7.775	-3.346	20.7	0.480	0.00224	-5.0	-3.0	2499	-	87.8
27	0.683	0.073	4.961	-1.067	10.270	-4.859	20.6	0.474	0.00224	-5.0	-3.0	2999	-	87.8
28	0.741	0.105	4.985	-1.112	10.826	-4.729	20.7	0.482	0.00224	-5.0	0.0	2999	-	87.8
29	0.543	0.101	3.452	-1.633	8.259	-3.239	20.7	0.481	0.00224	-5.0	0.0	2500	-	87.8
30	0.384	0.091	2.236	-1.980	5.908	-2.043	21.2	0.502	0.00224	-5.0	0.0	2000	-	87.8
31	0.343	0.113	2.078	-1.924	5.060	-2.178	20.6	0.475	0.00224	-10.0	0.0	1999	-	87.9
32	0.456	0.120	3.337	-1.605	7.382	-3.413	20.6	0.476	0.00224	-10.0	0.0	2499	-	87.9
33	0.625	0.126	4.853	-1.132	9.799	-4.942	20.7	0.481	0.00224	-10.0	0.0	3000	-	87.9
34	0.593	0.086	4.767	-1.204	9.132	-5.019	20.6	0.474	0.00224	-10.0	-3.0	2999	-	87.8
35	0.429	0.084	3.252	-1.648	6.701	-3.502	20.4	0.465	0.00224	-10.0	-3.0	2500	-	87.8
36	0.314	0.076	2.011	-1.837	4.603	-2.250	20.4	0.464	0.00224	-10.0	-3.0	2000	-	87.8

Continued on next page

Table F.4: Testing conditions and rotor 1 loads in the hub coordinate system for run 102.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
37	0.439	-0.007	2.062	-4.596	5.692	-2.358	41.1	1.885	0.00224	-10.0	-3.0	2000	-	88.1
39	0.624	-0.027	3.518	-4.605	8.677	-3.579	41.3	1.903	0.00224	-10.0	-3.0	2499	-	88.4
40	0.909	-0.029	5.142	-4.255	12.283	-5.078	41.3	1.907	0.00224	-10.0	-3.0	3000	-	88.4
41	0.999	-0.016	5.417	-4.317	13.426	-4.937	41.3	1.904	0.00223	-10.0	0.0	2999	-	88.5
42	0.650	-0.006	3.736	-4.727	9.389	-3.502	41.3	1.901	0.00223	-10.0	0.0	2500	-	88.6
43	0.511	-0.005	2.317	-4.781	6.306	-2.297	41.2	1.895	0.00223	-10.0	0.0	2000	-	88.6
44	0.544	-0.020	2.691	-5.185	7.285	-2.192	41.3	1.908	0.00223	-5.0	0.0	2000	-	88.6
45	0.719	-0.023	4.185	-5.039	10.954	-3.281	41.2	1.897	0.00223	-5.0	0.0	2499	-	88.6
46	1.126	-0.053	5.874	-4.437	15.245	-4.651	41.4	1.915	0.00223	-5.0	0.0	3000	-	88.6
47	1.092	-0.061	5.648	-4.295	14.494	-4.793	41.4	1.914	0.00223	-5.0	-3.0	2999	-	88.6
48	0.741	-0.071	3.950	-5.033	10.107	-3.396	41.4	1.916	0.00223	-5.0	-3.0	2500	-	88.6
49	0.543	-0.047	2.447	-4.976	6.735	-2.248	41.2	1.892	0.00223	-5.0	-3.0	2000	-	88.6
50	0.552	-0.052	2.615	-5.160	7.157	-2.210	41.2	1.897	0.00223	-3.0	-3.0	1999	-	88.6
51	0.736	-0.075	4.118	-5.126	10.616	-3.305	41.4	1.910	0.00223	-3.1	-3.0	2499	-	88.6
52	1.111	-0.084	5.809	-4.284	15.111	-4.657	41.3	1.908	0.00223	-3.0	-3.0	3000	-	88.6
53	1.220	-0.050	6.033	-4.098	15.998	-4.639	41.2	1.894	0.00223	-3.0	0.0	3000	-	88.6
54	0.815	-0.020	4.350	-4.972	11.373	-3.260	41.2	1.896	0.00223	-3.0	0.0	2500	-	88.7
55	0.586	-0.029	2.891	-5.361	7.353	-2.151	41.2	1.900	0.00223	-3.0	0.0	2000	-	88.7
56	0.598	-0.017	3.100	-5.296	7.584	-2.085	41.4	1.917	0.00223	-1.0	0.0	2000	-	88.7
57	0.804	-0.002	4.624	-4.846	12.014	-3.192	41.4	1.911	0.00223	-0.9	0.0	2499	-	88.7
58	1.239	-0.029	6.360	-3.482	16.850	-4.578	41.5	1.919	0.00223	-0.9	0.0	2999	-	88.7
59	1.190	-0.069	5.938	-4.179	15.647	-4.627	41.2	1.896	0.00223	-0.9	-3.0	2999	-	88.7
60	0.796	-0.051	4.291	-5.078	11.137	-3.297	41.1	1.882	0.00223	-0.9	-3.0	2500	-	88.7
61	0.587	-0.044	2.742	-5.212	7.296	-2.199	41.3	1.906	0.00223	-0.9	-3.0	2000	-	88.7
62	0.588	-0.048	2.882	-5.511	7.528	-2.167	41.4	1.910	0.00223	-0.0	-3.0	2000	-	88.6
63	0.797	-0.060	4.432	-5.228	11.502	-3.273	41.5	1.923	0.00223	-0.0	-3.0	2499	-	88.6
65	1.203	-0.071	6.080	-4.055	16.177	-4.671	41.1	1.889	0.00223	-0.0	-3.0	2999	-	88.6
66	1.263	-0.034	6.462	-3.440	17.065	-4.557	41.1	1.887	0.00223	-0.0	0.0	2999	-	88.6
67	0.834	-0.005	4.773	-4.550	11.926	-3.191	41.3	1.907	0.00223	0.0	0.0	2500	-	88.6
68	0.604	-0.009	3.151	-5.140	7.532	-2.080	41.3	1.905	0.00223	0.0	0.0	1999	-	88.6
69	0.414	0.097	2.295	-1.789	6.612	-1.999	20.9	0.487	0.00224	-0.0	0.0	2000	-	88.5
70	0.071	0.176	1.876	-0.663	1.768	-2.328	3.5	0.013	0.00224	-0.0	0.0	2000	-	88.3
71	-0.000	0.000	-0.000	0.000	0.000	0.000	2.4	0.006	0.00224	0.0	0.0	0	-	88.3

Run 103: Concept Quadrotor, Isolated Rotor

For Run 103, the tunnel speed (VFPS), dynamic pressure (Q), density (RHO), and temperature (TTF/T. Temp) were input from the recorded run logs due to an SDAS error.

The tunnel temperature was assumed to change linearly throughout the run. The beginning and end temperature recorded in the run log were used to linearly interpolate the tunnel temperature for the rest of the data points.

Using the interpolated tunnel temperature and the recorded wind tunnel speed, the dynamic pressure was calculated using the following equation:

$$Q = ((-5 * 10^{-6}) * TTF + 0.00267) * VFPS^2 * 1/2 \tag{11}$$

The density was similarly calculated:

$$RHO = (-5 * 10^{-6}) * TTF + 0.00267. \tag{12}$$

Table F.5: Run 103 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	none

Table F.6: Testing conditions and rotor 3 loads in the hub coordinate system for run 103.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	0.000	0.000	0.000	0.000	0.000	0.000	3.5	0.014	0.00235	0.0	0.0	0	0.00	63.9
4	0.081	-0.137	1.529	-1.013	0.263	3.065	4.3	0.022	0.00235	0.0	0.0	2000	0.00	63.6
5	0.176	0.005	1.893	2.516	6.393	2.804	20.0	0.472	0.00235	0.0	0.0	2000	0.00	63.3
6	0.305	0.119	3.190	2.459	9.080	4.048	20.0	0.469	0.00235	0.0	0.0	2500	0.00	63.1
7	0.572	0.254	4.773	1.626	11.754	5.635	20.4	0.490	0.00236	0.0	0.0	3000	0.00	62.8
8	0.410	0.225	4.727	1.691	11.186	5.799	20.4	0.489	0.00236	0.0	-3.0	3000	0.00	62.5
9	0.280	0.130	3.132	2.179	8.397	4.246	20.4	0.490	0.00236	0.0	-3.0	2500	0.00	62.2
10	0.103	0.079	1.918	2.568	5.953	2.835	20.2	0.483	0.00236	0.0	-3.0	2000	0.00	61.9
11	0.042	0.073	1.916	2.659	5.775	2.871	20.1	0.478	0.00236	-1.0	-3.0	2000	0.00	61.7
12	0.262	0.156	3.259	2.490	8.595	4.139	20.6	0.499	0.00236	-1.0	-3.0	2500	0.00	61.4
13	0.326	0.246	4.880	1.676	11.140	5.708	20.2	0.482	0.00236	-1.0	-3.0	3000	0.00	61.1
14	0.469	0.278	4.895	1.631	11.831	5.598	20.1	0.478	0.00237	-1.0	0.0	3000	0.00	60.8
15	0.339	0.183	3.287	2.285	9.204	4.053	20.1	0.479	0.00237	-1.0	0.0	2500	0.00	60.6
16	0.285	0.115	1.984	2.602	6.310	2.814	20.4	0.492	0.00237	-1.0	0.0	2000	0.00	60.3
17	0.147	0.104	1.960	2.697	5.928	2.849	20.3	0.487	0.00237	-3.0	0.0	2000	0.00	60.0
18	0.220	0.171	3.299	2.407	8.727	4.113	20.1	0.479	0.00237	-3.0	0.0	2500	0.00	59.7
19	0.385	0.262	4.867	1.750	11.482	5.675	20.2	0.485	0.00237	-3.0	0.0	3000	0.00	59.4
20	0.252	0.232	4.849	1.868	10.841	5.818	20.2	0.486	0.00237	-3.0	-3.0	3000	0.00	59.2
21	0.176	0.164	3.253	2.584	8.224	4.210	20.4	0.494	0.00238	-3.0	-3.0	2500	0.00	58.9
22	0.047	0.084	1.926	2.579	5.479	2.914	20.4	0.493	0.00238	-3.0	-3.0	2000	0.00	58.6
23	-0.093	0.067	1.886	2.624	5.089	2.962	20.2	0.486	0.00238	-5.0	-3.0	2000	0.00	58.3
24	0.010	0.135	3.216	2.558	7.742	4.290	20.2	0.487	0.00238	-5.0	-3.0	2500	0.00	58.0
25	0.182	0.225	4.819	2.041	10.456	5.889	20.4	0.497	0.00238	-5.0	-3.0	3000	0.00	57.8
26	0.357	0.253	4.891	2.041	11.166	5.787	20.4	0.498	0.00238	-5.0	0.0	3000	0.00	57.5
27	0.261	0.162	3.315	2.352	8.483	4.147	20.5	0.501	0.00238	-5.0	0.0	2500	0.00	57.2
28	0.122	0.097	1.956	2.826	5.612	2.880	20.5	0.500	0.00239	-5.0	0.0	2000	0.00	56.9
29	-0.176	0.063	1.846	2.887	4.623	3.025	20.2	0.489	0.00239	-10.0	0.0	2000	0.00	56.6
30	-0.028	0.123	3.226	2.693	7.481	4.331	20.4	0.497	0.00239	-10.0	0.0	2500	0.00	56.4
31	0.103	0.200	4.820	1.892	10.113	5.931	20.4	0.499	0.00239	-10.0	0.0	3000	0.00	56.1
32	-0.070	0.177	4.701	2.177	9.346	6.018	20.4	0.496	0.00239	-10.0	-3.0	3000	0.00	55.8
33	-0.187	0.115	3.094	2.685	6.671	4.412	20.3	0.495	0.00239	-10.0	-3.0	2500	0.00	55.5
34	-0.324	0.035	1.712	2.935	4.066	3.110	20.2	0.490	0.00239	-10.0	-3.0	2000	0.00	55.2

Continued on next page

Table F.6: Testing conditions and rotor 3 loads in the hub coordinate system for run 103.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	-0.069	0.125	1.637	5.286	4.565	3.192	40.3	1.941	0.00240	-10.0	-3.0	2000	0.00	55.0
36	0.109	0.252	3.075	5.658	7.758	4.522	40.3	1.945	0.00240	-10.0	-3.0	2500	0.00	54.7
37	0.359	0.465	4.772	5.119	11.470	6.113	40.1	1.923	0.00240	-10.0	-3.0	3000	0.00	54.4
38	0.547	0.538	5.106	5.120	12.759	6.002	40.1	1.928	0.00240	-10.0	0.0	3000	0.00	54.1
39	0.355	0.404	3.386	5.671	8.631	4.425	39.9	1.912	0.00240	-10.0	0.0	2500	0.00	53.9
40	0.173	0.274	1.901	5.453	5.208	3.136	40.2	1.936	0.00240	-10.0	0.0	2000	0.00	53.6
41	0.424	0.334	2.294	5.856	6.427	2.981	40.2	1.940	0.00240	-5.0	0.0	2000	0.00	53.3
42	0.603	0.469	3.799	5.826	10.301	4.199	40.1	1.935	0.00240	-5.0	0.0	2500	0.00	53.0
43	0.864	0.664	5.605	4.952	14.967	5.659	40.2	1.940	0.00241	-5.0	0.0	3000	0.00	52.7
44	0.682	0.597	5.307	4.999	13.618	5.886	40.1	1.940	0.00241	-5.0	-3.0	3000	0.00	52.5
45	0.472	0.453	3.570	5.634	9.284	4.329	40.2	1.942	0.00241	-5.0	-3.0	2500	0.00	52.2
47	0.257	0.311	2.052	5.608	5.718	3.070	40.1	1.940	0.00241	-5.0	-3.0	2000	0.00	51.6
48	0.367	0.333	2.204	5.819	6.191	3.003	40.3	1.955	0.00241	-3.0	-3.0	2000	0.00	51.3
49	0.559	0.477	3.726	5.828	9.949	4.233	40.2	1.946	0.00241	-3.0	-3.0	2500	0.00	51.1
50	0.791	0.623	5.495	4.911	14.481	5.743	40.2	1.955	0.00242	-3.0	-3.0	3000	0.00	50.8
51	0.971	0.689	5.752	4.946	15.620	5.513	40.2	1.954	0.00242	-3.0	0.0	3000	0.00	50.5
52	0.746	0.519	4.018	5.792	10.865	4.091	40.2	1.956	0.00242	-3.0	0.0	2500	0.00	50.2
53	0.539	0.369	2.486	5.886	6.791	2.931	40.1	1.946	0.00242	-3.0	0.0	2000	0.00	49.9
54	0.598	0.367	2.634	5.973	7.147	2.885	40.1	1.947	0.00242	-1.0	0.0	2000	0.00	49.7
55	0.809	0.518	4.194	5.720	11.661	4.050	40.1	1.952	0.00242	-1.0	0.0	2500	0.00	49.4
56	1.066	0.681	5.941	4.520	16.681	5.486	40.0	1.942	0.00242	-1.0	0.0	3000	0.00	49.1
57	0.892	0.641	5.651	4.844	15.349	5.588	40.0	1.943	0.00243	-1.0	-3.0	3000	0.00	48.8
59	0.668	0.486	3.906	5.866	10.652	4.127	40.3	1.970	0.00243	-1.0	-3.0	2500	0.00	48.3
60	0.476	0.341	2.379	5.950	6.699	2.950	40.3	1.972	0.00243	-1.0	-3.0	2000	0.00	48.0
61	0.495	0.339	2.444	5.928	6.825	2.927	40.1	1.952	0.00243	0.0	-3.0	2000	0.00	47.7
62	0.689	0.486	3.979	5.807	10.915	4.078	40.1	1.958	0.00243	0.0	-3.0	2500	0.00	47.4
63	0.942	0.645	5.726	4.882	15.693	5.512	40.2	1.964	0.00243	0.0	-3.0	3000	0.00	47.2
64	1.113	0.671	6.039	4.435	17.176	5.459	40.0	1.950	0.00244	0.0	0.0	3000	0.00	46.9
65	0.878	0.501	4.270	5.560	11.924	4.015	40.1	1.955	0.00244	0.0	0.0	2500	0.00	46.6
66	0.644	0.363	2.714	5.912	7.293	2.849	40.0	1.954	0.00244	0.0	0.0	2000	0.00	46.3
67	0.373	0.178	1.969	2.466	6.287	2.751	20.3	0.500	0.00244	0.0	0.0	2000	0.00	46.0
68	0.158	-0.017	1.533	0.381	1.000	3.078	3.8	0.018	0.00244	0.0	0.0	2000	0.00	45.8
70	0.000	0.000	0.000	0.000	0.000	0.000	3.5	0.015	0.00244	0.0	0.0	0	0.00	45.2

Run 104: Concept Quadrotor, Isolated Rotor

For Run 104,the tunnel speed (VFPS), dynamic pressure (Q), density (RHO), and temperature (TTF/T. Temp) were input from the recorded run logs due to an SDAS error.

The tunnel temperature was assumed to change linearly throught the run. The beginning and end temperature recorded in the run log were used to linearly interpolate the tunnel temperature for the rest of the data points.

Using the interpolated tunnel temperature and the recorded wind tunnel speed, the dynamic pressure was calculated using the following equation:

$$Q = ((-5 * 10^{-6}) * TTF + 0.00267) * VFPS^2 * 1/2 \tag{13}$$

The density was similarly calculated:

$$RHO = (-5 * 10^{-6}) * TTF + 0.00267. \tag{14}$$

Table F.7: Run 104 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R4
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	none

Table F.8: Testing conditions and rotor 4 loads in the hub coordinate system for run 104.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
4	-0.005	-0.001	-0.007	-0.003	0.003	-0.001	3.2	0.012	0.00235	0.0	0.0	0	0.00	64.8
5	-0.323	-0.358	1.127	1.502	-0.310	-1.660	3.9	0.018	0.00235	0.0	0.0	2000	0.00	64.9
6	-0.242	-0.382	1.792	-2.189	6.141	-1.482	20.3	0.481	0.00235	0.0	0.0	2000	0.00	65.0
7	-0.129	-0.378	3.157	-2.288	8.813	-2.665	20.0	0.469	0.00234	0.0	0.0	2500	0.00	65.1
8	0.046	-0.418	4.687	-1.718	11.660	-4.123	20.1	0.471	0.00234	0.0	0.0	3000	0.00	65.2
9	-0.072	-0.377	4.622	-1.868	10.943	-4.263	20.1	0.474	0.00234	0.0	-3.0	3000	0.00	65.3
10	-0.177	-0.369	2.981	-2.257	8.358	-2.766	20.4	0.487	0.00234	0.0	-3.0	2500	0.00	65.3
11	-0.350	-0.333	1.651	-2.232	5.621	-1.562	20.5	0.493	0.00234	0.0	-3.0	2000	0.00	65.4
12	-0.451	-0.338	1.756	-2.220	5.488	-1.588	20.3	0.482	0.00234	-1.0	-3.0	2000	0.00	65.5
13	-0.328	-0.367	3.129	-2.285	8.045	-2.815	20.0	0.469	0.00234	-1.0	-3.0	2500	0.00	65.6
14	-0.181	-0.373	4.727	-1.846	10.640	-4.328	19.9	0.463	0.00234	-1.0	-3.0	3000	0.00	65.7
15	0.026	-0.404	4.676	-1.825	11.516	-4.168	20.2	0.475	0.00234	-1.0	0.0	3000	0.00	65.8
16	-0.118	-0.392	3.063	-2.252	8.748	-2.685	20.3	0.483	0.00234	-1.0	0.0	2500	0.00	65.9
17	-0.305	-0.361	1.764	-2.239	5.984	-1.505	20.4	0.486	0.00234	-1.0	0.0	2000	0.00	66.0
18	-0.350	-0.382	1.695	-2.283	5.670	-1.554	20.4	0.489	0.00234	-3.0	0.0	2000	0.00	66.1
19	-0.210	-0.396	3.023	-2.435	8.310	-2.765	20.3	0.482	0.00234	-3.0	0.0	2500	0.00	66.2
20	-0.052	-0.408	4.625	-2.014	11.045	-4.253	20.2	0.476	0.00234	-3.0	0.0	3000	0.00	66.3
21	-0.200	-0.367	4.573	-1.993	10.199	-4.396	20.1	0.474	0.00234	-3.0	-3.0	3000	0.00	66.3
22	-0.311	-0.351	2.910	-2.355	7.667	-2.863	20.4	0.486	0.00234	-3.0	-3.0	2500	0.00	66.4
23	-0.521	-0.333	1.690	-2.158	5.030	-1.651	20.3	0.482	0.00234	-3.0	-3.0	2000	0.00	66.5
24	-0.595	-0.340	1.662	-2.178	4.719	-1.695	20.3	0.481	0.00234	-5.0	-3.0	2000	0.00	66.6
25	-0.428	-0.349	2.942	-2.332	7.190	-2.932	20.3	0.480	0.00234	-5.0	-3.0	2500	0.00	66.7
26	-0.213	-0.366	4.395	-2.113	9.780	-4.436	20.4	0.486	0.00234	-5.0	-3.0	3000	0.00	66.8
27	-0.105	-0.399	4.508	-2.082	10.475	-4.364	20.3	0.480	0.00234	-5.0	0.0	3000	0.00	66.9
28	-0.341	-0.386	3.079	-2.357	7.894	-2.828	20.1	0.470	0.00234	-5.0	0.0	2500	0.00	67.0
29	-0.566	-0.371	1.884	-2.140	5.388	-1.609	19.9	0.462	0.00233	-5.0	0.0	2000	0.00	67.1
30	-0.671	-0.367	1.627	-2.192	4.336	-1.727	20.3	0.481	0.00233	-10.1	0.0	2000	0.00	67.2
31	-0.517	-0.381	2.898	-2.452	6.795	-2.963	20.3	0.481	0.00233	-10.1	0.0	2500	0.00	67.3
32	-0.320	-0.388	4.348	-2.061	9.222	-4.483	20.4	0.485	0.00233	-10.0	0.0	3000	0.00	67.3
33	-0.473	-0.346	4.261	-2.220	8.495	-4.539	20.4	0.484	0.00233	-10.0	-3.0	3000	0.00	67.4
34	-0.681	-0.342	2.775	-2.330	6.057	-3.016	20.3	0.479	0.00233	-10.0	-3.0	2500	0.00	67.5
35	-0.835	-0.326	1.575	-2.155	3.962	-1.751	20.2	0.475	0.00233	-10.1	-3.0	2000	0.00	67.6

Continued on next page

Table F.8: Testing conditions and rotor 4 loads in the hub coordinate system for run 104.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
36	-0.483	-0.308	1.181	-4.735	4.184	-1.824	40.2	1.888	0.00233	-10.0	-3.0	2000	0.00	67.7
39	-0.283	-0.308	2.526	-5.530	7.115	-3.088	40.4	1.898	0.00233	-10.0	-3.0	2500	0.00	68.0
40	-0.058	-0.326	4.173	-5.522	10.784	-4.589	40.5	1.912	0.00233	-10.0	-3.0	3000	0.00	68.1
41	0.141	-0.361	4.560	-5.534	12.180	-4.505	40.3	1.893	0.00233	-10.0	0.0	3000	0.00	68.2
42	-0.104	-0.346	2.809	-5.643	8.054	-3.041	40.3	1.894	0.00233	-10.0	0.0	2500	0.00	68.3
43	-0.349	-0.331	1.443	-5.292	4.993	-1.807	40.2	1.879	0.00233	-10.0	0.0	2000	0.00	68.4
44	-0.084	-0.365	1.826	-5.617	6.107	-1.682	40.4	1.903	0.00233	-5.0	0.0	2000	0.00	68.4
45	0.176	-0.395	3.282	-5.969	9.774	-2.815	40.5	1.904	0.00233	-5.0	0.0	2500	0.00	68.5
46	0.448	-0.398	4.991	-5.515	14.383	-4.213	40.5	1.908	0.00233	-5.0	0.0	3000	0.00	68.6
47	0.290	-0.342	4.691	-5.446	13.029	-4.403	40.5	1.904	0.00233	-5.0	-3.0	3000	0.00	68.7
48	0.041	-0.325	2.986	-5.827	8.810	-2.982	40.4	1.899	0.00233	-5.0	-3.0	2500	0.00	68.8
49	-0.186	-0.316	1.580	-5.329	5.371	-1.766	40.2	1.883	0.00233	-5.0	-3.0	2000	0.00	68.9
50	-0.113	-0.333	1.639	-5.452	5.670	-1.731	40.4	1.901	0.00233	-3.0	-3.0	2000	0.00	69.0
51	0.155	-0.355	3.188	-5.977	9.586	-2.857	40.3	1.886	0.00232	-3.0	-3.0	2500	0.00	69.1
52	0.405	-0.351	4.776	-5.620	13.649	-4.339	40.5	1.903	0.00232	-3.0	-3.0	3000	0.00	69.2
54	0.562	-0.399	5.032	-5.377	14.734	-4.154	40.4	1.898	0.00232	-3.0	0.0	3000	0.00	69.4
55	0.306	-0.373	3.440	-6.256	10.394	-2.758	40.4	1.893	0.00232	-3.0	0.0	2500	0.00	69.4
56	0.029	-0.343	1.910	-5.907	6.379	-1.668	40.3	1.890	0.00232	-3.0	0.0	2000	0.00	69.5
57	0.114	-0.368	2.130	-5.965	6.761	-1.603	40.4	1.893	0.00232	-1.0	0.0	2000	0.00	69.6
58	0.395	-0.383	3.528	-6.080	10.837	-2.718	40.3	1.886	0.00232	-1.0	0.0	2500	0.00	69.7
59	0.690	-0.405	5.210	-5.365	15.729	-4.059	40.4	1.891	0.00232	-1.0	0.0	3000	0.00	69.8
60	0.538	-0.362	4.992	-5.502	14.624	-4.168	40.4	1.893	0.00232	-1.0	-3.0	3000	0.00	69.9
61	0.241	-0.355	3.357	-6.010	10.119	-2.756	40.6	1.914	0.00232	-1.0	-3.0	2500	0.00	70.0
62	-0.003	-0.320	1.775	-5.678	6.195	-1.681	40.6	1.909	0.00232	-1.0	-3.0	2000	0.00	70.1
63	0.057	-0.335	1.916	-5.808	6.456	-1.643	40.5	1.899	0.00232	-0.1	-3.0	2000	0.00	70.2
64	0.284	-0.371	3.340	-5.951	10.351	-2.723	40.3	1.885	0.00232	0.0	-3.0	2500	0.00	70.3
65	0.593	-0.371	5.039	-5.311	14.894	-4.097	40.3	1.882	0.00232	0.0	-3.0	3000	0.00	70.4
66	0.761	-0.385	5.318	-5.293	16.191	-4.061	40.5	1.897	0.00232	0.0	0.0	3000	0.00	70.4
67	0.455	-0.367	3.590	-5.867	11.137	-2.688	40.4	1.891	0.00232	0.0	0.0	2500	0.00	70.5
68	0.143	-0.357	2.184	-5.768	6.851	-1.563	40.5	1.904	0.00232	0.0	0.0	2000	0.00	70.6
69	-0.189	-0.320	1.766	-2.377	6.081	-1.472	20.2	0.472	0.00232	0.0	0.0	2000	0.00	70.7
70	-0.276	-0.345	1.004	0.601	-0.244	-1.635	3.7	0.016	0.00232	0.0	0.0	2000	0.00	70.8
71	0.000	0.000	0.000	0.000	0.000	0.000	3.2	0.011	0.00232	0.0	0.0	0	0.00	70.9

Run 105: Concept Quadrotor, Side-by-Side

Table F.9: Run 105 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R2
number of blades	2
RPM	2000, 2500, 3000
model pitch	0
rotor tilt	0
phase	0, -30, -45, -60, -90

Table F.10: Testing conditions and rotor 1 loads in the hub coordinate system for run 105.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.006	0.000	-0.009	0.000	-0.000	0.000	0.8	0.001	0.00230	0.0	0.0	0	-	75.7
4	0.042	0.055	2.116	-1.088	0.374	-2.468	4.7	0.026	0.00230	-0.0	0.0	2000	0.0	76.1
7	0.031	0.053	2.127	-1.155	0.666	-2.370	4.5	0.024	0.00230	-0.0	0.0	1999	0.0	76.6
8	0.058	0.069	3.299	-1.134	1.416	-3.715	5.8	0.039	0.00230	-0.0	0.0	2499	0.0	76.6
9	0.068	0.087	5.007	-2.656	0.405	-5.481	7.0	0.056	0.00230	-0.0	0.0	2999	0.0	76.7
10	0.034	0.057	3.391	-2.070	-0.069	-3.854	5.7	0.037	0.00230	-0.0	0.0	2500	0.0	76.7
11	0.015	0.049	2.018	-1.044	0.607	-2.392	4.3	0.022	0.00230	-0.0	0.0	2000	0.0	76.8
12	0.022	0.060	2.000	-1.050	0.456	-2.447	4.2	0.020	0.00230	-0.0	0.0	1999	0.0	76.8
13	0.018	0.067	2.005	-1.153	0.334	-2.416	4.3	0.022	0.00230	-0.0	0.0	2000	0.0	76.8
14	0.013	0.063	2.059	-1.341	0.236	-2.466	4.7	0.025	0.00230	-0.0	0.0	1999	0.0	76.9
15	0.003	0.088	1.976	-0.703	0.264	-2.428	4.6	0.025	0.00230	-0.0	0.0	1999	0.0	76.9
16	-0.005	0.000	-0.009	0.000	0.000	0.000	0.7	0.001	0.00230	-0.0	0.0	0	-	77.0

Table F.11: Testing conditions and rotor 2 loads in the hub coordinate system for run 105.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.000	0.000	0.009	0.000	-0.008	0.000	0.8	0.001	0.00230	0.0	0.0	0	-	75.7
4	-0.075	-0.072	1.915	0.919	0.758	2.755	4.7	0.026	0.00230	-0.0	0.0	2000	0.0	76.1
7	-0.096	-0.079	1.869	1.161	0.237	2.775	4.5	0.024	0.00230	-0.0	0.0	1999	0.0	76.6
8	-0.107	-0.076	3.243	1.385	-0.630	4.170	5.8	0.039	0.00230	-0.0	0.0	2499	0.0	76.6
9	-0.121	-0.026	4.928	2.900	1.830	5.759	7.0	0.056	0.00230	-0.0	0.0	2999	0.0	76.7
10	-0.104	-0.045	3.240	1.776	1.656	4.050	5.7	0.037	0.00230	-0.0	0.0	2500	0.0	76.7
11	-0.086	-0.075	1.915	1.182	0.514	2.730	4.3	0.022	0.00230	-0.0	0.0	2000	0.0	76.8
12	-0.098	-0.069	1.961	1.124	0.691	2.701	4.2	0.020	0.00230	-0.0	0.0	1999	-30.0	76.8
13	-0.085	-0.067	1.975	1.255	0.527	2.754	4.3	0.022	0.00230	-0.0	0.0	1999	-60.0	76.8
14	-0.100	-0.066	1.929	1.316	0.471	2.737	4.7	0.025	0.00230	-0.0	0.0	1999	-90.0	76.9
15	-0.072	-0.062	1.959	0.826	0.754	2.712	4.6	0.025	0.00230	-0.0	0.0	2000	0.0	76.9
16	0.000	0.000	0.009	0.000	-0.007	0.000	0.7	0.001	0.00230	-0.0	0.0	0	-	77.0

Run 106: Concept Quadrotor, Side-by-Side

Table F.12: Run 106 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R2
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	0

Table F.13: Testing conditions and rotor 1 loads in the hub coordinate system for run 106.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.007	0.000	-0.009	0.000	-0.001	0.000	0.7	0.001	0.00227	-0.0	0.0	0	-	82.8
4	0.031	0.064	2.064	-0.058	1.029	-2.209	4.4	0.022	0.00227	-0.0	0.0	2000	0.0	83.1
5	0.339	0.022	2.778	-1.355	6.574	-1.866	20.7	0.483	0.00227	-0.0	0.0	2000	0.0	84.0
6	0.491	0.053	4.081	-1.204	9.735	-3.073	20.7	0.485	0.00226	-0.0	0.0	2499	0.0	84.1
7	0.727	0.042	5.617	-0.416	12.733	-4.578	20.6	0.481	0.00226	-0.0	0.0	2999	0.0	84.2
8	0.734	-0.026	5.440	-1.181	12.460	-4.477	20.8	0.490	0.00226	0.0	-3.0	2999	0.0	84.4
9	0.509	-0.035	3.909	-1.599	9.254	-3.065	20.5	0.477	0.00226	-0.0	-3.0	2500	0.0	84.5
10	0.342	-0.033	2.646	-1.592	6.291	-1.916	20.3	0.468	0.00226	-0.0	-3.0	2000	0.0	84.6
11	0.325	-0.033	2.631	-1.768	6.199	-1.908	20.7	0.486	0.00226	-1.0	-3.0	2000	0.0	84.9
12	0.459	-0.027	3.885	-1.772	9.221	-3.053	20.8	0.489	0.00226	-1.0	-3.0	2499	0.0	85.0
13	0.687	-0.054	5.396	-1.403	12.338	-4.458	20.8	0.491	0.00226	-1.0	-3.0	3000	0.0	85.1
14	0.718	0.007	5.549	-0.536	12.683	-4.547	20.8	0.489	0.00226	-1.0	0.0	3000	0.0	85.2
15	0.511	0.005	3.950	-1.160	9.560	-3.078	20.5	0.476	0.00226	-1.0	0.0	2500	0.0	85.3
16	0.352	0.006	2.642	-1.374	6.487	-1.889	20.4	0.469	0.00226	-1.0	0.0	1999	0.0	85.4
17	0.319	0.012	2.622	-1.620	6.313	-1.909	20.7	0.486	0.00226	-3.0	0.0	2000	0.0	85.7
18	0.474	0.003	3.887	-1.573	9.357	-3.065	20.8	0.487	0.00226	-3.0	0.0	2499	0.0	85.8
19	0.705	-0.011	5.402	-1.193	12.396	-4.482	20.7	0.485	0.00226	-2.9	0.0	2999	0.0	85.7
20	0.696	-0.058	5.353	-1.496	11.818	-4.524	20.7	0.484	0.00226	-3.0	-3.0	3000	0.0	85.9
21	0.472	-0.055	3.826	-1.827	8.701	-3.107	20.5	0.472	0.00226	-3.0	-3.0	2500	0.0	86.0
22	0.313	-0.051	2.564	-1.859	5.960	-1.947	20.7	0.482	0.00226	-3.0	-3.0	1999	0.0	86.1
23	0.282	-0.043	2.518	-1.816	5.661	-2.006	20.5	0.473	0.00226	-5.0	-3.0	2000	0.0	86.2
24	0.423	-0.049	3.801	-1.801	8.297	-3.188	20.5	0.475	0.00226	-5.0	-3.0	2499	0.0	86.2
25	0.625	-0.053	5.313	-1.411	11.215	-4.655	20.7	0.485	0.00226	-4.9	-3.0	2999	0.0	86.3
26	0.707	-0.027	5.316	-1.454	11.991	-4.490	20.7	0.485	0.00225	-4.9	0.0	2999	0.0	86.4
27	0.507	-0.031	3.808	-1.860	8.896	-3.067	20.6	0.479	0.00225	-5.0	0.0	2500	0.0	86.7
28	0.346	-0.015	2.537	-1.862	6.037	-1.928	20.6	0.479	0.00225	-5.0	0.0	2000	0.0	86.7
29	0.272	0.002	2.449	-1.897	5.337	-2.075	20.8	0.485	0.00225	-10.0	0.0	2000	0.0	86.8
30	0.405	-0.006	3.748	-1.758	8.007	-3.278	21.0	0.496	0.00225	-10.0	0.0	2499	0.0	86.9
31	0.609	-0.002	5.258	-1.336	10.618	-4.771	20.7	0.481	0.00225	-10.0	0.0	3000	0.0	86.9
32	0.581	-0.019	5.169	-1.267	9.979	-4.886	20.8	0.487	0.00225	-10.0	-3.0	3000	0.0	87.0
33	0.400	-0.023	3.620	-1.645	7.216	-3.399	20.6	0.476	0.00225	-10.0	-3.0	2500	0.0	87.0
34	0.246	-0.012	2.345	-1.853	4.849	-2.156	20.8	0.485	0.00225	-10.0	-3.0	2000	0.0	87.1

Continued on next page

Table F.13: Testing conditions and rotor 1 loads in the hub coordinate system for run 106.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	0.367	-0.105	2.411	-4.543	5.566	-2.286	41.1	1.897	0.00225	-10.0	-3.0	2000	0.0	87.3
36	0.535	-0.116	3.853	-4.490	8.724	-3.520	41.0	1.891	0.00225	-10.0	-3.0	2500	0.0	87.4
37	0.832	-0.141	5.541	-4.187	12.456	-5.006	41.1	1.897	0.00225	-10.0	-3.0	3000	0.0	87.4
38	0.970	-0.120	5.861	-4.216	13.731	-4.838	41.3	1.915	0.00225	-10.0	0.0	2999	0.0	87.6
39	0.651	-0.129	4.114	-4.693	9.635	-3.402	40.9	1.881	0.00225	-10.0	0.0	2500	0.0	87.7
40	0.460	-0.111	2.600	-4.909	6.308	-2.253	41.0	1.891	0.00225	-10.0	0.0	2000	0.0	87.8
41	0.499	-0.101	3.046	-5.141	7.227	-2.141	41.1	1.897	0.00225	-5.0	0.0	2000	0.0	88.2
42	0.702	-0.111	4.545	-4.952	10.965	-3.250	41.1	1.893	0.00224	-5.0	0.0	2499	0.0	88.3
43	1.071	-0.151	6.310	-4.324	15.446	-4.605	41.1	1.894	0.00224	-5.0	0.0	2999	0.0	88.3
45	1.051	-0.179	6.051	-4.226	14.537	-4.682	41.0	1.889	0.00224	-5.0	-3.0	2999	0.0	88.6
46	0.717	-0.186	4.300	-5.047	10.235	-3.314	41.2	1.904	0.00224	-5.0	-3.0	2500	0.0	88.7
47	0.514	-0.154	2.766	-4.894	6.733	-2.198	41.3	1.911	0.00224	-5.0	-3.0	1999	0.0	88.8
48	0.342	-0.158	2.947	-5.138	7.026	-2.160	41.4	1.917	0.00224	-3.0	-0.3	2000	0.0	88.9
49	0.723	-0.175	4.440	-4.915	10.700	-3.263	41.4	1.917	0.00224	-3.0	-3.0	2499	0.0	88.9
50	1.054	-0.193	6.155	-4.058	15.213	-4.648	41.1	1.894	0.00224	-2.9	-3.0	2999	0.0	88.9
51	1.161	-0.152	6.510	-3.597	16.239	-4.616	41.1	1.889	0.00224	-2.9	0.0	3000	0.0	88.9
53	0.778	-0.135	4.729	-4.557	11.313	-3.228	41.1	1.889	0.00224	-2.9	0.0	2500	0.0	89.0
54	0.539	-0.128	3.190	-5.137	7.350	-2.100	41.1	1.896	0.00224	-2.9	0.0	2000	0.0	89.2
55	0.548	-0.110	3.317	-5.164	7.526	-2.053	41.1	1.889	0.00224	-1.0	0.0	1999	0.0	89.2
56	0.770	-0.105	4.974	-4.306	11.651	-3.173	41.2	1.903	0.00224	-1.0	0.0	2499	0.0	89.3
57	1.286	-0.129	6.779	-2.933	16.660	-4.526	41.2	1.901	0.00224	-1.0	-3.0	2999	0.0	89.2
58	1.157	-0.186	6.421	-3.754	15.827	-4.670	41.2	1.897	0.00224	-1.0	-3.0	3000	0.0	89.6
59	0.805	-0.183	4.594	-4.906	11.266	-3.271	41.3	1.913	0.00224	-1.0	-3.0	2500	0.0	89.6
60	0.552	-0.162	3.030	-5.001	7.250	-2.159	41.0	1.883	0.00224	-1.0	-3.0	2000	0.0	89.6
61	0.545	-0.163	3.161	-5.001	7.276	-2.124	41.1	1.891	0.00224	-0.0	-3.0	2000	0.0	89.7
62	0.786	-0.181	4.727	-4.776	11.424	-3.226	41.2	1.896	0.00224	-0.0	-3.0	2499	0.0	89.6
63	1.149	-0.186	6.473	-3.463	16.148	-4.638	41.2	1.896	0.00224	-0.0	-3.0	3000	0.0	89.7
64	1.207	-0.141	6.849	-3.060	16.821	-4.517	41.0	1.879	0.00224	-0.0	0.0	3000	0.0	89.7
65	0.822	-0.134	5.095	-4.332	11.656	-3.179	41.1	1.891	0.00224	-0.0	0.0	2500	0.0	89.7
68	0.572	-0.133	3.362	-5.280	7.441	-2.050	41.3	1.908	0.00224	-0.0	0.0	2000	0.0	89.8
69	0.425	-0.025	2.500	-1.519	6.556	-2.015	20.7	0.478	0.00224	-0.0	0.0	1999	0.0	89.6
70	0.011	0.085	1.959	-0.117	0.314	-2.408	5.1	0.029	0.00224	-0.0	0.0	1999	0.0	89.3
71	0.037	-0.012	-0.047	0.003	0.007	0.054	1.4	0.002	0.00224	0.0	0.0	0	-	89.1

Continued on next page

Table F.13: Testing conditions and rotor 1 loads in the hub coordinate system for run 106.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
74	-0.019	0.000	-0.010	0.000	-0.008	0.000	0.0	0.000	0.00225	0.0	0.0	0	-	87.4

Table F.14: Testing conditions and rotor 2 loads in the hub coordinate system for run 106.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.001	0.000	0.009	0.000	-0.008	0.000	0.7	0.001	0.00227	-0.0	0.0	0	-	82.8
4	-0.236	-0.004	1.926	1.049	-0.089	2.853	4.4	0.022	0.00227	-0.0	0.0	2000	0.0	83.1
5	-0.225	0.132	2.622	1.417	6.735	2.552	20.7	0.483	0.00227	-0.0	0.0	2000	0.0	84.0
6	-0.164	0.138	3.947	1.133	10.048	3.790	20.7	0.485	0.00226	-0.0	0.0	2499	0.0	84.1
7	-0.061	0.144	5.533	0.158	13.160	5.313	20.6	0.481	0.00226	-0.0	0.0	2999	0.0	84.2
8	-0.031	0.215	5.331	1.022	12.799	5.165	20.8	0.490	0.00226	0.0	-3.0	2999	0.0	84.4
9	-0.111	0.194	3.761	1.649	9.431	3.737	20.5	0.477	0.00226	-0.0	-3.0	2500	0.0	84.5
10	-0.179	0.191	2.449	1.751	6.292	2.565	20.3	0.468	0.00226	-0.0	-3.0	1999	0.0	84.6
11	-0.219	0.200	2.453	1.900	6.223	2.577	20.7	0.486	0.00226	-1.0	-3.0	1999	0.0	84.9
12	-0.168	0.221	3.734	1.884	9.268	3.741	20.8	0.489	0.00226	-1.0	-3.0	2499	0.0	85.0
13	-0.066	0.246	5.289	1.272	12.486	5.161	20.8	0.491	0.00226	-1.0	-3.0	3000	0.0	85.1
14	-0.027	0.167	5.396	0.524	12.879	5.252	20.8	0.489	0.00226	-1.0	0.0	2999	0.0	85.2
15	-0.157	0.138	3.878	1.355	9.681	3.776	20.5	0.476	0.00226	-1.0	0.0	2500	0.0	85.3
16	-0.245	0.135	2.593	1.533	6.542	2.566	20.4	0.469	0.00226	-1.0	0.0	2000	0.0	85.4
17	-0.235	0.141	2.494	1.851	6.353	2.593	20.7	0.486	0.00226	-3.0	0.0	2000	0.0	85.7
18	-0.181	0.155	3.783	1.776	9.432	3.762	20.8	0.487	0.00226	-3.0	0.0	2500	0.0	85.8
19	-0.076	0.172	5.326	1.120	12.668	5.184	20.7	0.485	0.00226	-2.9	0.0	3000	0.0	85.7
20	-0.020	0.235	5.218	1.329	11.789	5.238	20.7	0.484	0.00226	-3.0	-3.0	2999	0.0	85.9
21	-0.104	0.198	3.657	1.951	8.710	3.780	20.5	0.472	0.00226	-3.0	-3.0	2500	0.0	86.0
22	-0.190	0.199	2.369	1.983	5.890	2.606	20.7	0.482	0.00226	-3.0	-3.0	2000	0.0	86.1
23	-0.195	0.190	2.310	1.934	5.567	2.677	20.5	0.473	0.00226	-5.0	-3.0	2000	0.0	86.2
24	-0.142	0.200	3.630	1.811	8.311	3.887	20.5	0.475	0.00226	-5.0	-3.0	2499	0.0	86.2
25	-0.050	0.226	5.199	1.241	11.329	5.352	20.7	0.485	0.00226	-4.9	-3.0	2999	0.0	86.3
26	-0.047	0.179	5.268	1.364	12.075	5.203	20.7	0.485	0.00225	-4.9	0.0	2999	0.0	86.4
27	-0.174	0.154	3.770	1.956	8.934	3.775	20.6	0.479	0.00225	-5.0	0.0	2500	0.0	86.7
28	-0.225	0.147	2.469	2.014	6.067	2.602	20.6	0.479	0.00225	-5.0	0.0	2000	0.0	86.7
29	-0.190	0.125	2.291	1.976	5.293	2.755	20.8	0.485	0.00225	-10.0	0.0	2000	0.0	86.8
30	-0.101	0.137	3.557	1.814	7.921	3.982	21.0	0.496	0.00225	-10.0	0.0	2499	0.0	86.9
31	-0.046	0.152	5.169	1.208	10.682	5.473	20.7	0.481	0.00225	-10.0	0.0	3000	0.0	86.9
32	-0.020	0.201	5.068	1.195	9.890	5.547	20.8	0.487	0.00225	-10.0	-3.0	2999	0.0	87.0
33	-0.102	0.177	3.481	1.780	7.121	4.034	20.6	0.476	0.00225	-10.0	-3.0	2500	0.0	87.0
34	-0.196	0.168	2.195	1.890	4.762	2.782	20.8	0.485	0.00225	-10.0	-3.0	1999	0.0	87.1

Continued on next page

Table F.14: Testing conditions and rotor 2 loads in the hub coordinate system for run 106.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
35	-0.123	0.221	2.210	4.352	5.595	2.866	41.1	1.897	0.00225	-10.0	-3.0	1999	0.0	87.3
36	-0.031	0.245	3.665	4.388	8.511	4.112	41.0	1.891	0.00225	-10.0	-3.0	2499	0.0	87.4
37	0.108	0.262	5.354	3.666	12.142	5.625	41.1	1.897	0.00225	-10.0	-3.0	2999	0.0	87.4
38	0.181	0.234	5.704	3.703	13.589	5.490	41.3	1.915	0.00225	-10.0	0.0	2999	0.0	87.6
39	0.059	0.190	3.906	4.504	9.360	4.012	40.9	1.881	0.00225	-10.0	0.0	2500	0.0	87.7
40	-0.036	0.169	2.394	4.588	6.162	2.790	41.0	1.891	0.00225	-10.0	0.0	1999	0.0	87.8
41	-0.041	0.191	2.815	4.822	7.307	2.672	41.1	1.897	0.00225	-5.0	0.0	2000	0.0	88.2
42	0.081	0.230	4.349	4.646	10.892	3.785	41.1	1.893	0.00224	-5.0	0.0	2500	0.0	88.3
43	0.248	0.264	6.114	3.413	15.431	5.146	41.1	1.894	0.00224	-5.0	0.0	3000	0.0	88.3
45	0.251	0.311	5.878	3.468	14.380	5.307	41.0	1.889	0.00224	-5.0	-3.0	2999	0.0	88.6
46	0.115	0.284	4.147	4.433	10.263	3.857	41.2	1.904	0.00224	-5.0	-3.0	2500	0.0	88.7
47	-0.003	0.247	2.565	4.567	6.753	2.702	41.3	1.911	0.00224	-5.0	-3.0	1999	0.0	88.8
48	-0.186	0.258	2.729	4.820	6.968	2.665	41.4	1.917	0.00224	-3.0	-0.3	2000	0.0	88.9
49	0.085	0.301	4.267	4.637	10.777	3.792	41.4	1.917	0.00224	-3.0	-3.0	2499	0.0	88.9
50	0.249	0.331	6.015	3.387	15.172	5.175	41.1	1.894	0.00224	-2.9	-3.0	3000	0.0	88.9
51	0.299	0.263	6.293	2.997	16.127	5.189	41.1	1.889	0.00224	-2.9	0.0	2999	0.0	88.9
53	0.131	0.207	4.560	4.091	11.505	3.792	41.1	1.889	0.00224	-2.9	0.0	2500	0.0	89.0
54	-0.005	0.194	2.965	4.877	7.494	2.618	41.1	1.896	0.00224	-2.9	0.0	2000	0.0	89.2
55	-0.005	0.185	3.156	4.749	7.707	2.543	41.1	1.889	0.00224	-1.0	0.0	2000	0.0	89.2
56	0.114	0.214	4.746	3.999	11.802	3.718	41.2	1.903	0.00224	-1.0	0.0	2499	0.0	89.3
57	0.460	0.242	6.583	2.148	16.842	5.099	41.2	1.901	0.00224	-1.0	-3.0	3000	0.0	89.2
58	0.316	0.307	6.237	2.855	15.944	5.184	41.2	1.897	0.00224	-1.0	-3.0	2999	0.0	89.6
59	0.160	0.271	4.441	4.371	11.315	3.765	41.3	1.913	0.00224	-1.0	-3.0	2500	0.0	89.6
60	0.026	0.240	2.863	4.816	7.409	2.620	41.0	1.883	0.00224	-1.0	-3.0	1999	0.0	89.6
61	0.005	0.247	2.963	4.733	7.384	2.597	41.1	1.891	0.00224	-0.0	-3.0	2000	0.0	89.7
62	0.127	0.275	4.513	4.412	11.461	3.753	41.2	1.896	0.00224	-0.0	-3.0	2499	0.0	89.6
63	0.316	0.306	6.329	2.545	16.224	5.167	41.2	1.896	0.00224	-0.0	-3.0	2999	0.0	89.7
64	0.354	0.241	6.707	1.894	17.039	5.046	41.0	1.879	0.00224	-0.0	0.0	3000	0.0	89.7
65	0.186	0.194	4.837	3.883	11.882	3.667	41.1	1.891	0.00224	-0.0	0.0	2500	0.0	89.7
68	0.046	0.171	3.204	4.897	7.589	2.502	41.3	1.908	0.00224	-0.0	0.0	1999	0.0	89.8
69	0.012	0.097	2.437	1.398	6.526	2.436	20.7	0.478	0.00224	-0.0	0.0	1999	0.0	89.6
70	-0.097	0.004	1.900	1.093	0.087	2.792	5.1	0.029	0.00224	-0.0	0.0	2000	0.0	89.3
71	-0.030	0.089	-0.007	-0.030	0.017	0.072	1.4	0.002	0.00224	0.0	0.0	0	-	89.1

Continued on next page

Table F.14: Testing conditions and rotor 2 loads in the hub coordinate system for run 106.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
74	-0.013	0.000	0.004	0.000	-0.015	0.000	0.0	0.000	0.00225	0.0	0.0	0	-	87.4

Run 107: Concept Quadrotor, Side-by-Side, Hover

Table F.15: Run 107 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R2
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-90

Table F.16: Testing conditions and rotor 1 loads in the hub coordinate system for run 107.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.017	0.000	-0.010	0.000	-0.007	0.000	0.0	0.000	0.00225	-0.0	0.0	0	-	87.4
4	0.003	0.051	1.967	-0.627	0.833	-2.273	4.7	0.025	0.00225	0.0	0.0	2000	0.0	87.2
5	0.393	-0.028	2.561	-1.396	6.574	-2.010	20.6	0.479	0.00225	0.0	0.0	2000	0.0	87.2
6	0.558	-0.017	3.833	-1.091	9.627	-3.226	20.5	0.474	0.00225	0.0	0.0	2499	0.0	87.1
7	0.801	-0.018	5.385	-0.576	12.764	-4.715	20.6	0.477	0.00225	0.0	0.0	2999	0.0	87.2
8	0.797	-0.086	5.220	-1.234	12.491	-4.627	21.0	0.495	0.00225	0.0	-3.0	2999	0.0	87.3
9	0.564	-0.079	3.705	-1.591	9.228	-3.230	20.7	0.480	0.00225	0.0	-3.0	2500	0.0	87.3
10	0.403	-0.067	2.447	-1.592	6.282	-2.067	20.4	0.470	0.00225	0.0	-3.0	2000	0.0	87.3
11	0.388	-0.064	2.404	-1.792	6.133	-2.076	20.8	0.486	0.00225	-1.0	-3.0	2000	0.0	87.4
12	0.543	-0.079	3.663	-1.746	9.122	-3.217	20.9	0.490	0.00225	-1.0	-3.0	2499	0.0	87.4
13	0.780	-0.089	5.182	-1.519	12.243	-4.615	20.8	0.485	0.00225	-1.0	-3.0	2999	0.0	87.5
14	0.817	-0.029	5.290	-0.731	12.447	-4.703	20.4	0.468	0.00225	-1.0	0.0	2999	0.0	87.5
15	0.588	-0.022	3.730	-1.240	9.342	-3.246	20.4	0.466	0.00225	-1.0	0.0	2500	0.0	87.6
16	0.434	-0.024	2.453	-1.401	6.388	-2.046	20.4	0.468	0.00225	-1.0	0.0	2000	0.0	87.6
17	0.408	-0.024	2.406	-1.721	6.236	-2.068	20.6	0.478	0.00225	-3.0	0.0	2000	0.0	87.7
18	0.548	-0.035	3.664	-1.590	9.187	-3.227	20.6	0.478	0.00224	-3.0	0.0	2499	0.0	87.8
19	0.789	-0.044	5.182	-1.344	12.303	-4.641	20.6	0.478	0.00224	-3.0	0.0	3000	0.0	87.8
20	0.766	-0.090	5.112	-1.712	11.816	-4.679	20.9	0.488	0.00224	-3.0	-3.0	2999	0.0	87.8
21	0.536	-0.078	3.593	-2.008	8.674	-3.267	20.9	0.490	0.00224	-3.0	-3.0	2500	0.0	87.9
22	0.387	-0.073	2.338	-1.984	5.866	-2.120	20.7	0.480	0.00224	-3.0	-3.0	2000	0.0	87.9
23	0.358	-0.062	2.296	-1.875	5.604	-2.179	20.6	0.475	0.00224	-5.0	-3.0	2000	0.0	88.0
24	0.497	-0.069	3.576	-1.884	8.223	-3.357	20.7	0.481	0.00224	-5.0	-3.0	2499	0.0	88.0
25	0.722	-0.082	5.097	-1.537	11.295	-4.801	20.9	0.490	0.00224	-4.9	-3.0	3000	0.0	88.0
26	0.782	-0.053	5.115	-1.694	12.023	-4.650	20.9	0.490	0.00224	-4.9	0.0	3000	0.0	88.1
27	0.554	-0.048	3.572	-1.911	8.815	-3.251	20.7	0.479	0.00224	-4.9	0.0	2500	0.0	88.1
28	0.422	-0.033	2.291	-1.896	5.916	-2.108	20.4	0.467	0.00224	-4.9	0.0	2000	0.0	88.2
29	0.340	-0.023	2.209	-1.938	5.279	-2.248	20.7	0.483	0.00224	-10.0	0.0	2000	0.0	88.1
30	0.455	-0.031	3.513	-1.824	7.877	-3.450	21.0	0.495	0.00224	-10.0	0.0	2499	0.0	88.2
31	0.701	-0.041	5.031	-1.462	10.590	-4.933	20.8	0.483	0.00224	-10.0	0.0	3000	0.0	88.2
32	0.647	-0.072	4.955	-1.387	9.910	-5.053	20.9	0.488	0.00224	-10.0	-3.0	2999	0.0	88.2
33	0.448	-0.067	3.403	-1.803	7.155	-3.566	20.9	0.491	0.00224	-10.0	-3.0	2500	0.0	88.2
34	0.312	-0.065	2.145	-1.835	4.755	-2.327	20.3	0.463	0.00224	-10.0	-3.0	2000	0.0	88.2

Continued on next page

Table F.16: Testing conditions and rotor 1 loads in the hub coordinate system for run 107.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	0.403	-0.016	2.519	-1.424	6.582	-2.060	20.6	0.476	0.00224	0.0	0.0	2000	0.0	88.2
36	0.014	0.067	2.003	-0.938	0.602	-2.413	4.7	0.025	0.00224	0.0	0.0	2000	0.0	88.1
37	0.101	0.044	4.667	-1.834	2.098	-5.212	6.9	0.053	0.00224	0.0	0.0	2999	0.0	88.0
38	0.053	0.033	4.202	-2.638	0.736	-4.705	6.7	0.050	0.00224	0.0	0.0	2800	0.0	88.0
39	0.069	0.074	3.468	-0.591	1.360	-3.979	6.0	0.040	0.00224	0.0	0.0	2600	0.0	87.9
40	0.028	0.048	2.944	-1.611	0.350	-3.437	5.7	0.037	0.00224	0.0	0.0	2400	0.0	87.9
41	0.052	0.051	2.440	-0.583	1.333	-2.824	4.9	0.027	0.00224	0.0	0.0	2200	0.0	87.8
42	0.034	0.052	1.992	-0.636	0.953	-2.351	4.5	0.022	0.00224	0.0	0.0	2000	0.0	87.8
43	0.017	0.058	1.541	-0.778	0.615	-1.954	4.1	0.019	0.00224	0.0	0.0	1800	0.0	87.8
44	-0.004	0.062	1.132	-0.596	0.588	-1.503	3.7	0.016	0.00224	0.0	0.0	1600	0.0	87.7
45	-0.014	0.071	0.826	-0.192	0.496	-1.149	3.6	0.015	0.00224	0.0	0.0	1400	0.0	87.7
46	-0.024	0.069	0.551	-0.166	0.449	-0.857	3.2	0.012	0.00224	0.0	0.0	1200	0.0	87.7
47	-0.034	0.069	0.325	-0.280	0.225	-0.601	2.9	0.009	0.00224	0.0	0.0	1000	0.0	87.7
48	-0.037	0.076	0.113	-0.024	0.145	-0.363	2.4	0.007	0.00224	0.0	0.0	800	0.0	87.7
49	-0.023	0.071	-0.036	-0.126	0.226	-0.169	1.7	0.003	0.00224	0.0	0.0	600	0.0	87.7
50	-0.042	0.074	-0.194	-0.064	0.107	0.002	1.7	0.003	0.00224	0.0	0.0	400	0.0	87.7
51	-0.079	0.070	-0.303	-0.025	0.159	0.110	1.6	0.003	0.00224	0.0	0.0	200	0.0	87.7
52	0.003	0.000	-0.008	0.000	0.005	0.000	1.4	0.002	0.00224	0.0	0.0	0	-	87.7

Table F.17: Testing conditions and rotor 2 loads in the hub coordinate system for run 107.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.012	0.000	0.004	0.000	-0.013	0.000	0.0	0.000	0.00225	-0.0	0.0	0	-	87.4
4	-0.061	-0.059	1.910	0.883	0.128	2.759	4.7	0.025	0.00225	0.0	0.0	1999	-90.0	87.2
5	0.009	0.021	2.539	1.377	6.600	2.412	20.6	0.479	0.00225	0.0	0.0	1999	-90.0	87.2
6	0.057	0.039	3.867	1.018	9.779	3.646	20.5	0.474	0.00225	0.0	0.0	2499	-90.0	87.1
7	0.178	0.038	5.427	0.145	12.882	5.160	20.6	0.477	0.00225	0.0	0.0	2999	-90.0	87.2
8	0.196	0.111	5.243	1.052	12.569	5.010	21.0	0.495	0.00225	0.0	-3.0	3000	-90.0	87.3
9	0.124	0.096	3.670	1.629	9.264	3.574	20.7	0.480	0.00225	0.0	-3.0	2500	-90.0	87.3
10	0.059	0.073	2.368	1.767	6.157	2.406	20.4	0.470	0.00225	0.0	-3.0	2000	-90.0	87.3
11	0.033	0.079	2.354	1.927	6.048	2.412	20.8	0.486	0.00225	-1.0	-3.0	2000	-90.0	87.4
12	0.089	0.100	3.645	1.829	9.064	3.570	20.9	0.490	0.00225	-1.0	-3.0	2500	-90.0	87.4
13	0.195	0.123	5.179	1.324	12.169	4.991	20.8	0.485	0.00225	-1.0	-3.0	2999	-90.0	87.5
14	0.162	0.040	5.355	0.491	12.533	5.085	20.4	0.468	0.00225	-1.0	0.0	3000	-90.0	87.5
15	0.072	0.032	3.807	1.229	9.519	3.607	20.4	0.466	0.00225	-1.0	0.0	2500	-90.0	87.6
16	0.004	0.017	2.511	1.549	6.383	2.404	20.4	0.468	0.00225	-1.0	0.0	2000	-90.0	87.6
17	0.013	0.020	2.430	1.831	6.194	2.424	20.6	0.478	0.00225	-3.0	0.0	1999	-90.0	87.7
18	0.059	0.041	3.706	1.659	9.231	3.589	20.6	0.478	0.00224	-3.0	0.0	2499	-90.0	87.8
19	0.163	0.062	5.236	1.118	12.412	5.016	20.6	0.478	0.00224	-3.0	0.0	3000	-90.0	87.8
20	0.211	0.111	5.134	1.334	11.638	5.065	20.9	0.488	0.00224	-3.0	-3.0	2999	-90.0	87.8
21	0.116	0.084	3.576	1.828	8.640	3.614	20.9	0.490	0.00224	-3.0	-3.0	2500	-90.0	87.9
22	0.061	0.071	2.272	1.978	5.750	2.430	20.7	0.480	0.00224	-3.0	-3.0	1999	-90.0	87.9
23	0.049	0.063	2.216	1.943	5.402	2.498	20.6	0.475	0.00224	-5.0	-3.0	1999	-90.0	88.0
24	0.098	0.082	3.530	1.754	8.179	3.701	20.7	0.481	0.00224	-5.0	-3.0	2499	-90.0	88.0
25	0.186	0.105	5.099	1.300	11.107	5.176	20.9	0.490	0.00224	-4.9	-3.0	2999	-90.0	88.0
26	0.215	0.057	5.134	1.350	11.933	5.023	20.9	0.490	0.00224	-4.9	0.0	2999	-90.0	88.1
27	0.085	0.028	3.630	1.855	8.870	3.576	20.7	0.479	0.00224	-4.9	0.0	2500	-90.0	88.1
28	-0.016	0.005	2.380	1.978	5.875	2.416	20.4	0.467	0.00224	-4.9	0.0	1999	-90.0	88.2
29	0.053	-0.010	2.176	1.924	5.148	2.570	20.7	0.483	0.00224	-10.0	0.0	1999	-90.0	88.1
30	0.139	0.004	3.425	1.725	7.834	3.798	21.0	0.495	0.00224	-10.0	0.0	2499	-90.0	88.2
31	0.215	0.029	5.034	1.174	10.513	5.293	20.8	0.483	0.00224	-10.0	0.0	3000	-90.0	88.2
32	0.191	0.079	4.946	1.215	9.724	5.379	20.9	0.488	0.00224	-10.0	-3.0	3000	-90.0	88.2
33	0.101	0.062	3.389	1.681	7.134	3.859	20.9	0.491	0.00224	-10.0	-3.0	2500	-90.0	88.2
34	0.059	0.043	2.052	1.799	4.588	2.602	20.3	0.463	0.00224	-10.0	-3.0	1999	-90.0	88.2

Continued on next page

Table F.17: Testing conditions and rotor 2 loads in the hub coordinate system for run 107.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
35	0.048	0.003	2.477	1.446	6.487	2.372	20.6	0.476	0.00224	0.0	0.0	2000	-90.0	88.2
36	-0.018	-0.095	1.888	0.515	-0.001	2.694	4.7	0.025	0.00224	0.0	0.0	2000	-90.0	88.1
37	-0.059	-0.073	4.680	2.538	-0.467	5.659	6.9	0.053	0.00224	0.0	0.0	2999	-90.0	88.0
38	-0.043	-0.066	4.118	2.124	0.661	4.950	6.7	0.050	0.00224	0.0	0.0	2800	-90.0	88.0
39	-0.044	-0.080	3.411	1.648	-0.506	4.316	6.0	0.040	0.00224	0.0	0.0	2600	-90.0	87.9
40	-0.044	-0.075	2.904	1.392	0.585	3.735	5.7	0.037	0.00224	0.0	0.0	2400	-90.0	87.9
41	-0.031	-0.087	2.278	0.773	0.078	3.182	4.9	0.027	0.00224	0.0	0.0	2200	-90.0	87.8
42	-0.047	-0.076	1.890	1.339	0.209	2.731	4.5	0.022	0.00224	0.0	0.0	2000	-90.0	87.8
43	-0.057	-0.079	1.461	1.084	-0.265	2.246	4.1	0.019	0.00224	0.0	0.0	1800	-90.0	87.8
44	-0.054	-0.076	1.026	0.692	0.497	1.800	3.7	0.016	0.00224	0.0	0.0	1600	-90.0	87.7
45	-0.061	-0.091	0.706	0.376	-0.050	1.466	3.6	0.015	0.00224	0.0	0.0	1400	-90.0	87.7
46	-0.066	-0.089	0.407	0.421	-0.094	1.138	3.2	0.012	0.00224	0.0	0.0	1200	-90.0	87.7
47	-0.073	-0.084	0.184	0.339	0.095	0.886	2.9	0.009	0.00224	0.0	0.0	1000	-90.0	87.7
48	-0.069	-0.078	0.009	0.266	0.058	0.632	2.4	0.007	0.00224	0.0	0.0	800	-90.0	87.7
49	-0.077	-0.086	-0.174	0.225	0.052	0.433	1.7	0.003	0.00224	0.0	0.0	600	-90.0	87.7
50	-0.083	-0.085	-0.330	0.210	0.074	0.296	1.7	0.003	0.00224	0.0	0.0	400	-90.0	87.7
51	-0.065	-0.092	-0.364	0.179	0.051	0.207	1.6	0.003	0.00224	0.0	0.0	200	-90.0	87.7
52	0.009	0.000	0.013	0.000	-0.004	0.000	1.4	0.002	0.00224	0.0	0.0	0	-	87.7

Run 108: Concept Quadrotor, Side-by-Side

Table F.18: Run 108 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R2
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-90

Table F.19: Testing conditions and rotor 1 loads in the hub coordinate system for run 108.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
4	-0.018	0.000	-0.010	0.000	-0.008	0.000	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
5	0.051	0.020	2.056	-0.928	1.067	-2.387	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
6	0.416	-0.099	2.593	-1.589	6.604	-2.072	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
7	0.657	-0.191	3.357	-4.990	7.837	-2.165	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
8	0.919	-0.175	5.060	-4.268	12.234	-3.328	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
9	1.367	-0.204	6.986	-3.038	17.435	-4.735	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
10	1.239	-0.236	6.567	-3.589	16.427	-4.894	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
11	0.886	-0.209	4.719	-4.747	11.657	-3.460	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
12	0.616	-0.215	3.110	-5.056	7.589	-2.281	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
13	0.543	-0.213	3.038	-5.060	7.427	-2.304	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
14	0.757	-0.217	4.601	-4.975	11.432	-3.491	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
15	1.114	-0.241	6.470	-3.980	16.160	-4.893	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
16	1.306	-0.180	6.829	-3.078	17.009	-4.783	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
17	0.930	-0.140	4.940	-4.297	11.998	-3.387	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
18	0.684	-0.163	3.298	-4.952	7.647	-2.222	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
19	0.549	-0.164	3.123	-5.081	7.547	-2.292	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
20	0.752	-0.165	4.730	-4.744	11.659	-3.470	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
21	1.136	-0.188	6.586	-3.807	16.466	-4.905	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
22	1.026	-0.227	6.274	-4.467	15.448	-4.901	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
23	0.685	-0.200	4.430	-5.017	10.733	-3.492	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
24	0.447	-0.189	2.859	-5.067	7.155	-2.354	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
26	0.552	-0.187	2.666	-5.062	6.945	-2.413	40.4	1.916	0.00235	-5.0	-3.0	2000	0.0	64.1
28	0.782	-0.201	4.244	-5.071	10.395	-3.600	40.4	1.918	0.00235	-5.0	-3.0	2499	0.0	64.3
29	1.109	-0.207	6.074	-4.435	14.882	-5.043	40.4	1.920	0.00235	-4.9	-3.0	2999	0.0	64.3
30	1.232	-0.182	6.369	-4.450	15.844	-4.917	40.3	1.911	0.00235	-4.9	0.0	3000	0.0	64.4
31	0.851	-0.160	4.551	-5.078	11.134	-3.511	40.3	1.906	0.00235	-4.9	0.0	2500	0.0	64.4
32	0.620	-0.148	2.985	-5.213	7.365	-2.348	40.4	1.920	0.00235	-4.9	0.0	1999	0.0	64.5
33	0.525	-0.130	2.548	-4.893	6.424	-2.466	40.3	1.910	0.00235	-10.0	0.0	2000	0.0	64.7
34	0.711	-0.143	4.143	-4.897	9.752	-3.704	40.4	1.918	0.00235	-10.0	0.0	2499	0.0	64.8
35	1.085	-0.145	5.953	-4.447	14.043	-5.198	40.2	1.904	0.00235	-10.0	0.0	2999	0.0	64.9
36	0.998	-0.151	5.615	-4.415	12.893	-5.366	40.3	1.910	0.00235	-10.0	-3.0	2999	0.0	64.9
37	0.698	-0.138	3.830	-4.748	8.908	-3.826	40.2	1.903	0.00235	-10.0	-3.0	2500	0.0	64.9

Continued on next page

Table F.19: Testing conditions and rotor 1 loads in the hub coordinate system for run 108.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
39	0.449	-0.125	2.288	-4.588	5.798	-2.541	40.0	1.883	0.00235	-10.0	-3.0	2000	0.0	65.0
40	0.437	0.000	2.608	-1.573	6.711	-2.142	20.3	0.483	0.00235	0.0	0.0	2000	0.0	65.2
41	0.036	0.097	2.081	-0.677	0.998	-2.479	5.5	0.035	0.00235	0.0	0.0	2000	0.0	65.3
42	-0.000	0.000	-0.000	0.000	0.000	0.000	3.4	0.014	0.00235	0.0	0.0	0	-	65.3

Table F.20: Testing conditions and rotor 2 loads in the hub coordinate system for run 108.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
4	-0.012	0.000	0.004	0.000	-0.014	0.000	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
5	-0.148	-0.066	1.882	1.075	0.832	2.781	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
6	-0.022	-0.008	2.517	1.549	6.770	2.536	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
7	0.097	0.049	3.351	4.991	7.872	2.537	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
8	0.239	0.081	5.066	4.116	12.461	3.695	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
9	0.414	0.095	6.992	2.331	17.674	5.135	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
10	0.264	0.140	6.558	3.378	16.722	5.280	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
11	0.125	0.114	4.706	4.561	11.774	3.785	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
12	-0.004	0.099	3.069	5.037	7.496	2.604	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
13	-0.042	0.098	2.989	5.139	7.397	2.618	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
14	0.065	0.119	4.584	4.858	11.472	3.808	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
15	0.213	0.149	6.449	3.774	16.204	5.257	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
16	0.370	0.093	6.823	2.748	17.117	5.195	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
17	0.210	0.072	4.923	4.278	12.156	3.739	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
18	0.091	0.049	3.276	4.971	7.704	2.534	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
19	-0.003	0.061	3.082	5.161	7.512	2.609	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
20	0.102	0.079	4.709	4.686	11.744	3.808	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
21	0.256	0.097	6.586	3.454	16.522	5.287	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
22	0.134	0.142	6.256	3.941	15.377	5.263	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
23	0.009	0.122	4.410	4.843	10.702	3.797	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
24	-0.099	0.093	2.799	4.963	7.000	2.622	0.0	-0.000	-0.00000	0.0	0.0	0	0.0	0.0
26	0.104	0.092	2.617	4.980	6.874	2.638	40.4	1.916	0.00235	-5.0	-3.0	1999	-90.0	64.1
28	0.188	0.119	4.222	4.820	10.546	3.841	40.4	1.918	0.00235	-5.0	-3.0	2499	-90.0	64.3
29	0.311	0.134	6.064	3.904	15.130	5.338	40.4	1.920	0.00235	-4.9	-3.0	2999	-90.0	64.3
30	0.332	0.097	6.274	3.807	16.196	5.220	40.3	1.911	0.00235	-4.9	0.0	2999	-90.0	64.4
31	0.192	0.084	4.461	4.787	11.488	3.763	40.3	1.906	0.00235	-4.9	0.0	2500	-90.0	64.4
32	0.079	0.053	2.859	5.113	7.529	2.604	40.4	1.920	0.00235	-4.9	0.0	1999	-90.0	64.5
33	0.076	0.031	2.447	4.833	6.588	2.706	40.3	1.910	0.00235	-10.0	0.0	1999	-90.0	64.7
34	0.176	0.062	4.074	4.627	10.011	3.934	40.4	1.918	0.00235	-10.0	0.0	2499	-90.0	64.8
35	0.298	0.059	5.876	3.818	14.329	5.472	40.2	1.904	0.00235	-10.0	0.0	2999	-90.0	64.9
36	0.261	0.072	5.567	3.844	13.044	5.628	40.3	1.910	0.00235	-10.0	-3.0	2999	-90.0	64.9
37	0.160	0.070	3.796	4.496	9.127	4.040	40.2	1.903	0.00235	-10.0	-3.0	2500	-90.0	64.9

Continued on next page

Table F.20: Testing conditions and rotor 2 loads in the hub coordinate system for run 108.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
39	0.072	0.060	2.237	4.422	5.843	2.753	40.0	1.883	0.00235	-10.0	-3.0	2000	-90.0	65.0
40	-0.062	-0.039	2.567	1.474	6.582	2.444	20.3	0.483	0.00235	0.0	0.0	1999	-90.0	65.2
41	-0.094	-0.098	1.887	0.644	0.559	2.768	5.5	0.035	0.00235	0.0	0.0	2000	-90.0	65.3
42	-0.000	0.000	-0.000	0.000	0.000	0.000	3.4	0.014	0.00235	0.0	0.0	0	-	65.3

Run 109: Concept Quadrotor, Side-by-Side

Table F.21: Run 109 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R2
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-30

Table F.22: Testing conditions and rotor 1 loads in the hub coordinate system for run 109.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
4	-0.018	0.000	-0.010	0.000	-0.008	0.000	0.0	0.000	0.00235	0.0	0.0	0	-	66.1
5	0.060	0.045	1.985	-0.588	0.987	-2.392	4.3	0.022	0.00235	0.0	0.0	2000	0.0	66.4
6	0.037	0.048	2.041	-0.691	-0.007	-2.452	4.4	0.022	0.00235	0.0	0.0	1999	0.0	66.4
7	0.463	-0.074	2.618	-1.679	6.526	-2.066	20.2	0.481	0.00234	0.0	0.0	2000	0.0	66.6
8	0.608	-0.067	3.977	-1.530	9.722	-3.310	20.3	0.482	0.00234	0.0	0.0	2499	0.0	66.7
9	0.841	-0.051	5.604	-1.018	12.842	-4.878	20.1	0.474	0.00234	0.1	0.0	3000	0.0	66.8
10	0.831	-0.113	5.496	-1.699	12.664	-4.780	20.3	0.484	0.00234	0.1	-3.0	2999	0.0	67.0
11	0.635	-0.106	3.904	-1.944	9.507	-3.305	20.5	0.492	0.00234	0.1	-3.0	2500	0.0	67.1
12	0.460	-0.094	2.601	-1.897	6.435	-2.103	20.3	0.481	0.00234	0.1	-3.0	2000	0.0	67.2
13	0.421	-0.095	2.574	-2.037	6.288	-2.111	20.2	0.476	0.00234	-1.0	-3.0	2000	0.0	67.3
14	0.580	-0.108	3.881	-2.085	9.355	-3.293	20.3	0.480	0.00234	-1.0	-3.0	2499	0.0	67.4
15	0.795	-0.114	5.463	-1.849	12.475	-4.780	20.3	0.481	0.00234	-1.0	-3.0	3000	0.0	67.5
16	0.864	-0.056	5.574	-1.018	12.808	-4.863	20.3	0.483	0.00234	-1.0	0.0	3000	0.0	67.5
17	0.689	-0.068	3.913	-1.569	9.619	-3.318	20.1	0.474	0.00234	-1.0	0.0	2500	0.0	67.6
18	0.510	-0.049	2.575	-1.622	6.508	-2.075	20.0	0.468	0.00234	-1.0	0.0	2000	0.0	67.7
19	0.468	-0.050	2.498	-1.909	6.260	-2.093	20.1	0.471	0.00234	-3.0	0.0	2000	0.0	67.8
20	0.631	-0.067	3.810	-1.914	9.293	-3.300	20.0	0.468	0.00234	-3.0	0.0	2499	0.0	67.9
21	0.837	-0.066	5.389	-1.546	12.459	-4.786	20.1	0.471	0.00234	-2.9	0.0	3000	0.0	67.9
22	0.818	-0.120	5.400	-2.063	12.014	-4.822	20.3	0.480	0.00234	-3.0	-3.0	3000	0.0	68.2
23	0.610	-0.112	3.828	-2.170	8.941	-3.329	20.1	0.472	0.00234	-3.0	-3.0	2500	0.0	68.1
24	0.392	-0.088	2.516	-2.159	6.086	-2.119	20.3	0.483	0.00234	-3.0	-3.0	2000	0.0	68.4
25	0.373	-0.083	2.483	-2.151	5.764	-2.187	20.3	0.481	0.00234	-5.0	-3.0	2000	0.0	68.5
26	0.524	-0.092	3.796	-2.122	8.552	-3.409	20.4	0.485	0.00233	-5.0	-3.0	2499	0.0	68.6
27	0.732	-0.102	5.361	-1.926	11.579	-4.932	20.7	0.499	0.00233	-5.0	-3.0	3000	0.0	68.6
28	0.769	-0.100	5.375	-1.910	11.484	-4.944	20.3	0.480	0.00233	-5.0	-3.0	2999	0.0	68.8
29	0.866	-0.076	5.308	-1.917	12.071	-4.765	20.1	0.473	0.00233	-5.0	0.0	2999	0.0	68.8
30	0.636	-0.074	3.777	-2.177	9.111	-3.289	20.5	0.489	0.00233	-5.0	0.0	2500	0.0	68.9
31	0.458	-0.056	2.481	-2.188	6.144	-2.113	20.6	0.495	0.00233	-5.0	0.0	2000	0.0	69.0
32	0.395	-0.032	2.349	-2.048	5.374	-2.252	20.2	0.478	0.00233	-10.0	0.0	2000	0.0	69.1
33	0.528	-0.047	3.684	-1.958	8.013	-3.496	20.4	0.483	0.00233	-10.0	0.0	2499	0.0	69.2
35	0.761	-0.041	5.285	-1.654	10.812	-5.039	20.3	0.479	0.00233	-10.0	0.0	2999	0.0	69.5
36	0.674	-0.051	5.247	-1.638	10.151	-5.190	20.4	0.483	0.00233	-10.0	-3.0	2999	0.0	69.5

Continued on next page

Table F.22: Testing conditions and rotor 1 loads in the hub coordinate system for run 109.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
37	0.493	-0.057	3.641	-1.870	7.387	-3.622	20.2	0.474	0.00233	-10.0	-3.0	2500	0.0	69.6
38	0.307	-0.038	2.328	-2.058	4.986	-2.344	20.3	0.481	0.00233	-10.0	-3.0	2000	0.0	69.8
39	0.435	-0.127	2.369	-4.758	5.930	-2.468	40.4	1.895	0.00232	-10.0	-3.0	2000	0.0	70.5
40	0.602	-0.133	3.858	-4.652	9.013	-3.710	40.4	1.895	0.00232	-10.0	-3.0	2499	0.0	70.6
41	0.922	-0.165	5.674	-4.419	13.006	-5.248	40.3	1.887	0.00232	-10.0	-3.0	2999	0.0	70.9
42	1.051	-0.152	5.981	-4.464	14.062	-5.055	40.5	1.905	0.00232	-10.0	0.0	3000	0.0	71.0
43	0.727	-0.154	4.158	-5.000	9.829	-3.601	40.7	1.920	0.00232	-10.0	0.0	2500	0.0	71.2
44	0.514	-0.135	2.606	-4.968	6.439	-2.401	40.5	1.909	0.00232	-10.0	0.0	2000	0.0	71.2
45	0.530	-0.142	3.047	-5.284	7.366	-2.290	40.3	1.887	0.00232	-5.0	0.0	1999	0.0	71.4
46	0.749	-0.137	4.584	-4.965	11.115	-3.435	40.3	1.882	0.00232	-5.0	0.0	2499	0.0	71.5
47	1.127	-0.165	6.420	-4.448	15.795	-4.828	40.3	1.884	0.00232	-5.0	0.0	2999	0.0	71.5
48	1.078	-0.190	6.144	-4.423	14.823	-4.925	40.5	1.903	0.00232	-5.0	-3.0	2999	0.0	71.5
49	0.713	-0.172	4.269	-4.992	10.328	-3.499	40.3	1.886	0.00232	-5.0	-3.0	2500	0.0	71.7
50	0.497	-0.153	2.701	-4.989	6.853	-2.342	40.2	1.876	0.00232	-5.0	-3.0	2000	0.0	71.7
51	0.510	-0.156	2.890	-5.228	7.298	-2.303	40.5	1.907	0.00232	-3.0	-3.0	2000	0.0	71.8
52	0.729	-0.177	4.478	-5.312	11.034	-3.426	40.6	1.910	0.00232	-3.0	-3.0	2499	0.0	71.9
53	1.132	-0.197	6.279	-4.442	15.392	-4.838	40.6	1.911	0.00232	-3.0	-3.0	2999	0.0	71.9
54	1.192	-0.150	6.622	-3.668	16.336	-4.824	40.4	1.895	0.00232	-3.0	0.0	2999	0.0	72.0
55	0.815	-0.130	4.813	-4.669	11.564	-3.421	40.3	1.883	0.00232	-3.0	0.0	2500	0.0	72.0
56	0.561	-0.126	3.168	-5.133	7.403	-2.255	40.3	1.886	0.00232	-3.0	0.0	2000	0.0	72.1
57	0.546	-0.117	3.397	-5.189	7.526	-2.167	40.4	1.895	0.00232	-1.0	0.0	1999	0.0	72.1
58	0.793	-0.116	5.089	-4.452	12.038	-3.319	40.6	1.907	0.00232	-1.0	0.0	2499	0.0	72.1
59	1.197	-0.126	6.962	-3.147	16.985	-4.704	40.5	1.904	0.00232	-1.0	0.0	3000	0.0	72.2
60	1.143	-0.181	6.440	-3.985	15.938	-4.857	40.3	1.881	0.00232	-1.0	-3.0	3000	0.0	72.3
61	0.795	-0.157	4.666	-4.954	11.324	-3.474	40.5	1.901	0.00232	-1.0	-3.0	2500	0.0	72.4
62	0.537	-0.143	3.117	-5.134	7.398	-2.293	40.6	1.913	0.00232	-1.0	-3.0	2000	0.0	72.5
63	0.527	-0.144	3.199	-5.342	7.547	-2.250	40.6	1.905	0.00232	-0.0	-3.0	2000	0.0	72.5
64	0.752	-0.153	4.808	-4.852	11.713	-3.420	40.4	1.892	0.00232	-0.0	-3.0	2499	0.0	72.6
66	1.158	-0.173	6.626	-3.657	16.392	-4.853	40.5	1.903	0.00232	0.0	-3.0	3000	0.0	72.6
67	1.249	-0.135	7.068	-3.125	17.212	-4.704	40.6	1.906	0.00232	0.0	0.0	2999	0.0	72.6
68	0.829	-0.124	5.150	-4.466	12.009	-3.331	40.5	1.898	0.00232	0.0	0.0	2500	0.0	72.7
69	0.567	-0.111	3.508	-5.128	7.497	-2.159	40.4	1.890	0.00231	0.0	0.0	2000	0.0	72.8
70	0.439	-0.016	2.706	-1.594	6.904	-2.086	20.4	0.484	0.00232	0.0	0.0	1999	0.0	72.8

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Table F.22: Testing conditions and rotor 1 loads in the hub coordinate system for run 109.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
71	0.093	0.034	2.198	-0.595	2.378	-2.424	3.5	0.014	0.00232	0.0	0.0	2000	0.0	72.8
72	0.004	0.000	-0.008	0.000	0.006	0.000	1.5	0.002	0.00232	0.0	0.0	0	-	72.7

Table F.23: Testing conditions and rotor 2 loads in the hub coordinate system for run 109.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
4	-0.012	0.000	0.004	0.000	-0.014	0.000	0.0	0.000	0.00235	0.0	0.0	0	-	66.1
5	-0.117	-0.069	2.048	1.384	0.594	2.787	4.3	0.022	0.00235	0.0	0.0	2000	0.0	66.4
6	-0.128	-0.074	1.981	0.996	0.464	2.757	4.4	0.022	0.00235	0.0	0.0	2000	-30.0	66.4
7	-0.122	0.002	2.662	1.392	6.788	2.498	20.2	0.481	0.00234	0.0	0.0	2000	-30.0	66.6
8	-0.072	-0.003	4.016	1.151	9.959	3.764	20.3	0.482	0.00234	0.0	0.0	2499	-30.0	66.7
9	-0.002	0.016	5.659	0.389	13.011	5.308	20.1	0.474	0.00234	0.1	0.0	2999	-30.0	66.8
10	0.110	0.080	5.353	1.364	12.715	5.166	20.3	0.484	0.00234	0.1	-3.0	3000	-30.0	67.0
11	0.031	0.060	3.771	1.883	9.442	3.697	20.5	0.492	0.00234	0.1	-3.0	2500	-30.0	67.1
12	-0.024	0.051	2.427	1.834	6.376	2.482	20.3	0.481	0.00234	0.1	-3.0	2000	-30.0	67.2
13	-0.030	0.058	2.392	1.934	6.261	2.494	20.2	0.476	0.00234	-1.0	-3.0	2000	-30.0	67.3
14	0.016	0.070	3.730	1.941	9.282	3.700	20.3	0.480	0.00234	-1.0	-3.0	2499	-30.0	67.4
15	0.104	0.088	5.302	1.351	12.461	5.178	20.3	0.481	0.00234	-1.0	-3.0	2999	-30.0	67.5
16	0.032	0.025	5.585	0.574	12.952	5.269	20.3	0.483	0.00234	-1.0	0.0	3000	-30.0	67.5
17	-0.085	0.003	4.004	1.300	9.767	3.742	20.1	0.474	0.00234	-1.0	0.0	2500	-30.0	67.6
18	-0.157	0.000	2.672	1.517	6.607	2.497	20.0	0.468	0.00234	-1.0	0.0	1999	-30.0	67.7
19	-0.178	0.006	2.622	1.731	6.393	2.521	20.1	0.471	0.00234	-3.0	0.0	2000	-30.0	67.8
20	-0.143	0.016	3.959	1.734	9.395	3.723	20.0	0.468	0.00234	-3.0	0.0	2499	-30.0	67.9
21	-0.039	0.035	5.521	1.108	12.695	5.194	20.1	0.471	0.00234	-2.9	0.0	2999	-30.0	67.9
22	0.121	0.091	5.262	1.319	11.952	5.253	20.3	0.480	0.00234	-3.0	-3.0	3000	-30.0	68.2
23	0.043	0.061	3.651	1.907	8.752	3.770	20.1	0.472	0.00234	-3.0	-3.0	2500	-30.0	68.1
24	-0.042	0.060	2.345	2.002	6.016	2.537	20.3	0.483	0.00234	-3.0	-3.0	2000	-30.0	68.4
25	-0.039	0.059	2.291	1.963	5.583	2.610	20.3	0.481	0.00234	-5.0	-3.0	1999	-30.0	68.5
26	0.005	0.061	3.649	1.855	8.423	3.857	20.4	0.485	0.00233	-5.0	-3.0	2499	-30.0	68.6
27	0.084	0.075	5.266	1.290	11.535	5.372	20.7	0.499	0.00233	-5.0	-3.0	3000	-30.0	68.6
28	0.119	0.079	5.231	1.147	11.400	5.356	20.3	0.480	0.00233	-5.0	-3.0	3000	-30.0	68.8
29	-0.024	0.047	5.447	1.298	12.155	5.219	20.1	0.473	0.00233	-5.0	0.0	2999	-30.0	68.8
30	-0.066	0.027	3.828	1.850	9.210	3.728	20.5	0.489	0.00233	-5.0	0.0	2500	-30.0	68.9
31	-0.098	0.014	2.476	1.993	6.252	2.521	20.6	0.495	0.00233	-5.0	0.0	2000	-30.0	69.0
32	-0.135	0.001	2.396	1.974	5.312	2.680	20.2	0.478	0.00233	-10.0	0.0	1999	-30.0	69.1
33	-0.086	-0.000	3.696	1.799	8.034	3.942	20.4	0.483	0.00233	-10.0	0.0	2499	-30.0	69.2
35	0.002	0.017	5.315	1.304	10.820	5.479	20.3	0.479	0.00233	-10.0	0.0	2999	-30.0	69.5
36	0.082	0.051	5.099	1.226	10.070	5.557	20.4	0.483	0.00233	-10.0	-3.0	3000	-30.0	69.5

Continued on next page

Table F.23: Testing conditions and rotor 2 loads in the hub coordinate system for run 109.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
37	0.022	0.035	3.478	1.697	7.193	4.001	20.2	0.474	0.00233	-10.0	-3.0	2500	-30.0	69.6
38	-0.069	0.037	2.175	1.935	4.819	2.716	20.3	0.481	0.00233	-10.0	-3.0	1999	-30.0	69.8
39	0.003	0.091	2.203	4.413	5.633	2.789	40.4	1.895	0.00232	-10.0	-3.0	2000	-30.0	70.5
40	0.070	0.098	3.695	4.313	8.699	4.076	40.4	1.895	0.00232	-10.0	-3.0	2499	-30.0	70.6
41	0.201	0.131	5.492	3.742	12.619	5.631	40.3	1.887	0.00232	-10.0	-3.0	2999	-30.0	70.9
42	0.255	0.106	5.796	3.545	13.975	5.482	40.5	1.905	0.00232	-10.0	0.0	2999	-30.0	71.0
43	0.120	0.086	4.053	4.425	9.861	3.931	40.7	1.920	0.00232	-10.0	0.0	2500	-30.0	71.2
44	0.029	0.061	2.401	4.619	6.348	2.736	40.5	1.909	0.00232	-10.0	0.0	2000	-30.0	71.2
45	0.014	0.082	2.845	4.966	7.518	2.595	40.3	1.887	0.00232	-5.0	0.0	2000	-30.0	71.4
46	0.122	0.106	4.422	4.653	11.280	3.746	40.3	1.882	0.00232	-5.0	0.0	2500	-30.0	71.5
47	0.285	0.152	6.236	3.547	15.785	5.157	40.3	1.884	0.00232	-5.0	0.0	3000	-30.0	71.5
48	0.267	0.168	5.970	3.597	14.684	5.338	40.5	1.903	0.00232	-5.0	-3.0	2999	-30.0	71.5
49	0.136	0.147	4.161	4.502	10.261	3.862	40.3	1.886	0.00232	-5.0	-3.0	2500	-30.0	71.7
50	0.032	0.115	2.580	4.700	6.831	2.651	40.2	1.876	0.00232	-5.0	-3.0	2000	-30.0	71.7
51	0.008	0.127	2.763	5.066	7.453	2.603	40.5	1.907	0.00232	-3.0	-3.0	1999	-30.0	71.8
52	0.116	0.158	4.387	4.690	11.182	3.763	40.6	1.910	0.00232	-3.0	-3.0	2499	-30.0	71.9
53	0.290	0.202	6.187	3.716	15.605	5.178	40.6	1.911	0.00232	-3.0	-3.0	3000	-30.0	71.9
54	0.318	0.155	6.439	2.998	16.545	5.230	40.4	1.895	0.00232	-3.0	0.0	3000	-30.0	72.0
55	0.151	0.096	4.618	4.377	11.712	3.760	40.3	1.883	0.00232	-3.0	0.0	2500	-30.0	72.0
56	0.028	0.080	2.992	4.944	7.600	2.581	40.3	1.886	0.00232	-3.0	0.0	2000	-30.0	72.1
57	0.007	0.079	3.196	4.829	7.698	2.516	40.4	1.895	0.00232	-1.0	0.0	1999	-30.0	72.1
58	0.119	0.097	4.914	4.013	12.210	3.666	40.6	1.907	0.00232	-1.0	0.0	2499	-30.0	72.1
59	0.324	0.129	6.787	2.138	17.274	5.093	40.5	1.904	0.00232	-1.0	0.0	2999	-30.0	72.2
60	0.311	0.197	6.398	3.241	16.378	5.185	40.3	1.881	0.00232	-1.0	-3.0	2999	-30.0	72.3
61	0.160	0.158	4.525	4.565	11.378	3.725	40.5	1.901	0.00232	-1.0	-3.0	2500	-30.0	72.4
62	0.024	0.137	2.936	5.074	7.545	2.568	40.6	1.913	0.00232	-1.0	-3.0	1999	-30.0	72.5
63	0.028	0.133	3.009	4.909	7.526	2.553	40.6	1.905	0.00232	-0.0	-3.0	2000	-30.0	72.5
64	0.141	0.147	4.668	4.248	11.754	3.726	40.4	1.892	0.00232	-0.0	-3.0	2499	-30.0	72.6
66	0.324	0.183	6.547	2.847	16.803	5.150	40.5	1.903	0.00232	0.0	-3.0	2999	-30.0	72.6
67	0.357	0.129	6.923	2.101	17.645	5.034	40.6	1.906	0.00232	0.0	0.0	2999	-30.0	72.6
68	0.146	0.085	5.033	3.985	12.346	3.620	40.5	1.898	0.00232	0.0	0.0	2499	-30.0	72.7
69	0.035	0.069	3.283	4.888	7.690	2.466	40.4	1.890	0.00231	0.0	0.0	1999	-30.0	72.8
70	-0.034	-0.001	2.612	1.258	6.677	2.406	20.4	0.484	0.00232	0.0	0.0	2000	-30.0	72.8

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Table F.23: Testing conditions and rotor 2 loads in the hub coordinate system for run 109.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
71	-0.040	-0.042	2.113	0.579	2.259	2.666	3.5	0.014	0.00232	0.0	0.0	2000	-30.0	72.8
72	0.009	0.000	0.013	0.000	-0.003	0.000	1.5	0.002	0.00232	0.0	0.0	0	-	72.7

Run 111: Concept Quadrotor, Side-by-Side

Table F.24: Run 111 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R2
number of blades	2
RPM	3000 to 200 (Δ200)
model pitch	0
rotor tilt	0
phase	0

Table F.25: Testing conditions and rotor 1 loads in the hub coordinate system for run 111.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.012	0.000	-0.009	0.000	-0.004	0.000	0.4	0.000	0.00229	0.0	0.0	0	-	77.8
4	0.040	0.024	2.027	-0.592	0.928	-2.411	4.1	0.019	0.00229	0.0	0.0	1999	0.0	77.9
5	-0.072	0.012	-0.277	0.020	0.102	0.083	0.7	0.001	0.00229	0.0	0.0	200	0.0	77.9
6	-0.021	0.014	-0.117	0.012	0.050	-0.041	1.0	0.001	0.00229	0.0	0.0	399	0.0	78.0
7	0.002	0.007	0.044	0.020	0.036	-0.214	1.5	0.003	0.00229	0.0	0.0	599	0.0	78.0
8	0.014	-0.005	0.230	-0.100	0.138	-0.415	1.8	0.004	0.00229	0.0	0.0	799	0.0	78.0
9	0.006	-0.013	0.469	-0.181	0.190	-0.658	2.1	0.005	0.00229	0.0	0.0	999	0.0	78.0
10	0.008	-0.014	0.743	-0.224	0.200	-0.936	2.7	0.009	0.00229	0.0	0.0	1200	0.0	78.0
11	0.034	-0.026	1.115	-0.479	0.201	-1.302	3.1	0.011	0.00229	0.0	0.0	1399	0.0	78.0
12	0.043	-0.048	1.446	-0.698	0.271	-1.642	3.5	0.014	0.00229	0.0	0.0	1599	0.0	78.0
13	0.074	-0.056	1.840	-0.620	0.650	-2.048	4.1	0.019	0.00229	0.0	0.0	1799	0.0	78.0
14	0.097	-0.068	2.276	-0.684	0.879	-2.515	4.2	0.020	0.00229	0.0	0.0	1999	0.0	78.0
15	0.110	-0.068	2.714	-0.918	0.620	-3.035	4.5	0.023	0.00229	0.0	0.0	2199	0.0	78.1
16	0.126	-0.080	3.316	-1.261	0.503	-3.676	5.4	0.033	0.00229	0.0	0.0	2399	0.0	78.1
17	0.165	-0.088	3.909	-1.043	1.153	-4.272	5.9	0.040	0.00229	0.0	0.0	2599	0.0	78.1
18	0.198	-0.114	4.677	-1.898	1.105	-4.905	6.2	0.044	0.00229	0.0	0.0	2800	0.0	78.1
19	0.174	-0.132	5.274	-2.963	0.095	-5.636	6.8	0.053	0.00229	0.0	0.0	3000	0.0	78.1
20	0.240	-0.162	4.710	-2.253	1.788	-4.973	6.1	0.043	0.00229	0.0	0.0	2800	0.0	78.1
21	0.209	-0.145	3.961	-0.841	1.672	-4.162	6.0	0.041	0.00229	0.0	0.0	2600	0.0	78.1
22	0.168	-0.165	3.573	-1.740	0.376	-3.710	5.4	0.033	0.00229	0.0	0.0	2400	0.0	78.2
23	0.163	-0.156	2.986	-0.932	0.589	-3.099	4.9	0.028	0.00229	0.0	0.0	2200	0.0	78.2
24	0.157	-0.167	2.454	-0.641	0.441	-2.562	4.0	0.018	0.00229	0.0	0.0	2000	0.0	78.2
25	0.143	-0.174	2.187	-0.894	0.018	-2.208	3.8	0.017	0.00229	0.0	0.0	1800	0.0	78.2
26	0.134	-0.167	1.823	-0.550	-0.166	-1.847	3.4	0.013	0.00229	0.0	0.0	1600	0.0	78.3
27	0.129	-0.177	1.525	-0.407	-0.014	-1.438	3.0	0.010	0.00229	0.0	0.0	1400	0.0	78.2
28	0.128	-0.182	1.228	-0.271	-0.008	-1.130	2.8	0.009	0.00229	0.0	0.0	1200	0.0	78.3
29	0.122	-0.179	1.029	-0.120	-0.192	-0.873	2.4	0.007	0.00229	0.0	0.0	1000	0.0	78.3
30	0.135	-0.191	0.827	-0.048	-0.272	-0.647	2.0	0.004	0.00229	0.0	0.0	800	0.0	78.3
31	0.129	-0.199	0.670	0.042	-0.239	-0.445	1.1	0.002	0.00229	0.0	0.0	600	0.0	78.4
32	0.124	-0.209	0.551	0.099	-0.212	-0.290	1.1	0.001	0.00229	0.0	0.0	400	0.0	78.3
33	0.088	-0.216	0.463	0.162	-0.223	-0.191	0.7	0.001	0.00229	0.0	0.0	200	0.0	78.3
34	-0.010	0.000	-0.009	0.000	-0.003	0.000	0.7	0.001	0.00229	0.0	0.0	0	0.0	78.4

Table F.26: Testing conditions and rotor 2 loads in the hub coordinate system for run 111.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.007	0.000	0.007	0.000	-0.011	0.000	0.4	0.000	0.00229	0.0	0.0	0	-	77.8
4	-0.032	-0.094	1.931	0.840	-0.095	2.699	4.1	0.019	0.00229	0.0	0.0	1999	0.0	77.9
5	-0.044	-0.114	-0.307	0.165	0.006	0.161	0.7	0.001	0.00229	0.0	0.0	200	0.0	77.9
6	-0.064	-0.084	-0.223	0.137	0.066	0.228	1.0	0.001	0.00229	0.0	0.0	400	0.0	78.0
7	-0.044	-0.072	-0.023	0.071	0.054	0.344	1.5	0.003	0.00229	0.0	0.0	599	0.0	78.0
8	-0.021	-0.054	0.198	0.186	0.069	0.533	1.8	0.004	0.00229	0.0	0.0	799	0.0	78.0
9	-0.028	-0.045	0.418	0.251	0.017	0.758	2.1	0.005	0.00229	0.0	0.0	999	0.0	78.0
10	-0.005	-0.038	0.720	0.228	-0.037	1.026	2.7	0.009	0.00229	0.0	0.0	1199	0.0	78.0
11	0.004	-0.038	1.096	0.335	-0.025	1.365	3.1	0.011	0.00229	0.0	0.0	1399	0.0	78.0
12	0.019	-0.033	1.377	0.392	-0.122	1.639	3.5	0.014	0.00229	0.0	0.0	1599	0.0	78.0
13	0.032	-0.026	1.854	0.715	-0.244	2.077	4.1	0.019	0.00229	0.0	0.0	1799	0.0	78.0
14	0.052	-0.011	2.289	0.955	0.135	2.486	4.2	0.020	0.00229	0.0	0.0	1999	0.0	78.0
15	0.042	-0.005	2.805	1.002	0.654	2.929	4.5	0.023	0.00229	0.0	0.0	2199	0.0	78.1
16	0.062	0.015	3.485	0.758	1.442	3.509	5.4	0.033	0.00229	0.0	0.0	2399	0.0	78.1
17	0.057	0.000	4.141	1.627	-1.320	4.151	5.9	0.040	0.00229	0.0	0.0	2600	0.0	78.1
18	0.064	0.026	4.532	1.623	1.146	4.580	6.2	0.044	0.00229	0.0	0.0	2800	0.0	78.1
19	0.065	0.059	5.542	2.500	1.170	5.424	6.8	0.053	0.00229	0.0	0.0	3000	0.0	78.1
20	0.083	0.062	4.976	2.371	0.430	4.760	6.1	0.043	0.00229	0.0	0.0	2800	0.0	78.1
21	0.100	0.070	4.231	1.960	0.449	4.036	6.0	0.041	0.00229	0.0	0.0	2599	0.0	78.1
22	0.104	0.088	3.707	1.613	0.933	3.416	5.4	0.033	0.00229	0.0	0.0	2400	0.0	78.2
23	0.119	0.064	3.147	0.694	-0.043	2.850	4.9	0.028	0.00229	0.0	0.0	2200	0.0	78.2
24	0.136	0.080	2.778	0.535	0.005	2.359	4.0	0.018	0.00229	0.0	0.0	1999	0.0	78.2
25	0.127	0.087	2.356	0.498	0.151	1.856	3.8	0.017	0.00229	0.0	0.0	1800	0.0	78.2
26	0.131	0.105	2.004	0.293	0.353	1.396	3.4	0.013	0.00229	0.0	0.0	1599	0.0	78.3
27	0.152	0.109	1.673	-0.071	-0.239	1.042	3.0	0.010	0.00229	0.0	0.0	1399	0.0	78.2
28	0.155	0.116	1.449	-0.048	-0.400	0.718	2.8	0.009	0.00229	0.0	0.0	1200	0.0	78.3
29	0.165	0.127	1.241	-0.169	-0.257	0.429	2.4	0.007	0.00229	0.0	0.0	1000	0.0	78.3
30	0.192	0.138	1.093	-0.194	-0.269	0.158	2.0	0.004	0.00229	0.0	0.0	800	0.0	78.3
31	0.173	0.148	0.971	-0.189	-0.092	-0.055	1.1	0.002	0.00229	0.0	0.0	600	0.0	78.4
32	0.172	0.153	0.827	-0.344	-0.092	-0.218	1.1	0.001	0.00229	0.0	0.0	400	0.0	78.3
33	0.195	0.154	0.841	-0.356	-0.134	-0.326	0.7	0.001	0.00229	0.0	0.0	200	0.0	78.3
34	-0.004	0.000	0.008	0.000	-0.011	0.000	0.7	0.001	0.00229	0.0	0.0	0	0.0	78.4

Run 112: Concept Quadrotor, Side-by-Side

Table F.27: Run 112 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R2
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-60

Table F.28: Testing conditions and rotor 1 loads in the hub coordinate system for run 112.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
5	-0.010	0.000	-0.009	0.000	-0.003	0.000	0.5	0.000	0.00227	0.0	0.0	0	-	82.3
6	0.049	0.033	2.104	-1.024	0.502	-2.346	4.5	0.024	0.00227	0.0	0.0	2000	0.0	82.3
7	0.423	0.001	2.748	-1.413	6.564	-1.920	20.7	0.486	0.00227	0.0	0.0	1999	0.0	82.9
8	0.518	0.024	4.042	-1.128	9.766	-3.132	20.9	0.493	0.00227	0.1	0.0	2499	0.0	82.9
9	0.761	0.042	5.608	-0.598	13.004	-4.647	20.9	0.493	0.00227	0.1	0.0	3000	0.0	83.0
10	0.776	-0.026	5.406	-1.331	12.568	-4.557	20.9	0.495	0.00227	0.1	-3.0	3000	0.0	83.1
11	0.523	-0.023	3.891	-1.606	9.236	-3.134	20.5	0.478	0.00227	0.1	-3.0	2500	0.0	83.3
12	0.373	-0.022	2.636	-1.674	6.279	-1.970	20.5	0.476	0.00227	0.1	-3.0	1999	0.0	83.4
13	0.362	-0.015	2.609	-1.812	6.165	-1.973	20.6	0.480	0.00227	-1.0	-3.0	2000	0.0	83.5
14	0.490	-0.027	3.867	-1.765	9.106	-3.118	20.5	0.476	0.00227	-1.0	-3.0	2499	0.0	83.6
15	0.723	-0.039	5.371	-1.527	12.240	-4.535	20.6	0.480	0.00227	-1.0	-3.0	3000	0.0	83.6
16	0.761	0.022	5.486	-0.722	12.583	-4.616	20.6	0.478	0.00227	-1.0	0.0	2999	0.0	83.7
17	0.553	0.011	3.900	-1.234	9.425	-3.145	20.3	0.468	0.00227	-1.0	0.0	2500	0.0	83.7
18	0.372	0.016	2.663	-1.477	6.506	-1.952	20.7	0.483	0.00226	-1.0	0.0	2000	0.0	83.8
19	0.360	0.022	2.594	-1.719	6.253	-1.971	20.6	0.481	0.00226	-3.0	0.0	2000	0.0	83.9
20	0.512	-0.007	3.851	-1.598	9.263	-3.127	20.6	0.481	0.00226	-3.0	0.0	2499	0.0	83.9
21	0.732	-0.000	5.372	-1.346	12.351	-4.561	20.6	0.481	0.00226	-3.0	0.0	2999	0.0	84.0
22	0.707	-0.044	5.312	-1.721	11.874	-4.613	20.9	0.495	0.00226	-3.0	-3.0	3000	0.0	84.0
23	0.480	-0.046	3.795	-1.883	8.739	-3.183	20.7	0.483	0.00226	-3.0	-3.0	2500	0.0	84.0
24	0.324	-0.042	2.533	-1.929	5.909	-2.029	20.4	0.473	0.00226	-3.0	-3.0	2000	0.0	84.1
25	0.295	-0.020	2.497	-1.867	5.622	-2.093	20.5	0.475	0.00226	-5.0	-3.0	2000	0.0	84.2
26	0.427	-0.027	3.778	-1.786	8.266	-3.286	20.5	0.473	0.00226	-5.0	-3.0	2499	0.0	84.3
27	0.656	-0.039	5.298	-1.515	11.341	-4.747	20.9	0.492	0.00226	-5.0	-3.0	2999	0.0	84.3
28	0.739	-0.015	5.296	-1.622	11.977	-4.591	20.7	0.484	0.00226	-5.0	0.0	3000	0.0	84.4
29	0.524	-0.012	3.761	-1.829	8.866	-3.169	20.6	0.480	0.00226	-5.0	0.0	2500	0.0	84.4
30	0.376	0.001	2.466	-1.933	5.900	-2.025	20.3	0.466	0.00226	-5.0	0.0	2000	0.0	84.4
31	0.290	0.021	2.409	-1.931	5.247	-2.173	20.6	0.479	0.00226	-10.0	0.0	2000	0.0	84.6
32	0.432	0.013	3.699	-1.785	7.863	-3.391	20.7	0.483	0.00226	-10.0	0.0	2499	0.0	84.6
33	0.656	0.014	5.232	-1.422	10.567	-4.888	20.6	0.478	0.00226	-10.0	0.0	3000	0.0	84.7
34	0.601	-0.017	5.150	-1.388	9.885	-5.002	20.7	0.482	0.00226	-10.0	-3.0	3000	0.0	84.7
35	0.408	-0.019	3.607	-1.707	7.148	-3.497	20.5	0.477	0.00226	-10.0	-3.0	2500	0.0	84.7
36	0.258	0.001	2.343	-1.857	4.824	-2.247	20.6	0.480	0.00226	-10.0	-3.0	2000	0.0	84.8

Continued on next page

Table F.28: Testing conditions and rotor 1 loads in the hub coordinate system for run 112.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
37	0.402	-0.093	2.432	-4.463	5.776	-2.385	41.0	1.900	0.00226	-10.0	-3.0	2000	0.0	85.3
38	0.550	-0.111	3.872	-4.702	8.732	-3.632	41.2	1.914	0.00226	-10.0	-3.0	2499	0.0	85.3
39	0.861	-0.117	5.617	-4.270	12.507	-5.100	41.1	1.909	0.00226	-10.0	-3.0	3000	0.0	85.4
40	0.978	-0.102	5.889	-4.381	13.636	-4.938	41.0	1.896	0.00226	-10.0	0.0	2999	0.0	85.4
41	0.649	-0.112	4.130	-4.816	9.618	-3.514	40.9	1.888	0.00226	-10.0	0.0	2500	0.0	85.5
42	0.459	-0.097	2.619	-4.917	6.224	-2.336	41.2	1.910	0.00225	-10.0	0.0	1999	0.0	85.8
43	0.503	-0.100	3.047	-5.116	7.247	-2.240	41.0	1.897	0.00225	-5.0	0.0	2000	0.0	86.0
44	0.666	-0.113	4.582	-5.028	10.987	-3.369	41.2	1.916	0.00225	-5.0	0.0	2499	0.0	86.0
45	1.077	-0.137	6.347	-4.393	15.456	-4.739	41.0	1.893	0.00225	-5.0	0.0	3000	0.0	86.0
46	1.044	-0.168	6.072	-4.365	14.669	-4.809	41.1	1.904	0.00225	-5.0	-3.0	3000	0.0	86.0
47	0.687	-0.146	4.260	-5.000	10.115	-3.448	41.1	1.898	0.00225	-5.0	-3.0	2500	0.0	86.0
49	0.485	-0.139	2.757	-5.046	6.806	-2.300	41.1	1.901	0.00225	-5.0	-3.0	2000	0.0	86.2
50	0.496	-0.137	2.924	-5.108	7.111	-2.282	41.0	1.891	0.00225	-3.0	-3.0	2000	0.0	86.2
51	0.689	-0.155	4.453	-5.121	10.685	-3.382	41.1	1.898	0.00225	-3.0	-3.0	2499	0.0	86.2
52	1.051	-0.175	6.181	-4.396	15.124	-4.769	41.0	1.888	0.00225	-2.9	-3.0	3000	0.0	86.2
53	1.163	-0.119	6.543	-3.688	16.212	-4.738	41.0	1.888	0.00225	-2.9	0.0	2999	0.0	86.4
54	0.730	-0.110	4.763	-4.709	11.444	-3.337	41.1	1.897	0.00225	-2.9	0.0	2500	0.0	86.5
55	0.536	-0.110	3.195	-5.169	7.445	-2.207	41.1	1.897	0.00225	-2.9	0.0	2000	0.0	86.6
56	0.527	-0.105	3.388	-5.305	7.434	-2.144	41.2	1.911	0.00225	-1.0	0.0	1999	0.0	86.5
57	0.728	-0.101	5.005	-4.367	11.607	-3.283	41.2	1.912	0.00225	-1.0	0.0	2499	0.0	86.5
59	1.193	-0.120	6.840	-3.195	16.688	-4.647	41.2	1.909	0.00225	-1.0	0.0	2999	0.0	86.7
60	1.135	-0.179	6.388	-4.038	16.057	-4.791	40.9	1.881	0.00225	-1.0	-3.0	3000	0.0	86.7
61	0.746	-0.156	4.639	-5.153	11.287	-3.389	41.3	1.914	0.00225	-1.0	-3.0	2500	0.0	86.8
62	0.525	-0.148	3.073	-5.239	7.383	-2.274	41.2	1.905	0.00225	-1.0	-3.0	2000	0.0	86.8
63	0.515	-0.146	3.177	-5.117	7.326	-2.242	41.1	1.896	0.00225	-0.0	-3.0	2000	0.0	86.8
65	0.739	-0.140	4.689	-4.779	11.340	-3.410	41.2	1.910	0.00225	-0.0	-3.0	2499	0.0	86.8
66	1.152	-0.169	6.541	-3.705	16.150	-4.774	41.2	1.907	0.00225	0.0	-3.0	3000	0.0	86.9
67	1.221	-0.130	6.917	-3.339	17.064	-4.665	40.9	1.883	0.00225	0.0	0.0	2999	0.0	86.9
68	0.745	-0.102	5.063	-4.465	11.659	-3.315	41.0	1.890	0.00225	0.0	0.0	2500	0.0	86.9
69	0.530	-0.113	3.432	-5.058	7.335	-2.171	40.9	1.884	0.00225	0.0	0.0	1999	0.0	86.9
70	0.396	-0.006	2.555	-1.469	6.579	-2.133	20.5	0.472	0.00225	-0.0	0.0	2000	0.0	86.7
71	-0.023	0.102	1.993	-0.252	0.188	-2.481	5.6	0.035	0.00225	-0.0	0.0	2000	0.0	86.4
72	0.000	0.000	-0.000	0.000	0.000	0.000	2.7	0.008	0.00225	-0.0	0.0	0	-	86.3

Table F.29: Testing conditions and rotor 2 loads in the hub coordinate system for run 112.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
5	-0.004	0.000	0.008	0.000	-0.010	0.000	0.5	0.000	0.00227	0.0	0.0	0	-	82.3
6	-0.164	-0.011	1.945	1.049	0.513	2.793	4.5	0.024	0.00227	0.0	0.0	2000	-60.0	82.3
7	-0.169	0.122	2.609	1.404	6.806	2.525	20.7	0.486	0.00227	0.0	0.0	2000	-60.0	82.9
8	-0.091	0.133	3.902	1.101	10.057	3.767	20.9	0.493	0.00227	0.1	0.0	2500	-60.0	82.9
9	0.032	0.134	5.477	0.239	13.204	5.286	20.9	0.493	0.00227	0.1	0.0	3000	-60.0	83.0
10	0.008	0.199	5.328	1.099	12.807	5.134	20.9	0.495	0.00227	0.1	-3.0	3000	-60.0	83.1
11	-0.086	0.185	3.769	1.509	9.443	3.714	20.5	0.478	0.00227	0.1	-3.0	2500	-60.0	83.3
12	-0.149	0.168	2.453	1.739	6.334	2.535	20.5	0.476	0.00227	0.1	-3.0	2000	-60.0	83.4
13	-0.163	0.181	2.439	1.898	6.225	2.542	20.6	0.480	0.00227	-1.0	-3.0	2000	-60.0	83.5
14	-0.109	0.191	3.713	1.798	9.231	3.707	20.5	0.476	0.00227	-1.0	-3.0	2499	-60.0	83.6
15	-0.007	0.208	5.251	1.268	12.405	5.137	20.6	0.480	0.00227	-1.0	-3.0	2999	-60.0	83.6
16	-0.018	0.127	5.457	0.476	12.798	5.241	20.6	0.478	0.00227	-1.0	0.0	2999	-60.0	83.7
17	-0.150	0.108	3.922	1.214	9.651	3.751	20.3	0.468	0.00227	-1.0	0.0	2500	-60.0	83.7
18	-0.160	0.103	2.560	1.527	6.644	2.533	20.7	0.483	0.00226	-1.0	0.0	1999	-60.0	83.8
19	-0.209	0.106	2.518	1.842	6.399	2.553	20.6	0.481	0.00226	-3.0	0.0	2000	-60.0	83.9
20	-0.160	0.123	3.805	1.649	9.384	3.730	20.6	0.481	0.00226	-3.0	0.0	2499	-60.0	83.9
21	-0.057	0.137	5.359	1.106	12.635	5.163	20.6	0.481	0.00226	-3.0	0.0	2999	-60.0	84.0
22	0.001	0.183	5.238	1.318	11.855	5.208	20.9	0.495	0.00226	-3.0	-3.0	2999	-60.0	84.0
23	-0.073	0.157	3.670	1.875	8.731	3.745	20.7	0.483	0.00226	-3.0	-3.0	2500	-60.0	84.0
24	-0.135	0.137	2.331	1.975	5.861	2.564	20.4	0.473	0.00226	-3.0	-3.0	1999	-60.0	84.1
25	-0.152	0.140	2.302	1.926	5.590	2.628	20.5	0.475	0.00226	-5.0	-3.0	2000	-60.0	84.2
26	-0.097	0.152	3.619	1.763	8.283	3.839	20.5	0.473	0.00226	-5.0	-3.0	2500	-60.0	84.3
27	-0.007	0.173	5.208	1.293	11.317	5.325	20.9	0.492	0.00226	-5.0	-3.0	3000	-60.0	84.3
28	-0.011	0.138	5.273	1.415	11.972	5.170	20.7	0.484	0.00226	-5.0	0.0	2999	-60.0	84.4
29	-0.121	0.108	3.737	1.939	8.920	3.720	20.6	0.480	0.00226	-5.0	0.0	2500	-60.0	84.4
30	-0.236	0.088	2.492	1.964	6.058	2.545	20.3	0.466	0.00226	-5.0	0.0	2000	-60.0	84.4
31	-0.161	0.066	2.311	1.938	5.285	2.695	20.6	0.479	0.00226	-10.0	0.0	1999	-60.0	84.6
32	-0.105	0.077	3.611	1.770	7.876	3.926	20.7	0.483	0.00226	-10.0	0.0	2499	-60.0	84.6
33	0.014	0.100	5.198	1.251	10.653	5.432	20.6	0.478	0.00226	-10.0	0.0	2999	-60.0	84.7
34	0.020	0.143	5.054	1.214	9.845	5.522	20.7	0.482	0.00226	-10.0	-3.0	2999	-60.0	84.7
35	-0.065	0.130	3.474	1.681	7.117	4.000	20.5	0.477	0.00226	-10.0	-3.0	2500	-60.0	84.7
36	-0.138	0.116	2.190	1.871	4.765	2.740	20.6	0.480	0.00226	-10.0	-3.0	2000	-60.0	84.8

Continued on next page

Table F.29: Testing conditions and rotor 2 loads in the hub coordinate system for run 112.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
37	-0.041	0.148	2.200	4.308	5.566	2.801	41.0	1.900	0.00226	-10.0	-3.0	2000	-60.0	85.3
38	0.029	0.171	3.641	4.455	8.496	4.071	41.2	1.914	0.00226	-10.0	-3.0	2499	-60.0	85.3
39	0.169	0.183	5.361	3.554	12.265	5.572	41.1	1.909	0.00226	-10.0	-3.0	3000	-60.0	85.4
40	0.224	0.154	5.652	3.667	13.435	5.475	41.0	1.896	0.00226	-10.0	0.0	3000	-60.0	85.4
41	0.102	0.129	3.916	4.435	9.408	3.968	40.9	1.888	0.00226	-10.0	0.0	2500	-60.0	85.5
42	0.021	0.103	2.390	4.319	6.226	2.746	41.2	1.910	0.00225	-10.0	0.0	1999	-60.0	85.8
43	0.023	0.129	2.812	4.810	7.368	2.622	41.0	1.897	0.00225	-5.0	0.0	2000	-60.0	86.0
44	0.108	0.158	4.364	4.519	11.060	3.743	41.2	1.916	0.00225	-5.0	0.0	2500	-60.0	86.0
45	0.299	0.200	6.096	3.563	15.316	5.111	41.0	1.893	0.00225	-5.0	0.0	3000	-60.0	86.0
46	0.300	0.230	5.879	3.501	14.284	5.275	41.1	1.904	0.00225	-5.0	-3.0	3000	-60.0	86.0
47	0.164	0.201	4.091	4.485	10.087	3.834	41.1	1.898	0.00225	-5.0	-3.0	2500	-60.0	86.0
49	0.039	0.168	2.561	4.544	6.710	2.654	41.1	1.901	0.00225	-5.0	-3.0	2000	-60.0	86.2
50	0.023	0.181	2.705	4.845	7.040	2.607	41.0	1.891	0.00225	-3.0	-3.0	2000	-60.0	86.2
51	0.143	0.213	4.277	4.596	10.814	3.733	41.1	1.898	0.00225	-3.0	-3.0	2500	-60.0	86.2
52	0.302	0.236	6.040	3.391	15.105	5.134	41.0	1.888	0.00225	-2.9	-3.0	2999	-60.0	86.2
53	0.358	0.181	6.335	2.985	16.209	5.168	41.0	1.888	0.00225	-2.9	0.0	2999	-60.0	86.4
54	0.154	0.143	4.584	4.164	11.567	3.749	41.1	1.897	0.00225	-2.9	0.0	2500	-60.0	86.5
55	0.044	0.120	2.990	4.831	7.528	2.575	41.1	1.897	0.00225	-2.9	0.0	2000	-60.0	86.6
56	0.021	0.119	3.144	4.983	7.623	2.518	41.2	1.911	0.00225	-1.0	0.0	2000	-60.0	86.5
57	0.151	0.139	4.837	3.745	11.823	3.664	41.2	1.912	0.00225	-1.0	0.0	2500	-60.0	86.5
59	0.382	0.163	6.678	2.056	16.877	5.058	41.2	1.909	0.00225	-1.0	0.0	3000	-60.0	86.7
60	0.363	0.231	6.200	3.212	15.739	5.138	40.9	1.881	0.00225	-1.0	-3.0	3000	-60.0	86.7
61	0.180	0.200	4.425	4.688	11.175	3.721	41.3	1.914	0.00225	-1.0	-3.0	2500	-60.0	86.8
62	0.052	0.158	2.939	4.845	7.423	2.574	41.2	1.905	0.00225	-1.0	-3.0	1999	-60.0	86.8
63	0.045	0.156	2.968	4.898	7.472	2.553	41.1	1.896	0.00225	-0.0	-3.0	2000	-60.0	86.8
65	0.191	0.166	4.591	4.094	11.644	3.692	41.2	1.910	0.00225	-0.0	-3.0	2499	-60.0	86.8
66	0.387	0.204	6.375	2.694	16.447	5.116	41.2	1.907	0.00225	0.0	-3.0	2999	-60.0	86.9
67	0.401	0.146	6.722	2.098	16.936	5.011	40.9	1.883	0.00225	0.0	0.0	2999	-60.0	86.9
68	0.213	0.113	5.012	3.439	11.903	3.597	41.0	1.890	0.00225	0.0	0.0	2500	-60.0	86.9
69	0.078	0.079	3.244	4.750	7.600	2.460	40.9	1.884	0.00225	0.0	0.0	2000	-60.0	86.9
70	-0.011	0.011	2.512	1.333	6.511	2.404	20.5	0.472	0.00225	-0.0	0.0	1999	-60.0	86.7
71	-0.060	-0.068	1.888	0.813	0.209	2.740	5.6	0.035	0.00225	-0.0	0.0	1999	-60.0	86.4
72	0.000	0.000	-0.000	0.000	0.000	0.000	2.7	0.008	0.00225	-0.0	0.0	0	-	86.3

Run 113: Concept Quadrotor, Tandem

Table F.30: Run 113 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	0

Table F.31: Testing conditions and rotor 1 loads in the hub coordinate system for run 113.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
4	-0.018	0.000	-0.010	0.000	-0.008	0.000	0.0	0.000	0.00236	0.0	0.0	0	-	62.8
5	0.082	-0.018	2.151	-1.543	0.402	-2.442	2.8	0.010	0.00236	0.0	0.0	2000	0.0	62.8
6	0.488	-0.138	2.612	-1.812	6.783	-2.057	20.2	0.484	0.00236	0.0	0.0	2000	0.0	62.2
7	0.633	-0.157	3.948	-1.837	9.446	-3.295	20.3	0.486	0.00236	0.0	0.0	2499	0.0	62.0
8	0.830	-0.183	5.386	-1.802	11.967	-4.847	20.3	0.488	0.00236	0.0	0.0	2999	0.0	61.9
9	0.848	-0.193	5.518	-1.876	11.674	-4.867	20.3	0.487	0.00236	0.0	-3.0	2999	0.0	61.6
10	0.667	-0.183	3.978	-2.263	8.972	-3.327	20.3	0.485	0.00236	0.0	-3.0	2500	0.0	61.6
11	0.515	-0.188	2.678	-2.094	6.496	-2.086	20.2	0.484	0.00236	0.0	-3.0	2000	0.0	61.6
12	0.454	-0.172	2.599	-2.118	6.012	-2.136	20.6	0.500	0.00236	-1.0	-3.0	2000	0.0	61.6
13	0.597	-0.165	3.929	-2.129	8.576	-3.381	20.1	0.477	0.00236	-1.0	-3.0	2499	0.0	61.7
14	0.801	-0.183	5.583	-1.617	11.426	-4.914	19.9	0.468	0.00236	-1.0	-3.0	2999	0.0	61.7
15	0.914	-0.152	5.573	-1.675	12.052	-4.847	19.8	0.462	0.00236	-1.0	0.0	2999	0.0	61.7
16	0.678	-0.143	3.966	-1.788	9.223	-3.344	20.2	0.482	0.00236	-1.0	0.0	2500	0.0	61.7
17	0.524	-0.140	2.688	-1.839	6.496	-2.086	20.2	0.483	0.00236	-1.0	0.0	2000	0.0	61.7
18	0.491	-0.135	2.566	-2.098	5.926	-2.152	20.3	0.486	0.00236	-3.0	0.0	2000	0.0	61.7
19	0.638	-0.135	3.915	-2.243	8.885	-3.353	20.2	0.484	0.00236	-3.0	0.0	2499	0.0	61.7
20	0.829	-0.135	5.486	-1.857	11.652	-4.882	20.4	0.490	0.00236	-3.0	0.0	2999	0.0	61.8
21	0.787	-0.155	5.518	-1.742	10.942	-5.023	20.3	0.485	0.00236	-3.0	-3.0	2999	0.0	61.8
22	0.600	-0.140	3.857	-2.138	8.142	-3.469	20.3	0.486	0.00236	-3.0	-3.0	2500	0.0	61.8
23	0.445	-0.157	2.559	-2.172	5.682	-2.214	20.1	0.476	0.00236	-3.0	-3.0	2000	0.0	61.8
24	0.393	-0.137	2.505	-2.093	5.299	-2.298	20.1	0.477	0.00236	-5.0	-3.0	1999	0.0	61.8
25	0.502	-0.114	3.758	-1.745	7.613	-3.596	20.3	0.487	0.00236	-5.0	-3.0	2499	0.0	61.9
26	0.720	-0.119	5.432	-1.516	10.489	-5.224	20.0	0.474	0.00236	-5.0	-3.0	2999	0.0	61.9
28	0.829	-0.122	5.419	-1.634	10.827	-5.080	20.3	0.486	0.00236	-5.0	0.0	3000	0.0	61.9
29	0.634	-0.120	3.790	-1.994	8.129	-3.519	20.4	0.491	0.00236	-5.0	0.0	2500	0.0	62.0
30	0.506	-0.134	2.512	-2.315	5.841	-2.179	20.2	0.481	0.00236	-5.0	0.0	2000	0.0	62.0
31	0.411	-0.098	2.365	-2.039	5.045	-2.377	20.4	0.490	0.00236	-10.0	0.0	1999	0.0	62.0
32	0.521	-0.096	3.701	-1.943	7.285	-3.694	20.5	0.497	0.00236	-10.0	0.0	2499	0.0	62.1
33	0.699	-0.089	5.329	-1.642	9.762	-5.316	20.1	0.477	0.00236	-10.0	0.0	3000	0.0	62.1
34	0.652	-0.127	5.342	-1.682	9.188	-5.388	20.2	0.480	0.00236	-10.0	-3.0	3000	0.0	62.1
35	0.478	-0.121	3.638	-1.771	6.560	-3.773	19.8	0.465	0.00236	-10.0	-3.0	2500	0.0	62.1
37	0.323	-0.113	2.313	-2.058	4.754	-2.437	20.2	0.481	0.00236	-10.0	-3.0	2000	0.0	62.3

Continued on next page

Table F.31: Testing conditions and rotor 1 loads in the hub coordinate system for run 113.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
38	0.440	-0.196	2.313	-4.668	5.863	-2.512	40.3	1.915	0.00236	-10.0	-3.0	1999	0.0	62.4
39	0.616	-0.186	3.792	-4.839	8.889	-3.822	40.1	1.899	0.00236	-10.0	-3.0	2499	0.0	62.4
40	0.819	-0.210	5.651	-4.426	12.597	-5.401	40.1	1.901	0.00236	-10.0	0.0	3000	0.0	62.5
41	1.054	-0.192	5.936	-4.505	13.760	-5.251	40.0	1.887	0.00236	-10.0	0.0	3000	0.0	62.6
42	0.749	-0.171	4.133	-4.956	9.632	-3.724	40.0	1.886	0.00236	-10.0	0.0	2500	0.0	62.6
43	0.562	-0.179	2.602	-4.927	6.370	-2.474	40.2	1.907	0.00236	-10.0	0.0	2000	0.0	62.6
44	0.552	-0.180	2.985	-5.308	7.426	-2.342	40.2	1.907	0.00236	-5.0	0.0	2000	0.0	62.7
45	0.749	-0.185	4.524	-5.189	11.074	-3.486	40.3	1.910	0.00236	-5.0	0.0	2499	0.0	62.7
46	1.117	-0.206	6.332	-4.476	15.667	-4.896	40.0	1.890	0.00236	-5.0	0.0	2999	0.0	62.8
47	1.098	-0.216	6.050	-4.537	14.741	-5.109	40.1	1.895	0.00236	-5.0	-3.0	2999	0.0	62.8
48	0.764	-0.202	4.227	-5.136	10.323	-3.616	39.9	1.880	0.00236	-5.0	-3.0	2500	0.0	62.8
49	0.557	-0.199	2.700	-5.070	6.894	-2.418	40.2	1.902	0.00236	-5.0	-3.0	2000	0.0	62.9
50	0.529	-0.204	2.862	-5.273	7.338	-2.368	40.3	1.910	0.00236	-3.0	-3.0	1999	0.0	63.0
52	0.751	-0.210	4.429	-5.213	10.927	-3.520	40.0	1.890	0.00236	-3.0	-3.0	2499	0.0	63.1
53	1.099	-0.229	6.226	-4.515	15.443	-4.966	40.2	1.904	0.00236	-3.0	-3.0	2999	0.0	63.1
55	1.228	-0.192	6.530	-4.400	16.518	-4.939	40.1	1.898	0.00236	-3.0	0.0	2999	0.0	63.2
56	0.842	-0.168	4.761	-5.174	11.687	-3.511	40.3	1.911	0.00236	-3.0	0.0	2500	0.0	63.2
57	0.621	-0.166	3.203	-5.376	7.575	-2.329	40.4	1.920	0.00236	-3.0	0.0	2000	0.0	63.3
58	0.587	-0.159	3.390	-5.206	7.716	-2.254	40.2	1.907	0.00235	-1.0	0.0	2000	0.0	63.3
59	0.798	-0.159	4.998	-4.732	12.153	-3.432	40.3	1.908	0.00235	-1.0	0.0	2499	0.0	63.4
60	1.203	-0.185	6.783	-3.688	17.192	-4.847	40.1	1.896	0.00235	-1.0	0.0	2999	0.0	63.5
61	1.169	-0.222	6.398	-4.524	16.162	-4.914	40.1	1.893	0.00235	-1.0	-3.0	2999	0.0	63.4
62	0.795	-0.206	4.604	-5.282	11.438	-3.529	40.1	1.895	0.00235	-1.0	-3.0	2500	0.0	63.6
63	0.547	-0.188	3.031	-5.281	7.519	-2.348	39.9	1.876	0.00235	-1.0	-3.0	2000	0.0	63.6
64	0.539	-0.183	3.154	-5.250	7.630	-2.324	40.1	1.891	0.00235	-0.0	-3.0	1999	0.0	63.7
65	0.771	-0.197	4.701	-5.155	11.767	-3.506	40.0	1.882	0.00235	-0.0	-3.0	2499	0.0	63.7
66	1.167	-0.212	6.519	-4.339	16.636	-4.947	40.2	1.899	0.00235	0.0	-3.0	3000	0.0	63.7
67	1.266	-0.173	6.926	-3.623	17.477	-4.817	40.1	1.891	0.00235	0.1	0.0	3000	0.0	63.8
68	0.871	-0.123	5.131	-4.648	12.256	-3.402	40.2	1.904	0.00235	0.0	0.0	2500	0.0	63.8
69	0.614	-0.135	3.503	-5.184	7.696	-2.236	40.3	1.908	0.00235	0.1	0.0	2000	0.0	63.8
70	0.451	-0.038	2.612	-1.837	6.765	-2.156	20.2	0.481	0.00235	-0.0	0.0	2000	0.0	63.9
71	0.077	0.075	2.114	-0.111	2.289	-2.463	3.7	0.017	0.00235	-0.0	0.0	2000	0.0	64.0
72	0.000	0.000	-0.000	0.000	0.000	0.000	2.3	0.006	0.00235	-0.0	0.0	0	-	64.0

Table F.32: Testing conditions and rotor 3 loads in the hub coordinate system for run 113.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
4	-0.006	0.000	-0.005	0.000	-0.003	0.000	0.0	0.000	0.00236	0.0	0.0	0	-	62.8
5	-0.241	-0.206	1.937	-1.777	-0.210	2.915	2.8	0.010	0.00236	0.0	0.0	0	0.0	62.8
6	-0.007	-0.008	2.092	2.721	4.311	2.868	20.2	0.484	0.00236	0.0	0.0	0	0.0	62.2
7	0.086	0.074	3.304	3.291	5.838	4.265	20.3	0.486	0.00236	0.0	0.0	0	0.0	62.0
8	0.210	0.163	4.733	2.994	7.222	5.938	20.3	0.488	0.00236	0.0	0.0	0	0.0	61.9
9	0.317	0.174	4.835	3.514	7.212	6.005	20.3	0.487	0.00236	0.0	-3.0	0	0.0	61.6
10	0.249	0.112	3.322	3.211	5.532	4.319	20.3	0.485	0.00236	0.0	-3.0	0	0.0	61.6
11	0.176	0.043	2.060	2.806	3.797	2.905	20.2	0.484	0.00236	0.0	-3.0	0	0.0	61.6
12	0.175	0.040	1.999	3.101	3.685	2.927	20.6	0.500	0.00236	-1.0	-3.0	0	0.0	61.6
13	0.250	0.099	3.296	3.330	5.355	4.313	20.1	0.477	0.00236	-1.0	-3.0	0	0.0	61.7
14	0.343	0.179	4.906	3.521	7.121	5.969	19.9	0.468	0.00236	-1.0	-3.0	0	0.0	61.7
15	0.147	0.191	5.106	3.058	8.068	5.956	19.8	0.462	0.00236	-1.0	0.0	0	0.0	61.7
16	0.162	0.141	3.454	3.402	5.974	4.274	20.2	0.482	0.00236	-1.0	0.0	0	0.0	61.7
17	0.091	0.068	2.169	3.024	4.174	2.869	20.2	0.483	0.00236	-1.0	0.0	0	0.0	61.7
18	0.093	0.066	2.125	3.181	4.033	2.892	20.3	0.486	0.00236	-3.0	0.0	0	0.0	61.7
19	0.166	0.132	3.458	3.386	5.972	4.285	20.2	0.484	0.00236	-3.0	0.0	0	0.0	61.7
20	0.289	0.197	4.975	3.398	8.005	5.973	20.4	0.490	0.00236	-3.0	0.0	0	0.0	61.8
21	0.394	0.181	4.917	3.292	7.310	5.996	20.3	0.485	0.00236	-3.0	-3.0	0	0.0	61.8
22	0.310	0.119	3.265	3.338	5.246	4.307	20.3	0.486	0.00236	-3.0	-3.0	0	0.0	61.8
23	0.241	0.050	2.041	2.974	3.686	2.925	20.1	0.476	0.00236	-3.0	-3.0	0	0.0	61.8
24	0.215	0.036	1.973	2.942	3.594	2.935	20.1	0.477	0.00236	-5.0	-3.0	0	0.0	61.8
25	0.274	0.094	3.166	3.535	5.150	4.320	20.3	0.487	0.00236	-5.0	-3.0	0	0.0	61.9
26	0.362	0.142	4.789	3.096	7.121	6.004	20.0	0.474	0.00236	-5.0	-3.0	0	0.0	61.9
28	0.226	0.174	4.880	3.271	7.774	5.948	20.3	0.486	0.00236	-5.0	0.0	0	0.0	61.9
29	0.165	0.110	3.280	3.259	5.661	4.288	20.4	0.491	0.00236	-5.0	0.0	0	0.0	62.0
30	0.050	0.049	2.147	2.943	4.140	2.886	20.2	0.481	0.00236	-5.0	0.0	0	0.0	62.0
31	0.094	0.024	1.971	2.842	3.607	2.914	20.4	0.490	0.00236	-10.0	0.0	0	0.0	62.0
32	0.199	0.085	3.205	3.520	5.422	4.311	20.5	0.497	0.00236	-10.0	0.0	0	0.0	62.1
33	0.190	0.138	4.827	3.141	7.389	5.976	20.1	0.477	0.00236	-10.0	0.0	0	0.0	62.1
34	0.320	0.132	4.676	3.269	7.165	5.974	20.2	0.480	0.00236	-10.0	-3.0	0	0.0	62.1
35	0.225	0.069	3.068	3.390	4.835	4.294	19.8	0.465	0.00236	-10.0	-3.0	0	0.0	62.1
37	0.135	-0.017	1.784	2.569	3.081	2.889	20.2	0.481	0.00236	-10.0	-3.0	0	0.0	62.3

Continued on next page

Table F.32: Testing conditions and rotor 3 loads in the hub coordinate system for run 113.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
38	0.336	0.064	1.740	5.383	4.331	2.993	40.3	1.915	0.00236	-10.0	-3.0	0	0.0	62.4
39	0.487	0.168	3.013	5.804	6.700	4.356	40.1	1.899	0.00236	-10.0	-3.0	0	0.0	62.4
40	0.531	0.355	4.605	5.730	9.406	5.967	40.1	1.901	0.00236	-10.0	0.0	0	0.0	62.5
41	0.732	0.428	4.944	5.620	10.511	5.966	40.0	1.887	0.00236	-10.0	0.0	0	0.0	62.6
42	0.602	0.335	3.386	5.800	7.486	4.324	40.0	1.886	0.00236	-10.0	0.0	0	0.0	62.6
43	0.481	0.245	2.090	5.508	4.800	2.959	40.2	1.907	0.00236	-10.0	0.0	0	0.0	62.6
44	0.497	0.277	2.334	5.918	5.558	2.909	40.2	1.907	0.00236	-5.0	0.0	0	0.0	62.7
45	0.640	0.367	3.640	6.131	8.423	4.286	40.3	1.910	0.00236	-5.0	0.0	0	0.0	62.7
46	0.813	0.494	5.197	5.714	11.521	5.939	40.0	1.890	0.00236	-5.0	0.0	0	0.0	62.8
47	0.816	0.456	4.851	5.703	10.270	5.986	40.1	1.895	0.00236	-5.0	-3.0	0	0.0	62.8
48	0.670	0.367	3.327	5.941	7.400	4.348	39.9	1.880	0.00236	-5.0	-3.0	0	0.0	62.8
49	0.538	0.282	2.096	5.696	4.863	2.966	40.2	1.902	0.00236	-5.0	-3.0	0	0.0	62.9
50	0.545	0.285	2.188	5.864	5.133	2.950	40.3	1.910	0.00236	-3.0	-3.0	0	0.0	63.0
52	0.677	0.379	3.453	6.046	7.719	4.320	40.0	1.890	0.00236	-3.0	-3.0	0	0.0	63.1
53	0.816	0.466	4.948	5.855	10.550	5.965	40.2	1.904	0.00236	-3.0	-3.0	0	0.0	63.1
55	0.846	0.516	5.305	5.640	11.886	5.888	40.1	1.898	0.00236	-3.0	0.0	0	0.0	63.2
56	0.697	0.432	3.762	6.065	8.741	4.223	40.3	1.911	0.00236	-3.0	0.0	0	0.0	63.2
57	0.552	0.334	2.454	6.002	5.790	2.855	40.4	1.920	0.00236	-3.0	0.0	0	0.0	63.3
58	0.556	0.334	2.530	6.076	5.985	2.816	40.2	1.907	0.00235	-1.0	0.0	0	0.0	63.3
59	0.713	0.444	3.887	6.113	9.007	4.166	40.3	1.908	0.00235	-1.0	0.0	0	0.0	63.4
60	0.861	0.528	5.420	5.587	12.243	5.840	40.1	1.896	0.00235	-1.0	0.0	0	0.0	63.5
61	0.848	0.485	5.062	5.838	10.769	5.924	40.1	1.893	0.00235	-1.0	-3.0	0	0.0	63.4
62	0.695	0.392	3.519	5.993	7.895	4.282	40.1	1.895	0.00235	-1.0	-3.0	0	0.0	63.6
63	0.555	0.307	2.277	5.871	5.306	2.899	39.9	1.876	0.00235	-1.0	-3.0	0	0.0	63.6
64	0.557	0.301	2.308	5.964	5.390	2.908	40.1	1.891	0.00235	-0.0	-3.0	0	0.0	63.7
65	0.690	0.386	3.550	5.981	8.006	4.276	40.0	1.882	0.00235	-0.0	-3.0	0	0.0	63.7
66	0.837	0.477	5.064	5.849	10.866	5.909	40.2	1.899	0.00235	0.0	-3.0	0	0.0	63.7
67	0.882	0.520	5.424	5.527	12.315	5.823	40.1	1.891	0.00235	0.1	0.0	0	0.0	63.8
68	0.739	0.450	3.864	6.034	9.114	4.159	40.2	1.904	0.00235	0.0	0.0	0	0.0	63.8
69	0.567	0.345	2.564	6.154	6.099	2.793	40.3	1.908	0.00235	0.1	0.0	0	0.0	63.8
70	0.248	0.145	2.124	2.625	4.032	2.819	20.2	0.481	0.00235	-0.0	0.0	0	0.0	63.9
71	0.098	-0.003	1.703	0.693	0.616	2.754	3.7	0.017	0.00235	-0.0	0.0	0	0.0	64.0
72	0.000	0.000	-0.000	0.000	0.000	0.000	2.3	0.006	0.00235	-0.0	0.0	0	-	64.0

Run 114: Concept Quadrotor, Tandem

Table F.33: Run 114 operational settings for MTBII.

Feature	Value
number of rotors	NaN
rotors used	NaN
number of blades	NaN
RPM	NaN
model pitch	NaN
rotor tilt	NaN
phase	NaN

Run 116: Concept Quadrotor, Tandem

Table F.34: Run 116 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-90

Table F.35: Testing conditions and rotor 1 loads in the hub coordinate system for run 116.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.017	0.000	-0.010	0.000	-0.007	0.000	0.0	0.000	0.00227	-0.0	0.0	0	-	81.5
4	0.051	0.058	2.174	-1.582	0.886	-2.526	3.8	0.017	0.00227	0.0	0.0	2000	0.0	81.6
5	0.405	0.039	2.651	-1.742	6.580	-2.059	20.6	0.481	0.00227	-0.0	0.0	2000	0.0	82.2
6	0.524	-0.070	3.495	-5.198	7.594	-2.145	40.9	1.898	0.00227	0.0	0.0	2000	0.0	82.9
7	0.700	-0.023	5.068	-4.676	11.931	-3.283	40.9	1.893	0.00227	0.0	0.0	2499	0.0	83.1
8	1.144	-0.058	6.799	-3.425	16.940	-4.643	40.8	1.887	0.00227	0.0	0.0	2999	0.0	83.2
9	1.122	-0.107	6.442	-4.316	16.153	-4.741	41.0	1.900	0.00226	0.0	-3.0	2999	0.0	83.4
10	0.749	-0.080	4.705	-5.208	11.381	-3.376	41.1	1.913	0.00226	0.0	-3.0	2500	0.0	83.5
11	0.514	-0.090	3.205	-5.324	7.400	-2.248	40.9	1.896	0.00226	0.0	-3.0	2000	0.0	83.6
12	0.496	-0.094	3.136	-5.353	7.253	-2.269	41.0	1.905	0.00226	-1.0	-3.0	1999	0.0	84.1
14	0.709	-0.102	4.608	-5.234	10.972	-3.396	41.0	1.903	0.00226	-1.0	-3.0	2499	0.0	84.4
15	1.095	-0.142	6.385	-4.388	15.792	-4.734	41.2	1.916	0.00226	-1.0	-3.0	2999	0.0	84.5
16	1.172	-0.087	6.667	-3.792	16.616	-4.686	41.0	1.901	0.00226	-1.0	0.0	2999	0.0	84.7
17	0.740	-0.055	4.950	-4.936	11.816	-3.313	41.0	1.903	0.00226	-1.0	0.0	2500	0.0	84.8
18	0.523	-0.076	3.394	-5.355	7.554	-2.176	41.0	1.897	0.00226	-1.0	0.0	1999	0.0	84.8
19	0.499	-0.073	3.273	-5.407	7.518	-2.222	41.1	1.911	0.00226	-3.0	0.0	2000	0.0	84.9
20	0.687	-0.063	4.757	-5.348	11.467	-3.357	41.2	1.919	0.00226	-3.0	0.0	2499	0.0	85.1
21	1.096	-0.111	6.505	-4.497	16.249	-4.744	41.2	1.916	0.00226	-3.0	0.0	2999	0.0	85.1
22	1.057	-0.141	6.233	-4.510	15.195	-4.764	41.1	1.901	0.00226	-3.0	-3.0	3000	0.0	85.3
23	0.689	-0.122	4.433	-5.137	10.560	-3.412	41.1	1.901	0.00226	-3.0	-3.0	2500	0.0	85.3
24	0.470	-0.116	3.006	-5.265	7.252	-2.276	41.1	1.901	0.00226	-3.0	-3.0	2000	0.0	85.5
25	0.442	-0.108	2.808	-5.136	6.807	-2.312	40.9	1.888	0.00225	-5.0	-3.0	2000	0.0	85.7
26	0.640	-0.127	4.310	-5.253	10.087	-3.470	41.2	1.911	0.00225	-5.0	-3.0	2500	0.0	85.8
28	1.019	-0.127	6.030	-4.522	14.568	-4.899	41.2	1.911	0.00225	-5.0	-3.0	2999	0.0	85.9
29	1.089	-0.112	6.261	-4.591	15.265	-4.720	41.1	1.907	0.00225	-5.0	0.0	2999	0.0	85.9
30	0.692	-0.101	4.521	-5.232	10.907	-3.377	41.1	1.900	0.00225	-5.0	0.0	2500	0.0	85.9
31	0.490	-0.093	3.069	-5.184	7.141	-2.278	40.9	1.884	0.00225	-5.0	0.0	2000	0.0	86.0
32	0.438	-0.074	2.652	-4.957	6.320	-2.376	41.1	1.901	0.00225	-10.0	0.0	2000	0.0	86.2
33	0.581	-0.076	4.131	-4.980	9.575	-3.571	41.1	1.901	0.00225	-10.0	0.0	2499	0.0	86.3
34	0.949	-0.090	5.864	-4.585	13.748	-5.030	41.2	1.910	0.00225	-10.0	0.0	2999	0.0	86.3
35	0.874	-0.108	5.551	-4.407	12.481	-5.183	41.1	1.898	0.00225	-10.0	-3.0	2999	0.0	86.4
36	0.559	-0.101	3.835	-4.719	8.621	-3.689	41.1	1.903	0.00225	-10.0	-3.0	2500	0.0	86.4

Continued on next page

Table F.35: Testing conditions and rotor 1 loads in the hub coordinate system for run 116.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
37	0.416	-0.101	2.436	-4.682	5.846	-2.451	41.0	1.893	0.00225	-10.0	-3.0	1999	0.0	86.3
38	0.245	0.007	2.333	-1.940	4.647	-2.359	20.6	0.479	0.00225	-10.0	-3.0	2000	0.0	86.4
39	0.358	0.002	3.600	-1.861	6.898	-3.623	20.8	0.489	0.00225	-10.0	-3.0	2500	0.0	86.4
40	0.569	0.002	5.134	-1.425	9.315	-5.157	20.7	0.484	0.00225	-10.0	-3.0	2999	0.0	86.3
41	0.627	0.027	5.196	-1.356	9.877	-5.067	20.5	0.474	0.00225	-10.0	0.0	2999	0.0	86.3
42	0.428	-0.004	3.684	-1.749	7.410	-3.537	20.6	0.479	0.00225	-10.0	0.0	2500	0.0	86.2
43	0.314	-0.004	2.383	-1.947	5.037	-2.292	20.5	0.476	0.00225	-10.0	0.0	2000	0.0	86.1
44	0.342	-0.004	2.532	-2.041	5.848	-2.137	20.8	0.487	0.00225	-5.0	0.0	2000	0.0	86.1
45	0.451	-0.010	3.825	-1.869	8.495	-3.337	21.0	0.497	0.00225	-5.0	0.0	2499	0.0	86.1
46	0.465	-0.008	3.817	-1.826	8.456	-3.341	20.9	0.491	0.00225	-5.0	0.0	2499	0.0	86.1
47	0.696	0.005	5.309	-1.337	11.028	-4.833	20.6	0.476	0.00225	-5.0	0.0	2999	0.0	86.1
48	0.649	-0.028	5.280	-1.336	10.534	-4.991	20.7	0.483	0.00225	-5.0	-3.0	2999	0.0	86.1
49	0.459	-0.026	3.722	-1.809	7.883	-3.479	20.7	0.485	0.00225	-5.0	-3.0	2500	0.0	86.2
50	0.333	-0.047	2.465	-1.942	5.395	-2.253	20.5	0.475	0.00225	-5.0	-3.0	2000	0.0	86.2
51	0.344	-0.049	2.509	-1.927	5.702	-2.183	20.4	0.471	0.00225	-3.0	-3.0	2000	0.0	86.2
52	0.466	-0.033	3.764	-1.892	8.244	-3.390	20.7	0.485	0.00225	-3.0	-3.0	2499	0.0	86.2
53	0.690	-0.049	5.317	-1.386	11.135	-4.878	21.0	0.497	0.00225	-3.0	-3.0	3000	0.0	86.2
54	0.743	-0.009	5.307	-1.325	11.524	-4.737	20.5	0.474	0.00225	-3.0	0.0	2999	0.0	86.2
55	0.521	-0.018	3.744	-1.818	8.793	-3.278	20.6	0.478	0.00225	-3.0	0.0	2500	0.0	86.2
56	0.391	-0.030	2.486	-1.972	6.077	-2.110	20.5	0.475	0.00225	-3.0	0.0	2000	0.0	86.2
57	0.402	-0.019	2.551	-1.774	6.467	-2.083	20.5	0.472	0.00225	-1.0	0.0	2000	0.0	86.2
58	0.520	-0.004	3.765	-1.660	9.275	-3.239	20.5	0.471	0.00225	-1.0	0.0	2499	0.0	86.1
59	0.753	-0.019	5.297	-1.298	12.083	-4.672	20.4	0.470	0.00225	-1.0	0.0	3000	0.0	86.2
61	0.719	-0.058	5.299	-1.377	11.399	-4.797	20.6	0.477	0.00225	-1.0	-3.0	3000	0.0	86.3
62	0.507	-0.057	3.742	-1.838	8.570	-3.328	20.4	0.469	0.00225	-1.0	-3.0	2500	0.0	86.2
63	0.372	-0.064	2.479	-2.005	6.017	-2.142	20.8	0.488	0.00225	-1.0	-3.0	2000	0.0	86.3
64	0.376	-0.062	2.488	-1.998	6.195	-2.119	20.9	0.492	0.00225	0.0	-3.0	2000	0.0	86.3
65	0.507	-0.064	3.728	-1.923	8.956	-3.286	20.9	0.490	0.00225	0.0	-3.0	2499	0.0	86.3
66	0.728	-0.068	5.278	-1.421	11.762	-4.741	20.7	0.484	0.00225	0.0	-3.0	2999	0.0	86.3
67	0.784	-0.030	5.288	-1.193	12.413	-4.679	20.5	0.475	0.00225	0.0	0.0	3000	0.0	86.2
68	0.548	-0.025	3.731	-1.576	9.454	-3.264	20.4	0.466	0.00225	0.0	0.0	2500	0.0	86.3
69	0.397	-0.030	2.564	-1.663	6.688	-2.099	20.8	0.487	0.00225	0.0	0.0	2000	0.0	86.2
70	0.036	0.094	1.992	0.327	1.285	-2.441	4.3	0.021	0.00225	0.0	0.0	2000	0.0	86.3

Continued on next page

Table F.35: Testing conditions and rotor 1 loads in the hub coordinate system for run 116.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
71	0.009	0.000	-0.008	0.000	0.009	0.000	1.8	0.004	0.00225	0.0	0.0	0	-	86.2

Table F.36: Testing conditions and rotor 3 loads in the hub coordinate system for run 116.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.005	0.000	-0.005	0.000	-0.002	0.000	0.0	0.000	0.00227	-0.0	0.0	0	-	81.5
4	0.071	-0.102	1.976	-1.893	-0.501	2.776	3.8	0.017	0.00227	0.0	0.0	0	-90.0	81.6
5	0.206	0.254	2.071	2.593	3.946	2.749	20.6	0.481	0.00227	-0.0	0.0	0	-90.0	82.2
6	0.520	0.414	2.496	5.959	6.152	2.713	40.9	1.898	0.00227	0.0	0.0	0	-90.0	82.9
7	0.713	0.512	3.767	5.929	8.975	4.028	40.9	1.893	0.00227	0.0	0.0	0	-90.0	83.1
8	0.887	0.605	5.243	5.308	12.198	5.621	40.8	1.887	0.00227	0.0	0.0	0	-90.0	83.2
9	0.851	0.572	4.928	5.402	10.703	5.704	41.0	1.900	0.00226	0.0	-3.0	0	-90.0	83.4
10	0.714	0.502	3.482	5.756	7.949	4.126	41.1	1.913	0.00226	0.0	-3.0	0	-90.0	83.5
11	0.561	0.433	2.280	5.616	5.392	2.802	40.9	1.896	0.00226	0.0	-3.0	0	-90.0	83.6
12	0.552	0.429	2.260	5.761	5.405	2.813	41.0	1.905	0.00226	-1.0	-3.0	0	-90.0	84.1
14	0.710	0.495	3.446	5.795	7.818	4.142	41.0	1.903	0.00226	-1.0	-3.0	0	-90.0	84.4
15	0.860	0.568	4.882	5.583	10.562	5.718	41.2	1.916	0.00226	-1.0	-3.0	0	-90.0	84.5
16	0.895	0.614	5.207	5.213	11.973	5.635	41.0	1.901	0.00226	-1.0	0.0	0	-90.0	84.7
17	0.742	0.536	3.727	5.620	8.888	4.040	41.0	1.903	0.00226	-1.0	0.0	0	-90.0	84.8
18	0.575	0.466	2.483	5.671	6.064	2.715	41.0	1.897	0.00226	-1.0	0.0	0	-90.0	84.8
19	0.554	0.449	2.423	5.675	5.937	2.741	41.1	1.911	0.00226	-3.0	0.0	0	-90.0	84.9
20	0.734	0.523	3.671	5.690	8.714	4.072	41.2	1.919	0.00226	-3.0	0.0	0	-90.0	85.1
21	0.890	0.597	5.165	5.228	11.784	5.658	41.2	1.916	0.00226	-3.0	0.0	0	-90.0	85.1
22	0.836	0.556	4.815	5.350	10.311	5.711	41.1	1.901	0.00226	-3.0	-3.0	0	-90.0	85.3
23	0.702	0.485	3.361	5.824	7.625	4.143	41.1	1.901	0.00226	-3.0	-3.0	0	-90.0	85.3
24	0.552	0.406	2.191	5.560	5.187	2.817	41.1	1.901	0.00226	-3.0	-3.0	0	-90.0	85.5
25	0.540	0.382	2.061	5.321	4.886	2.835	40.9	1.888	0.00225	-5.0	-3.0	0	-90.0	85.7
26	0.698	0.462	3.296	5.557	7.467	4.152	41.2	1.911	0.00225	-5.0	-3.0	0	-90.0	85.8
28	0.844	0.538	4.713	5.292	10.165	5.708	41.2	1.911	0.00225	-5.0	-3.0	0	-90.0	85.9
29	0.877	0.578	5.039	5.218	11.198	5.665	41.1	1.907	0.00225	-5.0	0.0	0	-90.0	85.9
30	0.715	0.503	3.558	5.591	8.242	4.089	41.1	1.900	0.00225	-5.0	0.0	0	-90.0	85.9
31	0.569	0.429	2.319	5.598	5.615	2.769	40.9	1.884	0.00225	-5.0	0.0	0	-90.0	86.0
32	0.559	0.370	2.021	5.239	4.775	2.838	41.1	1.901	0.00225	-10.0	0.0	0	-90.0	86.2
33	0.706	0.453	3.275	5.452	7.359	4.137	41.1	1.901	0.00225	-10.0	0.0	0	-90.0	86.3
34	0.852	0.528	4.750	5.107	10.228	5.698	41.2	1.910	0.00225	-10.0	0.0	0	-90.0	86.3
35	0.819	0.493	4.427	5.331	9.198	5.697	41.1	1.898	0.00225	-10.0	-3.0	0	-90.0	86.4
36	0.656	0.406	2.948	5.319	6.390	4.133	41.1	1.903	0.00225	-10.0	-3.0	0	-90.0	86.4

Continued on next page

Table F.36: Testing conditions and rotor 3 loads in the hub coordinate system for run 116.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
37	0.531	0.324	1.805	4.850	4.221	2.826	41.0	1.893	0.00225	-10.0	-3.0	0	-90.0	86.3
38	0.340	0.216	1.814	2.396	2.945	2.749	20.6	0.479	0.00225	-10.0	-3.0	0	-90.0	86.4
39	0.407	0.268	2.992	2.575	4.510	4.062	20.8	0.489	0.00225	-10.0	-3.0	0	-90.0	86.4
40	0.456	0.326	4.449	2.389	6.175	5.624	20.7	0.484	0.00225	-10.0	-3.0	0	-90.0	86.3
41	0.409	0.335	4.570	2.349	6.751	5.621	20.5	0.474	0.00225	-10.0	0.0	0	-90.0	86.3
42	0.323	0.266	3.088	2.574	4.979	4.064	20.6	0.479	0.00225	-10.0	0.0	0	-90.0	86.2
43	0.223	0.213	1.902	2.397	3.312	2.756	20.5	0.476	0.00225	-10.0	0.0	0	-90.0	86.1
44	0.274	0.211	1.964	2.532	3.650	2.742	20.8	0.487	0.00225	-5.0	0.0	0	-90.0	86.1
45	0.402	0.264	3.172	2.630	5.345	4.052	21.0	0.497	0.00225	-5.0	0.0	0	-90.0	86.1
46	0.394	0.271	3.203	2.657	5.323	4.050	20.9	0.491	0.00225	-5.0	0.0	0	-90.0	86.1
47	0.408	0.325	4.670	2.555	7.163	5.629	20.6	0.476	0.00225	-5.0	0.0	0	-90.0	86.1
48	0.472	0.310	4.539	2.546	6.528	5.637	20.7	0.483	0.00225	-5.0	-3.0	0	-90.0	86.1
49	0.387	0.252	3.077	2.658	4.786	4.065	20.7	0.485	0.00225	-5.0	-3.0	0	-90.0	86.2
50	0.313	0.185	1.889	2.472	3.200	2.755	20.5	0.475	0.00225	-5.0	-3.0	0	-90.0	86.2
51	0.311	0.177	1.902	2.494	3.254	2.747	20.4	0.471	0.00225	-3.0	-3.0	0	-90.0	86.2
52	0.391	0.240	3.093	2.644	4.858	4.071	20.7	0.485	0.00225	-3.0	-3.0	0	-90.0	86.2
53	0.472	0.305	4.578	2.569	6.597	5.639	21.0	0.497	0.00225	-3.0	-3.0	0	-90.0	86.2
54	0.416	0.311	4.731	2.522	7.262	5.620	20.5	0.474	0.00225	-3.0	0.0	0	-90.0	86.2
55	0.342	0.252	3.209	2.626	5.440	4.039	20.6	0.478	0.00225	-3.0	0.0	0	-90.0	86.2
56	0.260	0.185	1.992	2.529	3.732	2.728	20.5	0.475	0.00225	-3.0	0.0	0	-90.0	86.2
57	0.263	0.192	2.011	2.500	3.860	2.717	20.5	0.472	0.00225	-1.0	0.0	0	-90.0	86.2
58	0.337	0.239	3.228	2.584	5.528	4.032	20.5	0.471	0.00225	-1.0	0.0	0	-90.0	86.1
59	0.427	0.305	4.748	2.414	7.410	5.624	20.4	0.470	0.00225	-1.0	0.0	0	-90.0	86.2
61	0.497	0.291	4.603	2.598	6.559	5.629	20.6	0.477	0.00225	-1.0	-3.0	0	-90.0	86.3
62	0.417	0.233	3.102	2.695	4.846	4.051	20.4	0.469	0.00225	-1.0	-3.0	0	-90.0	86.2
63	0.339	0.162	1.899	2.585	3.349	2.739	20.8	0.488	0.00225	-1.0	-3.0	0	-90.0	86.3
64	0.340	0.165	1.891	2.625	3.397	2.739	20.9	0.492	0.00225	0.0	-3.0	0	-90.0	86.3
65	0.417	0.224	3.100	2.812	4.933	4.054	20.9	0.490	0.00225	0.0	-3.0	0	-90.0	86.3
66	0.513	0.276	4.605	2.583	6.581	5.624	20.7	0.484	0.00225	0.0	-3.0	0	-90.0	86.3
67	0.495	0.302	4.756	2.418	7.378	5.610	20.5	0.475	0.00225	0.0	0.0	0	-90.0	86.2
68	0.370	0.249	3.233	2.608	5.505	4.026	20.4	0.466	0.00225	0.0	0.0	0	-90.0	86.3
69	0.394	0.177	1.995	2.634	3.899	2.707	20.8	0.487	0.00225	0.0	0.0	0	-90.0	86.2
70	0.096	-0.046	1.691	-0.138	-0.478	2.572	4.3	0.021	0.00225	0.0	0.0	0	0.0	86.3

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Table F.36: Testing conditions and rotor 3 loads in the hub coordinate system for run 116.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
71	-0.024	0.000	0.004	0.000	0.028	0.000	1.8	0.004	0.00225	0.0	0.0	0	-	86.2

Run 117: Concept Quadrotor, Tandem

Table F.37: Run 117 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-30

Table F.38: Testing conditions and rotor 1 loads in the hub coordinate system for run 117.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
8	-0.014	0.000	-0.010	0.000	-0.006	0.000	0.3	0.000	0.00234	0.0	0.0	0	-	63.9
9	0.108	-0.030	2.177	-1.523	0.533	-2.462	3.2	0.012	0.00234	0.0	0.0	2000	0.0	63.9
10	0.511	-0.159	2.641	-1.686	6.631	-2.087	20.4	0.487	0.00234	0.0	0.0	2000	0.0	63.2
11	0.671	-0.189	3.869	-2.087	8.903	-3.322	20.2	0.480	0.00234	0.0	0.0	2499	0.0	62.9
12	0.852	-0.168	5.424	-1.598	12.086	-4.886	20.5	0.491	0.00234	0.0	0.0	3000	0.0	62.8
13	0.841	-0.201	5.502	-1.478	11.805	-4.902	20.6	0.498	0.00234	0.0	-3.0	2999	0.0	62.8
14	0.662	-0.199	3.914	-2.051	8.780	-3.396	20.1	0.474	0.00234	0.0	-3.0	2500	0.0	62.7
15	0.512	-0.197	2.651	-2.016	6.090	-2.151	19.8	0.462	0.00234	0.0	-3.0	2000	0.0	62.7
16	0.476	-0.179	2.665	-1.921	6.253	-2.131	20.5	0.494	0.00235	-1.0	-3.0	2000	0.0	62.6
18	0.624	-0.168	3.902	-1.799	8.497	-3.402	20.3	0.481	0.00235	-1.0	-3.0	2499	0.0	62.6
19	0.840	-0.188	5.560	-1.708	11.399	-4.928	20.5	0.492	0.00235	-1.0	-3.0	2999	0.0	62.6
20	0.917	-0.158	5.571	-1.673	12.282	-4.824	20.3	0.483	0.00235	-1.0	0.0	2999	0.0	62.5
21	0.751	-0.160	3.967	-1.947	9.269	-3.323	20.0	0.469	0.00235	-1.0	0.0	2500	0.0	62.6
22	0.584	-0.152	2.646	-1.862	6.241	-2.114	20.0	0.468	0.00235	-1.0	0.0	2000	0.0	62.6
23	0.497	-0.141	2.580	-1.981	6.001	-2.166	20.5	0.491	0.00235	-3.0	0.0	2000	0.0	62.6
24	0.637	-0.145	3.911	-2.186	8.733	-3.374	20.5	0.491	0.00235	-3.0	0.0	2499	0.0	62.6
25	0.833	-0.153	5.519	-1.855	11.609	-4.894	20.4	0.489	0.00235	-3.0	0.0	3000	0.0	62.6
26	0.794	-0.179	5.579	-1.821	11.089	-5.043	20.7	0.501	0.00235	-3.0	-3.0	2999	0.0	62.6
27	0.617	-0.165	3.893	-2.095	8.093	-3.488	20.2	0.477	0.00235	-3.0	-3.0	2500	0.0	62.6
28	0.440	-0.159	2.577	-2.093	5.660	-2.227	20.3	0.483	0.00234	-3.0	-3.0	2000	0.0	62.7
29	0.410	-0.147	2.509	-1.912	5.199	-2.309	20.2	0.479	0.00234	-5.0	-3.0	2000	0.0	62.7
30	0.539	-0.143	3.862	-2.013	7.856	-3.535	20.3	0.482	0.00234	-5.0	-3.0	2499	0.0	62.7
31	0.694	-0.126	5.400	-1.567	10.250	-5.232	20.5	0.493	0.00234	-5.0	-3.0	3000	0.0	62.7
32	0.823	-0.111	5.420	-1.706	10.680	-5.036	20.1	0.472	0.00234	-5.0	0.0	2999	0.0	62.7
33	0.639	-0.122	3.841	-2.334	8.395	-3.442	20.4	0.487	0.00234	-5.0	0.0	2500	0.0	62.7
34	0.493	-0.128	2.522	-2.200	5.721	-2.210	20.5	0.492	0.00234	-5.0	0.0	1999	0.0	62.7
35	0.416	-0.104	2.404	-1.988	4.903	-2.347	20.4	0.487	0.00234	-10.0	0.0	2000	0.0	62.7
36	0.507	-0.093	3.707	-1.921	7.217	-3.680	20.6	0.499	0.00234	-10.0	0.0	2500	0.0	62.8
37	0.735	-0.086	5.356	-1.732	9.700	-5.275	20.2	0.480	0.00234	-10.0	0.0	2999	0.0	62.8
38	0.650	-0.110	5.242	-1.646	8.999	-5.375	20.4	0.489	0.00234	-10.0	-3.0	2999	0.0	62.8
39	0.489	-0.124	3.612	-1.917	6.564	-3.779	20.3	0.482	0.00234	-10.0	-3.0	2500	0.0	62.8
40	0.312	-0.109	2.278	-1.629	4.255	-2.433	20.4	0.489	0.00234	-10.0	-3.0	2000	0.0	63.0

Continued on next page

Table F.38: Testing conditions and rotor 1 loads in the hub coordinate system for run 117.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
41	0.460	-0.202	2.334	-4.625	5.771	-2.552	40.3	1.903	0.00234	-10.0	-3.0	2000	0.0	63.1
42	0.616	-0.193	3.811	-4.866	8.856	-3.840	40.4	1.916	0.00234	-10.0	-3.0	2499	0.0	63.1
43	0.950	-0.184	5.536	-4.517	12.589	-5.395	40.3	1.899	0.00234	-10.0	-3.0	2999	0.0	63.1
44	1.052	-0.177	5.889	-4.560	13.667	-5.250	40.3	1.901	0.00234	-10.0	0.0	3000	0.0	63.1
45	0.767	-0.165	4.092	-5.014	9.575	-3.727	40.1	1.886	0.00234	-10.0	0.0	2500	0.0	63.2
46	0.582	-0.186	2.595	-4.995	6.363	-2.493	40.4	1.914	0.00234	-10.0	0.0	2000	0.0	63.2
47	0.589	-0.194	2.987	-5.237	7.311	-2.370	40.3	1.903	0.00234	-5.0	0.0	2000	0.0	63.3
48	0.755	-0.190	4.518	-5.249	11.000	-3.502	40.2	1.889	0.00234	-5.0	0.0	2500	0.0	63.3
49	1.181	-0.212	6.328	-4.579	15.514	-4.919	40.2	1.893	0.00234	-5.0	0.0	2999	0.0	63.4
50	1.132	-0.218	6.034	-4.557	14.632	-5.104	40.3	1.905	0.00234	-5.0	-3.0	2999	0.0	63.4
51	0.817	-0.214	4.240	-5.178	10.257	-3.621	40.3	1.904	0.00234	-5.0	-3.0	2500	0.0	63.4
52	0.552	-0.211	2.699	-5.056	6.815	-2.427	40.2	1.895	0.00234	-5.0	-3.0	2000	0.0	63.6
53	0.551	-0.210	2.860	-5.161	7.224	-2.380	40.2	1.894	0.00234	-3.0	-3.0	2000	0.0	63.6
54	0.758	-0.214	4.405	-5.246	10.841	-3.533	40.4	1.905	0.00234	-3.0	-3.0	2499	0.0	63.6
55	1.098	-0.220	6.188	-4.569	15.343	-4.963	40.3	1.903	0.00234	-3.0	-3.0	2999	0.0	63.6
56	1.221	-0.182	6.469	-4.427	16.352	-4.912	40.2	1.888	0.00234	-3.0	0.0	2999	0.0	63.7
57	0.870	-0.162	4.691	-5.224	11.570	-3.516	40.1	1.884	0.00234	-3.0	0.0	2500	0.0	63.7
59	0.607	-0.167	3.194	-5.285	7.511	-2.351	40.3	1.902	0.00234	-3.0	0.0	2000	0.0	63.7
60	0.601	-0.161	3.364	-5.181	7.650	-2.274	40.3	1.900	0.00234	-1.0	0.0	2000	0.0	63.8
61	0.815	-0.151	4.954	-4.804	12.084	-3.455	40.4	1.906	0.00234	-1.0	0.0	2499	0.0	63.8
62	1.264	-0.172	6.737	-3.743	17.029	-4.859	40.3	1.898	0.00234	-1.0	0.0	2999	0.0	63.9
64	1.210	-0.234	6.404	-4.544	16.040	-4.925	40.2	1.893	0.00234	-1.0	-3.0	2999	0.0	64.0
65	0.858	-0.212	4.604	-5.207	11.310	-3.540	40.1	1.883	0.00234	-1.0	-3.0	2500	0.0	64.1
66	0.621	-0.204	3.105	-5.318	7.408	-2.384	40.5	1.919	0.00234	-1.0	-3.0	2000	0.0	64.1
67	0.581	-0.200	3.206	-5.251	7.534	-2.358	40.5	1.915	0.00234	-0.0	-3.0	1999	0.0	64.1
69	0.815	-0.202	4.739	-5.175	11.676	-3.528	40.4	1.908	0.00234	-0.0	-3.0	2499	0.0	64.2
70	0.564	-0.180	3.188	-5.313	7.539	-2.389	40.4	1.905	0.00234	0.0	-3.0	1999	0.0	64.5
71	1.172	-0.213	6.509	-4.400	16.482	-4.954	40.3	1.899	0.00234	0.0	-3.0	2999	0.0	64.5
72	1.296	-0.171	6.943	-3.724	17.355	-4.836	40.5	1.913	0.00234	0.0	0.0	2999	0.0	64.6
73	0.865	-0.150	5.118	-4.643	12.145	-3.428	40.3	1.893	0.00233	0.1	0.0	2500	0.0	64.8
74	0.625	-0.150	3.492	-5.195	7.621	-2.246	40.2	1.891	0.00233	0.0	0.0	2000	0.0	64.8
75	0.469	-0.046	2.612	-1.849	6.659	-2.174	20.2	0.474	0.00234	-0.0	0.0	2000	0.0	64.9
76	0.104	0.055	2.144	-0.071	2.139	-2.478	3.5	0.014	0.00234	0.0	0.0	2000	0.0	64.9

Continued on next page

Table F.38: Testing conditions and rotor 1 loads in the hub coordinate system for run 117.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
77	-0.000	0.000	-0.000	0.000	0.000	0.000	2.1	0.005	0.00234	0.0	0.0	0	-	65.0

Table F.39: Testing conditions and rotor 3 loads in the hub coordinate system for run 117.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
8	-0.009	0.000	-0.004	0.000	0.001	0.000	0.3	0.000	0.00234	0.0	0.0	0	-	63.9
9	-0.167	-0.178	1.932	-1.907	0.251	2.883	3.2	0.012	0.00234	0.0	0.0	0	-30.0	63.9
10	0.097	0.005	2.113	2.847	4.179	2.823	20.4	0.487	0.00234	0.0	0.0	0	-30.0	63.2
11	0.129	0.066	3.296	3.222	5.644	4.234	20.2	0.480	0.00234	0.0	0.0	0	-30.0	62.9
12	0.261	0.080	4.693	2.106	6.911	5.844	20.5	0.491	0.00234	0.0	0.0	0	-30.0	62.8
13	0.345	0.099	4.682	2.889	6.888	5.874	20.6	0.498	0.00234	0.0	-3.0	0	-30.0	62.8
14	0.267	0.054	3.243	3.157	5.116	4.245	20.1	0.474	0.00234	0.0	-3.0	0	-30.0	62.7
15	0.217	0.004	2.036	3.089	3.622	2.861	19.8	0.462	0.00234	0.0	-3.0	0	-30.0	62.7
16	0.226	0.012	2.063	3.079	3.589	2.854	20.5	0.494	0.00235	-1.0	-3.0	0	-30.0	62.6
18	0.316	0.088	3.310	3.690	5.196	4.258	20.3	0.481	0.00235	-1.0	-3.0	0	-30.0	62.6
19	0.419	0.155	4.875	3.389	7.127	5.912	20.5	0.492	0.00235	-1.0	-3.0	0	-30.0	62.6
20	0.325	0.167	5.061	2.954	7.909	5.882	20.3	0.483	0.00235	-1.0	0.0	0	-30.0	62.5
21	0.176	0.113	3.494	3.220	5.815	4.215	20.0	0.469	0.00235	-1.0	0.0	0	-30.0	62.6
22	0.086	0.042	2.178	2.915	3.941	2.834	20.0	0.468	0.00235	-1.0	0.0	0	-30.0	62.6
23	0.193	0.044	2.152	3.154	4.019	2.856	20.5	0.491	0.00235	-3.0	0.0	0	-30.0	62.6
24	0.267	0.110	3.432	3.360	5.857	4.242	20.5	0.491	0.00235	-3.0	0.0	0	-30.0	62.6
25	0.347	0.192	4.997	3.394	7.772	5.892	20.4	0.489	0.00235	-3.0	0.0	0	-30.0	62.6
26	0.445	0.171	4.912	3.316	7.266	5.940	20.7	0.501	0.00235	-3.0	-3.0	0	-30.0	62.6
27	0.358	0.104	3.355	3.306	5.236	4.258	20.2	0.477	0.00235	-3.0	-3.0	0	-30.0	62.6
28	0.264	0.036	2.062	2.983	3.553	2.872	20.3	0.483	0.00234	-3.0	-3.0	0	-30.0	62.7
29	0.266	0.032	2.049	3.012	3.473	2.880	20.2	0.479	0.00234	-5.0	-3.0	0	-30.0	62.7
30	0.330	0.091	3.310	3.304	5.105	4.265	20.3	0.482	0.00234	-5.0	-3.0	0	-30.0	62.7
31	0.404	0.136	4.740	3.092	6.970	5.916	20.5	0.493	0.00234	-5.0	-3.0	0	-30.0	62.7
32	0.255	0.177	4.971	3.305	7.690	5.914	20.1	0.472	0.00234	-5.0	0.0	0	-30.0	62.7
33	0.229	0.106	3.448	3.046	5.880	4.243	20.4	0.487	0.00234	-5.0	0.0	0	-30.0	62.7
34	0.178	0.048	2.124	3.093	3.926	2.862	20.5	0.492	0.00234	-5.0	0.0	0	-30.0	62.7
35	0.176	0.040	2.071	3.238	3.693	2.886	20.4	0.487	0.00234	-10.0	0.0	0	-30.0	62.7
36	0.303	0.099	3.260	3.614	5.503	4.268	20.6	0.499	0.00234	-10.0	0.0	0	-30.0	62.8
37	0.303	0.145	4.858	2.989	7.488	5.917	20.2	0.480	0.00234	-10.0	0.0	0	-30.0	62.8
38	0.394	0.120	4.693	3.148	6.972	5.920	20.4	0.489	0.00234	-10.0	-3.0	0	-30.0	62.8
39	0.293	0.058	3.093	3.199	4.795	4.257	20.3	0.482	0.00234	-10.0	-3.0	0	-30.0	62.8
40	0.218	0.008	1.894	3.346	3.269	2.892	20.4	0.489	0.00234	-10.0	-3.0	0	-30.0	63.0

Continued on next page

Table F.39: Testing conditions and rotor 3 loads in the hub coordinate system for run 117.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
41	0.431	0.101	1.823	5.329	4.239	2.937	40.3	1.903	0.00234	-10.0	-3.0	0	-30.0	63.1
42	0.565	0.200	3.053	5.884	6.618	4.315	40.4	1.916	0.00234	-10.0	-3.0	0	-30.0	63.1
43	0.756	0.379	4.541	5.756	9.337	5.931	40.3	1.899	0.00234	-10.0	-3.0	0	-30.0	63.1
44	0.792	0.429	4.912	5.704	10.427	5.931	40.3	1.901	0.00234	-10.0	0.0	0	-30.0	63.1
45	0.653	0.335	3.365	5.876	7.374	4.302	40.1	1.886	0.00234	-10.0	0.0	0	-30.0	63.2
46	0.525	0.246	2.103	5.508	4.790	2.937	40.4	1.914	0.00234	-10.0	0.0	0	-30.0	63.2
47	0.546	0.284	2.381	5.888	5.493	2.869	40.3	1.903	0.00234	-5.0	0.0	0	-30.0	63.3
48	0.676	0.364	3.659	6.024	8.328	4.244	40.2	1.889	0.00234	-5.0	0.0	0	-30.0	63.3
49	0.858	0.500	5.218	5.726	11.422	5.877	40.2	1.893	0.00234	-5.0	0.0	0	-30.0	63.4
50	0.819	0.449	4.868	5.811	10.203	5.917	40.3	1.905	0.00234	-5.0	-3.0	0	-30.0	63.4
51	0.682	0.367	3.373	6.005	7.358	4.290	40.3	1.904	0.00234	-5.0	-3.0	0	-30.0	63.4
52	0.555	0.265	2.129	5.657	4.842	2.924	40.2	1.895	0.00234	-5.0	-3.0	0	-30.0	63.6
53	0.575	0.286	2.223	5.823	5.071	2.907	40.2	1.894	0.00234	-3.0	-3.0	0	-30.0	63.6
54	0.707	0.371	3.470	6.070	7.643	4.277	40.4	1.905	0.00234	-3.0	-3.0	0	-30.0	63.6
55	0.844	0.458	4.966	5.850	10.461	5.906	40.3	1.903	0.00234	-3.0	-3.0	0	-30.0	63.6
56	0.877	0.509	5.303	5.642	11.789	5.839	40.2	1.888	0.00234	-3.0	0.0	0	-30.0	63.7
57	0.737	0.422	3.757	6.000	8.593	4.193	40.1	1.884	0.00234	-3.0	0.0	0	-30.0	63.7
59	0.578	0.329	2.488	6.008	5.713	2.819	40.3	1.902	0.00234	-3.0	0.0	0	-30.0	63.7
60	0.601	0.329	2.528	6.085	5.914	2.801	40.3	1.900	0.00234	-1.0	0.0	0	-30.0	63.8
61	0.744	0.431	3.858	6.100	8.915	4.144	40.4	1.906	0.00234	-1.0	0.0	0	-30.0	63.8
62	0.916	0.528	5.401	5.642	12.158	5.795	40.3	1.898	0.00234	-1.0	0.0	0	-30.0	63.9
64	0.855	0.479	5.081	5.857	10.680	5.845	40.2	1.893	0.00234	-1.0	-3.0	0	-30.0	64.0
65	0.716	0.398	3.571	5.994	7.806	4.218	40.1	1.883	0.00234	-1.0	-3.0	0	-30.0	64.1
66	0.585	0.323	2.361	5.924	5.268	2.851	40.5	1.919	0.00234	-1.0	-3.0	0	-30.0	64.1
67	0.581	0.314	2.381	5.981	5.357	2.849	40.5	1.915	0.00234	-0.0	-3.0	0	-30.0	64.1
69	0.715	0.389	3.602	6.068	7.901	4.213	40.4	1.908	0.00234	-0.0	-3.0	0	-30.0	64.2
70	0.632	0.305	2.408	5.947	5.321	2.837	40.4	1.905	0.00234	0.0	-3.0	0	-30.0	64.5
71	0.889	0.485	5.124	5.837	10.746	5.832	40.3	1.899	0.00234	0.0	-3.0	0	-30.0	64.5
72	0.926	0.534	5.487	5.635	12.267	5.742	40.5	1.913	0.00234	0.0	0.0	0	-30.0	64.6
73	0.744	0.449	3.902	6.061	8.989	4.103	40.3	1.893	0.00233	0.1	0.0	0	-30.0	64.8
74	0.588	0.355	2.593	6.034	6.030	2.753	40.2	1.891	0.00233	0.0	0.0	0	-30.0	64.8
75	0.263	0.160	2.165	2.550	3.943	2.766	20.2	0.474	0.00234	-0.0	0.0	0	-30.0	64.9
76	0.111	0.016	1.829	0.533	0.403	2.689	3.5	0.014	0.00234	0.0	0.0	0	0.0	64.9

Continued on next page

Table F.39: Testing conditions and rotor 3 loads in the hub coordinate system for run 117.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
77	-0.000	0.000	-0.000	0.000	0.000	0.000	2.1	0.005	0.00234	0.0	0.0	0	-	65.0

Run 119: Concept Quadrotor, Tandem

Table F.40: Run 119 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-60

Table F.41: Testing conditions and rotor 1 loads in the hub coordinate system for run 119.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.018	0.000	-0.010	0.000	-0.008	0.000	0.0	0.000	0.00225	0.0	0.0	0	-	84.8
4	0.050	-0.006	2.173	-1.415	1.016	-2.402	3.4	0.013	0.00224	-0.0	0.0	1999	0.0	85.3
5	0.283	-0.016	2.817	-1.533	6.584	-1.874	20.8	0.483	0.00224	-0.0	0.0	2000	0.0	86.4
6	0.396	0.015	4.010	-1.408	9.514	-3.019	20.6	0.474	0.00224	0.0	0.0	2500	0.0	86.5
7	0.385	0.007	4.040	-1.369	9.614	-3.005	20.8	0.483	0.00224	0.0	0.0	2499	0.0	86.8
8	0.633	-0.010	5.565	-0.978	12.536	-4.403	20.9	0.486	0.00224	0.0	0.0	2999	0.0	86.9
9	0.612	-0.052	5.534	-1.209	11.757	-4.487	21.0	0.491	0.00224	0.0	-3.0	2999	0.0	87.0
10	0.363	-0.064	4.004	-1.650	8.908	-3.046	20.7	0.479	0.00223	-0.0	-3.0	2500	0.0	87.2
11	0.221	-0.081	2.761	-1.801	6.198	-1.890	20.8	0.484	0.00223	0.0	-3.0	1999	0.0	87.3
12	0.205	-0.073	2.772	-1.822	6.048	-1.896	20.8	0.482	0.00223	-1.0	-3.0	2000	0.0	87.6
13	0.318	-0.066	4.021	-1.697	8.686	-3.071	20.8	0.483	0.00223	-1.0	-3.0	2500	0.0	87.7
14	0.533	-0.073	5.561	-1.116	11.497	-4.531	20.8	0.483	0.00223	-1.0	-3.0	2999	0.0	87.8
15	0.595	-0.024	5.550	-1.006	12.121	-4.414	20.7	0.477	0.00223	-1.0	0.0	3000	0.0	87.9
16	0.374	-0.022	3.998	-1.453	9.277	-3.006	20.4	0.466	0.00223	-1.0	0.0	2500	0.0	87.9
17	0.233	-0.025	2.764	-1.548	6.493	-1.865	20.5	0.467	0.00223	-1.0	0.0	2000	0.0	87.9
18	0.213	-0.024	2.745	-1.816	6.157	-1.890	20.6	0.475	0.00223	-3.0	0.0	2000	0.0	88.0
19	0.340	-0.021	3.972	-1.673	8.825	-3.050	20.6	0.474	0.00223	-3.0	0.0	2499	0.0	88.1
20	0.556	-0.022	5.515	-1.216	11.579	-4.499	20.7	0.478	0.00223	-3.0	0.0	3000	0.0	88.1
21	0.531	-0.057	5.509	-1.099	11.068	-4.661	20.8	0.482	0.00223	-3.0	-3.0	2999	0.0	88.2
22	0.335	-0.063	3.947	-1.644	8.381	-3.182	21.0	0.492	0.00223	-3.0	-3.0	2500	0.0	88.3
23	0.199	-0.074	2.690	-1.786	5.838	-1.992	21.0	0.491	0.00223	-3.0	-3.0	2000	0.0	88.3
24	0.175	-0.062	2.667	-1.788	5.458	-2.049	20.6	0.473	0.00223	-5.0	-3.0	2000	0.0	88.4
25	0.303	-0.051	3.913	-1.618	7.981	-3.256	20.8	0.482	0.00223	-5.0	-3.0	2499	0.0	88.6
26	0.519	-0.044	5.459	-1.057	10.586	-4.756	20.8	0.484	0.00223	-5.0	-3.0	2999	0.0	88.8
27	0.558	-0.017	5.480	-1.138	11.032	-4.622	20.7	0.477	0.00223	-5.0	0.0	3000	0.0	88.9
28	0.339	-0.029	3.957	-1.634	8.436	-3.146	20.7	0.479	0.00223	-5.0	0.0	2500	0.0	88.9
29	0.204	-0.036	2.702	-1.818	5.894	-1.967	20.8	0.480	0.00223	-5.0	0.0	2000	0.0	89.0
30	0.141	-0.014	2.605	-1.854	5.171	-2.111	20.9	0.488	0.00223	-10.0	0.0	2000	0.0	89.1
31	0.256	-0.015	3.880	-1.646	7.605	-3.342	21.1	0.495	0.00223	-10.0	0.0	2499	0.0	89.1
32	0.472	0.001	5.377	-1.237	10.025	-4.851	20.8	0.483	0.00222	-10.0	0.0	3000	0.0	89.4
33	0.448	-0.036	5.275	-1.262	9.358	-4.948	20.9	0.486	0.00222	-10.0	-3.0	3000	0.0	89.4
34	0.274	-0.045	3.743	-1.641	6.925	-3.435	20.9	0.485	0.00222	-10.0	-3.0	2500	0.0	89.5

Continued on next page

Table F.41: Testing conditions and rotor 1 loads in the hub coordinate system for run 119.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
36	0.141	-0.033	2.516	-1.807	4.708	-2.189	21.0	0.489	0.00222	-10.0	-3.0	2000	0.0	89.6
37	0.293	-0.113	2.604	-4.495	5.618	-2.313	41.4	1.900	0.00222	-10.0	-3.0	2000	0.0	90.5
39	0.452	-0.125	4.019	-4.609	8.604	-3.546	41.4	1.898	0.00222	-10.0	-3.0	2499	0.0	90.8
40	0.822	-0.141	5.683	-4.120	12.229	-4.987	41.4	1.901	0.00222	-10.0	-3.0	2999	0.0	91.1
41	0.906	-0.116	5.973	-4.248	13.324	-4.854	41.4	1.898	0.00222	-10.0	0.0	2999	0.0	91.2
42	0.538	-0.120	4.261	-4.729	9.211	-3.413	41.2	1.884	0.00221	-10.0	0.0	2500	0.0	91.3
44	0.366	-0.098	2.808	-4.950	6.137	-2.256	41.3	1.889	0.00221	-10.0	0.0	2000	0.0	91.6
45	0.424	-0.109	3.256	-5.284	7.216	-2.150	41.4	1.893	0.00221	-5.0	0.0	2000	0.0	91.7
47	0.603	-0.126	4.680	-5.183	10.710	-3.260	41.5	1.904	0.00221	-5.0	0.0	2500	0.0	91.8
49	1.020	-0.143	6.350	-4.334	15.022	-4.597	41.5	1.908	0.00221	-5.0	0.0	3000	0.0	92.0
50	0.981	-0.176	6.099	-4.455	14.175	-4.759	41.6	1.910	0.00221	-5.0	-3.0	3000	0.0	92.0
51	0.655	-0.166	4.377	-4.900	9.969	-3.369	41.5	1.908	0.00221	-5.0	-3.0	2500	0.0	92.0
53	0.447	-0.158	2.891	-5.019	6.671	-2.235	41.4	1.899	0.00221	-5.0	-3.0	2000	0.0	92.0
54	0.464	-0.157	3.091	-5.253	7.033	-2.204	41.5	1.908	0.00221	-3.0	-3.0	1999	0.0	92.1
55	0.668	-0.179	4.526	-5.260	10.551	-3.298	41.7	1.918	0.00221	-3.0	-3.0	2499	0.0	92.2
56	1.044	-0.185	6.176	-4.416	14.705	-4.673	41.5	1.905	0.00221	-3.0	-3.0	2999	0.0	92.3
58	1.115	-0.154	6.430	-4.402	15.840	-4.598	41.3	1.889	0.00221	-3.0	0.0	2999	0.0	92.3
59	0.699	-0.134	4.780	-4.747	11.193	-3.299	41.5	1.904	0.00221	-3.0	0.0	2500	0.0	92.4
60	0.500	-0.134	3.242	-5.184	7.209	-2.171	41.5	1.904	0.00221	-3.0	0.0	2000	0.0	92.5
61	0.505	-0.123	3.487	-5.131	7.321	-2.099	41.5	1.901	0.00221	-1.0	0.0	2000	0.0	92.6
63	0.717	-0.097	4.978	-4.673	11.744	-3.237	41.5	1.906	0.00221	-1.0	0.0	2499	0.0	92.7
64	1.139	-0.145	6.633	-3.864	16.569	-4.597	41.7	1.917	0.00221	-1.0	0.0	2999	0.0	92.7
66	1.115	-0.200	6.263	-4.450	15.462	-4.649	41.5	1.903	0.00221	-1.0	-3.0	3000	0.0	92.7
67	0.747	-0.184	4.607	-5.101	11.126	-3.340	41.3	1.884	0.00221	-1.0	-3.0	2500	0.0	92.7
68	0.516	-0.175	3.056	-5.287	7.221	-2.222	41.4	1.897	0.00221	-1.0	-3.0	2000	0.0	92.8
70	0.523	-0.164	3.151	-5.333	7.265	-2.222	41.5	1.905	0.00221	-0.0	-3.0	1999	0.0	92.8
72	0.752	-0.183	4.629	-5.054	11.149	-3.353	41.5	1.903	0.00221	-0.0	-3.0	2499	0.0	92.9
73	1.159	-0.196	6.306	-4.266	15.884	-4.680	41.5	1.902	0.00221	0.0	-3.0	2999	0.0	93.0
74	1.210	-0.143	6.655	-3.606	16.734	-4.612	41.4	1.893	0.00221	0.0	0.0	3000	0.0	93.0
75	0.788	-0.130	4.955	-4.921	11.833	-3.268	41.6	1.906	0.00221	0.0	0.0	2500	0.0	93.0
76	0.576	-0.141	3.350	-5.301	7.459	-2.154	41.7	1.916	0.00221	0.0	0.0	2000	0.0	93.0
77	0.386	-0.025	2.541	-1.669	6.541	-2.065	20.9	0.482	0.00221	0.0	0.0	2000	0.0	93.0
78	0.055	0.097	1.983	0.386	1.544	-2.390	4.6	0.023	0.00221	-0.0	0.0	2000	0.0	92.8

Continued on next page

Table F.41: Testing conditions and rotor 1 loads in the hub coordinate system for run 119.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
79	0.000	0.000	0.000	0.000	0.000	0.000	2.6	0.008	0.00221	0.0	0.0	0	-	92.8

Table F.42: Testing conditions and rotor 3 loads in the hub coordinate system for run 119.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.006	0.000	-0.005	0.000	-0.003	0.000	0.0	0.000	0.00225	0.0	0.0	0	-	84.8
4	-0.245	-0.074	1.837	-1.995	-0.179	2.787	3.4	0.013	0.00224	-0.0	0.0	0	-60.0	85.3
5	-0.271	0.293	1.903	2.622	4.213	2.772	20.8	0.483	0.00224	-0.0	0.0	0	-60.0	86.4
6	-0.246	0.351	3.114	2.725	5.848	4.070	20.6	0.474	0.00224	0.0	0.0	0	-60.0	86.5
7	-0.251	0.352	3.040	2.724	6.031	4.069	20.8	0.483	0.00224	0.0	0.0	0	-60.0	86.8
8	-0.156	0.393	4.492	2.366	7.878	5.625	20.9	0.486	0.00224	0.0	0.0	0	-60.0	86.9
9	-0.200	0.378	4.362	2.625	7.093	5.637	21.0	0.491	0.00224	0.0	-3.0	0	-60.0	87.0
10	-0.311	0.280	2.867	2.676	5.443	4.080	20.7	0.479	0.00223	-0.0	-3.0	0	-60.0	87.2
11	-0.378	0.199	1.706	2.612	3.889	2.775	20.8	0.484	0.00223	0.0	-3.0	0	-60.0	87.3
12	-0.383	0.169	1.700	2.532	3.778	2.777	20.8	0.482	0.00223	-1.0	-3.0	0	-60.0	87.6
13	-0.290	0.228	2.874	2.741	5.342	4.081	20.8	0.483	0.00223	-1.0	-3.0	0	-60.0	87.7
14	-0.176	0.281	4.335	2.633	7.017	5.631	20.8	0.483	0.00223	-1.0	-3.0	0	-60.0	87.8
15	-0.169	0.313	4.485	2.536	7.806	5.626	20.7	0.477	0.00223	-1.0	0.0	0	-60.0	87.9
16	-0.290	0.247	2.991	2.646	5.869	4.054	20.4	0.466	0.00223	-1.0	0.0	0	-60.0	87.9
17	-0.363	0.186	1.797	2.580	4.162	2.751	20.5	0.467	0.00223	-1.0	0.0	0	-60.0	87.9
18	-0.344	0.165	1.774	2.537	4.112	2.759	20.6	0.475	0.00223	-3.0	0.0	0	-60.0	88.0
19	-0.268	0.232	2.963	2.637	5.729	4.058	20.6	0.474	0.00223	-3.0	0.0	0	-60.0	88.1
20	-0.144	0.301	4.428	2.481	7.612	5.617	20.7	0.478	0.00223	-3.0	0.0	0	-60.0	88.1
21	-0.110	0.285	4.287	2.423	6.878	5.610	20.8	0.482	0.00223	-3.0	-3.0	0	-60.0	88.2
22	-0.180	0.220	2.831	2.634	5.178	4.062	21.0	0.492	0.00223	-3.0	-3.0	0	-60.0	88.3
23	-0.237	0.153	1.679	2.606	3.652	2.777	21.0	0.491	0.00223	-3.0	-3.0	0	-60.0	88.3
24	-0.238	0.131	1.688	2.515	3.521	2.775	20.6	0.473	0.00223	-5.0	-3.0	0	-60.0	88.4
25	-0.162	0.203	2.853	2.702	5.090	4.067	20.8	0.482	0.00223	-5.0	-3.0	0	-60.0	88.6
26	-0.053	0.258	4.291	2.527	6.793	5.602	20.8	0.484	0.00223	-5.0	-3.0	0	-60.0	88.8
27	-0.079	0.277	4.421	2.503	7.420	5.604	20.7	0.477	0.00223	-5.0	0.0	0	-60.0	88.9
28	-0.168	0.215	2.952	2.622	5.492	4.053	20.7	0.479	0.00223	-5.0	0.0	0	-60.0	88.9
29	-0.225	0.150	1.791	2.527	3.931	2.763	20.8	0.480	0.00223	-5.0	0.0	0	-60.0	89.0
30	-0.154	0.111	1.685	2.468	3.577	2.770	20.9	0.488	0.00223	-10.0	0.0	0	-60.0	89.1
31	-0.034	0.188	2.868	2.652	5.229	4.077	21.1	0.495	0.00223	-10.0	0.0	0	-60.0	89.1
32	0.013	0.259	4.346	2.415	7.083	5.609	20.8	0.483	0.00222	-10.0	0.0	0	-60.0	89.4
33	-0.019	0.243	4.213	2.440	6.461	5.602	20.9	0.486	0.00222	-10.0	-3.0	0	-60.0	89.4
34	-0.084	0.165	2.771	2.563	4.747	4.053	20.9	0.485	0.00222	-10.0	-3.0	0	-60.0	89.5

Continued on next page

Table F.42: Testing conditions and rotor 3 loads in the hub coordinate system for run 119.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
36	-0.130	0.092	1.648	2.451	3.220	2.773	21.0	0.489	0.00222	-10.0	-3.0	0	-60.0	89.6
37	0.227	0.203	1.709	4.991	4.257	2.835	41.4	1.900	0.00222	-10.0	-3.0	0	-60.0	90.5
39	0.387	0.316	2.898	5.315	6.532	4.115	41.4	1.898	0.00222	-10.0	-3.0	0	-60.0	90.8
40	0.496	0.421	4.307	5.436	9.161	5.637	41.4	1.901	0.00222	-10.0	-3.0	0	-60.0	91.1
41	0.546	0.460	4.623	5.350	10.301	5.659	41.4	1.898	0.00222	-10.0	0.0	0	-60.0	91.2
42	0.399	0.369	3.147	5.417	7.232	4.121	41.2	1.884	0.00221	-10.0	0.0	0	-60.0	91.3
44	0.323	0.278	1.966	5.172	4.807	2.836	41.3	1.889	0.00221	-10.0	0.0	0	-60.0	91.6
45	0.377	0.336	2.273	5.572	5.645	2.763	41.4	1.893	0.00221	-5.0	0.0	0	-60.0	91.7
47	0.551	0.428	3.507	5.602	8.281	4.058	41.5	1.904	0.00221	-5.0	0.0	0	-60.0	91.8
49	0.720	0.524	4.906	5.324	11.266	5.608	41.5	1.908	0.00221	-5.0	0.0	0	-60.0	92.0
50	0.681	0.487	4.605	5.259	10.026	5.643	41.6	1.910	0.00221	-5.0	-3.0	0	-60.0	92.0
51	0.544	0.418	3.171	5.589	7.271	4.106	41.5	1.908	0.00221	-5.0	-3.0	0	-60.0	92.0
53	0.404	0.317	1.996	5.377	4.887	2.823	41.4	1.899	0.00221	-5.0	-3.0	0	-60.0	92.0
54	0.445	0.324	2.109	5.464	5.237	2.802	41.5	1.908	0.00221	-3.0	-3.0	0	-60.0	92.1
55	0.591	0.407	3.261	5.627	7.604	4.104	41.7	1.918	0.00221	-3.0	-3.0	0	-60.0	92.2
56	0.735	0.508	4.631	5.474	10.238	5.635	41.5	1.905	0.00221	-3.0	-3.0	0	-60.0	92.3
58	0.778	0.550	4.982	5.114	11.546	5.574	41.3	1.889	0.00221	-3.0	0.0	0	-60.0	92.3
59	0.637	0.475	3.520	5.937	8.646	4.024	41.5	1.904	0.00221	-3.0	0.0	0	-60.0	92.4
60	0.488	0.390	2.274	5.704	5.750	2.740	41.5	1.904	0.00221	-3.0	0.0	0	-60.0	92.5
61	0.536	0.398	2.391	5.795	6.072	2.689	41.5	1.901	0.00221	-1.0	0.0	0	-60.0	92.6
63	0.730	0.486	3.605	5.666	8.858	3.984	41.5	1.906	0.00221	-1.0	0.0	0	-60.0	92.7
64	0.893	0.568	5.040	5.129	11.935	5.542	41.7	1.917	0.00221	-1.0	0.0	0	-60.0	92.7
66	0.836	0.529	4.682	5.241	10.351	5.606	41.5	1.903	0.00221	-1.0	-3.0	0	-60.0	92.7
67	0.705	0.451	3.296	5.481	7.685	4.067	41.3	1.884	0.00221	-1.0	-3.0	0	-60.0	92.7
68	0.563	0.378	2.121	5.671	5.254	2.783	41.4	1.897	0.00221	-1.0	-3.0	0	-60.0	92.8
70	0.601	0.392	2.165	5.741	5.327	2.773	41.5	1.905	0.00221	-0.0	-3.0	0	-60.0	92.8
72	0.765	0.461	3.285	5.489	7.640	4.066	41.5	1.903	0.00221	-0.0	-3.0	0	-60.0	92.9
73	0.907	0.548	4.687	5.246	10.456	5.591	41.5	1.902	0.00221	0.0	-3.0	0	-60.0	93.0
74	0.979	0.596	5.016	5.076	11.789	5.512	41.4	1.893	0.00221	0.0	0.0	0	-60.0	93.0
75	0.822	0.519	3.588	5.618	8.876	3.961	41.6	1.906	0.00221	0.0	0.0	0	-60.0	93.0
76	0.675	0.440	2.363	5.935	6.015	2.675	41.7	1.916	0.00221	0.0	0.0	0	-60.0	93.0
77	0.441	0.252	1.877	2.487	3.779	2.693	20.9	0.482	0.00221	0.0	0.0	0	-60.0	93.0
78	0.068	0.021	1.472	0.011	-0.594	2.534	4.6	0.023	0.00221	-0.0	0.0	0	0.0	92.8

Continued on next page

Table F.42: Testing conditions and rotor 3 loads in the hub coordinate system for run 119.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
79	0.000	0.000	0.000	0.000	0.000	0.000	2.6	0.008	0.00221	0.0	0.0	0	-	92.8

Run 120: Concept Quadrotor, Tandem, Hover

Table F.43: Run 120 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R3
number of blades	2
RPM	3000 to 200 (Δ200)
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	0, -90

Table F.44: Testing conditions and rotor 1 loads in the hub coordinate system for run 120.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.009	0.000	-0.009	0.000	-0.002	0.000	0.6	0.000	0.00221	0.0	0.0	0	-	91.0
4	0.006	0.011	-0.129	-0.012	0.071	0.041	1.2	0.002	0.00221	0.0	0.0	200	0.0	91.1
5	0.021	0.028	-0.060	-0.016	0.085	-0.043	1.1	0.001	0.00221	0.0	0.0	399	0.0	91.1
6	0.027	0.032	0.047	-0.070	0.094	-0.186	1.5	0.003	0.00221	0.0	0.0	599	0.0	91.2
7	0.032	0.039	0.212	0.013	0.067	-0.383	2.0	0.004	0.00221	0.0	0.0	800	0.0	91.1
8	0.033	0.032	0.447	-0.344	0.269	-0.624	2.1	0.005	0.00221	0.0	0.0	999	0.0	91.2
9	0.023	0.031	0.675	-0.489	0.227	-0.885	2.5	0.007	0.00221	0.0	0.0	1199	0.0	91.2
10	0.030	0.034	0.993	-0.641	0.300	-1.239	3.2	0.011	0.00221	0.0	0.0	1399	0.0	91.2
11	0.053	0.025	1.332	-0.901	0.602	-1.561	2.8	0.009	0.00221	0.0	0.0	1599	0.0	91.2
12	0.050	0.020	1.681	-1.203	0.456	-1.999	3.9	0.017	0.00221	0.0	0.0	1800	0.0	91.2
13	0.097	0.009	2.154	-1.411	1.195	-2.406	3.5	0.014	0.00221	0.0	0.0	1999	0.0	91.2
14	0.111	0.009	2.649	-1.302	1.516	-2.879	3.7	0.015	0.00221	0.0	0.0	2199	0.0	91.2
15	0.105	0.006	3.049	-2.098	0.734	-3.522	4.3	0.021	0.00221	0.0	0.0	2399	0.0	91.2
16	0.153	-0.008	3.673	-2.226	1.650	-4.041	4.5	0.023	0.00221	0.0	0.0	2599	0.0	91.2
17	0.218	-0.010	4.450	-2.466	2.368	-4.801	5.7	0.035	0.00221	0.0	0.0	2800	0.0	91.2
18	0.213	-0.014	4.912	-2.835	1.964	-5.464	5.2	0.030	0.00221	0.0	0.0	2999	0.0	91.2
19	0.215	-0.034	4.329	-2.901	2.118	-4.769	5.4	0.033	0.00221	0.0	0.0	2800	0.0	91.2
20	0.155	-0.022	3.602	-2.416	1.295	-4.125	4.8	0.025	0.00221	0.0	0.0	2600	0.0	91.2
21	0.153	-0.025	3.125	-2.004	1.430	-3.496	5.3	0.031	0.00221	0.0	0.0	2400	0.0	91.2
22	0.127	-0.015	2.609	-1.652	1.152	-2.971	4.5	0.022	0.00221	0.0	0.0	2200	0.0	91.2
23	0.097	-0.002	2.100	-1.387	0.750	-2.434	4.1	0.019	0.00221	0.0	0.0	2000	0.0	91.2
24	0.078	0.020	1.631	-0.351	0.718	-2.013	4.5	0.023	0.00221	0.0	0.0	1800	0.0	91.2
25	0.060	0.006	1.283	-0.914	0.390	-1.561	3.4	0.013	0.00221	0.0	0.0	1600	0.0	91.3
26	0.041	0.017	0.971	-0.577	0.307	-1.207	3.2	0.011	0.00221	0.0	0.0	1400	0.0	91.2
27	0.018	0.030	0.652	-0.239	-0.022	-0.889	3.0	0.010	0.00221	0.0	0.0	1200	0.0	91.3
28	0.021	0.030	0.441	-0.326	0.291	-0.598	2.3	0.006	0.00221	0.0	0.0	1000	0.0	91.3
29	0.017	0.032	0.241	-0.196	0.185	-0.364	2.1	0.005	0.00221	0.0	0.0	800	0.0	91.3
30	0.020	0.038	0.057	-0.101	0.165	-0.170	1.9	0.004	0.00221	0.0	0.0	600	0.0	91.3
31	0.009	0.043	-0.055	0.001	0.116	-0.008	1.6	0.003	0.00221	0.0	0.0	400	0.0	91.3
32	-0.015	0.039	-0.116	-0.031	0.089	0.079	1.6	0.003	0.00221	0.0	0.0	200	0.0	91.3
33	0.007	-0.008	-0.001	0.010	0.025	0.054	1.6	0.003	0.00221	0.0	0.0	0	-	91.2
34	0.010	0.032	-0.089	-0.024	0.070	0.061	1.6	0.003	0.00221	0.0	0.0	200	0.0	91.2

Continued on next page

Table F.44: Testing conditions and rotor 1 loads in the hub coordinate system for run 120.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	0.030	0.052	-0.025	-0.037	0.072	-0.021	1.7	0.003	0.00221	0.0	0.0	400	0.0	91.2
36	0.031	0.049	0.093	-0.154	0.085	-0.177	1.8	0.004	0.00221	0.0	0.0	599	0.0	91.2
37	0.026	0.051	0.280	-0.323	0.104	-0.392	2.4	0.006	0.00221	0.0	0.0	800	0.0	91.2
38	0.024	0.059	0.477	-0.424	0.200	-0.605	2.2	0.005	0.00221	0.0	0.0	999	0.0	91.1
40	0.024	0.057	0.727	-0.560	0.277	-0.912	3.2	0.011	0.00221	0.0	0.0	1199	0.0	91.2
41	0.033	0.056	1.007	-0.722	0.278	-1.249	3.2	0.011	0.00221	0.0	0.0	1399	0.0	91.1
42	0.056	0.046	1.343	-0.963	0.642	-1.631	4.2	0.019	0.00221	0.0	0.0	1599	0.0	91.1
43	0.074	0.034	1.737	-1.291	0.761	-2.042	3.7	0.015	0.00221	0.0	0.0	1799	0.0	91.1
44	0.083	0.035	2.144	-1.412	0.854	-2.516	4.9	0.027	0.00221	0.0	0.0	1999	0.0	91.1
45	0.095	0.022	2.591	-1.752	0.839	-3.004	4.3	0.020	0.00221	0.0	0.0	2199	0.0	91.1
46	0.128	0.020	3.076	-1.691	1.359	-3.565	4.8	0.025	0.00221	0.0	0.0	2399	0.0	91.0
47	0.165	0.013	3.751	-1.902	1.936	-4.062	4.7	0.024	0.00221	0.0	0.0	2599	0.0	91.1
48	0.179	0.001	4.217	-2.643	1.629	-4.807	5.0	0.028	0.00221	0.0	0.0	2800	0.0	91.1
49	0.205	-0.014	4.929	-3.143	1.893	-5.527	6.2	0.042	0.00221	0.0	0.0	3000	0.0	91.1
50	0.204	-0.026	4.307	-2.920	2.225	-4.762	5.2	0.029	0.00221	0.0	0.0	2799	0.0	91.1
51	0.173	-0.017	3.693	-2.458	1.906	-4.156	5.2	0.030	0.00221	0.0	0.0	2600	0.0	91.1
52	0.155	-0.005	3.181	-1.954	1.742	-3.600	5.4	0.032	0.00221	0.0	0.0	2400	0.0	91.1
53	0.118	0.002	2.583	-1.590	1.237	-2.957	4.1	0.019	0.00221	0.0	0.0	2200	0.0	91.1
54	0.108	0.017	2.177	-1.199	1.097	-2.474	4.3	0.020	0.00221	0.0	0.0	2000	0.0	91.1
55	0.086	0.019	1.734	-1.094	0.866	-2.077	4.3	0.020	0.00221	0.0	0.0	1800	0.0	91.1
56	0.064	0.020	1.296	-0.899	0.585	-1.584	3.4	0.013	0.00221	0.0	0.0	1600	0.0	91.1
57	0.036	0.040	0.982	-0.560	0.284	-1.258	3.5	0.013	0.00221	0.0	0.0	1400	0.0	91.1
58	0.025	0.042	0.707	-0.545	0.221	-0.954	3.3	0.012	0.00221	0.0	0.0	1200	0.0	91.0
59	0.014	0.055	0.410	-0.215	0.104	-0.657	2.7	0.008	0.00221	0.0	0.0	1000	0.0	91.0
60	0.014	0.057	0.222	-0.154	0.105	-0.421	2.3	0.006	0.00221	0.0	0.0	800	0.0	91.1
61	0.010	0.062	0.076	0.052	0.163	-0.225	2.1	0.005	0.00221	0.0	0.0	600	0.0	91.1
62	0.012	0.059	-0.049	-0.019	0.066	-0.065	1.7	0.003	0.00221	0.0	0.0	400	0.0	91.0
63	-0.014	0.047	-0.122	-0.038	0.071	0.026	1.7	0.003	0.00221	0.0	0.0	200	0.0	91.1
64	0.008	0.000	-0.008	0.000	0.008	0.000	1.8	0.003	0.00221	0.0	0.0	0	-	91.0

Table F.45: Testing conditions and rotor 3 loads in the hub coordinate system for run 120.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.012	0.000	-0.002	0.000	0.008	0.000	0.6	0.000	0.00221	0.0	0.0	0	0.0	91.0
4	-0.107	-0.127	-0.115	0.110	0.146	0.149	1.2	0.002	0.00221	0.0	0.0	0	0.0	91.1
5	-0.134	-0.100	-0.063	0.104	0.183	0.226	1.1	0.001	0.00221	0.0	0.0	0	0.0	91.1
6	-0.149	-0.103	0.049	-0.080	0.122	0.382	1.5	0.003	0.00221	0.0	0.0	0	0.0	91.2
7	-0.147	-0.095	0.226	-0.170	0.139	0.566	2.0	0.004	0.00221	0.0	0.0	0	0.0	91.1
8	-0.117	-0.097	0.416	-0.311	0.081	0.821	2.1	0.005	0.00221	0.0	0.0	0	0.0	91.2
9	-0.109	-0.104	0.663	-0.592	0.141	1.105	2.5	0.007	0.00221	0.0	0.0	0	0.0	91.2
10	-0.103	-0.115	0.972	-0.781	0.003	1.422	3.2	0.011	0.00221	0.0	0.0	0	0.0	91.2
11	-0.098	-0.118	1.283	-1.106	0.060	1.783	2.8	0.009	0.00221	0.0	0.0	0	0.0	91.2
12	-0.091	-0.131	1.674	-1.349	-0.173	2.223	3.9	0.017	0.00221	0.0	0.0	0	0.0	91.2
13	-0.090	-0.144	2.081	-1.775	-0.233	2.674	3.5	0.014	0.00221	0.0	0.0	0	0.0	91.2
14	-0.095	-0.153	2.512	-2.088	-0.345	3.195	3.7	0.015	0.00221	0.0	0.0	0	0.0	91.2
15	-0.106	-0.174	3.136	-2.824	-0.894	3.724	4.3	0.021	0.00221	0.0	0.0	0	0.0	91.2
16	-0.107	-0.176	3.609	-2.946	-0.724	4.315	4.5	0.023	0.00221	0.0	0.0	0	0.0	91.2
17	-0.143	-0.221	4.379	-3.852	-1.592	4.960	5.7	0.035	0.00221	0.0	0.0	0	0.0	91.2
18	-0.141	-0.216	4.836	-4.245	-1.308	5.637	5.2	0.030	0.00221	0.0	0.0	0	0.0	91.2
19	-0.167	-0.221	4.365	-3.678	-1.728	4.914	5.4	0.033	0.00221	0.0	0.0	0	0.0	91.2
20	-0.165	-0.204	3.695	-3.263	-1.146	4.283	4.8	0.025	0.00221	0.0	0.0	0	0.0	91.2
21	-0.161	-0.189	3.082	-2.989	-0.198	3.673	5.3	0.031	0.00221	0.0	0.0	0	0.0	91.2
22	-0.161	-0.168	2.503	-2.243	-0.049	3.127	4.5	0.022	0.00221	0.0	0.0	0	0.0	91.2
23	-0.177	-0.161	2.134	-1.723	-0.539	2.673	4.1	0.019	0.00221	0.0	0.0	0	0.0	91.2
24	-0.159	-0.138	1.709	-0.979	-0.285	2.106	4.5	0.023	0.00221	0.0	0.0	0	0.0	91.2
25	-0.167	-0.120	1.226	-0.795	0.195	1.784	3.4	0.013	0.00221	0.0	0.0	0	0.0	91.3
26	-0.179	-0.119	0.930	-0.840	0.069	1.429	3.2	0.011	0.00221	0.0	0.0	0	0.0	91.2
27	-0.176	-0.111	0.647	-0.471	0.021	1.104	3.0	0.010	0.00221	0.0	0.0	0	0.0	91.3
28	-0.177	-0.103	0.399	-0.429	0.164	0.826	2.3	0.006	0.00221	0.0	0.0	0	0.0	91.3
29	-0.174	-0.093	0.183	-0.165	0.172	0.588	2.1	0.005	0.00221	0.0	0.0	0	0.0	91.3
30	-0.199	-0.095	0.009	-0.105	0.127	0.375	1.9	0.004	0.00221	0.0	0.0	0	0.0	91.3
31	-0.185	-0.080	-0.097	0.099	0.196	0.234	1.6	0.003	0.00221	0.0	0.0	0	0.0	91.3
32	-0.168	-0.074	-0.160	0.055	0.154	0.159	1.6	0.003	0.00221	0.0	0.0	0	0.0	91.3
33	-0.187	-0.043	-0.025	0.030	0.141	0.022	1.6	0.003	0.00221	0.0	0.0	0	-	91.2
34	-0.135	-0.095	-0.125	0.086	0.153	0.154	1.6	0.003	0.00221	0.0	0.0	0	-90.0	91.2

Continued on next page

Table F.45: Testing conditions and rotor 3 loads in the hub coordinate system for run 120.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	-0.152	-0.070	-0.078	0.040	0.161	0.228	1.7	0.003	0.00221	0.0	0.0	0	-90.0	91.2
36	-0.152	-0.073	0.036	-0.096	0.150	0.384	1.8	0.004	0.00221	0.0	0.0	0	-90.0	91.2
37	-0.110	-0.071	0.215	-0.238	0.094	0.570	2.4	0.006	0.00221	0.0	0.0	0	-90.0	91.2
38	-0.074	-0.070	0.409	-0.441	0.121	0.822	2.2	0.005	0.00221	0.0	0.0	0	-90.0	91.1
40	-0.020	-0.075	0.680	-0.669	-0.047	1.099	3.2	0.011	0.00221	0.0	0.0	0	-90.0	91.2
41	-0.003	-0.081	0.974	-0.867	-0.165	1.400	3.2	0.011	0.00221	0.0	0.0	0	-90.0	91.1
42	0.017	-0.085	1.325	-1.083	-0.341	1.751	4.2	0.019	0.00221	0.0	0.0	0	-90.0	91.1
43	0.019	-0.097	1.724	-1.480	-0.619	2.180	3.7	0.015	0.00221	0.0	0.0	0	-90.0	91.1
44	0.042	-0.102	2.058	-1.811	-0.120	2.615	4.9	0.027	0.00221	0.0	0.0	0	-90.0	91.1
45	0.031	-0.120	2.581	-2.129	-0.660	3.139	4.3	0.020	0.00221	0.0	0.0	0	-90.0	91.1
46	0.028	-0.139	3.098	-2.637	-0.961	3.651	4.8	0.025	0.00221	0.0	0.0	0	-90.0	91.0
47	-0.003	-0.152	3.648	-3.168	-0.995	4.285	4.7	0.024	0.00221	0.0	0.0	0	-90.0	91.1
48	-0.022	-0.167	4.262	-3.632	-1.409	4.889	5.0	0.028	0.00221	0.0	0.0	0	-90.0	91.1
49	-0.074	-0.193	5.045	-3.963	-2.671	5.559	6.2	0.042	0.00221	0.0	0.0	0	-90.0	91.1
50	-0.067	-0.196	4.340	-4.043	-1.756	4.873	5.2	0.029	0.00221	0.0	0.0	0	-90.0	91.1
51	-0.047	-0.160	3.619	-3.210	-1.036	4.273	5.2	0.030	0.00221	0.0	0.0	0	-90.0	91.1
52	-0.052	-0.144	3.129	-2.564	-0.906	3.658	5.4	0.032	0.00221	0.0	0.0	0	-90.0	91.1
53	-0.052	-0.133	2.561	-2.402	-0.496	3.139	4.1	0.019	0.00221	0.0	0.0	0	-90.0	91.1
54	-0.044	-0.112	2.110	-1.868	-0.204	2.666	4.3	0.020	0.00221	0.0	0.0	0	-90.0	91.1
55	-0.038	-0.103	1.714	-1.491	-0.334	2.178	4.3	0.020	0.00221	0.0	0.0	0	-90.0	91.1
56	-0.033	-0.086	1.254	-1.192	0.211	1.776	3.4	0.013	0.00221	0.0	0.0	0	-90.0	91.1
57	-0.027	-0.079	0.993	-0.827	-0.149	1.399	3.5	0.013	0.00221	0.0	0.0	0	-90.0	91.1
58	-0.014	-0.067	0.693	-0.409	-0.193	1.052	3.3	0.012	0.00221	0.0	0.0	0	-90.0	91.0
59	-0.010	-0.064	0.424	-0.341	-0.096	0.795	2.7	0.008	0.00221	0.0	0.0	0	-90.0	91.0
60	-0.003	-0.046	0.204	-0.178	-0.063	0.543	2.3	0.006	0.00221	0.0	0.0	0	-90.0	91.1
61	0.004	-0.043	0.015	-0.007	-0.053	0.345	2.1	0.005	0.00221	0.0	0.0	0	-90.0	91.1
62	-0.011	-0.032	-0.075	-0.003	0.032	0.210	1.7	0.003	0.00221	0.0	0.0	0	-90.0	91.0
63	0.001	-0.035	-0.132	0.035	0.043	0.135	1.7	0.003	0.00221	0.0	0.0	0	0.0	91.1
64	-0.023	0.000	0.003	0.000	0.027	0.000	1.8	0.003	0.00221	0.0	0.0	0	-	91.0

Run 121: 2-bladed Concept Quadrotor

Table F.46: Run 121 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	0

Table F.47: Testing conditions and rotor 1 loads in the hub coordinate system for run 121.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.014	0.000	-0.010	0.000	-0.005	0.000	0.3	0.000	0.00233	-0.0	0.0	0	-	65.2
5	0.106	0.102	2.074	-1.822	0.464	-2.341	5.5	0.035	0.00233	0.0	0.0	2000	0.0	65.3
6	0.498	0.007	2.658	-1.577	6.721	-1.959	20.3	0.481	0.00233	0.0	0.0	2000	0.0	65.1
7	0.676	0.008	3.909	-1.473	9.362	-3.238	20.4	0.483	0.00233	0.0	0.0	2500	0.0	64.7
8	0.913	-0.008	5.456	-1.653	13.225	-4.760	20.4	0.483	0.00233	0.0	0.0	3000	0.0	64.6
9	0.889	-0.042	5.426	-1.871	12.880	-4.722	20.5	0.491	0.00233	0.0	-3.0	3000	0.0	64.6
10	0.650	-0.008	3.863	-1.697	9.489	-3.263	20.4	0.485	0.00233	0.0	-3.0	2500	0.0	64.7
11	0.499	-0.027	2.512	-2.022	6.218	-2.081	20.3	0.482	0.00233	0.0	-3.0	1999	0.0	64.6
12	0.443	-0.017	2.553	-2.027	5.883	-2.106	20.6	0.496	0.00233	-1.0	-3.0	2000	0.0	64.6
13	0.622	-0.012	3.813	-2.008	9.047	-3.308	20.3	0.478	0.00233	-1.0	-3.0	2499	0.0	64.6
14	0.825	-0.027	5.491	-1.644	12.078	-4.833	20.1	0.472	0.00233	-1.0	-3.0	3000	0.0	64.5
15	0.898	0.033	5.466	-0.887	12.382	-4.842	20.1	0.473	0.00233	-1.0	0.0	2999	0.0	64.6
16	0.726	0.024	3.942	-1.556	9.442	-3.276	20.1	0.472	0.00233	-1.0	0.0	2500	0.0	64.6
17	0.550	0.016	2.542	-1.736	6.247	-2.051	20.0	0.468	0.00233	-1.0	0.0	2000	0.0	64.6
18	0.492	0.022	2.448	-2.015	5.910	-2.122	20.2	0.476	0.00233	-3.0	0.0	2000	0.0	64.6
19	0.650	0.020	3.746	-1.911	8.784	-3.327	20.2	0.475	0.00233	-3.0	0.0	2499	0.0	64.6
20	0.864	0.021	5.400	-1.459	12.290	-4.829	20.3	0.481	0.00233	-3.0	0.0	2999	0.0	64.6
21	0.871	-0.035	5.305	-2.333	12.011	-4.806	20.2	0.477	0.00233	-3.0	-3.0	3000	0.0	64.7
22	0.624	-0.017	3.698	-2.432	8.894	-3.319	20.2	0.478	0.00233	-3.0	-3.0	2500	0.0	64.8
23	0.466	-0.011	2.392	-2.213	5.990	-2.136	20.2	0.474	0.00233	-3.0	-3.0	2000	0.0	64.8
24	0.411	-0.009	2.347	-2.206	5.695	-2.209	20.3	0.483	0.00233	-5.0	-3.0	2000	0.0	64.9
25	0.582	-0.009	3.653	-2.344	8.536	-3.423	20.4	0.485	0.00233	-5.0	-3.0	2499	0.0	64.9
26	0.795	-0.015	5.257	-2.077	11.681	-4.916	20.6	0.494	0.00233	-5.0	-3.0	2999	0.0	64.9
27	0.843	-0.019	5.217	-2.118	11.775	-4.867	20.3	0.478	0.00233	-5.0	-3.0	2999	0.0	64.9
28	0.608	-0.016	3.657	-2.356	8.598	-3.385	20.2	0.477	0.00233	-5.0	-3.0	2500	0.0	65.0
29	0.431	-0.004	2.335	-2.187	5.694	-2.201	20.0	0.466	0.00233	-5.0	-3.0	2000	0.0	65.1
30	0.364	0.019	2.188	-2.149	4.991	-2.354	20.3	0.479	0.00233	-10.0	-3.0	2000	0.0	65.2
32	0.524	0.012	3.501	-2.143	7.507	-3.627	20.3	0.480	0.00233	-10.0	-3.0	2499	0.0	65.3
34	0.742	0.012	5.109	-1.823	10.345	-5.165	20.2	0.476	0.00233	-10.0	-3.0	2999	0.0	65.4
35	0.834	0.029	5.122	-1.886	11.076	-4.999	20.3	0.481	0.00233	-10.0	0.0	2999	0.0	65.4
37	0.606	0.026	3.541	-2.217	8.169	-3.474	20.4	0.485	0.00233	-10.0	0.0	2500	0.0	65.6
38	0.455	0.040	2.154	-2.154	5.298	-2.264	20.1	0.468	0.00233	-10.0	0.0	2000	0.0	65.5

Continued on next page

Table F.47: Testing conditions and rotor 1 loads in the hub coordinate system for run 121.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
40	0.529	-0.044	2.407	-5.087	6.347	-2.434	40.4	1.897	0.00232	-10.0	0.0	2000	0.0	66.0
42	0.787	-0.074	3.949	-5.150	9.741	-3.617	40.4	1.900	0.00232	-10.0	0.0	2499	0.0	66.3
43	1.109	-0.078	5.773	-4.501	13.865	-5.104	40.4	1.899	0.00232	-10.0	0.0	3000	0.0	66.5
44	1.017	-0.076	5.439	-4.474	12.722	-5.283	40.4	1.894	0.00232	-10.0	-3.0	3000	0.0	66.5
45	0.719	-0.065	3.627	-4.906	8.806	-3.764	40.5	1.903	0.00232	-10.0	-3.0	2500	0.0	66.6
47	0.480	-0.046	2.094	-4.802	5.735	-2.515	40.5	1.905	0.00232	-10.0	-3.0	1999	0.0	66.8
48	0.518	-0.077	2.509	-5.222	6.852	-2.388	40.3	1.882	0.00232	-5.0	-3.0	2000	0.0	66.9
49	0.789	-0.090	4.097	-5.324	10.366	-3.528	40.5	1.903	0.00232	-5.0	-3.0	2499	0.0	67.0
50	1.089	-0.103	5.819	-4.571	14.803	-4.860	40.3	1.882	0.00232	-5.0	-3.0	3000	0.0	67.7
51	1.184	-0.068	6.163	-4.417	15.699	-4.794	40.4	1.895	0.00232	-5.0	0.0	3000	0.0	67.9
52	0.850	-0.056	4.311	-5.199	11.129	-3.386	40.4	1.887	0.00232	-5.0	0.0	2500	0.0	68.0
53	0.551	-0.025	2.760	-5.439	7.282	-2.240	40.4	1.891	0.00231	-5.0	0.0	2000	0.0	68.3
54	0.556	-0.010	2.930	-5.353	7.383	-2.216	40.7	1.913	0.00231	-3.0	0.0	2000	0.0	68.7
55	0.824	-0.030	4.543	-4.825	11.446	-3.390	40.5	1.898	0.00231	-3.0	0.0	2499	0.0	68.9
56	1.199	-0.044	6.424	-3.714	16.292	-4.744	40.6	1.903	0.00231	-3.0	0.0	3000	0.0	69.0
57	1.171	-0.106	6.060	-4.764	15.439	-4.789	40.6	1.902	0.00231	-3.0	-3.0	3000	0.0	69.0
58	0.802	-0.077	4.211	-5.432	10.821	-3.372	40.6	1.903	0.00231	-3.0	-3.0	2500	0.0	69.2
59	0.517	-0.051	2.596	-5.341	7.208	-2.232	40.5	1.899	0.00231	-3.0	-3.0	2000	0.0	69.3
60	0.529	-0.039	2.855	-5.458	7.400	-2.216	40.5	1.897	0.00231	-1.0	-3.0	2000	0.0	69.6
61	0.780	-0.051	4.481	-5.182	11.433	-3.381	40.5	1.897	0.00231	-1.0	-3.0	2499	0.0	69.7
62	1.172	-0.070	6.300	-4.202	16.080	-4.801	40.5	1.897	0.00231	-1.0	-3.0	2999	0.0	69.8
63	1.257	-0.024	6.715	-3.485	16.794	-4.672	40.6	1.901	0.00231	-1.0	0.0	3000	0.0	69.9
64	0.868	-0.003	4.856	-4.579	11.682	-3.291	40.5	1.893	0.00231	-1.0	0.0	2500	0.0	69.8
65	0.574	-0.002	3.139	-5.292	7.418	-2.129	40.6	1.902	0.00231	-1.0	0.0	1999	0.0	70.0
66	0.562	-0.001	3.244	-5.449	7.458	-2.096	40.7	1.908	0.00231	-0.0	0.0	2000	0.0	70.2
67	0.823	0.001	5.011	-4.641	11.729	-3.253	40.7	1.907	0.00231	-0.0	0.0	2499	0.0	70.3
68	1.258	-0.019	6.875	-3.578	17.159	-4.630	40.5	1.892	0.00231	-0.0	0.0	3000	0.0	70.4
69	1.200	-0.051	6.450	-3.804	16.274	-4.783	40.7	1.911	0.00231	-0.0	-3.0	3000	0.0	70.4
70	0.824	-0.032	4.572	-5.020	11.530	-3.371	40.5	1.894	0.00231	-0.0	-3.0	2500	0.0	70.5
71	0.538	-0.026	2.973	-5.362	7.419	-2.187	40.7	1.911	0.00231	-0.0	-3.0	2000	0.0	70.5
72	0.443	0.118	2.493	-1.886	7.009	-1.995	20.5	0.485	0.00231	-0.0	0.0	2000	0.0	70.7
73	0.132	0.190	1.899	-0.269	3.158	-2.312	3.9	0.018	0.00231	-0.0	0.0	2000	0.0	70.7
75	-0.018	0.000	-0.010	0.000	-0.008	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	70.6

Table F.48: Testing conditions and rotor 2 loads in the hub coordinate system for run 121.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.008	0.000	0.006	0.000	-0.012	0.000	0.3	0.000	0.00233	-0.0	0.0	0	-	65.2
5	-0.246	-0.025	2.071	1.631	1.090	2.859	5.5	0.035	0.00233	0.0	0.0	1999	0.0	65.3
6	-0.195	0.012	2.762	1.546	6.982	2.487	20.3	0.481	0.00233	0.0	0.0	2000	0.0	65.1
7	-0.072	0.003	4.161	1.019	10.419	3.755	20.4	0.483	0.00233	0.0	0.0	2499	0.0	64.7
8	0.038	-0.015	5.914	-0.401	13.929	5.346	20.4	0.483	0.00233	0.0	0.0	3000	0.0	64.6
9	0.088	0.023	5.515	0.241	13.086	5.207	20.5	0.491	0.00233	0.0	-3.0	2999	0.0	64.6
10	0.013	0.036	3.915	1.659	9.755	3.678	20.4	0.485	0.00233	0.0	-3.0	2500	0.0	64.7
11	-0.048	0.021	2.488	1.777	6.398	2.466	20.3	0.482	0.00233	0.0	-3.0	1999	0.0	64.6
12	-0.040	0.024	2.548	1.834	6.317	2.451	20.6	0.496	0.00233	-1.0	-3.0	2000	0.0	64.6
13	0.065	0.032	3.873	1.573	9.687	3.655	20.3	0.478	0.00233	-1.0	-3.0	2499	0.0	64.6
14	0.121	0.028	5.515	0.734	12.858	5.202	20.1	0.472	0.00233	-1.0	-3.0	2999	0.0	64.5
15	0.027	-0.031	5.874	0.018	13.116	5.311	20.1	0.473	0.00233	-1.0	0.0	2999	0.0	64.6
16	-0.054	-0.031	4.192	1.260	10.070	3.703	20.1	0.472	0.00233	-1.0	0.0	2500	0.0	64.6
17	-0.144	-0.038	2.790	1.401	6.700	2.409	20.0	0.468	0.00233	-1.0	0.0	1999	0.0	64.6
18	-0.126	-0.037	2.720	1.502	6.578	2.425	20.2	0.476	0.00233	-3.0	0.0	1999	0.0	64.6
19	-0.066	-0.034	4.107	1.191	9.810	3.691	20.2	0.475	0.00233	-3.0	0.0	2499	0.0	64.6
20	0.034	-0.030	5.733	0.568	13.100	5.234	20.3	0.481	0.00233	-3.0	0.0	2999	0.0	64.6
21	0.147	0.033	5.396	1.399	12.593	5.091	20.2	0.477	0.00233	-3.0	-3.0	2999	0.0	64.7
22	0.072	0.013	3.759	1.890	9.307	3.616	20.2	0.478	0.00233	-3.0	-3.0	2500	0.0	64.8
23	-0.004	-0.002	2.384	1.955	6.129	2.424	20.2	0.474	0.00233	-3.0	-3.0	2000	0.0	64.8
24	-0.013	0.002	2.354	2.025	5.741	2.486	20.3	0.483	0.00233	-5.0	-3.0	2000	0.0	64.9
25	0.060	-0.004	3.664	1.821	8.682	3.720	20.4	0.485	0.00233	-5.0	-3.0	2499	0.0	64.9
26	0.123	0.012	5.348	1.273	12.032	5.217	20.6	0.494	0.00233	-5.0	-3.0	3000	0.0	64.9
27	0.132	0.026	5.274	1.588	11.845	5.181	20.3	0.478	0.00233	-5.0	-3.0	2999	0.0	64.9
28	0.053	0.005	3.656	2.001	8.557	3.729	20.2	0.477	0.00233	-5.0	-3.0	2500	0.0	65.0
29	0.002	-0.018	2.261	1.868	5.662	2.524	20.0	0.466	0.00233	-5.0	-3.0	2000	0.0	65.1
30	-0.025	-0.024	2.179	1.965	4.861	2.627	20.3	0.479	0.00233	-10.0	-3.0	2000	0.0	65.2
32	0.025	-0.020	3.510	1.865	7.266	3.902	20.3	0.480	0.00233	-10.0	-3.0	2499	0.0	65.3
34	0.120	0.010	5.164	1.560	10.124	5.451	20.2	0.476	0.00233	-10.0	-3.0	2999	0.0	65.4
35	0.043	-0.021	5.385	1.604	11.219	5.323	20.3	0.481	0.00233	-10.0	0.0	2999	0.0	65.4
37	-0.046	-0.046	3.754	1.996	8.377	3.771	20.4	0.485	0.00233	-10.0	0.0	2500	0.0	65.6
38	-0.142	-0.057	2.457	1.985	5.530	2.536	20.1	0.468	0.00233	-10.0	0.0	2000	0.0	65.5

Continued on next page

Table F.48: Testing conditions and rotor 2 loads in the hub coordinate system for run 121.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
40	0.042	-0.008	2.448	4.804	6.442	2.627	40.4	1.897	0.00232	-10.0	0.0	2000	0.0	66.0
42	0.150	0.020	4.018	4.809	9.862	3.858	40.4	1.900	0.00232	-10.0	0.0	2499	0.0	66.3
43	0.273	0.049	5.883	3.966	14.331	5.335	40.4	1.899	0.00232	-10.0	0.0	2999	0.0	66.5
44	0.237	0.060	5.577	3.902	12.953	5.494	40.4	1.894	0.00232	-10.0	-3.0	2999	0.0	66.5
45	0.132	0.050	3.760	4.645	8.992	3.963	40.5	1.903	0.00232	-10.0	-3.0	2500	0.0	66.6
47	0.060	0.032	2.221	4.495	5.755	2.671	40.5	1.905	0.00232	-10.0	-3.0	1999	0.0	66.8
48	0.041	0.055	2.618	4.893	6.897	2.522	40.3	1.882	0.00232	-5.0	-3.0	2000	0.0	66.9
49	0.144	0.077	4.210	4.937	10.585	3.712	40.5	1.903	0.00232	-5.0	-3.0	2499	0.0	67.0
50	0.284	0.084	5.877	4.019	15.193	5.322	40.3	1.882	0.00232	-5.0	-3.0	3000	0.0	67.7
51	0.318	0.063	6.124	3.945	16.208	5.262	40.4	1.895	0.00232	-5.0	0.0	2999	0.0	67.9
52	0.171	0.007	4.228	4.987	11.354	3.827	40.4	1.887	0.00232	-5.0	0.0	2500	0.0	68.0
53	0.012	-0.019	2.585	5.309	7.442	2.691	40.4	1.891	0.00231	-5.0	0.0	1999	0.0	68.3
54	0.061	0.007	2.854	5.258	7.560	2.607	40.7	1.913	0.00231	-3.0	0.0	2000	0.0	68.7
55	0.171	0.015	4.504	4.544	11.848	3.779	40.5	1.898	0.00231	-3.0	0.0	2499	0.0	68.9
56	0.347	0.047	6.362	3.109	16.746	5.245	40.6	1.903	0.00231	-3.0	0.0	2999	0.0	69.0
57	0.334	0.126	6.063	4.009	15.650	5.205	40.6	1.902	0.00231	-3.0	-3.0	2999	0.0	69.0
58	0.187	0.091	4.204	4.970	11.051	3.810	40.6	1.903	0.00231	-3.0	-3.0	2500	0.0	69.2
59	0.053	0.052	2.576	5.167	7.252	2.676	40.5	1.899	0.00231	-3.0	-3.0	1999	0.0	69.3
60	0.047	0.055	2.811	5.122	7.464	2.618	40.5	1.897	0.00231	-1.0	-3.0	2000	0.0	69.6
61	0.164	0.080	4.398	4.876	11.639	3.791	40.5	1.897	0.00231	-1.0	-3.0	2499	0.0	69.7
62	0.341	0.110	6.278	3.372	16.496	5.249	40.5	1.897	0.00231	-1.0	-3.0	2999	0.0	69.8
63	0.373	0.060	6.668	2.538	17.256	5.137	40.6	1.901	0.00231	-1.0	0.0	3000	0.0	69.9
64	0.205	0.017	4.752	4.187	12.066	3.713	40.5	1.893	0.00231	-1.0	0.0	2500	0.0	69.8
65	0.059	0.001	3.033	5.023	7.633	2.562	40.6	1.902	0.00231	-1.0	0.0	2000	0.0	70.0
66	0.040	0.005	3.139	5.207	7.675	2.529	40.7	1.908	0.00231	-0.0	0.0	2000	0.0	70.2
67	0.172	0.025	4.816	4.466	12.258	3.710	40.7	1.907	0.00231	-0.0	0.0	2499	0.0	70.3
68	0.363	0.051	6.742	2.569	17.288	5.112	40.5	1.892	0.00231	-0.0	0.0	2999	0.0	70.4
69	0.359	0.096	6.405	3.171	16.651	5.229	40.7	1.911	0.00231	-0.0	-3.0	2999	0.0	70.4
70	0.215	0.062	4.514	4.610	11.831	3.763	40.5	1.894	0.00231	-0.0	-3.0	2500	0.0	70.5
71	0.040	0.038	2.843	5.210	7.477	2.610	40.7	1.911	0.00231	-0.0	-3.0	1999	0.0	70.5
72	-0.008	-0.076	2.375	1.530	6.399	2.504	20.5	0.485	0.00231	-0.0	0.0	2000	0.0	70.7
73	-0.003	-0.118	1.903	0.427	2.744	2.722	3.9	0.018	0.00231	-0.0	0.0	1999	0.0	70.7
75	-0.013	0.000	0.004	0.000	-0.014	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	70.6

Table F.49: Testing conditions and rotor 3 loads in the hub coordinate system for run 121.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.008	0.000	-0.004	0.000	0.002	0.000	0.3	0.000	0.00233	-0.0	0.0	0	-	65.2
5	-0.306	-0.174	1.891	-1.910	0.013	2.977	5.5	0.035	0.00233	0.0	0.0	2000	0.0	65.3
6	-0.038	-0.024	1.969	1.724	4.607	2.898	20.3	0.481	0.00233	0.0	0.0	1999	0.0	65.1
7	0.094	0.016	2.971	0.972	5.829	4.203	20.4	0.483	0.00233	0.0	0.0	2499	0.0	64.7
8	0.226	0.133	4.693	1.122	7.689	5.854	20.4	0.483	0.00233	0.0	0.0	3000	0.0	64.6
9	0.296	0.074	4.467	0.380	6.891	5.838	20.5	0.491	0.00233	0.0	-3.0	3000	0.0	64.6
10	0.237	0.062	3.042	1.598	5.443	4.203	20.4	0.485	0.00233	0.0	-3.0	2500	0.0	64.7
11	0.176	0.023	1.880	1.905	3.852	2.928	20.3	0.482	0.00233	0.0	-3.0	1999	0.0	64.6
12	0.174	0.013	1.855	1.607	3.998	2.926	20.6	0.496	0.00233	-1.0	-3.0	1999	0.0	64.6
13	0.257	0.052	3.005	1.395	5.343	4.255	20.3	0.478	0.00233	-1.0	-3.0	2499	0.0	64.6
14	0.327	0.092	4.472	0.916	6.839	5.803	20.1	0.472	0.00233	-1.0	-3.0	2999	0.0	64.5
15	0.183	0.089	4.568	0.496	7.103	5.750	20.1	0.473	0.00233	-1.0	0.0	3000	0.0	64.6
16	0.121	0.045	3.145	0.929	5.884	4.201	20.1	0.472	0.00233	-1.0	0.0	2500	0.0	64.6
17	0.043	0.011	2.036	1.496	4.438	2.912	20.0	0.468	0.00233	-1.0	0.0	2000	0.0	64.6
18	0.053	0.016	1.966	1.747	4.295	2.941	20.2	0.476	0.00233	-3.0	0.0	2000	0.0	64.6
19	0.139	0.081	3.164	1.856	5.829	4.282	20.2	0.475	0.00233	-3.0	0.0	2499	0.0	64.6
20	0.275	0.171	4.804	2.028	7.961	5.880	20.3	0.481	0.00233	-3.0	0.0	2999	0.0	64.6
21	0.378	0.134	4.629	1.839	7.038	5.918	20.2	0.477	0.00233	-3.0	-3.0	2999	0.0	64.7
22	0.277	0.065	3.098	1.836	5.372	4.277	20.2	0.478	0.00233	-3.0	-3.0	2500	0.0	64.8
23	0.214	0.023	1.932	2.201	3.738	2.924	20.2	0.474	0.00233	-3.0	-3.0	1999	0.0	64.8
24	0.206	0.029	1.936	2.390	3.782	2.933	20.3	0.483	0.00233	-5.0	-3.0	1999	0.0	64.9
25	0.298	0.074	3.109	1.994	5.379	4.283	20.4	0.485	0.00233	-5.0	-3.0	2499	0.0	64.9
26	0.366	0.107	4.595	1.361	7.009	5.904	20.6	0.494	0.00233	-5.0	-3.0	3000	0.0	64.9
27	0.366	0.098	4.565	1.306	6.937	5.882	20.3	0.478	0.00233	-5.0	-3.0	2999	0.0	64.9
28	0.298	0.061	3.125	2.016	5.549	4.272	20.2	0.477	0.00233	-5.0	-3.0	2500	0.0	65.0
29	0.215	0.020	1.952	2.264	3.698	2.922	20.0	0.466	0.00233	-5.0	-3.0	1999	0.0	65.1
30	0.225	0.024	1.913	2.455	3.529	2.934	20.3	0.479	0.00233	-10.0	-3.0	2000	0.0	65.2
32	0.322	0.074	3.121	2.374	5.314	4.280	20.3	0.480	0.00233	-10.0	-3.0	2499	0.0	65.3
34	0.369	0.104	4.562	1.652	6.868	5.900	20.2	0.476	0.00233	-10.0	-3.0	3000	0.0	65.4
35	0.263	0.111	4.711	1.525	7.611	5.890	20.3	0.481	0.00233	-10.0	0.0	3000	0.0	65.4
37	0.207	0.081	3.217	2.515	5.963	4.271	20.4	0.485	0.00233	-10.0	0.0	2500	0.0	65.6
38	0.041	0.020	1.991	2.491	3.904	2.916	20.1	0.468	0.00233	-10.0	0.0	2000	0.0	65.5

Continued on next page

Table F.49: Testing conditions and rotor 3 loads in the hub coordinate system for run 121.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
40	0.507	0.224	2.173	5.660	5.143	3.009	40.4	1.897	0.00232	-10.0	0.0	1999	0.0	66.0
42	0.703	0.364	3.513	6.030	8.051	4.344	40.4	1.900	0.00232	-10.0	0.0	2499	0.0	66.3
43	0.873	0.506	5.034	5.396	11.107	5.949	40.4	1.899	0.00232	-10.0	0.0	3000	0.0	66.5
44	0.854	0.480	4.699	5.547	9.982	5.974	40.4	1.894	0.00232	-10.0	-3.0	2999	0.0	66.5
45	0.678	0.365	3.183	5.755	7.065	4.362	40.5	1.903	0.00232	-10.0	-3.0	2500	0.0	66.6
47	0.552	0.270	1.897	5.329	4.444	3.008	40.5	1.905	0.00232	-10.0	-3.0	1999	0.0	66.8
48	0.616	0.323	2.227	5.780	5.166	2.980	40.3	1.882	0.00232	-5.0	-3.0	2000	0.0	66.9
49	0.775	0.425	3.509	5.987	7.932	4.335	40.5	1.903	0.00232	-5.0	-3.0	2499	0.0	67.0
50	0.921	0.465	4.585	5.310	10.724	6.106	40.3	1.882	0.00232	-5.0	-3.0	2999	0.0	67.7
51	0.955	0.514	4.938	5.233	12.124	6.031	40.4	1.895	0.00232	-5.0	0.0	3000	0.0	67.9
52	0.802	0.441	3.425	5.918	8.882	4.400	40.4	1.887	0.00232	-5.0	0.0	2500	0.0	68.0
53	0.642	0.338	2.087	6.122	5.924	3.078	40.4	1.891	0.00231	-5.0	0.0	2000	0.0	68.3
54	0.703	0.378	2.212	6.122	6.041	3.023	40.7	1.913	0.00231	-3.0	0.0	2000	0.0	68.7
55	0.884	0.483	3.502	5.869	9.081	4.359	40.5	1.898	0.00231	-3.0	0.0	2499	0.0	68.9
56	1.009	0.526	4.988	4.804	12.286	6.021	40.6	1.903	0.00231	-3.0	0.0	3000	0.0	69.0
57	0.972	0.502	4.703	5.086	10.984	6.069	40.6	1.902	0.00231	-3.0	-3.0	2999	0.0	69.0
58	0.808	0.423	3.223	5.640	8.082	4.457	40.6	1.903	0.00231	-3.0	-3.0	2500	0.0	69.2
59	0.667	0.326	1.928	5.907	5.356	3.132	40.5	1.899	0.00231	-3.0	-3.0	1999	0.0	69.3
60	0.694	0.348	2.032	5.716	5.605	3.086	40.5	1.897	0.00231	-1.0	-3.0	2000	0.0	69.6
61	0.843	0.405	3.241	5.329	8.348	4.446	40.5	1.897	0.00231	-1.0	-3.0	2499	0.0	69.7
62	0.969	0.459	4.644	4.266	10.979	6.063	40.5	1.897	0.00231	-1.0	-3.0	2999	0.0	69.8
63	0.989	0.465	4.918	3.494	12.259	5.968	40.6	1.901	0.00231	-1.0	0.0	3000	0.0	69.9
64	0.858	0.440	3.492	4.960	9.274	4.330	40.5	1.893	0.00231	-1.0	0.0	2500	0.0	69.8
65	0.687	0.365	2.223	5.723	6.257	2.996	40.6	1.902	0.00231	-1.0	0.0	2000	0.0	70.0
66	0.710	0.382	2.265	5.880	6.334	2.962	40.7	1.908	0.00231	-0.0	0.0	2000	0.0	70.2
67	0.876	0.449	3.493	4.949	9.407	4.309	40.7	1.907	0.00231	-0.0	0.0	2500	0.0	70.3
68	0.964	0.417	4.842	2.740	12.164	5.963	40.5	1.892	0.00231	-0.0	0.0	3000	0.0	70.4
69	0.951	0.427	4.578	3.810	10.908	6.029	40.7	1.911	0.00231	-0.0	-3.0	2999	0.0	70.4
70	0.830	0.396	3.234	4.951	8.325	4.413	40.5	1.894	0.00231	-0.0	-3.0	2500	0.0	70.5
71	0.677	0.322	2.022	5.527	5.740	3.082	40.7	1.911	0.00231	-0.0	-3.0	2000	0.0	70.5
72	0.419	0.122	1.690	1.045	4.302	2.968	20.5	0.485	0.00231	-0.0	0.0	1999	0.0	70.7
73	0.223	-0.005	1.507	-0.364	0.383	2.876	3.9	0.018	0.00231	-0.0	0.0	2000	0.0	70.7
75	-0.006	0.000	-0.005	0.000	-0.003	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	70.6

Table F.50: Testing conditions and rotor 4 loads in the hub coordinate system for run 121.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.006	0.000	0.017	0.000	0.001	0.000	0.3	0.000	0.00233	-0.0	0.0	0	-	65.2
5	0.069	-0.315	1.563	1.912	-0.100	-2.158	5.5	0.035	0.00233	0.0	0.0	2000	0.0	65.3
6	0.267	-0.315	1.927	-1.601	4.059	-2.123	20.3	0.481	0.00233	0.0	0.0	2000	0.0	65.1
7	0.381	-0.334	2.894	-0.925	5.456	-3.313	20.4	0.483	0.00233	0.0	0.0	2500	0.0	64.7
8	0.558	-0.344	4.542	-1.385	7.374	-4.820	20.4	0.483	0.00233	0.0	0.0	3000	0.0	64.6
9	0.577	-0.297	4.001	-1.555	6.188	-4.781	20.5	0.491	0.00233	0.0	-3.0	3000	0.0	64.6
10	0.399	-0.271	2.654	-0.913	5.034	-3.393	20.4	0.485	0.00233	0.0	-3.0	2500	0.0	64.7
11	0.277	-0.272	1.536	-2.039	3.582	-2.133	20.3	0.482	0.00233	0.0	-3.0	2000	0.0	64.6
12	0.303	-0.257	1.560	-1.614	3.550	-2.148	20.6	0.496	0.00233	-1.0	-3.0	2000	0.0	64.6
13	0.399	-0.253	2.685	-1.597	5.120	-3.393	20.3	0.478	0.00233	-1.0	-3.0	2499	0.0	64.6
14	0.489	-0.256	4.047	-0.513	6.234	-4.827	20.1	0.472	0.00233	-1.0	-3.0	2999	0.0	64.5
15	0.375	-0.287	4.425	-0.233	6.705	-4.757	20.1	0.473	0.00233	-1.0	0.0	2999	0.0	64.6
16	0.251	-0.289	3.073	-0.899	5.613	-3.321	20.1	0.472	0.00233	-1.0	0.0	2500	0.0	64.6
17	0.085	-0.296	2.027	-1.568	4.129	-2.107	20.0	0.468	0.00233	-1.0	0.0	2000	0.0	64.6
18	0.133	-0.279	2.061	-2.141	4.123	-2.132	20.2	0.476	0.00233	-3.0	0.0	2000	0.0	64.6
19	0.271	-0.289	3.185	-1.870	5.842	-3.358	20.2	0.475	0.00233	-3.0	0.0	2499	0.0	64.6
20	0.444	-0.296	4.571	-1.639	7.174	-4.875	20.3	0.481	0.00233	-3.0	0.0	3000	0.0	64.6
21	0.478	-0.253	4.150	-2.033	6.694	-4.944	20.2	0.477	0.00233	-3.0	-3.0	3000	0.0	64.7
22	0.338	-0.268	2.724	-2.070	5.232	-3.408	20.2	0.478	0.00233	-3.0	-3.0	2500	0.0	64.8
23	0.201	-0.276	1.549	-2.267	3.562	-2.160	20.2	0.474	0.00233	-3.0	-3.0	2000	0.0	64.8
24	0.216	-0.260	1.553	-2.259	3.497	-2.193	20.3	0.483	0.00233	-5.0	-3.0	1999	0.0	64.9
25	0.351	-0.270	2.595	-1.888	4.858	-3.384	20.4	0.485	0.00233	-5.0	-3.0	2499	0.0	64.9
26	0.503	-0.266	4.013	-1.039	6.415	-4.894	20.6	0.494	0.00233	-5.0	-3.0	3000	0.0	64.9
27	0.444	-0.258	4.018	-1.681	6.468	-4.955	20.3	0.478	0.00233	-5.0	-3.0	3000	0.0	64.9
28	0.303	-0.266	2.597	-2.106	5.152	-3.431	20.2	0.477	0.00233	-5.0	-3.0	2499	0.0	65.0
29	0.134	-0.266	1.415	-2.198	3.420	-2.160	20.0	0.466	0.00233	-5.0	-3.0	2000	0.0	65.1
30	0.189	-0.272	1.428	-2.323	3.239	-2.211	20.3	0.479	0.00233	-10.0	-3.0	2000	0.0	65.2
32	0.319	-0.267	2.598	-2.455	4.851	-3.480	20.3	0.480	0.00233	-10.0	-3.0	2499	0.0	65.3
34	0.406	-0.250	4.022	-1.754	6.420	-5.007	20.2	0.476	0.00233	-10.0	-3.0	3000	0.0	65.4
35	0.362	-0.287	4.424	-1.690	7.111	-5.008	20.3	0.481	0.00233	-10.0	0.0	2999	0.0	65.4
37	0.275	-0.312	2.941	-2.256	5.519	-3.473	20.4	0.485	0.00233	-10.0	0.0	2500	0.0	65.6
38	0.034	-0.305	1.919	-2.300	3.736	-2.203	20.1	0.468	0.00233	-10.0	0.0	2000	0.0	65.5

Continued on next page

Table F.50: Testing conditions and rotor 4 loads in the hub coordinate system for run 121.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
40	0.471	-0.282	1.684	-5.494	4.585	-2.274	40.4	1.897	0.00232	-10.0	0.0	2000	0.0	66.0
42	0.671	-0.304	2.935	-6.198	7.436	-3.520	40.4	1.900	0.00232	-10.0	0.0	2500	0.0	66.3
43	0.888	-0.303	4.472	-6.063	10.433	-5.047	40.4	1.899	0.00232	-10.0	0.0	2999	0.0	66.5
44	0.753	-0.273	4.117	-6.030	9.364	-5.046	40.4	1.894	0.00232	-10.0	-3.0	2999	0.0	66.5
45	0.538	-0.265	2.651	-5.983	6.544	-3.528	40.5	1.903	0.00232	-10.0	-3.0	2500	0.0	66.6
47	0.363	-0.242	1.434	-5.301	4.087	-2.266	40.5	1.905	0.00232	-10.0	-3.0	2000	0.0	66.8
48	0.439	-0.265	1.743	-5.815	4.729	-2.263	40.3	1.882	0.00232	-5.0	-3.0	2000	0.0	66.9
49	0.662	-0.291	2.946	-6.381	7.369	-3.512	40.5	1.903	0.00232	-5.0	-3.0	2499	0.0	67.0
50	0.865	-0.499	3.813	-5.759	10.130	-4.781	40.3	1.882	0.00232	-5.0	-3.0	3000	0.0	67.7
51	1.020	-0.521	4.174	-5.684	11.469	-4.699	40.4	1.895	0.00232	-5.0	0.0	3000	0.0	67.9
52	0.809	-0.533	2.667	-6.058	8.195	-3.193	40.4	1.887	0.00232	-5.0	0.0	2500	0.0	68.0
53	0.585	-0.594	1.312	-5.656	5.279	-1.922	40.4	1.891	0.00231	-5.0	0.0	2000	0.0	68.3
54	0.613	-0.480	1.508	-6.045	5.486	-1.932	40.7	1.913	0.00231	-3.0	0.0	2000	0.0	68.7
55	0.880	-0.517	2.764	-6.057	8.463	-3.162	40.5	1.898	0.00231	-3.0	0.0	2500	0.0	68.9
56	1.052	-0.510	4.189	-5.583	11.784	-4.658	40.6	1.903	0.00231	-3.0	0.0	2999	0.0	69.0
57	0.940	-0.441	3.900	-5.888	10.312	-4.762	40.6	1.902	0.00231	-3.0	-3.0	2999	0.0	69.0
58	0.734	-0.451	2.485	-6.107	7.529	-3.263	40.6	1.903	0.00231	-3.0	-3.0	2500	0.0	69.2
59	0.528	-0.465	1.227	-5.746	4.866	-1.971	40.5	1.899	0.00231	-3.0	-3.0	2000	0.0	69.3
60	0.566	-0.450	1.327	-5.700	5.046	-1.975	40.5	1.897	0.00231	-1.0	-3.0	2000	0.0	69.6
61	0.765	-0.474	2.478	-5.865	7.792	-3.233	40.5	1.897	0.00231	-1.0	-3.0	2499	0.0	69.7
62	0.960	-0.450	3.851	-5.324	10.460	-4.721	40.5	1.897	0.00231	-1.0	-3.0	2999	0.0	69.8
63	1.051	-0.483	4.158	-4.829	11.799	-4.637	40.6	1.901	0.00231	-1.0	0.0	2999	0.0	69.9
64	0.864	-0.497	2.760	-5.827	8.733	-3.132	40.5	1.893	0.00231	-1.0	0.0	2499	0.0	69.8
65	0.607	-0.489	1.537	-5.900	5.667	-1.854	40.6	1.902	0.00231	-1.0	0.0	1999	0.0	70.0
66	0.638	-0.486	1.550	-5.963	5.689	-1.856	40.7	1.908	0.00231	-0.0	0.0	2000	0.0	70.2
67	0.846	-0.522	2.696	-5.413	8.586	-3.128	40.7	1.907	0.00231	-0.0	0.0	2499	0.0	70.3
68	1.041	-0.494	4.033	-4.092	11.637	-4.613	40.5	1.892	0.00231	-0.0	0.0	3000	0.0	70.4
69	0.965	-0.426	3.847	-5.026	10.516	-4.676	40.7	1.911	0.00231	-0.0	-3.0	3000	0.0	70.4
70	0.752	-0.430	2.496	-5.625	7.805	-3.203	40.5	1.894	0.00231	-0.0	-3.0	2500	0.0	70.5
71	0.561	-0.441	1.306	-5.713	5.127	-1.928	40.7	1.911	0.00231	-0.0	-3.0	2000	0.0	70.5
72	0.309	-0.479	1.044	-1.539	3.896	-1.839	20.5	0.485	0.00231	-0.0	0.0	2000	0.0	70.7
73	0.181	-0.468	0.822	0.299	0.898	-1.857	3.9	0.018	0.00231	-0.0	0.0	2000	0.0	70.7
75	0.005	0.000	0.021	0.000	-0.002	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	70.6

Run 122: 2-bladed Concept Quadrotor

Table F.51: Run 122 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-90

Table F.52: Testing conditions and rotor 1 loads in the hub coordinate system for run 122.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
4	-0.009	0.000	-0.009	0.000	-0.002	0.000	0.6	0.000	0.00230	0.0	0.0	0	-	71.9
5	0.040	0.146	1.819	-1.332	0.514	-2.264	6.1	0.042	0.00230	0.0	0.0	2000	0.0	72.6
6	0.398	0.104	2.514	-1.575	6.724	-1.831	20.6	0.485	0.00229	0.0	0.0	2000	0.0	73.5
7	0.507	0.143	3.862	-1.443	9.998	-3.084	20.5	0.481	0.00229	0.0	0.0	2499	0.0	73.7
8	0.802	0.169	5.486	-0.638	13.339	-4.642	20.4	0.475	0.00229	0.0	0.0	3000	0.0	73.8
9	0.798	0.121	5.275	-1.306	12.961	-4.552	20.8	0.496	0.00229	0.0	-3.0	2999	0.0	74.1
10	0.555	0.074	3.746	-1.665	9.561	-3.101	20.5	0.482	0.00229	0.0	-3.0	2500	0.0	74.6
11	0.393	0.092	2.402	-1.787	6.453	-1.898	20.6	0.484	0.00229	-0.0	-3.0	1999	0.0	74.7
12	0.373	0.099	2.408	-1.947	6.282	-1.920	20.4	0.477	0.00228	-1.0	-3.0	2000	0.0	75.4
13	0.512	0.098	3.685	-1.947	9.400	-3.087	20.6	0.483	0.00228	-1.0	-3.0	2499	0.0	75.5
14	0.800	0.108	5.235	-1.522	12.647	-4.538	20.5	0.481	0.00228	-1.0	-3.0	2999	0.0	75.8
15	0.862	0.162	5.371	-0.756	12.907	-4.636	20.2	0.467	0.00228	-1.0	0.0	2999	0.0	75.9
16	0.575	0.139	3.796	-1.436	9.778	-3.100	20.5	0.477	0.00228	-1.0	0.0	2500	0.0	76.1
17	0.414	0.148	2.446	-1.632	6.575	-1.865	20.6	0.482	0.00228	-1.0	0.0	2000	0.0	76.2
18	0.400	0.155	2.395	-1.784	6.356	-1.894	20.4	0.474	0.00228	-3.0	0.0	1999	0.0	76.6
19	0.520	0.144	3.692	-1.681	9.434	-3.090	20.5	0.477	0.00228	-3.0	0.0	2499	0.0	76.7
20	0.806	0.163	5.274	-1.072	12.638	-4.580	20.5	0.481	0.00228	-3.0	0.0	3000	0.0	76.8
21	0.787	0.091	5.151	-2.011	12.430	-4.513	20.6	0.485	0.00228	-3.0	-3.0	3000	0.0	76.9
22	0.535	0.100	3.622	-2.201	9.043	-3.106	20.5	0.478	0.00228	-3.0	-3.0	2500	0.0	77.0
23	0.374	0.100	2.332	-2.161	6.057	-1.952	20.5	0.476	0.00228	-3.0	-3.0	1999	0.0	77.1
24	0.332	0.111	2.297	-2.234	5.823	-1.985	20.6	0.481	0.00227	-5.0	-3.0	1999	0.0	77.5
25	0.480	0.108	3.577	-2.354	8.710	-3.146	20.8	0.491	0.00227	-5.0	-3.0	2500	0.0	77.5
26	0.774	0.112	5.094	-2.144	11.874	-4.573	20.6	0.481	0.00227	-5.0	-3.0	3000	0.0	77.7
27	0.836	0.149	5.164	-1.809	12.363	-4.514	20.6	0.483	0.00227	-5.0	0.0	3000	0.0	77.9
28	0.563	0.142	3.584	-2.112	9.066	-3.091	20.4	0.474	0.00227	-5.0	0.0	2500	0.0	77.9
29	0.375	0.147	2.342	-2.120	6.117	-1.931	20.6	0.484	0.00227	-5.1	0.0	2000	0.0	78.0
30	0.325	0.174	2.196	-2.214	5.486	-2.040	20.5	0.478	0.00227	-10.0	0.0	2000	0.0	78.3
31	0.454	0.157	3.523	-2.216	8.233	-3.244	20.8	0.490	0.00227	-10.0	0.0	2499	0.0	78.3
32	0.725	0.153	5.047	-1.981	11.090	-4.714	20.4	0.475	0.00227	-10.0	0.0	2999	0.0	78.6
33	0.657	0.133	5.017	-1.877	10.428	-4.872	20.6	0.480	0.00227	-10.0	-3.0	2999	0.0	78.7
34	0.431	0.125	3.445	-2.086	7.467	-3.379	20.4	0.473	0.00227	-10.0	-3.0	2500	0.0	78.7
35	0.276	0.138	2.139	-2.136	5.027	-2.147	20.6	0.481	0.00227	-10.0	-3.0	2000	0.0	78.8

Continued on next page

Table F.52: Testing conditions and rotor 1 loads in the hub coordinate system for run 122.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
36	0.374	0.178	2.535	-1.595	6.681	-1.872	20.6	0.480	0.00227	0.0	0.0	2000	0.0	79.1
37	0.074	0.249	1.903	-0.938	2.353	-2.212	2.5	0.007	0.00227	0.0	0.0	2000	0.0	79.2
38	-0.121	0.242	-0.424	-0.152	0.289	0.295	0.0	0.000	0.00227	0.0	0.0	200	0.0	79.2
39	-0.079	0.234	-0.297	-0.165	0.319	0.180	0.0	0.000	0.00227	0.0	0.0	399	0.0	79.2
40	-0.063	0.243	-0.155	-0.240	0.404	0.015	0.0	0.000	0.00227	0.0	0.0	599	0.0	79.2
41	-0.065	0.247	0.006	-0.309	0.456	-0.188	0.0	0.000	0.00227	0.0	0.0	800	0.0	79.2
42	-0.041	0.251	0.174	-0.222	0.550	-0.426	1.2	0.002	0.00227	0.0	0.0	999	0.0	79.2
43	-0.052	0.263	0.425	-0.034	0.356	-0.716	3.7	0.016	0.00227	0.0	0.0	1200	0.0	79.2
44	-0.028	0.252	0.683	-0.153	0.671	-1.051	4.7	0.026	0.00227	0.0	0.0	1399	0.0	79.2
45	-0.015	0.233	1.096	-0.872	0.789	-1.443	4.7	0.025	0.00227	0.0	0.0	1599	0.0	79.2
46	-0.006	0.215	1.500	-1.546	0.345	-1.887	5.0	0.029	0.00227	0.0	0.0	1799	0.0	79.2
47	0.016	0.203	1.873	-1.837	0.830	-2.345	5.9	0.039	0.00227	0.0	0.0	1999	0.0	79.1
48	0.027	0.193	2.359	-2.168	0.849	-2.860	4.9	0.027	0.00227	0.0	0.0	2199	0.0	79.2
49	0.072	0.189	2.932	-2.108	1.815	-3.395	6.2	0.044	0.00227	0.0	0.0	2399	0.0	79.1
50	0.066	0.184	3.399	-2.477	1.591	-4.002	5.8	0.038	0.00227	0.0	0.0	2599	0.0	79.1
51	0.089	0.180	4.050	-3.017	1.779	-4.732	6.9	0.055	0.00227	0.0	0.0	2800	0.0	79.1
52	0.130	0.148	4.687	-4.090	2.010	-5.403	7.7	0.067	0.00227	0.0	0.0	3000	0.0	79.1
53	0.069	0.169	3.946	-3.470	1.076	-4.687	8.0	0.072	0.00227	0.0	0.0	2800	0.0	79.1
54	0.053	0.176	3.346	-2.489	0.825	-3.996	6.8	0.052	0.00227	0.0	0.0	2599	0.0	79.1
55	0.068	0.179	2.858	-2.391	1.370	-3.482	6.5	0.049	0.00227	0.0	0.0	2400	0.0	79.1
56	0.024	0.184	2.253	-1.304	0.888	-2.862	6.4	0.046	0.00227	0.0	0.0	2200	0.0	79.1
57	0.014	0.180	1.814	-1.859	0.536	-2.407	5.8	0.038	0.00227	0.0	0.0	2000	0.0	79.1
58	-0.028	0.207	1.284	-0.675	0.141	-1.894	3.9	0.018	0.00227	0.0	0.0	1800	0.0	79.0
59	-0.022	0.191	0.929	-1.042	0.444	-1.453	3.8	0.017	0.00227	0.0	0.0	1600	0.0	79.1
60	-0.031	0.180	0.722	-0.874	0.433	-1.138	3.7	0.016	0.00227	0.0	0.0	1400	0.0	79.1
61	-0.043	0.188	0.363	-0.489	0.284	-0.818	3.1	0.011	0.00227	0.0	0.0	1200	0.0	79.1
62	-0.050	0.188	0.128	-0.370	0.148	-0.537	2.7	0.008	0.00227	0.0	0.0	1000	0.0	79.0
63	-0.046	0.182	-0.041	-0.369	0.335	-0.295	1.4	0.002	0.00227	0.0	0.0	800	0.0	79.0
64	-0.068	0.172	-0.221	-0.311	0.205	-0.096	0.9	0.001	0.00227	0.0	0.0	600	0.0	79.0
65	-0.092	0.162	-0.360	-0.141	0.149	0.067	0.0	0.000	0.00227	0.0	0.0	400	0.0	79.0
66	-0.132	0.177	-0.509	-0.088	0.239	0.198	0.0	0.000	0.00227	0.0	0.0	200	0.0	79.0
67	-0.019	0.000	-0.010	0.000	-0.009	0.000	0.0	0.000	0.00227	0.0	0.0	0	-	79.0

Table F.53: Testing conditions and rotor 2 loads in the hub coordinate system for run 122.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
4	-0.004	0.000	0.008	0.000	-0.010	0.000	0.6	0.000	0.00230	0.0	0.0	0	-	71.9
5	-0.144	-0.035	1.785	1.672	0.522	2.954	6.1	0.042	0.00230	0.0	0.0	2000	-90.0	72.6
6	-0.089	0.038	2.519	1.589	6.717	2.603	20.6	0.485	0.00229	0.0	0.0	1999	-90.0	73.5
7	-0.060	0.037	3.892	1.158	10.023	3.868	20.5	0.481	0.00229	0.0	0.0	2499	-90.0	73.7
8	0.064	0.032	5.578	0.308	13.293	5.446	20.4	0.475	0.00229	0.0	0.0	2999	-90.0	73.8
9	0.139	0.087	5.301	1.040	12.931	5.304	20.8	0.496	0.00229	0.0	-3.0	2999	-90.0	74.1
10	0.009	0.096	3.670	1.710	9.540	3.819	20.5	0.482	0.00229	0.0	-3.0	2500	-90.0	74.6
11	-0.061	0.081	2.351	1.866	6.322	2.615	20.6	0.484	0.00229	-0.0	-3.0	2000	-90.0	74.7
12	-0.058	0.099	2.327	1.964	6.211	2.625	20.4	0.477	0.00228	-1.0	-3.0	1999	-90.0	75.4
13	-0.005	0.106	3.632	1.897	9.367	3.812	20.6	0.483	0.00228	-1.0	-3.0	2499	-90.0	75.5
14	0.134	0.113	5.219	1.370	12.666	5.280	20.5	0.481	0.00228	-1.0	-3.0	2999	-90.0	75.8
15	0.043	0.031	5.516	0.418	12.972	5.417	20.2	0.467	0.00228	-1.0	0.0	2999	-90.0	75.9
16	-0.048	0.045	3.854	1.327	9.824	3.866	20.5	0.477	0.00228	-1.0	0.0	2500	-90.0	76.1
17	-0.097	0.028	2.458	1.613	6.592	2.611	20.6	0.482	0.00228	-1.0	0.0	2000	-90.0	76.2
18	-0.139	0.037	2.474	1.820	6.370	2.635	20.4	0.474	0.00228	-3.0	0.0	1999	-90.0	76.6
19	-0.090	0.040	3.768	1.607	9.563	3.843	20.5	0.477	0.00228	-3.0	0.0	2499	-90.0	76.7
20	0.058	0.037	5.357	0.947	12.703	5.336	20.5	0.481	0.00228	-3.0	0.0	3000	-90.0	76.8
21	0.132	0.099	5.129	1.716	12.358	5.232	20.6	0.485	0.00228	-3.0	-3.0	2999	-90.0	76.9
22	0.042	0.088	3.550	2.175	8.978	3.795	20.5	0.478	0.00228	-3.0	-3.0	2500	-90.0	77.0
23	-0.021	0.074	2.226	2.165	5.945	2.617	20.5	0.476	0.00228	-3.0	-3.0	1999	-90.0	77.1
24	-0.046	0.074	2.194	2.166	5.648	2.687	20.6	0.481	0.00227	-5.0	-3.0	2000	-90.0	77.5
25	-0.000	0.092	3.541	2.198	8.512	3.878	20.8	0.491	0.00227	-5.0	-3.0	2500	-90.0	77.5
26	0.150	0.112	5.082	1.812	11.673	5.324	20.6	0.481	0.00227	-5.0	-3.0	3000	-90.0	77.7
27	0.082	0.051	5.245	1.568	12.490	5.262	20.6	0.483	0.00227	-5.0	0.0	3000	-90.0	77.9
28	-0.054	0.046	3.701	1.993	9.120	3.808	20.4	0.474	0.00227	-5.0	0.0	2500	-90.0	77.9
29	-0.104	0.032	2.339	2.127	6.107	2.642	20.6	0.484	0.00227	-5.1	0.0	1999	-90.0	78.0
30	-0.079	0.018	2.208	2.143	5.311	2.770	20.5	0.478	0.00227	-10.0	0.0	2000	-90.0	78.3
31	-0.000	0.024	3.498	2.021	8.177	3.966	20.8	0.490	0.00227	-10.0	0.0	2499	-90.0	78.3
32	0.071	0.036	5.134	1.576	11.076	5.442	20.4	0.475	0.00227	-10.0	0.0	3000	-90.0	78.6
33	0.111	0.080	4.999	1.583	10.271	5.559	20.6	0.480	0.00227	-10.0	-3.0	3000	-90.0	78.7
34	0.030	0.064	3.386	1.942	7.380	4.042	20.4	0.473	0.00227	-10.0	-3.0	2500	-90.0	78.7
35	-0.052	0.057	2.057	2.097	4.773	2.811	20.6	0.481	0.00227	-10.0	-3.0	2000	-90.0	78.8

Continued on next page

Table F.53: Testing conditions and rotor 2 loads in the hub coordinate system for run 122.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
36	-0.055	0.022	2.502	1.495	6.679	2.560	20.6	0.480	0.00227	0.0	0.0	1999	-90.0	79.1
37	-0.073	-0.040	1.822	0.820	2.483	2.841	2.5	0.007	0.00227	0.0	0.0	2000	-90.0	79.2
38	-0.124	-0.074	-0.447	0.264	0.107	0.379	0.0	0.000	0.00227	0.0	0.0	200	-90.0	79.2
39	-0.186	-0.077	-0.461	0.265	0.231	0.475	0.0	0.000	0.00227	0.0	0.0	400	-90.0	79.2
40	-0.193	-0.076	-0.303	0.323	0.336	0.602	0.0	0.000	0.00227	0.0	0.0	599	-90.0	79.2
41	-0.152	-0.064	-0.115	0.365	0.355	0.795	0.0	0.000	0.00227	0.0	0.0	799	-90.0	79.2
42	-0.121	-0.060	0.150	0.459	0.457	1.059	1.2	0.002	0.00227	0.0	0.0	999	-90.0	79.2
43	-0.130	-0.077	0.321	0.405	0.334	1.348	3.7	0.016	0.00227	0.0	0.0	1199	-90.0	79.2
44	-0.133	-0.091	0.582	0.509	0.400	1.647	4.7	0.026	0.00227	0.0	0.0	1399	-90.0	79.2
45	-0.121	-0.086	0.884	0.806	-0.031	2.044	4.7	0.025	0.00227	0.0	0.0	1599	-90.0	79.2
46	-0.113	-0.075	1.403	1.590	0.537	2.498	5.0	0.029	0.00227	0.0	0.0	1799	-90.0	79.2
47	-0.092	-0.074	1.872	1.992	0.411	2.941	5.9	0.039	0.00227	0.0	0.0	1999	-90.0	79.1
48	-0.112	-0.080	2.310	2.137	1.028	3.413	4.9	0.027	0.00227	0.0	0.0	2199	-90.0	79.2
49	-0.110	-0.081	2.782	2.564	1.031	3.977	6.2	0.044	0.00227	0.0	0.0	2399	-90.0	79.1
50	-0.116	-0.079	3.393	3.112	0.934	4.594	5.8	0.038	0.00227	0.0	0.0	2599	-90.0	79.1
51	-0.110	-0.080	4.051	3.403	0.986	5.214	6.9	0.055	0.00227	0.0	0.0	2800	-90.0	79.1
52	-0.096	-0.058	4.711	3.878	2.555	5.875	7.7	0.067	0.00227	0.0	0.0	2999	-90.0	79.1
53	-0.074	-0.077	4.205	3.243	2.396	5.225	8.0	0.072	0.00227	0.0	0.0	2800	-90.0	79.1
54	-0.091	-0.116	3.246	2.167	1.076	4.530	6.8	0.052	0.00227	0.0	0.0	2599	-90.0	79.1
55	-0.074	-0.107	2.871	2.605	1.117	3.983	6.5	0.049	0.00227	0.0	0.0	2400	-90.0	79.1
56	-0.057	-0.113	2.230	1.826	0.539	3.372	6.4	0.046	0.00227	0.0	0.0	2200	-90.0	79.1
57	-0.068	-0.108	1.824	1.963	0.687	2.875	5.8	0.038	0.00227	0.0	0.0	2000	-90.0	79.1
58	-0.083	-0.117	1.349	1.465	0.404	2.388	3.9	0.018	0.00227	0.0	0.0	1800	-90.0	79.0
59	-0.086	-0.114	1.029	1.372	0.895	1.972	3.8	0.017	0.00227	0.0	0.0	1600	-90.0	79.1
60	-0.081	-0.131	0.543	0.757	0.267	1.601	3.7	0.016	0.00227	0.0	0.0	1400	-90.0	79.1
61	-0.084	-0.127	0.352	0.811	0.353	1.262	3.1	0.011	0.00227	0.0	0.0	1200	-90.0	79.1
62	-0.086	-0.129	0.073	0.644	0.216	0.962	2.7	0.008	0.00227	0.0	0.0	1000	-90.0	79.0
63	-0.085	-0.129	-0.156	0.463	0.048	0.729	1.4	0.002	0.00227	0.0	0.0	800	-90.0	79.0
64	-0.119	-0.138	-0.345	0.370	0.179	0.531	0.9	0.001	0.00227	0.0	0.0	600	-90.0	79.0
65	-0.131	-0.137	-0.508	0.348	0.109	0.387	0.0	0.000	0.00227	0.0	0.0	400	-90.0	79.0
66	-0.067	-0.128	-0.504	0.268	0.048	0.282	0.0	0.000	0.00227	0.0	0.0	200	-90.0	79.0
67	-0.013	0.000	0.004	0.000	-0.015	0.000	0.0	0.000	0.00227	0.0	0.0	0	-	79.0

Table F.54: Testing conditions and rotor 3 loads in the hub coordinate system for run 122.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
4	-0.012	0.000	-0.002	0.000	0.007	0.000	0.6	0.000	0.00230	0.0	0.0	0	-	71.9
5	-0.204	-0.189	1.637	-2.078	-0.288	3.022	6.1	0.042	0.00230	0.0	0.0	1999	-90.0	72.6
6	0.004	0.074	1.587	1.638	4.397	3.003	20.6	0.485	0.00229	0.0	0.0	2000	-90.0	73.5
7	0.040	0.144	2.711	0.888	5.860	4.256	20.5	0.481	0.00229	0.0	0.0	2499	-90.0	73.7
8	0.098	0.179	4.147	0.200	7.108	5.743	20.4	0.475	0.00229	0.0	0.0	2999	-90.0	73.8
9	0.207	0.191	4.070	0.942	6.979	5.824	20.8	0.496	0.00229	0.0	-3.0	2999	-90.0	74.1
10	0.144	0.135	2.619	1.486	5.440	4.288	20.5	0.482	0.00229	0.0	-3.0	2500	-90.0	74.6
11	0.091	0.089	1.439	1.669	3.860	2.999	20.6	0.484	0.00229	-0.0	-3.0	1999	-90.0	74.7
12	0.091	0.110	1.485	1.819	3.770	3.000	20.4	0.477	0.00228	-1.0	-3.0	2000	-90.0	75.4
13	0.181	0.161	2.640	1.856	5.391	4.310	20.6	0.483	0.00228	-1.0	-3.0	2499	-90.0	75.5
14	0.271	0.208	4.064	1.204	7.000	5.834	20.5	0.481	0.00228	-1.0	-3.0	2999	-90.0	75.8
15	0.137	0.203	4.132	0.498	7.237	5.739	20.2	0.467	0.00228	-1.0	0.0	2999	-90.0	75.9
16	0.116	0.166	2.695	1.253	5.966	4.248	20.5	0.477	0.00228	-1.0	0.0	2500	-90.0	76.1
17	0.080	0.134	1.556	1.757	4.332	2.991	20.6	0.482	0.00228	-1.0	0.0	2000	-90.0	76.2
18	0.036	0.159	1.604	2.136	4.209	2.986	20.4	0.474	0.00228	-3.0	0.0	1999	-90.0	76.6
19	0.149	0.218	2.791	2.165	5.995	4.294	20.5	0.477	0.00228	-3.0	0.0	2499	-90.0	76.7
20	0.268	0.262	4.233	1.546	7.628	5.814	20.5	0.481	0.00228	-3.0	0.0	2999	-90.0	76.8
21	0.330	0.260	4.110	1.810	7.027	5.881	20.6	0.485	0.00228	-3.0	-3.0	2999	-90.0	76.9
22	0.238	0.208	2.647	2.022	5.350	4.307	20.5	0.478	0.00228	-3.0	-3.0	2500	-90.0	77.0
23	0.165	0.161	1.516	2.158	3.688	3.000	20.5	0.476	0.00228	-3.0	-3.0	1999	-90.0	77.1
24	0.174	0.171	1.520	2.293	3.668	3.012	20.6	0.481	0.00227	-5.0	-3.0	2000	-90.0	77.5
25	0.262	0.220	2.683	2.143	5.393	4.313	20.8	0.491	0.00227	-5.0	-3.0	2499	-90.0	77.5
26	0.331	0.258	4.065	1.401	6.901	5.858	20.6	0.481	0.00227	-5.0	-3.0	2999	-90.0	77.7
27	0.286	0.277	4.241	1.630	7.626	5.865	20.6	0.483	0.00227	-5.0	0.0	3000	-90.0	77.9
28	0.161	0.226	2.774	1.895	5.887	4.288	20.4	0.474	0.00227	-5.0	0.0	2500	-90.0	77.9
29	0.130	0.179	1.603	2.315	4.135	2.993	20.6	0.484	0.00227	-5.1	0.0	2000	-90.0	78.0
30	0.143	0.192	1.588	2.453	3.850	3.010	20.5	0.478	0.00227	-10.0	0.0	2000	-90.0	78.3
31	0.292	0.248	2.778	2.395	5.685	4.319	20.8	0.490	0.00227	-10.0	0.0	2499	-90.0	78.3
32	0.309	0.291	4.217	1.615	7.355	5.889	20.4	0.475	0.00227	-10.0	0.0	2999	-90.0	78.6
33	0.361	0.272	4.076	1.737	6.763	5.897	20.6	0.480	0.00227	-10.0	-3.0	3000	-90.0	78.7
34	0.284	0.237	2.670	2.370	5.049	4.320	20.4	0.473	0.00227	-10.0	-3.0	2500	-90.0	78.7
35	0.200	0.181	1.488	2.419	3.404	3.018	20.6	0.481	0.00227	-10.0	-3.0	2000	-90.0	78.8

Continued on next page

Table F.54: Testing conditions and rotor 3 loads in the hub coordinate system for run 122.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
36	0.200	0.184	1.586	1.476	4.196	2.937	20.6	0.480	0.00227	0.0	0.0	1999	-90.0	79.1
37	0.019	0.079	1.500	-0.116	1.141	2.973	2.5	0.007	0.00227	0.0	0.0	2000	-90.0	79.2
38	-0.063	-0.029	-0.704	0.134	0.143	0.497	0.0	0.000	0.00227	0.0	0.0	200	-90.0	79.2
39	-0.108	-0.000	-0.617	0.119	0.240	0.513	0.0	0.000	0.00227	0.0	0.0	399	-90.0	79.2
40	-0.089	0.008	-0.509	0.049	0.315	0.680	0.0	0.000	0.00227	0.0	0.0	599	-90.0	79.2
41	-0.066	0.007	-0.322	-0.014	0.185	0.868	0.0	0.000	0.00227	0.0	0.0	800	-90.0	79.2
42	-0.059	0.005	-0.069	-0.219	-0.112	1.073	1.2	0.002	0.00227	0.0	0.0	999	-90.0	79.2
43	-0.021	-0.010	0.119	-0.335	-0.150	1.357	3.7	0.016	0.00227	0.0	0.0	1200	-90.0	79.2
44	-0.000	-0.019	0.409	-0.619	-0.368	1.653	4.7	0.026	0.00227	0.0	0.0	1399	-90.0	79.2
45	0.023	-0.023	0.752	-1.082	-0.022	2.092	4.7	0.025	0.00227	0.0	0.0	1599	-90.0	79.2
46	0.036	-0.038	1.167	-1.570	0.061	2.500	5.0	0.029	0.00227	0.0	0.0	1799	-90.0	79.2
47	0.053	-0.051	1.552	-1.799	-0.094	2.908	5.9	0.039	0.00227	0.0	0.0	1999	-90.0	79.1
48	0.053	-0.073	2.075	-2.305	-0.204	3.493	4.9	0.027	0.00227	0.0	0.0	2199	-90.0	79.2
49	0.066	-0.086	2.520	-2.554	-0.287	4.081	6.2	0.044	0.00227	0.0	0.0	2399	-90.0	79.1
50	0.060	-0.117	3.219	-3.324	-1.103	4.645	5.8	0.038	0.00227	0.0	0.0	2599	-90.0	79.1
51	0.069	-0.127	3.808	-3.824	-0.873	5.285	6.9	0.055	0.00227	0.0	0.0	2799	-90.0	79.1
52	0.059	-0.172	4.464	-4.809	-1.109	5.975	7.7	0.067	0.00227	0.0	0.0	2999	-90.0	79.1
53	0.075	-0.138	3.659	-3.761	0.153	5.321	8.0	0.072	0.00227	0.0	0.0	2800	-90.0	79.1
54	0.055	-0.147	3.052	-3.188	-0.874	4.614	6.8	0.052	0.00227	0.0	0.0	2600	-90.0	79.1
55	0.058	-0.117	2.609	-2.189	-0.971	4.069	6.5	0.049	0.00227	0.0	0.0	2399	-90.0	79.1
56	0.076	-0.097	2.017	-1.885	0.197	3.438	6.4	0.046	0.00227	0.0	0.0	2199	-90.0	79.1
57	0.070	-0.106	1.638	-1.890	-0.009	2.981	5.8	0.038	0.00227	0.0	0.0	1999	-90.0	79.1
58	0.080	-0.096	1.191	-1.401	0.082	2.491	3.9	0.018	0.00227	0.0	0.0	1800	-90.0	79.0
59	0.078	-0.087	0.769	-0.807	0.084	2.084	3.8	0.017	0.00227	0.0	0.0	1600	-90.0	79.1
60	0.069	-0.087	0.475	-0.704	-0.145	1.735	3.7	0.016	0.00227	0.0	0.0	1400	-90.0	79.1
61	0.076	-0.082	0.211	-0.467	-0.070	1.379	3.1	0.011	0.00227	0.0	0.0	1200	-90.0	79.1
62	0.080	-0.075	-0.046	-0.292	0.054	1.091	2.7	0.008	0.00227	0.0	0.0	1000	-90.0	79.0
63	0.052	-0.080	-0.234	-0.202	0.083	0.856	1.4	0.002	0.00227	0.0	0.0	800	-90.0	79.0
64	0.043	-0.085	-0.433	-0.028	0.036	0.670	0.9	0.001	0.00227	0.0	0.0	600	-90.0	79.0
65	0.046	-0.079	-0.545	0.079	0.088	0.495	0.0	0.000	0.00227	0.0	0.0	400	-90.0	79.0
66	0.087	-0.097	-0.644	0.158	0.058	0.488	0.0	0.000	0.00227	0.0	0.0	200	90.0	79.0
67	-0.007	0.000	-0.005	0.000	-0.004	0.000	0.0	0.000	0.00227	0.0	0.0	0	-	79.0

Table F.55: Testing conditions and rotor 4 loads in the hub coordinate system for run 122.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
4	0.006	0.000	0.013	0.000	0.004	0.000	0.6	0.000	0.00230	0.0	0.0	0	-	71.9
5	0.070	-0.487	1.077	2.605	-0.611	-1.834	6.1	0.042	0.00230	0.0	0.0	1999	0.0	72.6
6	0.203	-0.410	1.190	-1.181	3.970	-1.836	20.6	0.485	0.00229	0.0	0.0	2000	0.0	73.5
7	0.292	-0.411	2.312	-0.858	5.517	-3.012	20.5	0.481	0.00229	0.0	0.0	2499	0.0	73.7
8	0.380	-0.419	3.736	0.091	6.642	-4.425	20.4	0.475	0.00229	0.0	0.0	3000	0.0	73.8
9	0.517	-0.358	3.489	-0.718	6.392	-4.519	20.8	0.496	0.00229	0.0	-3.0	2999	0.0	74.1
10	0.344	-0.372	2.070	-1.125	4.945	-3.083	20.5	0.482	0.00229	0.0	-3.0	2500	0.0	74.6
11	0.230	-0.372	0.963	-1.234	3.487	-1.849	20.6	0.484	0.00229	-0.0	-3.0	1999	0.0	74.7
12	0.261	-0.366	1.043	-1.586	3.449	-1.881	20.4	0.477	0.00228	-1.0	-3.0	2000	0.0	75.4
13	0.373	-0.365	2.142	-1.688	4.926	-3.106	20.6	0.483	0.00228	-1.0	-3.0	2499	0.0	75.5
14	0.483	-0.364	3.508	-1.192	6.464	-4.539	20.5	0.481	0.00228	-1.0	-3.0	3000	0.0	75.8
15	0.325	-0.414	3.854	-0.254	6.891	-4.446	20.2	0.467	0.00228	-1.0	0.0	3000	0.0	75.9
16	0.277	-0.403	2.412	-1.315	5.694	-3.041	20.5	0.477	0.00228	-1.0	0.0	2500	0.0	76.1
17	0.178	-0.397	1.235	-1.432	3.989	-1.841	20.6	0.482	0.00228	-1.0	0.0	1999	0.0	76.2
18	0.162	-0.386	1.416	-1.720	3.936	-1.857	20.4	0.474	0.00228	-3.0	0.0	2000	0.0	76.6
19	0.280	-0.401	2.485	-1.806	5.624	-3.083	20.5	0.477	0.00228	-3.0	0.0	2499	0.0	76.7
20	0.423	-0.399	3.864	-1.188	7.192	-4.541	20.5	0.481	0.00228	-3.0	0.0	3000	0.0	76.8
21	0.498	-0.349	3.564	-1.571	6.493	-4.584	20.6	0.485	0.00228	-3.0	-3.0	2999	0.0	76.9
22	0.346	-0.327	2.139	-1.676	4.956	-3.103	20.5	0.478	0.00228	-3.0	-3.0	2500	0.0	77.0
23	0.238	-0.338	1.036	-1.636	3.427	-1.874	20.5	0.476	0.00228	-3.0	-3.0	1999	0.0	77.1
24	0.263	-0.353	1.048	-1.772	3.345	-1.887	20.6	0.481	0.00227	-5.0	-3.0	2000	0.0	77.5
25	0.394	-0.350	2.174	-1.693	5.002	-3.113	20.8	0.491	0.00227	-5.0	-3.0	2499	0.0	77.5
26	0.464	-0.329	3.528	-1.262	6.404	-4.595	20.6	0.481	0.00227	-5.0	-3.0	3000	0.0	77.7
27	0.407	-0.373	3.836	-1.435	7.205	-4.574	20.6	0.483	0.00227	-5.0	0.0	3000	0.0	77.9
28	0.227	-0.367	2.502	-1.586	5.671	-3.073	20.4	0.474	0.00227	-5.0	0.0	2500	0.0	77.9
29	0.184	-0.369	1.288	-1.776	3.865	-1.855	20.6	0.484	0.00227	-5.1	0.0	1999	0.0	78.0
30	0.212	-0.366	1.240	-1.888	3.518	-1.887	20.5	0.478	0.00227	-10.0	0.0	1999	0.0	78.3
31	0.385	-0.369	2.279	-1.959	5.332	-3.115	20.8	0.490	0.00227	-10.0	0.0	2499	0.0	78.3
32	0.382	-0.371	3.790	-1.188	6.993	-4.608	20.4	0.475	0.00227	-10.0	0.0	2999	0.0	78.6
33	0.440	-0.324	3.496	-1.304	6.414	-4.603	20.6	0.480	0.00227	-10.0	-3.0	3000	0.0	78.7
34	0.316	-0.317	2.137	-1.964	4.757	-3.130	20.4	0.473	0.00227	-10.0	-3.0	2500	0.0	78.7
35	0.236	-0.325	1.007	-1.841	3.045	-1.900	20.6	0.481	0.00227	-10.0	-3.0	1999	0.0	78.8

Continued on next page

Table F.55: Testing conditions and rotor 4 loads in the hub coordinate system for run 122.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
36	0.237	-0.377	1.210	-1.222	3.974	-1.820	20.6	0.480	0.00227	0.0	0.0	2000	0.0	79.1
37	0.136	-0.389	1.022	1.092	0.802	-1.791	2.5	0.007	0.00227	0.0	0.0	1999	0.0	79.2
38	-0.030	-0.375	-1.106	0.651	-0.096	0.573	0.0	0.000	0.00227	0.0	0.0	200	0.0	79.2
39	-0.066	-0.376	-0.970	0.658	0.052	0.420	0.0	0.000	0.00227	0.0	0.0	400	0.0	79.2
40	-0.029	-0.434	-0.908	0.765	0.116	0.307	0.0	0.000	0.00227	0.0	0.0	599	0.0	79.2
41	0.022	-0.384	-0.699	0.789	-0.010	0.097	0.0	0.000	0.00227	0.0	0.0	799	0.0	79.2
42	0.071	-0.376	-0.520	0.760	-0.314	-0.103	1.2	0.002	0.00227	0.0	0.0	999	0.0	79.2
43	0.071	-0.425	-0.299	1.346	-0.442	-0.350	3.7	0.016	0.00227	0.0	0.0	1199	0.0	79.2
44	0.106	-0.451	-0.094	1.597	-0.343	-0.641	4.7	0.026	0.00227	0.0	0.0	1399	0.0	79.2
45	0.139	-0.450	0.303	1.953	-0.487	-0.972	4.7	0.025	0.00227	0.0	0.0	1599	0.0	79.2
46	0.148	-0.452	0.695	2.458	-0.458	-1.388	5.0	0.029	0.00227	0.0	0.0	1799	0.0	79.2
47	0.165	-0.455	1.068	2.754	-0.428	-1.842	5.9	0.039	0.00227	0.0	0.0	1999	0.0	79.1
48	0.172	-0.444	1.495	2.599	-0.156	-2.362	4.9	0.027	0.00227	0.0	0.0	2199	0.0	79.2
49	0.184	-0.445	2.042	3.814	-0.427	-2.857	6.2	0.044	0.00227	0.0	0.0	2399	0.0	79.1
50	0.208	-0.459	2.577	3.865	-0.949	-3.466	5.8	0.038	0.00227	0.0	0.0	2599	0.0	79.1
51	0.200	-0.462	3.031	4.489	-0.295	-4.093	6.9	0.055	0.00227	0.0	0.0	2800	0.0	79.1
52	0.213	-0.463	3.664	5.486	-0.771	-4.625	7.7	0.067	0.00227	0.0	0.0	3000	0.0	79.1
53	0.186	-0.461	3.098	4.158	-1.025	-4.020	8.0	0.072	0.00227	0.0	0.0	2799	0.0	79.1
54	0.156	-0.461	2.482	3.980	-0.574	-3.306	6.8	0.052	0.00227	0.0	0.0	2600	0.0	79.1
55	0.117	-0.452	1.974	3.874	-0.142	-2.832	6.5	0.049	0.00227	0.0	0.0	2400	0.0	79.1
56	0.077	-0.451	1.491	2.930	-0.171	-2.357	6.4	0.046	0.00227	0.0	0.0	2200	0.0	79.1
57	0.081	-0.453	1.104	2.790	-0.634	-1.835	5.8	0.038	0.00227	0.0	0.0	1999	0.0	79.1
58	0.068	-0.458	0.636	2.325	-0.264	-1.416	3.9	0.018	0.00227	0.0	0.0	1800	0.0	79.0
59	0.058	-0.460	0.283	2.037	0.029	-1.021	3.8	0.017	0.00227	0.0	0.0	1599	0.0	79.1
60	0.061	-0.456	-0.079	1.482	-0.092	-0.647	3.7	0.016	0.00227	0.0	0.0	1400	0.0	79.1
61	0.053	-0.456	-0.336	1.350	0.219	-0.405	3.1	0.011	0.00227	0.0	0.0	1200	0.0	79.1
62	0.051	-0.455	-0.563	1.209	-0.076	-0.130	2.7	0.008	0.00227	0.0	0.0	1000	0.0	79.0
63	0.039	-0.460	-0.771	0.938	-0.075	0.080	1.4	0.002	0.00227	0.0	0.0	800	0.0	79.0
64	0.007	-0.509	-0.993	0.856	0.012	0.293	0.9	0.001	0.00227	0.0	0.0	600	0.0	79.0
65	-0.014	-0.451	-1.006	0.719	-0.027	0.385	0.0	0.000	0.00227	0.0	0.0	400	0.0	79.0
66	0.020	-0.445	-1.182	0.640	-0.125	0.554	0.0	0.000	0.00227	0.0	0.0	200	0.0	79.0
67	0.004	0.000	0.021	0.000	-0.002	0.000	0.0	0.000	0.00227	0.0	0.0	0	-	79.0

Run 123: 2-bladed Concept Quadrotor

Table F.56: Run 123 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-90

Table F.57: Testing conditions and rotor 1 loads in the hub coordinate system for run 123.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.019	0.000	-0.010	0.000	-0.008	0.000	0.0	0.000	0.00224	0.0	0.0	0	-	85.7
4	-0.021	0.149	1.898	-1.391	0.658	-2.201	6.1	0.042	0.00223	0.0	0.0	2000	0.0	86.5
5	0.242	0.160	2.654	-1.414	6.670	-1.715	20.8	0.480	0.00223	0.0	0.0	2000	0.0	88.0
6	0.378	0.017	3.537	-5.303	7.416	-1.769	41.5	1.905	0.00221	0.0	0.0	2000	0.0	90.9
7	0.525	0.085	5.270	-4.426	11.257	-2.905	41.5	1.903	0.00221	0.1	0.0	2499	0.0	91.8
9	1.045	0.040	7.071	-3.463	16.931	-4.257	41.5	1.902	0.00221	0.1	0.0	3000	0.0	92.0
10	1.036	-0.011	6.643	-3.685	16.219	-4.369	41.7	1.919	0.00221	0.1	-3.0	3000	0.0	92.1
11	0.587	0.010	4.854	-4.854	11.247	-3.016	41.4	1.893	0.00221	0.1	-3.0	2500	0.0	92.3
12	0.403	-0.006	3.226	-5.159	7.386	-1.910	41.4	1.894	0.00221	0.1	-3.0	2000	0.0	92.4
13	0.385	-0.002	3.126	-5.267	7.350	-1.938	41.5	1.899	0.00220	-1.0	-3.0	2000	0.0	92.7
14	0.554	0.021	4.685	-4.821	11.065	-3.069	41.5	1.899	0.00220	-1.0	-3.0	2499	0.0	92.9
15	0.992	-0.026	6.407	-4.180	15.905	-4.426	41.5	1.895	0.00220	-1.0	-3.0	3000	0.0	93.1
16	1.082	0.029	6.821	-3.275	16.512	-4.315	41.5	1.895	0.00220	-1.0	0.0	2999	0.0	93.3
17	0.567	0.049	5.006	-4.475	11.401	-2.991	41.4	1.891	0.00220	-1.0	0.0	2500	0.0	93.4
18	0.416	0.037	3.301	-5.256	7.388	-1.875	41.5	1.897	0.00220	-1.0	0.0	2000	0.0	93.4
19	0.395	0.041	3.119	-5.235	7.347	-1.947	41.5	1.895	0.00220	-3.0	0.0	2000	0.0	93.6
21	0.560	0.060	4.711	-4.746	11.331	-3.081	41.7	1.910	0.00220	-3.0	0.0	2499	0.0	93.9
22	1.039	0.019	6.462	-3.748	16.112	-4.432	41.6	1.905	0.00220	-3.0	0.0	3000	0.0	94.0
23	1.010	-0.028	6.041	-4.585	15.205	-4.454	41.6	1.905	0.00220	-3.0	-3.0	3000	0.0	94.1
24	0.589	-0.021	4.326	-5.181	10.644	-3.151	41.5	1.894	0.00220	-3.0	-3.0	2500	0.0	94.2
25	0.395	-0.020	2.817	-5.291	7.023	-2.050	41.6	1.901	0.00220	-3.0	-3.0	2000	0.0	94.3
26	0.378	-0.007	2.612	-5.068	6.801	-2.071	41.5	1.890	0.00220	-5.0	-3.0	2000	0.0	94.7
27	0.540	-0.018	4.136	-5.095	10.184	-3.190	41.6	1.897	0.00220	-5.0	-3.0	2499	0.0	94.8
29	0.987	-0.055	5.865	-4.607	14.560	-4.526	41.7	1.910	0.00219	-5.0	-3.0	3000	0.0	95.1
30	1.059	-0.018	6.109	-4.442	15.503	-4.535	41.6	1.898	0.00219	-5.0	0.0	2999	0.0	95.1
31	0.590	0.002	4.370	-5.043	10.816	-3.178	41.7	1.906	0.00219	-5.0	0.0	2500	0.0	95.2
32	0.431	-0.014	2.822	-5.346	7.187	-2.080	41.6	1.903	0.00219	-5.0	0.0	1999	0.0	95.3
33	0.395	0.001	2.405	-5.033	6.435	-2.181	41.8	1.913	0.00219	-10.0	0.0	2000	0.0	95.5
34	0.522	0.017	3.848	-4.941	9.590	-3.327	41.5	1.892	0.00219	-10.0	0.0	2499	0.0	95.7
35	0.957	-0.018	5.586	-4.534	13.832	-4.717	41.8	1.911	0.00219	-10.0	0.0	3000	0.0	95.6
36	0.904	-0.041	5.328	-4.554	12.733	-4.898	41.9	1.921	0.00219	-10.0	-3.0	2999	0.0	95.6
37	0.553	-0.025	3.554	-4.798	8.657	-3.498	41.7	1.907	0.00219	-10.0	-3.0	2500	0.0	95.7

Continued on next page

Table F.57: Testing conditions and rotor 1 loads in the hub coordinate system for run 123.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
38	0.388	-0.006	2.070	-4.698	5.681	-2.288	41.6	1.900	0.00219	-10.0	-3.0	2000	0.0	95.8
40	0.331	0.128	2.402	-1.548	6.604	-1.907	20.9	0.481	0.00219	0.0	0.0	2000	0.0	95.6
41	0.067	0.194	1.827	-0.577	2.556	-2.203	3.5	0.014	0.00219	0.0	0.0	2000	0.0	95.5
42	0.007	0.000	-0.008	0.000	0.007	0.000	1.7	0.003	0.00219	0.0	0.0	0	-	95.4

Table F.58: Testing conditions and rotor 2 loads in the hub coordinate system for run 123.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.013	0.000	0.004	0.000	-0.015	0.000	0.0	0.000	0.00224	0.0	0.0	0	-	85.7
4	-0.184	-0.014	1.849	1.694	0.685	2.965	6.1	0.042	0.00223	0.0	0.0	2000	-90.0	86.5
5	-0.168	0.113	2.525	1.448	6.650	2.592	20.8	0.480	0.00223	0.0	0.0	1999	-90.0	88.0
6	-0.177	0.215	3.306	5.076	7.509	2.681	41.5	1.905	0.00221	0.0	0.0	2000	-90.0	90.9
7	-0.021	0.243	4.998	4.037	11.828	3.827	41.5	1.903	0.00221	0.1	0.0	2499	-90.0	91.8
9	0.215	0.262	6.905	2.465	16.922	5.166	41.5	1.902	0.00221	0.1	0.0	2999	-90.0	92.0
10	0.223	0.314	6.411	3.159	16.063	5.298	41.7	1.919	0.00221	0.1	-3.0	2999	-90.0	92.1
11	0.053	0.301	4.595	4.551	11.354	3.889	41.4	1.893	0.00221	0.1	-3.0	2500	-90.0	92.3
12	-0.087	0.278	3.017	5.003	7.383	2.723	41.4	1.894	0.00221	0.1	-3.0	2000	-90.0	92.4
13	-0.103	0.285	2.897	4.850	7.278	2.759	41.5	1.899	0.00220	-1.0	-3.0	2000	-90.0	92.7
14	0.030	0.293	4.476	4.394	11.204	3.908	41.5	1.899	0.00220	-1.0	-3.0	2499	-90.0	92.9
15	0.231	0.309	6.280	3.154	15.972	5.284	41.5	1.895	0.00220	-1.0	-3.0	3000	-90.0	93.1
16	0.285	0.219	6.668	2.226	16.618	5.193	41.5	1.895	0.00220	-1.0	0.0	2999	-90.0	93.3
17	0.085	0.234	4.763	4.086	11.609	3.822	41.4	1.891	0.00220	-1.0	0.0	2500	-90.0	93.4
18	-0.031	0.202	3.134	5.110	7.398	2.666	41.5	1.897	0.00220	-1.0	0.0	2000	-90.0	93.4
19	-0.023	0.185	2.954	4.848	7.385	2.721	41.5	1.895	0.00220	-3.0	0.0	2000	-90.0	93.6
21	0.098	0.211	4.555	4.376	11.367	3.853	41.7	1.910	0.00220	-3.0	0.0	2500	-90.0	93.9
22	0.312	0.211	6.373	2.940	16.066	5.247	41.6	1.905	0.00220	-3.0	0.0	3000	-90.0	94.0
23	0.311	0.281	5.969	3.700	14.894	5.203	41.6	1.905	0.00220	-3.0	-3.0	3000	-90.0	94.1
24	0.160	0.248	4.189	4.726	10.598	3.823	41.5	1.894	0.00220	-3.0	-3.0	2500	-90.0	94.2
25	0.005	0.225	2.610	4.935	6.978	2.720	41.6	1.901	0.00220	-3.0	-3.0	2000	-90.0	94.3
26	0.010	0.207	2.446	4.788	6.651	2.742	41.5	1.890	0.00220	-5.0	-3.0	2000	-90.0	94.7
27	0.138	0.238	3.989	4.491	9.931	3.877	41.6	1.897	0.00220	-5.0	-3.0	2499	-90.0	94.8
29	0.335	0.257	5.754	3.847	14.260	5.274	41.7	1.910	0.00219	-5.0	-3.0	2999	-90.0	95.1
30	0.363	0.195	5.982	3.774	15.092	5.161	41.6	1.898	0.00219	-5.0	0.0	2999	-90.0	95.1
31	0.173	0.184	4.213	4.767	10.843	3.792	41.7	1.906	0.00219	-5.0	0.0	2500	-90.0	95.2
32	0.040	0.140	2.706	4.936	7.219	2.681	41.6	1.903	0.00219	-5.0	0.0	2000	-90.0	95.3
33	0.057	0.106	2.275	4.654	6.222	2.770	41.8	1.913	0.00219	-10.0	0.0	2000	-90.0	95.5
34	0.170	0.132	3.769	4.574	9.409	3.934	41.5	1.892	0.00219	-10.0	0.0	2499	-90.0	95.7
35	0.340	0.138	5.513	3.805	13.484	5.383	41.8	1.911	0.00219	-10.0	0.0	3000	-90.0	95.6
36	0.313	0.160	5.153	3.929	12.101	5.510	41.9	1.921	0.00219	-10.0	-3.0	3000	-90.0	95.6
37	0.187	0.138	3.451	4.255	8.428	3.996	41.7	1.907	0.00219	-10.0	-3.0	2500	-90.0	95.7

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Table F.58: Testing conditions and rotor 2 loads in the hub coordinate system for run 123.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
38	0.096	0.106	1.955	4.430	5.429	2.776	41.6	1.900	0.00219	-10.0	-3.0	2000	-90.0	95.8
40	0.093	0.013	2.327	1.551	6.494	2.429	20.9	0.481	0.00219	0.0	0.0	2000	-90.0	95.6
41	0.025	-0.057	1.837	0.552	2.462	2.712	3.5	0.014	0.00219	0.0	0.0	1999	-90.0	95.5
42	0.012	0.000	0.015	0.000	-0.003	0.000	1.7	0.003	0.00219	0.0	0.0	0	-	95.4

Table F.59: Testing conditions and rotor 3 loads in the hub coordinate system for run 123.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.007	0.000	-0.005	0.000	-0.004	0.000	0.0	0.000	0.00224	0.0	0.0	0	-	85.7
4	-0.250	-0.172	1.632	-2.100	-0.182	2.978	6.1	0.042	0.00223	0.0	0.0	2000	-90.0	86.5
5	-0.174	0.193	1.585	1.474	4.410	2.955	20.8	0.480	0.00223	0.0	0.0	1999	-90.0	88.0
6	0.217	0.403	2.194	5.573	6.641	2.913	41.5	1.905	0.00221	0.0	0.0	1999	-90.0	90.9
7	0.391	0.456	3.322	4.519	9.356	4.200	41.5	1.903	0.00221	0.1	0.0	2499	-90.0	91.8
9	0.513	0.451	4.650	2.330	12.098	5.767	41.5	1.902	0.00221	0.1	0.0	3000	-90.0	92.0
10	0.476	0.449	4.397	2.984	10.843	5.824	41.7	1.919	0.00221	0.1	-3.0	3000	-90.0	92.1
11	0.357	0.407	3.088	4.117	8.410	4.291	41.4	1.893	0.00221	0.1	-3.0	2500	-90.0	92.3
12	0.241	0.396	1.963	5.275	5.849	2.996	41.4	1.894	0.00221	0.1	-3.0	2000	-90.0	92.4
13	0.266	0.390	1.943	5.364	5.697	3.012	41.5	1.899	0.00220	-1.0	-3.0	1999	-90.0	92.7
14	0.415	0.437	3.051	4.781	8.179	4.310	41.5	1.899	0.00220	-1.0	-3.0	2499	-90.0	92.9
15	0.574	0.483	4.429	3.719	10.893	5.842	41.5	1.895	0.00220	-1.0	-3.0	2999	-90.0	93.1
16	0.622	0.497	4.737	3.259	12.157	5.762	41.5	1.895	0.00220	-1.0	0.0	2999	-90.0	93.3
17	0.484	0.475	3.355	4.678	9.265	4.198	41.4	1.891	0.00220	-1.0	0.0	2500	-90.0	93.4
18	0.346	0.431	2.175	5.423	6.432	2.904	41.5	1.897	0.00220	-1.0	0.0	2000	-90.0	93.4
19	0.364	0.432	2.120	5.727	6.160	2.935	41.5	1.895	0.00220	-3.0	0.0	2000	-90.0	93.6
21	0.588	0.513	3.388	5.489	9.146	4.202	41.7	1.910	0.00220	-3.0	0.0	2500	-90.0	93.9
22	0.762	0.563	4.826	4.619	12.324	5.766	41.6	1.905	0.00220	-3.0	0.0	3000	-90.0	94.0
23	0.704	0.521	4.432	4.927	10.939	5.845	41.6	1.905	0.00220	-3.0	-3.0	3000	-90.0	94.1
24	0.571	0.457	3.085	5.341	8.028	4.294	41.5	1.894	0.00220	-3.0	-3.0	2500	-90.0	94.2
25	0.430	0.388	1.918	5.596	5.532	3.008	41.6	1.901	0.00220	-3.0	-3.0	1999	-90.0	94.3
26	0.460	0.375	1.805	5.557	5.158	3.030	41.5	1.890	0.00220	-5.0	-3.0	1999	-90.0	94.7
27	0.645	0.466	3.050	5.690	7.824	4.297	41.6	1.897	0.00220	-5.0	-3.0	2499	-90.0	94.8
29	0.822	0.516	4.445	4.920	10.613	5.816	41.7	1.910	0.00219	-5.0	-3.0	3000	-90.0	95.1
30	0.860	0.546	4.759	4.718	12.021	5.758	41.6	1.898	0.00219	-5.0	0.0	3000	-90.0	95.1
31	0.719	0.487	3.312	5.610	8.765	4.214	41.7	1.906	0.00219	-5.0	0.0	2500	-90.0	95.2
32	0.566	0.405	2.036	5.760	5.809	2.948	41.6	1.903	0.00219	-5.0	0.0	2000	-90.0	95.3
33	0.576	0.367	1.779	5.518	5.077	3.025	41.8	1.913	0.00219	-10.0	0.0	2000	-90.0	95.5
34	0.752	0.443	3.023	5.454	7.704	4.284	41.5	1.892	0.00219	-10.0	0.0	2499	-90.0	95.7
35	0.937	0.524	4.508	4.936	10.857	5.797	41.8	1.911	0.00219	-10.0	0.0	2999	-90.0	95.6
36	0.904	0.489	4.222	5.136	9.852	5.818	41.9	1.921	0.00219	-10.0	-3.0	3000	-90.0	95.6
37	0.753	0.405	2.729	5.462	6.749	4.295	41.7	1.907	0.00219	-10.0	-3.0	2500	-90.0	95.7

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Table F.59: Testing conditions and rotor 3 loads in the hub coordinate system for run 123.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
38	0.604	0.302	1.528	5.140	4.429	3.020	41.6	1.900	0.00219	-10.0	-3.0	2000	-90.0	95.8
40	0.463	0.162	1.609	1.436	4.058	2.858	20.9	0.481	0.00219	0.0	0.0	1999	-90.0	95.6
41	0.192	0.011	1.553	-0.528	1.376	2.888	3.5	0.014	0.00219	0.0	0.0	1999	90.0	95.5
42	-0.024	0.000	0.003	0.000	0.026	0.000	1.7	0.003	0.00219	0.0	0.0	0	-	95.4

Table F.60: Testing conditions and rotor 4 loads in the hub coordinate system for run 123.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.004	0.000	0.021	0.000	-0.002	0.000	0.0	0.000	0.00224	0.0	0.0	0	-	85.7
4	0.029	-0.394	1.131	2.711	-0.091	-1.814	6.1	0.042	0.00223	0.0	0.0	1999	0.0	86.5
5	0.066	-0.211	1.211	-1.096	3.945	-1.750	20.8	0.480	0.00223	0.0	0.0	1999	0.0	88.0
6	0.226	-0.234	1.883	-5.991	5.687	-1.739	41.5	1.905	0.00221	0.0	0.0	2000	0.0	90.9
7	0.391	-0.269	3.009	-5.527	8.768	-2.917	41.5	1.903	0.00221	0.1	0.0	2499	0.0	91.8
9	0.573	-0.288	4.321	-4.145	11.885	-4.367	41.5	1.902	0.00221	0.1	0.0	2999	0.0	92.0
10	0.600	-0.239	4.038	-5.158	10.620	-4.441	41.7	1.919	0.00221	0.1	-3.0	2999	0.0	92.1
11	0.462	-0.219	2.775	-5.786	7.865	-3.024	41.4	1.893	0.00221	0.1	-3.0	2500	0.0	92.3
12	0.300	-0.220	1.620	-5.696	5.070	-1.823	41.4	1.894	0.00221	0.1	-3.0	2000	0.0	92.4
13	0.312	-0.230	1.610	-5.803	4.908	-1.842	41.5	1.899	0.00220	-1.0	-3.0	2000	0.0	92.7
14	0.462	-0.244	2.713	-5.865	7.674	-3.049	41.5	1.899	0.00220	-1.0	-3.0	2499	0.0	92.9
15	0.603	-0.252	3.970	-5.462	10.496	-4.484	41.5	1.895	0.00220	-1.0	-3.0	3000	0.0	93.1
16	0.616	-0.309	4.302	-5.059	11.803	-4.384	41.5	1.895	0.00220	-1.0	0.0	2999	0.0	93.3
17	0.430	-0.261	2.959	-5.939	8.669	-2.940	41.4	1.891	0.00220	-1.0	0.0	2500	0.0	93.4
18	0.237	-0.254	1.767	-5.890	5.652	-1.763	41.5	1.897	0.00220	-1.0	0.0	1999	0.0	93.4
19	0.263	-0.259	1.710	-5.953	5.328	-1.794	41.5	1.895	0.00220	-3.0	0.0	1999	0.0	93.6
21	0.452	-0.298	2.891	-6.108	8.364	-2.995	41.7	1.910	0.00220	-3.0	0.0	2500	0.0	93.9
22	0.636	-0.324	4.258	-5.718	11.711	-4.434	41.6	1.905	0.00220	-3.0	0.0	3000	0.0	94.0
23	0.610	-0.279	3.897	-5.801	10.248	-4.512	41.6	1.905	0.00220	-3.0	-3.0	3000	0.0	94.1
24	0.470	-0.269	2.598	-5.981	7.366	-3.070	41.5	1.894	0.00220	-3.0	-3.0	2500	0.0	94.2
25	0.337	-0.279	1.457	-5.863	4.700	-1.877	41.6	1.901	0.00220	-3.0	-3.0	2000	0.0	94.3
26	0.336	-0.296	1.331	-5.526	4.466	-1.897	41.5	1.890	0.00220	-5.0	-3.0	2000	0.0	94.7
27	0.490	-0.308	2.476	-6.078	7.069	-3.093	41.6	1.897	0.00220	-5.0	-3.0	2499	0.0	94.8
29	0.653	-0.328	3.819	-5.922	10.093	-4.540	41.7	1.910	0.00219	-5.0	-3.0	2999	0.0	95.1
30	0.667	-0.372	4.124	-5.860	11.379	-4.455	41.6	1.898	0.00219	-5.0	0.0	2999	0.0	95.1
31	0.508	-0.364	2.712	-6.212	8.071	-3.032	41.7	1.906	0.00219	-5.0	0.0	2500	0.0	95.2
32	0.340	-0.371	1.501	-5.823	5.145	-1.839	41.6	1.903	0.00219	-5.0	0.0	2000	0.0	95.3
33	0.309	-0.347	1.180	-5.200	4.378	-1.915	41.8	1.913	0.00219	-10.0	0.0	1999	0.0	95.5
34	0.474	-0.400	2.360	-5.890	7.070	-3.109	41.5	1.892	0.00219	-10.0	0.0	2499	0.0	95.7
35	0.621	-0.405	3.754	-5.798	10.099	-4.536	41.8	1.911	0.00219	-10.0	0.0	3000	0.0	95.6
36	0.633	-0.367	3.397	-5.738	8.831	-4.532	41.9	1.921	0.00219	-10.0	-3.0	2999	0.0	95.6
37	0.501	-0.351	2.026	-5.690	6.148	-3.101	41.7	1.907	0.00219	-10.0	-3.0	2500	0.0	95.7

Continued on next page

Table F.60: Testing conditions and rotor 4 loads in the hub coordinate system for run 123.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
38	0.380	-0.340	0.875	-5.000	3.742	-1.917	41.6	1.900	0.00219	-10.0	-3.0	1999	0.0	95.8
40	0.341	-0.412	0.919	-1.144	3.847	-1.787	20.9	0.481	0.00219	0.0	0.0	1999	0.0	95.6
41	0.159	-0.428	0.920	1.120	1.192	-1.832	3.5	0.014	0.00219	0.0	0.0	1999	0.0	95.5
42	0.007	0.000	-0.003	0.000	0.014	0.000	1.7	0.003	0.00219	0.0	0.0	0	-	95.4

Run 124: 2-bladed Concept Quadrotor

Table F.61: Run 124 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-30

Table F.62: Testing conditions and rotor 1 loads in the hub coordinate system for run 124.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.020	0.000	-0.010	0.000	-0.009	0.000	0.0	0.000	0.00220	0.0	0.0	0	-	94.3
4	0.031	0.136	1.874	-1.531	1.001	-2.346	6.5	0.047	0.00220	0.0	0.0	1999	0.0	94.3
5	0.376	0.122	2.469	-1.506	6.563	-1.866	21.0	0.482	0.00219	0.0	0.0	2000	0.0	94.7
6	0.564	0.132	3.727	-1.207	9.873	-3.038	20.9	0.480	0.00219	0.0	0.0	2499	0.0	94.7
7	0.780	0.132	5.320	-0.516	13.231	-4.545	21.1	0.486	0.00219	0.1	0.0	3000	0.0	94.8
8	0.806	0.091	5.084	-0.888	12.500	-4.485	20.9	0.479	0.00219	0.1	-3.0	3000	0.0	94.9
9	0.595	0.080	3.540	-1.453	9.335	-3.048	20.8	0.475	0.00219	0.1	-3.0	2500	0.0	95.0
10	0.389	0.079	2.278	-1.664	6.244	-1.896	21.0	0.483	0.00219	0.1	-3.0	2000	0.0	95.2
11	0.377	0.088	2.290	-1.831	6.124	-1.917	21.0	0.482	0.00219	-1.0	-3.0	2000	0.0	95.6
12	0.536	0.088	3.529	-1.647	9.160	-3.040	21.0	0.482	0.00219	-1.0	-3.0	2499	0.0	95.6
13	0.800	0.093	5.042	-1.027	12.334	-4.437	20.9	0.479	0.00219	-0.9	-3.0	3000	0.0	95.9
14	0.818	0.126	5.315	-0.539	12.964	-4.518	21.0	0.483	0.00219	-0.9	0.0	2999	0.0	96.3
15	0.612	0.104	3.706	-1.243	9.628	-3.036	20.7	0.469	0.00219	-0.9	0.0	2500	0.0	96.3
16	0.401	0.127	2.435	-1.518	6.422	-1.858	20.9	0.480	0.00219	-0.9	0.0	2000	0.0	96.3
17	0.377	0.140	2.353	-1.697	6.298	-1.873	21.0	0.484	0.00219	-3.0	0.0	2000	0.0	96.4
18	0.544	0.124	3.630	-1.501	9.438	-3.027	21.1	0.487	0.00219	-3.0	0.0	2499	0.0	96.5
19	0.776	0.129	5.151	-0.802	12.379	-4.494	20.9	0.477	0.00219	-3.0	0.0	3000	0.0	96.5
20	0.775	0.084	4.964	-1.675	12.013	-4.402	21.1	0.485	0.00219	-3.0	-3.0	2999	0.0	96.6
21	0.553	0.062	3.482	-2.001	8.780	-3.048	20.8	0.474	0.00219	-3.0	-3.0	2500	0.0	96.6
22	0.372	0.089	2.245	-2.063	5.893	-1.929	21.0	0.480	0.00219	-3.0	-3.0	2000	0.0	96.6
23	0.350	0.096	2.200	-2.086	5.635	-1.983	21.0	0.482	0.00218	-5.0	-3.0	2000	0.0	96.7
24	0.518	0.089	3.419	-2.068	8.436	-3.106	21.0	0.481	0.00218	-5.0	-3.0	2499	0.0	96.8
25	0.741	0.085	4.909	-1.844	11.588	-4.481	21.2	0.492	0.00218	-5.0	-3.0	3000	0.0	96.8
26	0.781	0.110	5.036	-1.544	12.157	-4.433	21.1	0.485	0.00218	-5.0	0.0	2999	0.0	96.8
27	0.582	0.106	3.487	-1.878	8.874	-3.058	20.8	0.471	0.00218	-5.0	0.0	2500	0.0	96.9
28	0.374	0.130	2.297	-2.014	6.017	-1.924	21.1	0.484	0.00218	-5.0	0.0	2000	0.0	96.9
29	0.342	0.133	2.156	-2.034	5.315	-2.065	20.8	0.472	0.00218	-10.0	0.0	2000	0.0	97.0
30	0.480	0.120	3.445	-1.983	8.078	-3.214	21.1	0.485	0.00218	-10.0	0.0	2499	0.0	96.9
31	0.702	0.112	4.941	-1.706	10.829	-4.621	21.0	0.482	0.00218	-10.0	0.0	3000	0.0	97.0
32	0.676	0.103	4.806	-1.620	10.100	-4.768	21.3	0.493	0.00218	-10.0	-3.0	3000	0.0	97.0
33	0.471	0.095	3.304	-1.926	7.300	-3.318	21.2	0.491	0.00218	-10.0	-3.0	2500	0.0	96.9
34	0.329	0.098	2.072	-1.970	4.789	-2.141	20.7	0.470	0.00218	-10.0	-3.0	2000	0.0	96.9

Continued on next page

Table F.62: Testing conditions and rotor 1 loads in the hub coordinate system for run 124.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	0.396	0.151	2.505	-1.545	6.576	-1.872	21.0	0.480	0.00218	-0.0	0.0	2000	0.0	96.9
36	0.092	0.229	1.807	-0.590	1.597	-2.257	6.2	0.041	0.00218	-0.0	0.0	1999	0.0	97.0
37	0.077	0.020	0.131	0.018	-0.054	0.038	1.7	0.003	0.00218	-0.0	0.0	0	-	96.9
38	-0.029	0.208	-0.337	-0.103	0.189	0.247	1.8	0.004	0.00218	-0.0	0.0	200	0.0	96.5
39	0.003	0.205	-0.204	-0.119	0.150	0.130	1.6	0.003	0.00218	-0.0	0.0	400	0.0	96.4
40	0.005	0.203	-0.076	-0.178	0.192	-0.029	2.1	0.005	0.00218	-0.0	0.0	599	0.0	96.4
41	0.001	0.212	0.083	-0.265	0.114	-0.241	3.0	0.010	0.00218	-0.0	0.0	799	0.0	96.4
42	-0.001	0.212	0.273	-0.490	0.279	-0.479	3.2	0.011	0.00218	-0.0	0.0	999	0.0	96.4
43	-0.012	0.220	0.474	-0.532	0.083	-0.728	4.2	0.019	0.00218	-0.0	0.0	1200	0.0	96.4
44	0.013	0.220	0.740	-0.556	0.542	-1.059	4.7	0.024	0.00218	-0.0	0.0	1399	0.0	96.4
45	0.019	0.219	1.072	-0.972	0.481	-1.417	4.9	0.026	0.00218	-0.0	0.0	1599	0.0	96.4
46	0.018	0.197	1.462	-1.355	0.447	-1.872	5.7	0.035	0.00218	-0.0	0.0	1799	0.0	96.3
47	0.031	0.200	1.828	-1.327	0.820	-2.270	5.3	0.031	0.00218	-0.0	0.0	1999	0.0	96.3
48	0.044	0.204	2.242	-1.151	0.988	-2.751	6.0	0.039	0.00218	-0.0	0.0	2199	0.0	96.3
49	0.051	0.181	2.763	-1.622	1.065	-3.290	6.6	0.047	0.00219	-0.0	0.0	2399	0.0	96.2
50	0.044	0.186	3.245	-1.861	0.560	-3.964	7.0	0.054	0.00219	-0.0	0.0	2599	0.0	96.2
51	0.115	0.150	3.877	-2.762	1.957	-4.525	7.2	0.057	0.00219	-0.0	0.0	2799	0.0	96.2
52	0.141	0.118	4.512	-3.991	1.864	-5.247	7.3	0.058	0.00218	-0.0	0.0	2999	0.0	96.3
53	0.118	0.139	3.930	-3.041	1.827	-4.544	7.0	0.053	0.00218	-0.0	0.0	2800	0.0	96.2
54	0.062	0.161	3.188	-2.305	0.973	-3.870	6.9	0.053	0.00219	-0.0	0.0	2600	0.0	96.2
55	0.070	0.143	2.742	-2.329	1.105	-3.342	6.9	0.052	0.00219	-0.0	0.0	2400	0.0	96.2
56	0.042	0.151	2.195	-1.877	0.668	-2.796	6.1	0.041	0.00219	-0.0	0.0	2200	0.0	96.2
57	0.037	0.172	1.774	-1.055	0.814	-2.329	5.6	0.035	0.00219	-0.0	0.0	2000	0.0	96.2
58	0.003	0.178	1.250	-0.859	0.490	-1.814	5.3	0.030	0.00219	-0.0	0.0	1799	0.0	96.2
59	0.004	0.164	1.026	-1.258	0.446	-1.458	4.4	0.021	0.00219	-0.0	0.0	1600	0.0	96.2
60	-0.017	0.186	0.622	-0.747	0.311	-1.088	4.1	0.018	0.00219	-0.0	0.0	1400	0.0	96.1
61	-0.026	0.187	0.394	-0.678	0.130	-0.817	4.0	0.017	0.00219	-0.0	0.0	1200	0.0	96.2
62	-0.021	0.184	0.160	-0.459	0.526	-0.517	3.2	0.011	0.00219	-0.0	0.0	1000	0.0	96.1
63	-0.035	0.184	-0.057	-0.229	0.236	-0.290	3.2	0.012	0.00219	-0.0	0.0	800	0.0	96.1
64	-0.041	0.181	-0.225	-0.149	0.228	-0.087	2.7	0.008	0.00219	-0.0	0.0	600	0.0	96.1
65	-0.058	0.174	-0.355	-0.117	0.213	0.070	2.3	0.006	0.00219	-0.0	0.0	400	0.0	96.1
66	-0.088	0.189	-0.506	-0.133	0.260	0.198	1.9	0.004	0.00219	-0.0	0.0	200	0.0	96.1
67	0.012	0.000	-0.008	0.000	0.011	0.000	1.9	0.004	0.00219	-0.0	0.0	0	-	96.1

Table F.63: Testing conditions and rotor 2 loads in the hub coordinate system for run 124.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.014	0.000	0.004	0.000	-0.015	0.000	0.0	0.000	0.00220	0.0	0.0	0	-	94.3
4	0.003	-0.081	1.734	1.507	0.479	2.805	6.5	0.047	0.00220	0.0	0.0	2000	-30.0	94.3
5	0.096	0.056	2.395	1.467	6.485	2.457	21.0	0.482	0.00219	0.0	0.0	2000	-30.0	94.7
6	0.180	0.070	3.722	1.123	9.747	3.682	20.9	0.480	0.00219	0.0	0.0	2499	-30.0	94.7
7	0.325	0.083	5.282	0.179	13.187	5.197	21.1	0.486	0.00219	0.1	0.0	2999	-30.0	94.8
8	0.268	0.165	5.130	0.860	12.469	5.061	20.9	0.479	0.00219	0.1	-3.0	2999	-30.0	94.9
9	0.174	0.140	3.587	1.533	9.236	3.636	20.8	0.475	0.00219	0.1	-3.0	2500	-30.0	95.0
10	0.019	0.127	2.279	1.747	6.101	2.502	21.0	0.483	0.00219	0.1	-3.0	2000	-30.0	95.2
11	0.032	0.146	2.295	1.889	5.998	2.504	21.0	0.482	0.00219	-1.0	-3.0	2000	-30.0	95.6
12	0.101	0.162	3.566	1.844	9.083	3.647	21.0	0.482	0.00219	-1.0	-3.0	2499	-30.0	95.6
13	0.235	0.200	5.090	1.160	12.353	5.057	20.9	0.479	0.00219	-0.9	-3.0	2999	-30.0	95.9
14	0.290	0.141	5.231	0.371	12.866	5.197	21.0	0.483	0.00219	-0.9	0.0	3000	-30.0	96.3
15	0.141	0.115	3.721	1.228	9.517	3.716	20.7	0.469	0.00219	-0.9	0.0	2500	-30.0	96.3
16	0.065	0.106	2.364	1.488	6.352	2.508	20.9	0.480	0.00219	-0.9	0.0	2000	-30.0	96.3
17	0.040	0.099	2.282	1.763	6.170	2.540	21.0	0.484	0.00219	-3.0	0.0	1999	-30.0	96.4
18	0.147	0.120	3.571	1.565	9.283	3.694	21.1	0.487	0.00219	-3.0	0.0	2499	-30.0	96.5
19	0.233	0.128	5.140	0.772	12.463	5.124	20.9	0.477	0.00219	-3.0	0.0	2999	-30.0	96.5
20	0.243	0.205	5.038	1.514	11.981	5.040	21.1	0.485	0.00219	-3.0	-3.0	3000	-30.0	96.6
21	0.147	0.171	3.501	2.007	8.661	3.655	20.8	0.474	0.00219	-3.0	-3.0	2500	-30.0	96.6
22	0.041	0.154	2.227	2.039	5.760	2.526	21.0	0.480	0.00219	-3.0	-3.0	2000	-30.0	96.6
23	0.025	0.136	2.195	2.016	5.465	2.577	21.0	0.482	0.00218	-5.0	-3.0	2000	-30.0	96.7
24	0.150	0.145	3.479	1.985	8.245	3.723	21.0	0.481	0.00218	-5.0	-3.0	2499	-30.0	96.8
25	0.225	0.183	5.029	1.536	11.446	5.126	21.2	0.492	0.00218	-5.0	-3.0	3000	-30.0	96.8
26	0.292	0.132	5.019	1.403	12.218	5.039	21.1	0.485	0.00218	-5.0	0.0	2999	-30.0	96.8
27	0.141	0.106	3.564	1.884	8.841	3.654	20.8	0.471	0.00218	-5.0	0.0	2500	-30.0	96.9
28	0.075	0.083	2.239	2.041	5.889	2.522	21.1	0.484	0.00218	-5.0	0.0	2000	-30.0	96.9
29	0.061	0.049	2.144	2.022	5.184	2.629	20.8	0.472	0.00218	-10.0	0.0	1999	-30.0	97.0
30	0.184	0.065	3.382	1.978	7.808	3.815	21.1	0.485	0.00218	-10.0	0.0	2499	-30.0	96.9
31	0.296	0.107	4.942	1.399	10.827	5.242	21.0	0.482	0.00218	-10.0	0.0	3000	-30.0	97.0
32	0.237	0.154	4.930	1.320	10.061	5.355	21.3	0.493	0.00218	-10.0	-3.0	2999	-30.0	97.0
33	0.106	0.130	3.392	1.858	7.164	3.909	21.2	0.491	0.00218	-10.0	-3.0	2500	-30.0	96.9
34	0.035	0.116	2.069	1.913	4.634	2.684	20.7	0.470	0.00218	-10.0	-3.0	1999	-30.0	96.9

Continued on next page

Table F.63: Testing conditions and rotor 2 loads in the hub coordinate system for run 124.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
35	0.114	0.068	2.416	1.478	6.407	2.453	21.0	0.480	0.00218	-0.0	0.0	2000	-30.0	96.9
36	-0.021	-0.048	1.774	0.596	1.455	2.782	6.2	0.041	0.00218	-0.0	0.0	2000	-30.0	97.0
37	-0.011	0.054	0.128	-0.030	0.025	0.047	1.7	0.003	0.00218	-0.0	0.0	0	-	96.9
38	-0.050	-0.083	-0.344	0.245	0.085	0.318	1.8	0.004	0.00218	-0.0	0.0	200	0.0	96.5
39	-0.103	-0.072	-0.328	0.249	0.153	0.402	1.6	0.003	0.00218	-0.0	0.0	399	0.0	96.4
40	-0.138	-0.075	-0.235	0.297	0.164	0.538	2.1	0.005	0.00218	-0.0	0.0	599	0.0	96.4
41	-0.103	-0.059	-0.034	0.407	0.112	0.735	3.0	0.010	0.00218	-0.0	0.0	799	0.0	96.4
42	-0.102	-0.065	0.167	0.517	0.078	0.987	3.2	0.011	0.00218	-0.0	0.0	999	0.0	96.4
43	-0.091	-0.068	0.405	0.629	-0.001	1.291	4.2	0.019	0.00218	-0.0	0.0	1200	0.0	96.4
44	-0.091	-0.073	0.713	0.885	0.161	1.590	4.7	0.024	0.00218	-0.0	0.0	1399	0.0	96.4
45	-0.070	-0.077	0.993	0.791	0.351	1.942	4.9	0.026	0.00218	-0.0	0.0	1599	0.0	96.4
46	-0.046	-0.067	1.433	1.451	0.406	2.357	5.7	0.035	0.00218	-0.0	0.0	1799	0.0	96.3
47	-0.040	-0.066	1.820	1.596	0.910	2.811	5.3	0.031	0.00218	-0.0	0.0	1999	0.0	96.3
48	-0.026	-0.068	2.292	1.708	0.977	3.260	6.0	0.039	0.00218	-0.0	0.0	2199	0.0	96.3
49	-0.022	-0.066	2.772	2.171	1.165	3.831	6.6	0.047	0.00219	-0.0	0.0	2399	0.0	96.2
50	-0.014	-0.064	3.274	2.277	1.134	4.353	7.0	0.054	0.00219	-0.0	0.0	2599	0.0	96.2
51	0.001	-0.041	3.894	3.529	0.846	5.034	7.2	0.057	0.00219	-0.0	0.0	2799	0.0	96.2
52	0.034	-0.027	4.645	3.628	2.340	5.671	7.3	0.058	0.00218	-0.0	0.0	3000	0.0	96.3
53	0.028	-0.042	3.989	3.741	1.147	5.052	7.0	0.053	0.00218	-0.0	0.0	2800	0.0	96.2
54	0.012	-0.056	3.406	3.140	1.124	4.404	6.9	0.053	0.00219	-0.0	0.0	2600	0.0	96.2
55	0.005	-0.079	2.784	2.219	1.202	3.784	6.9	0.052	0.00219	-0.0	0.0	2400	0.0	96.2
56	-0.031	-0.089	2.266	2.153	0.918	3.265	6.1	0.041	0.00219	-0.0	0.0	2200	0.0	96.2
57	-0.015	-0.091	1.767	1.600	0.811	2.754	5.6	0.035	0.00219	-0.0	0.0	2000	0.0	96.2
58	-0.034	-0.095	1.416	1.394	0.963	2.286	5.3	0.030	0.00219	-0.0	0.0	1800	0.0	96.2
59	-0.050	-0.108	0.894	1.109	0.288	1.896	4.4	0.021	0.00219	-0.0	0.0	1600	0.0	96.2
60	-0.051	-0.106	0.665	1.074	0.560	1.564	4.1	0.018	0.00219	-0.0	0.0	1400	0.0	96.1
61	-0.062	-0.113	0.324	0.769	0.105	1.240	4.0	0.017	0.00219	-0.0	0.0	1200	0.0	96.2
62	-0.071	-0.121	0.017	0.488	0.144	0.910	3.2	0.011	0.00219	-0.0	0.0	1000	0.0	96.1
63	-0.061	-0.114	-0.142	0.274	0.070	0.672	3.2	0.012	0.00219	-0.0	0.0	800	0.0	96.1
64	-0.102	-0.128	-0.321	0.403	0.093	0.516	2.7	0.008	0.00219	-0.0	0.0	599	0.0	96.1
65	-0.088	-0.127	-0.466	0.271	0.089	0.362	2.3	0.006	0.00219	-0.0	0.0	400	0.0	96.1
66	-0.024	-0.124	-0.472	0.252	0.062	0.276	1.9	0.004	0.00219	-0.0	0.0	200	0.0	96.1
67	0.017	0.000	0.016	0.000	0.001	0.000	1.9	0.004	0.00219	-0.0	0.0	0	-	96.1

Table F.64: Testing conditions and rotor 3 loads in the hub coordinate system for run 124.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.008	0.000	-0.005	0.000	-0.004	0.000	0.0	0.000	0.00220	0.0	0.0	0	-	94.3
4	-0.037	-0.190	1.656	-1.979	0.046	2.947	6.5	0.047	0.00220	0.0	0.0	2000	-30.0	94.3
5	0.163	0.135	1.663	1.567	4.271	2.898	21.0	0.482	0.00219	0.0	0.0	2000	-30.0	94.7
6	0.238	0.172	2.739	1.009	5.854	4.111	20.9	0.480	0.00219	0.0	0.0	2500	-30.0	94.7
7	0.364	0.196	4.066	0.179	7.170	5.540	21.1	0.486	0.00219	0.1	0.0	2999	-30.0	94.8
8	0.304	0.192	3.973	0.852	6.727	5.595	20.9	0.479	0.00219	0.1	-3.0	3000	-30.0	94.9
9	0.239	0.164	2.644	1.705	5.318	4.142	20.8	0.475	0.00219	0.1	-3.0	2500	-30.0	95.0
10	0.128	0.093	1.461	1.714	3.693	2.921	21.0	0.483	0.00219	0.1	-3.0	2000	-30.0	95.2
11	0.187	0.116	1.530	2.048	3.728	2.915	21.0	0.482	0.00219	-1.0	-3.0	2000	-30.0	95.6
12	0.283	0.167	2.632	1.909	5.320	4.165	21.0	0.482	0.00219	-1.0	-3.0	2499	-30.0	95.6
13	0.353	0.228	4.025	1.422	6.821	5.612	20.9	0.479	0.00219	-0.9	-3.0	2999	-30.0	95.9
14	0.374	0.213	4.088	0.631	7.413	5.556	21.0	0.483	0.00219	-0.9	0.0	2999	-30.0	96.3
15	0.228	0.174	2.737	1.344	5.894	4.114	20.7	0.469	0.00219	-0.9	0.0	2500	-30.0	96.3
16	0.186	0.131	1.596	1.670	4.204	2.901	20.9	0.480	0.00219	-0.9	0.0	2000	-30.0	96.3
17	0.225	0.140	1.629	2.205	4.198	2.913	21.0	0.484	0.00219	-3.0	0.0	2000	-30.0	96.4
18	0.357	0.196	2.800	2.124	5.946	4.155	21.1	0.487	0.00219	-3.0	0.0	2500	-30.0	96.5
19	0.424	0.247	4.195	1.520	7.512	5.623	20.9	0.477	0.00219	-3.0	0.0	3000	-30.0	96.5
20	0.382	0.235	4.046	1.561	6.838	5.658	21.1	0.485	0.00219	-3.0	-3.0	2999	-30.0	96.6
21	0.297	0.186	2.656	1.892	5.270	4.162	20.8	0.474	0.00219	-3.0	-3.0	2500	-30.0	96.6
22	0.211	0.126	1.561	2.210	3.623	2.913	21.0	0.480	0.00219	-3.0	-3.0	2000	-30.0	96.6
23	0.253	0.133	1.565	2.280	3.543	2.917	21.0	0.482	0.00218	-5.0	-3.0	2000	-30.0	96.7
24	0.361	0.185	2.684	2.042	5.186	4.162	21.0	0.481	0.00218	-5.0	-3.0	2499	-30.0	96.8
25	0.437	0.218	3.998	1.204	6.828	5.655	21.2	0.492	0.00218	-5.0	-3.0	2999	-30.0	96.8
26	0.485	0.257	4.200	1.319	7.430	5.654	21.1	0.485	0.00218	-5.0	0.0	3000	-30.0	96.8
27	0.335	0.206	2.774	1.876	5.772	4.145	20.8	0.471	0.00218	-5.0	0.0	2499	-30.0	96.9
28	0.308	0.147	1.661	2.320	4.004	2.894	21.1	0.484	0.00218	-5.0	0.0	2000	-30.0	96.9
29	0.337	0.164	1.664	2.458	3.596	2.912	20.8	0.472	0.00218	-10.0	0.0	2000	-30.0	97.0
30	0.502	0.222	2.815	2.418	5.531	4.171	21.1	0.485	0.00218	-10.0	0.0	2499	-30.0	96.9
31	0.534	0.255	4.174	1.537	7.222	5.684	21.0	0.482	0.00218	-10.0	0.0	2999	-30.0	97.0
32	0.460	0.244	4.030	1.683	6.561	5.684	21.3	0.493	0.00218	-10.0	-3.0	2999	-30.0	97.0
33	0.354	0.199	2.665	2.424	4.921	4.187	21.2	0.491	0.00218	-10.0	-3.0	2500	-30.0	96.9
34	0.267	0.148	1.535	2.353	3.228	2.925	20.7	0.470	0.00218	-10.0	-3.0	2000	-30.0	96.9

Continued on next page

Table F.64: Testing conditions and rotor 3 loads in the hub coordinate system for run 124.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	0.381	0.144	1.650	1.581	4.161	2.855	21.0	0.480	0.00218	-0.0	0.0	1999	-30.0	96.9
36	0.053	-0.068	1.648	-1.250	-0.552	2.824	6.2	0.041	0.00218	-0.0	0.0	2000	-30.0	97.0
37	-0.102	-0.009	0.062	-0.001	0.061	0.013	1.7	0.003	0.00218	-0.0	0.0	0	-	96.9
38	-0.002	-0.134	-0.535	0.191	0.136	0.503	1.8	0.004	0.00218	-0.0	0.0	200	0.0	96.5
39	-0.043	-0.084	-0.428	0.142	0.172	0.508	1.6	0.003	0.00218	-0.0	0.0	400	0.0	96.4
40	-0.017	-0.080	-0.356	0.016	0.142	0.671	2.1	0.005	0.00218	-0.0	0.0	599	0.0	96.4
41	0.007	-0.077	-0.128	-0.235	0.012	0.854	3.0	0.010	0.00218	-0.0	0.0	800	0.0	96.4
42	0.031	-0.073	0.045	-0.330	0.066	1.088	3.2	0.011	0.00218	-0.0	0.0	999	0.0	96.4
43	0.048	-0.082	0.276	-0.633	0.032	1.366	4.2	0.019	0.00218	-0.0	0.0	1200	0.0	96.4
44	0.072	-0.080	0.511	-0.759	0.073	1.649	4.7	0.024	0.00218	-0.0	0.0	1399	0.0	96.4
45	0.090	-0.086	0.871	-1.102	-0.005	2.053	4.9	0.026	0.00218	-0.0	0.0	1599	0.0	96.4
46	0.100	-0.091	1.242	-1.424	0.051	2.448	5.7	0.035	0.00218	-0.0	0.0	1799	0.0	96.3
47	0.111	-0.102	1.610	-1.712	-0.189	2.909	5.3	0.031	0.00218	-0.0	0.0	2000	0.0	96.3
48	0.128	-0.113	2.080	-2.050	-0.256	3.347	6.0	0.039	0.00218	-0.0	0.0	2199	0.0	96.3
49	0.121	-0.140	2.611	-2.886	-0.413	3.935	6.6	0.047	0.00219	-0.0	0.0	2399	0.0	96.2
50	0.110	-0.163	3.240	-3.406	-1.147	4.514	7.0	0.054	0.00219	-0.0	0.0	2599	0.0	96.2
51	0.124	-0.165	3.679	-3.711	-0.700	5.143	7.2	0.057	0.00219	-0.0	0.0	2799	0.0	96.2
52	0.112	-0.191	4.356	-4.226	-1.151	5.794	7.3	0.058	0.00218	-0.0	0.0	3000	0.0	96.3
53	0.106	-0.172	3.749	-3.522	-0.942	5.171	7.0	0.053	0.00218	-0.0	0.0	2800	0.0	96.2
54	0.116	-0.154	3.124	-2.877	-0.236	4.499	6.9	0.053	0.00219	-0.0	0.0	2600	0.0	96.2
55	0.086	-0.157	2.592	-2.881	-0.515	3.935	6.9	0.052	0.00219	-0.0	0.0	2400	0.0	96.2
56	0.092	-0.136	2.091	-1.855	-0.458	3.362	6.1	0.041	0.00219	-0.0	0.0	2200	0.0	96.2
57	0.083	-0.135	1.611	-2.056	-0.123	2.917	5.6	0.035	0.00219	-0.0	0.0	2000	0.0	96.2
58	0.081	-0.123	1.202	-1.442	-0.209	2.462	5.3	0.030	0.00219	-0.0	0.0	1800	0.0	96.2
59	0.075	-0.111	0.834	-1.322	0.105	2.101	4.4	0.021	0.00219	-0.0	0.0	1599	0.0	96.2
60	0.081	-0.100	0.485	-0.871	0.187	1.697	4.1	0.018	0.00219	-0.0	0.0	1400	0.0	96.1
61	0.078	-0.095	0.265	-0.661	0.028	1.383	4.0	0.017	0.00219	-0.0	0.0	1200	0.0	96.2
62	0.076	-0.082	-0.015	-0.387	0.185	1.093	3.2	0.011	0.00219	-0.0	0.0	1000	0.0	96.1
63	0.071	-0.076	-0.211	-0.175	0.011	0.839	3.2	0.012	0.00219	-0.0	0.0	800	0.0	96.1
64	0.060	-0.082	-0.426	0.037	0.011	0.653	2.7	0.008	0.00219	-0.0	0.0	600	0.0	96.1
65	0.057	-0.074	-0.512	0.098	0.132	0.493	2.3	0.006	0.00219	-0.0	0.0	400	0.0	96.1
66	0.073	-0.102	-0.629	0.167	0.108	0.488	1.9	0.004	0.00219	-0.0	0.0	200	0.0	96.1
67	-0.023	0.000	0.004	0.000	0.031	0.000	1.9	0.004	0.00219	-0.0	0.0	0	-	96.1

Table F.65: Testing conditions and rotor 4 loads in the hub coordinate system for run 124.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.004	0.000	0.021	0.000	-0.003	0.000	0.0	0.000	0.00220	0.0	0.0	0	-	94.3
4	-0.031	-0.488	1.090	2.669	0.092	-1.798	6.5	0.047	0.00220	0.0	0.0	2000	0.0	94.3
5	0.235	-0.403	1.028	-1.126	3.859	-1.786	21.0	0.482	0.00219	0.0	0.0	1999	0.0	94.7
6	0.308	-0.409	2.103	-0.957	5.437	-2.937	20.9	0.480	0.00219	0.0	0.0	2499	0.0	94.7
7	0.449	-0.424	3.314	0.015	6.694	-4.286	21.1	0.486	0.00219	0.1	0.0	3000	0.0	94.8
8	0.412	-0.370	3.357	-0.469	6.177	-4.356	20.9	0.479	0.00219	0.1	-3.0	3000	0.0	94.9
9	0.337	-0.364	2.068	-1.329	4.856	-2.989	20.8	0.475	0.00219	0.1	-3.0	2500	0.0	95.0
10	0.285	-0.396	0.945	-1.197	3.345	-1.793	21.0	0.483	0.00219	0.1	-3.0	1999	0.0	95.2
11	0.335	-0.362	1.052	-1.445	3.270	-1.841	21.0	0.482	0.00219	-1.0	-3.0	2000	0.0	95.6
12	0.409	-0.371	2.074	-1.310	4.765	-3.002	21.0	0.482	0.00219	-1.0	-3.0	2500	0.0	95.6
13	0.475	-0.352	3.422	-1.122	6.279	-4.388	20.9	0.479	0.00219	-0.9	-3.0	3000	0.0	95.9
14	0.488	-0.382	3.430	-0.530	6.915	-4.327	21.0	0.483	0.00219	-0.9	0.0	2999	0.0	96.3
15	0.325	-0.371	2.280	-1.451	5.464	-2.967	20.7	0.469	0.00219	-0.9	0.0	2500	0.0	96.3
16	0.305	-0.377	1.071	-1.369	3.826	-1.793	20.9	0.480	0.00219	-0.9	0.0	1999	0.0	96.3
17	0.330	-0.402	1.061	-1.542	3.709	-1.804	21.0	0.484	0.00219	-3.0	0.0	2000	0.0	96.4
18	0.426	-0.385	2.126	-1.472	5.470	-2.994	21.1	0.487	0.00219	-3.0	0.0	2499	0.0	96.5
19	0.455	-0.384	3.587	-1.178	6.932	-4.401	20.9	0.477	0.00219	-3.0	0.0	3000	0.0	96.5
20	0.475	-0.321	3.468	-1.399	6.334	-4.435	21.1	0.485	0.00219	-3.0	-3.0	3000	0.0	96.6
21	0.362	-0.320	2.096	-1.456	4.796	-3.006	20.8	0.474	0.00219	-3.0	-3.0	2500	0.0	96.6
22	0.331	-0.322	1.079	-1.684	3.234	-1.838	21.0	0.480	0.00219	-3.0	-3.0	2000	0.0	96.6
23	0.347	-0.332	1.072	-1.753	3.179	-1.848	21.0	0.482	0.00218	-5.0	-3.0	1999	0.0	96.7
24	0.395	-0.329	2.127	-1.517	4.772	-3.020	21.0	0.481	0.00218	-5.0	-3.0	2499	0.0	96.8
25	0.505	-0.340	3.420	-1.052	6.224	-4.432	21.2	0.492	0.00218	-5.0	-3.0	3000	0.0	96.8
26	0.499	-0.381	3.468	-1.078	7.026	-4.419	21.1	0.485	0.00218	-5.0	0.0	2999	0.0	96.8
27	0.322	-0.374	2.272	-1.449	5.414	-2.982	20.8	0.471	0.00218	-5.0	0.0	2500	0.0	96.9
28	0.356	-0.384	1.089	-1.732	3.593	-1.820	21.1	0.484	0.00218	-5.0	0.0	2000	0.0	96.9
29	0.326	-0.397	1.098	-1.727	3.339	-1.841	20.8	0.472	0.00218	-10.0	0.0	1999	0.0	97.0
30	0.480	-0.395	2.069	-1.840	5.034	-3.036	21.1	0.485	0.00218	-10.0	0.0	2500	0.0	96.9
31	0.509	-0.382	3.413	-1.079	6.787	-4.455	21.0	0.482	0.00218	-10.0	0.0	2999	0.0	97.0
32	0.504	-0.327	3.412	-1.285	6.141	-4.458	21.3	0.493	0.00218	-10.0	-3.0	2999	0.0	97.0
33	0.439	-0.327	2.137	-1.947	4.472	-3.046	21.2	0.491	0.00218	-10.0	-3.0	2500	0.0	96.9
34	0.331	-0.331	1.014	-1.730	2.913	-1.851	20.7	0.470	0.00218	-10.0	-3.0	1999	0.0	96.9

Continued on next page

Table F.65: Testing conditions and rotor 4 loads in the hub coordinate system for run 124.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
35	0.395	-0.382	1.036	-1.152	3.697	-1.788	21.0	0.480	0.00218	-0.0	0.0	2000	0.0	96.9
36	0.213	-0.434	0.998	1.077	-1.155	-1.693	6.2	0.041	0.00218	-0.0	0.0	1999	0.0	97.0
37	0.054	0.017	0.148	0.040	-0.043	0.006	1.7	0.003	0.00218	-0.0	0.0	0	-	96.9
38	0.029	-0.447	-1.039	0.674	-0.089	0.577	1.8	0.004	0.00218	-0.0	0.0	200	0.0	96.5
39	-0.011	-0.414	-0.843	0.660	0.002	0.405	1.6	0.003	0.00218	-0.0	0.0	399	0.0	96.4
40	-0.000	-0.486	-0.825	0.835	-0.051	0.303	2.1	0.005	0.00218	-0.0	0.0	599	0.0	96.4
41	0.053	-0.426	-0.582	0.906	-0.201	0.096	3.0	0.010	0.00218	-0.0	0.0	799	0.0	96.4
42	0.094	-0.441	-0.447	1.101	-0.269	-0.109	3.2	0.011	0.00218	-0.0	0.0	999	0.0	96.4
43	0.113	-0.453	-0.208	1.318	-0.334	-0.364	4.2	0.019	0.00218	-0.0	0.0	1200	0.0	96.4
44	0.136	-0.464	0.051	1.600	-0.504	-0.675	4.7	0.024	0.00218	-0.0	0.0	1399	0.0	96.4
45	0.146	-0.473	0.362	1.833	-0.364	-1.015	4.9	0.026	0.00218	-0.0	0.0	1599	0.0	96.4
46	0.156	-0.468	0.696	2.358	-0.044	-1.408	5.7	0.035	0.00218	-0.0	0.0	1800	0.0	96.3
47	0.176	-0.478	1.100	2.401	-0.523	-1.754	5.3	0.031	0.00218	-0.0	0.0	1999	0.0	96.3
48	0.181	-0.477	1.383	2.550	0.025	-2.229	6.0	0.039	0.00218	-0.0	0.0	2199	0.0	96.3
49	0.173	-0.486	1.892	4.004	-0.507	-2.717	6.6	0.047	0.00219	-0.0	0.0	2399	0.0	96.2
50	0.191	-0.486	2.394	3.680	-0.927	-3.299	7.0	0.054	0.00219	-0.0	0.0	2599	0.0	96.2
51	0.187	-0.491	3.054	4.749	-1.585	-3.879	7.2	0.057	0.00219	-0.0	0.0	2800	0.0	96.2
52	0.204	-0.488	3.492	4.047	-0.471	-4.574	7.3	0.058	0.00218	-0.0	0.0	3000	0.0	96.3
53	0.157	-0.480	3.020	3.926	-0.649	-3.941	7.0	0.053	0.00218	-0.0	0.0	2800	0.0	96.2
54	0.105	-0.478	2.445	4.337	-0.672	-3.349	6.9	0.053	0.00219	-0.0	0.0	2599	0.0	96.2
55	0.099	-0.482	1.889	3.238	-0.194	-2.766	6.9	0.052	0.00219	-0.0	0.0	2400	0.0	96.2
56	0.070	-0.484	1.343	2.826	-0.022	-2.278	6.1	0.041	0.00219	-0.0	0.0	2200	0.0	96.2
57	0.070	-0.479	0.927	2.394	-0.149	-1.769	5.6	0.035	0.00219	-0.0	0.0	1999	0.0	96.2
58	0.057	-0.483	0.535	2.135	0.092	-1.336	5.3	0.030	0.00219	-0.0	0.0	1800	0.0	96.2
59	0.062	-0.480	0.253	1.870	-0.277	-0.993	4.4	0.021	0.00219	-0.0	0.0	1600	0.0	96.2
60	0.054	-0.479	-0.068	1.665	-0.052	-0.655	4.1	0.018	0.00219	-0.0	0.0	1400	0.0	96.1
61	0.052	-0.477	-0.324	1.350	-0.110	-0.382	4.0	0.017	0.00219	-0.0	0.0	1200	0.0	96.2
62	0.043	-0.479	-0.587	1.093	-0.153	-0.123	3.2	0.011	0.00219	-0.0	0.0	1000	0.0	96.1
63	0.037	-0.453	-0.733	0.873	-0.013	0.084	3.2	0.012	0.00219	-0.0	0.0	800	0.0	96.1
64	0.003	-0.523	-1.009	0.818	-0.063	0.297	2.7	0.008	0.00219	-0.0	0.0	600	0.0	96.1
65	-0.015	-0.450	-1.020	0.687	-0.090	0.389	2.3	0.006	0.00219	-0.0	0.0	400	0.0	96.1
66	0.035	-0.454	-1.220	0.646	-0.095	0.560	1.9	0.004	0.00219	-0.0	0.0	200	0.0	96.1
67	0.010	0.000	-0.005	0.000	0.018	0.000	1.9	0.004	0.00219	-0.0	0.0	0	-	96.1

Run 125: 2-bladed Concept Quadrotor

Table F.66: Run 125 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-30

Table F.67: Testing conditions and rotor 1 loads in the hub coordinate system for run 125.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.009	0.000	-0.009	0.000	-0.002	0.000	0.6	0.000	0.00231	-0.0	0.0	0	-	69.5
4	0.062	0.123	1.872	-2.022	0.693	-2.325	4.8	0.027	0.00231	0.0	0.0	2000	0.0	69.5
5	0.464	0.034	2.477	-1.584	6.846	-1.900	20.4	0.481	0.00231	0.0	0.0	1999	0.0	69.3
6	0.607	-0.072	3.309	-5.182	7.450	-2.019	40.6	1.905	0.00231	0.0	0.0	2000	0.0	68.7
7	0.842	-0.079	5.017	-4.371	11.904	-3.173	40.5	1.903	0.00232	0.0	0.0	2499	0.0	68.7
8	1.321	-0.078	6.896	-3.136	17.074	-4.576	40.4	1.893	0.00232	0.0	0.0	2999	0.0	68.5
9	1.281	-0.108	6.465	-3.714	16.434	-4.724	40.5	1.899	0.00232	0.0	-3.0	2999	0.0	68.5
10	0.916	-0.102	4.594	-4.818	11.560	-3.323	40.6	1.906	0.00232	0.0	-3.0	2500	0.0	68.5
11	0.671	-0.105	3.005	-5.303	7.509	-2.149	40.7	1.920	0.00232	0.0	-3.0	1999	0.0	68.5
12	0.605	-0.096	2.875	-5.253	7.427	-2.183	40.6	1.910	0.00232	-1.0	-3.0	2000	0.0	68.5
14	0.855	-0.096	4.442	-5.114	11.418	-3.344	40.4	1.891	0.00232	-1.0	-3.0	2499	0.0	68.5
15	1.213	-0.102	6.335	-4.171	16.159	-4.776	40.6	1.907	0.00232	-1.0	-3.0	3000	0.0	68.5
16	1.297	-0.057	6.767	-3.316	16.823	-4.635	40.5	1.900	0.00232	-1.0	0.0	3000	0.0	68.5
17	0.913	-0.037	4.845	-4.441	11.809	-3.243	40.5	1.904	0.00232	-1.0	0.0	2500	0.0	68.6
18	0.656	-0.047	3.169	-5.103	7.454	-2.095	40.3	1.881	0.00232	-1.0	0.0	2000	0.0	68.5
19	0.616	-0.054	2.978	-5.260	7.449	-2.172	40.5	1.902	0.00232	-3.0	0.0	2000	0.0	68.5
20	0.851	-0.052	4.605	-4.851	11.593	-3.331	40.6	1.912	0.00232	-3.0	0.0	2499	0.0	68.6
21	1.232	-0.054	6.472	-3.817	16.337	-4.753	40.7	1.915	0.00232	-3.0	0.0	3000	0.0	68.5
22	1.182	-0.101	6.078	-4.662	15.473	-4.752	40.4	1.895	0.00232	-3.0	-3.0	2999	0.0	68.5
24	0.825	-0.091	4.240	-5.233	10.870	-3.345	40.5	1.902	0.00232	-3.0	-3.0	2500	0.0	68.5
25	0.585	-0.077	2.668	-5.313	7.233	-2.233	40.3	1.880	0.00232	-3.0	-3.0	2000	0.0	68.5
26	0.554	-0.067	2.520	-5.218	6.947	-2.270	40.6	1.906	0.00232	-5.0	-3.0	2000	0.0	68.5
28	0.762	-0.067	4.065	-5.160	10.394	-3.416	40.4	1.893	0.00232	-5.0	-3.0	2499	0.0	68.5
29	1.105	-0.077	5.905	-4.563	14.808	-4.840	40.3	1.883	0.00232	-5.0	-3.0	3000	0.0	68.5
30	1.207	-0.057	6.226	-4.479	15.694	-4.779	40.6	1.907	0.00232	-5.0	0.0	2999	0.0	68.5
31	0.843	-0.046	4.361	-5.193	11.156	-3.367	40.5	1.903	0.00232	-5.0	0.0	2500	0.0	68.5
32	0.596	-0.030	2.795	-5.318	7.306	-2.222	40.4	1.887	0.00232	-5.0	0.0	1999	0.0	68.6
33	0.521	-0.020	2.376	-5.098	6.461	-2.334	40.6	1.908	0.00232	-10.0	0.0	1999	0.0	68.5
34	0.739	-0.037	3.922	-5.029	9.808	-3.523	40.4	1.892	0.00232	-10.0	0.0	2499	0.0	68.6
35	1.047	-0.025	5.744	-4.574	14.005	-5.006	40.6	1.906	0.00232	-10.0	0.0	3000	0.0	68.5
37	0.985	-0.044	5.410	-4.569	12.822	-5.186	40.6	1.909	0.00232	-10.0	-3.0	2999	0.0	68.6
38	0.664	-0.042	3.624	-4.861	8.941	-3.660	40.5	1.903	0.00232	-10.0	-3.0	2500	0.0	68.6

Continued on next page

Table F.67: Testing conditions and rotor 1 loads in the hub coordinate system for run 125.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
39	0.446	-0.029	2.110	-4.669	5.817	-2.407	40.3	1.882	0.00232	-10.0	-3.0	1999	0.0	68.6
40	0.408	0.103	2.440	-1.665	6.774	-2.013	20.4	0.482	0.00232	-0.0	0.0	2000	0.0	68.6
41	0.062	0.192	1.860	-0.731	2.134	-2.342	3.4	0.014	0.00232	-0.0	0.0	2000	0.0	68.6
42	0.000	0.000	-0.000	0.000	0.000	0.000	2.4	0.007	0.00232	-0.0	0.0	0	-	68.7

Table F.68: Testing conditions and rotor 2 loads in the hub coordinate system for run 125.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.004	0.000	0.008	0.000	-0.009	0.000	0.6	0.000	0.00231	-0.0	0.0	0	-	69.5
4	-0.135	-0.041	1.845	2.018	0.662	2.947	4.8	0.027	0.00231	0.0	0.0	2000	-30.0	69.5
5	-0.040	0.016	2.555	1.666	6.862	2.580	20.4	0.481	0.00231	0.0	0.0	2000	-30.0	69.3
6	0.106	0.086	3.315	5.021	7.672	2.573	40.6	1.905	0.00231	0.0	0.0	2000	-30.0	68.7
7	0.186	0.108	4.988	4.329	12.176	3.772	40.5	1.903	0.00232	0.0	0.0	2499	-30.0	68.7
8	0.429	0.133	6.928	2.694	17.658	5.172	40.4	1.893	0.00232	0.0	0.0	3000	-30.0	68.5
9	0.422	0.175	6.519	3.316	16.723	5.293	40.5	1.899	0.00232	0.0	-3.0	3000	-30.0	68.5
10	0.235	0.142	4.602	4.797	11.821	3.855	40.6	1.906	0.00232	0.0	-3.0	2500	-30.0	68.5
11	0.115	0.127	2.991	5.236	7.484	2.650	40.7	1.920	0.00232	0.0	-3.0	1999	-30.0	68.5
12	0.112	0.130	2.865	5.261	7.418	2.680	40.6	1.910	0.00232	-1.0	-3.0	1999	-30.0	68.5
14	0.247	0.149	4.487	4.962	11.595	3.852	40.4	1.891	0.00232	-1.0	-3.0	2500	-30.0	68.5
15	0.401	0.179	6.367	3.766	16.408	5.326	40.6	1.907	0.00232	-1.0	-3.0	3000	-30.0	68.5
16	0.440	0.128	6.776	2.765	17.286	5.187	40.5	1.900	0.00232	-1.0	0.0	3000	-30.0	68.5
17	0.244	0.098	4.841	4.353	12.049	3.770	40.5	1.904	0.00232	-1.0	0.0	2500	-30.0	68.6
18	0.137	0.080	3.114	5.113	7.486	2.602	40.3	1.881	0.00232	-1.0	0.0	1999	-30.0	68.5
19	0.143	0.081	2.942	5.195	7.448	2.658	40.5	1.902	0.00232	-3.0	0.0	1999	-30.0	68.5
20	0.245	0.095	4.589	4.775	11.792	3.853	40.6	1.912	0.00232	-3.0	0.0	2499	-30.0	68.6
21	0.431	0.128	6.508	3.229	16.634	5.290	40.7	1.915	0.00232	-3.0	0.0	2999	-30.0	68.5
22	0.416	0.176	6.146	4.167	15.671	5.263	40.4	1.895	0.00232	-3.0	-3.0	2999	-30.0	68.5
24	0.265	0.146	4.287	5.055	11.027	3.846	40.5	1.902	0.00232	-3.0	-3.0	2500	-30.0	68.5
25	0.159	0.118	2.696	5.141	7.180	2.678	40.3	1.880	0.00232	-3.0	-3.0	2000	-30.0	68.5
26	0.141	0.118	2.525	5.138	6.883	2.724	40.6	1.906	0.00232	-5.0	-3.0	2000	-30.0	68.5
28	0.241	0.135	4.101	4.968	10.427	3.919	40.4	1.893	0.00232	-5.0	-3.0	2499	-30.0	68.5
29	0.388	0.160	5.983	4.123	14.984	5.367	40.3	1.883	0.00232	-5.0	-3.0	2999	-30.0	68.5
30	0.418	0.126	6.244	3.933	16.044	5.312	40.6	1.907	0.00232	-5.0	0.0	2999	-30.0	68.5
31	0.263	0.102	4.381	5.061	11.303	3.847	40.5	1.903	0.00232	-5.0	0.0	2500	-30.0	68.5
32	0.136	0.070	2.754	5.181	7.338	2.685	40.4	1.887	0.00232	-5.0	0.0	1999	-30.0	68.6
33	0.123	0.057	2.360	4.982	6.444	2.790	40.6	1.908	0.00232	-10.0	0.0	2000	-30.0	68.5
34	0.220	0.070	3.915	4.885	9.829	4.024	40.4	1.892	0.00232	-10.0	0.0	2499	-30.0	68.6
35	0.355	0.093	5.776	4.128	14.180	5.521	40.6	1.906	0.00232	-10.0	0.0	3000	-30.0	68.5
37	0.315	0.110	5.482	4.139	12.938	5.683	40.6	1.909	0.00232	-10.0	-3.0	2999	-30.0	68.6
38	0.196	0.093	3.658	4.735	8.891	4.140	40.5	1.903	0.00232	-10.0	-3.0	2499	-30.0	68.6

Continued on next page

Table F.68: Testing conditions and rotor 2 loads in the hub coordinate system for run 125.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
39	0.107	0.082	2.108	4.620	5.713	2.846	40.3	1.882	0.00232	-10.0	-3.0	1999	-30.0	68.6
40	-0.011	-0.032	2.491	1.700	6.662	2.515	20.4	0.482	0.00232	-0.0	0.0	2000	-30.0	68.6
41	-0.009	-0.093	1.844	0.533	2.365	2.795	3.4	0.014	0.00232	-0.0	0.0	2000	-30.0	68.6
42	0.000	0.000	-0.000	0.000	0.000	0.000	2.4	0.007	0.00232	-0.0	0.0	0	-	68.7

Table F.69: Testing conditions and rotor 3 loads in the hub coordinate system for run 125.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.011	0.000	-0.002	0.000	0.007	0.000	0.6	0.000	0.00231	-0.0	0.0	0	-	69.5
4	-0.140	-0.197	1.602	-1.756	-0.190	3.045	4.8	0.027	0.00231	0.0	0.0	2000	-30.0	69.5
5	0.089	-0.051	1.644	1.539	4.528	3.001	20.4	0.481	0.00231	0.0	0.0	1999	-30.0	69.3
6	0.525	0.276	2.262	6.094	6.521	2.953	40.6	1.905	0.00231	0.0	0.0	2000	-30.0	68.7
7	0.706	0.344	3.434	5.167	9.460	4.331	40.5	1.903	0.00232	0.0	0.0	2499	-30.0	68.7
8	0.935	0.406	4.846	3.215	12.443	5.994	40.4	1.893	0.00232	0.0	0.0	3000	-30.0	68.5
9	0.929	0.426	4.630	4.272	11.234	6.059	40.5	1.899	0.00232	0.0	-3.0	2999	-30.0	68.5
10	0.802	0.395	3.203	5.355	8.400	4.445	40.6	1.906	0.00232	0.0	-3.0	2500	-30.0	68.5
11	0.660	0.354	2.041	5.815	5.653	3.079	40.7	1.920	0.00232	0.0	-3.0	2000	-30.0	68.5
12	0.663	0.352	2.003	5.906	5.541	3.105	40.6	1.910	0.00232	-1.0	-3.0	2000	-30.0	68.5
14	0.817	0.418	3.231	5.533	8.253	4.461	40.4	1.891	0.00232	-1.0	-3.0	2499	-30.0	68.5
15	0.951	0.474	4.682	4.765	11.164	6.083	40.6	1.907	0.00232	-1.0	-3.0	2999	-30.0	68.5
16	0.988	0.493	4.995	4.058	12.519	5.985	40.5	1.900	0.00232	-1.0	0.0	2999	-30.0	68.5
17	0.859	0.475	3.514	5.529	9.350	4.352	40.5	1.904	0.00232	-1.0	0.0	2500	-30.0	68.6
18	0.681	0.394	2.231	5.907	6.199	2.997	40.3	1.881	0.00232	-1.0	0.0	1999	-30.0	68.5
19	0.679	0.401	2.199	6.145	6.022	3.027	40.5	1.902	0.00232	-3.0	0.0	2000	-30.0	68.5
20	0.849	0.492	3.511	5.982	9.161	4.372	40.6	1.912	0.00232	-3.0	0.0	2500	-30.0	68.6
21	1.020	0.562	5.054	5.030	12.573	6.002	40.7	1.915	0.00232	-3.0	0.0	3000	-30.0	68.5
22	0.980	0.518	4.680	5.236	11.038	6.090	40.4	1.895	0.00232	-3.0	-3.0	2999	-30.0	68.5
24	0.832	0.440	3.210	5.838	8.077	4.470	40.5	1.902	0.00232	-3.0	-3.0	2500	-30.0	68.5
25	0.693	0.369	1.988	5.902	5.322	3.106	40.3	1.880	0.00232	-3.0	-3.0	2000	-30.0	68.5
26	0.678	0.357	1.899	5.892	5.156	3.137	40.6	1.906	0.00232	-5.0	-3.0	2000	-30.0	68.5
28	0.816	0.427	3.139	5.998	7.850	4.491	40.4	1.893	0.00232	-5.0	-3.0	2499	-30.0	68.5
29	0.952	0.502	4.648	5.425	10.770	6.089	40.3	1.883	0.00232	-5.0	-3.0	3000	-30.0	68.5
30	0.997	0.550	5.005	5.358	12.262	6.012	40.6	1.907	0.00232	-5.0	0.0	2999	-30.0	68.5
31	0.831	0.478	3.463	6.011	8.870	4.382	40.5	1.903	0.00232	-5.0	0.0	2500	-30.0	68.5
32	0.660	0.386	2.115	6.009	5.787	3.061	40.4	1.887	0.00232	-5.0	0.0	2000	-30.0	68.6
33	0.646	0.337	1.865	5.654	5.025	3.139	40.6	1.908	0.00232	-10.0	0.0	2000	-30.0	68.5
34	0.793	0.423	3.169	5.990	7.893	4.480	40.4	1.892	0.00232	-10.0	0.0	2499	-30.0	68.6
35	0.948	0.515	4.716	5.628	11.147	6.093	40.6	1.906	0.00232	-10.0	0.0	2999	-30.0	68.5
37	0.867	0.459	4.360	5.594	10.028	6.110	40.6	1.909	0.00232	-10.0	-3.0	2999	-30.0	68.6
38	0.712	0.369	2.869	5.878	7.021	4.496	40.5	1.903	0.00232	-10.0	-3.0	2500	-30.0	68.6

Continued on next page

Table F.69: Testing conditions and rotor 3 loads in the hub coordinate system for run 125.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
39	0.576	0.279	1.592	5.439	4.436	3.149	40.3	1.882	0.00232	-10.0	-3.0	2000	-30.0	68.6
40	0.360	0.140	1.701	1.784	4.270	2.995	20.4	0.482	0.00232	-0.0	0.0	1999	-30.0	68.6
41	0.181	0.027	1.480	0.332	1.265	3.009	3.4	0.014	0.00232	-0.0	0.0	2000	-30.0	68.6
42	0.000	0.000	-0.000	0.000	0.000	0.000	2.4	0.007	0.00232	-0.0	0.0	0	-	68.7

Table F.70: Testing conditions and rotor 4 loads in the hub coordinate system for run 125.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.006	0.000	0.013	0.000	0.004	0.000	0.6	0.000	0.00231	-0.0	0.0	0	-	69.5
4	0.095	-0.517	1.042	2.690	-0.625	-1.867	4.8	0.027	0.00231	0.0	0.0	2000	0.0	69.5
5	0.332	-0.534	1.265	-0.867	3.886	-1.881	20.4	0.481	0.00231	0.0	0.0	1999	0.0	69.3
6	0.762	-0.527	1.743	-5.901	5.485	-1.905	40.6	1.905	0.00231	0.0	0.0	2000	0.0	68.7
7	1.003	-0.575	2.836	-5.001	8.562	-3.140	40.5	1.903	0.00232	0.0	0.0	2500	0.0	68.7
8	1.218	-0.552	4.165	-3.364	11.433	-4.646	40.4	1.893	0.00232	0.0	0.0	3000	0.0	68.5
9	1.133	-0.510	3.988	-4.453	10.369	-4.743	40.5	1.899	0.00232	0.0	-3.0	3000	0.0	68.5
10	0.916	-0.522	2.574	-5.178	7.637	-3.232	40.6	1.906	0.00232	0.0	-3.0	2500	0.0	68.5
11	0.718	-0.492	1.458	-5.449	5.056	-1.975	40.7	1.920	0.00232	0.0	-3.0	2000	0.0	68.5
12	0.707	-0.485	1.432	-5.481	4.948	-1.995	40.6	1.910	0.00232	-1.0	-3.0	1999	0.0	68.5
14	0.917	-0.501	2.601	-5.520	7.600	-3.256	40.4	1.891	0.00232	-1.0	-3.0	2500	0.0	68.5
15	1.131	-0.501	3.995	-5.038	10.256	-4.749	40.6	1.907	0.00232	-1.0	-3.0	3000	0.0	68.5
16	1.246	-0.533	4.293	-4.344	11.590	-4.667	40.5	1.900	0.00232	-1.0	0.0	3000	0.0	68.5
17	1.025	-0.555	2.836	-5.455	8.563	-3.143	40.5	1.904	0.00232	-1.0	0.0	2500	0.0	68.6
18	0.807	-0.527	1.605	-5.585	5.548	-1.890	40.3	1.881	0.00232	-1.0	0.0	2000	0.0	68.5
19	0.799	-0.511	1.590	-5.831	5.350	-1.928	40.5	1.902	0.00232	-3.0	0.0	1999	0.0	68.5
20	1.043	-0.547	2.815	-5.950	8.338	-3.171	40.6	1.912	0.00232	-3.0	0.0	2500	0.0	68.6
21	1.280	-0.530	4.313	-5.452	11.549	-4.687	40.7	1.915	0.00232	-3.0	0.0	2999	0.0	68.5
22	1.143	-0.498	3.981	-5.470	10.198	-4.771	40.4	1.895	0.00232	-3.0	-3.0	3000	0.0	68.5
24	0.901	-0.502	2.539	-5.813	7.419	-3.252	40.5	1.902	0.00232	-3.0	-3.0	2500	0.0	68.5
25	0.674	-0.474	1.373	-5.559	4.793	-1.999	40.3	1.880	0.00232	-3.0	-3.0	2000	0.0	68.5
26	0.653	-0.477	1.279	-5.432	4.573	-2.015	40.6	1.906	0.00232	-5.0	-3.0	2000	0.0	68.5
28	0.872	-0.499	2.450	-5.917	7.230	-3.242	40.4	1.893	0.00232	-5.0	-3.0	2499	0.0	68.5
29	1.074	-0.475	3.932	-5.524	9.943	-4.772	40.3	1.883	0.00232	-5.0	-3.0	2999	0.0	68.5
30	1.217	-0.511	4.265	-5.676	11.316	-4.710	40.6	1.907	0.00232	-5.0	0.0	3000	0.0	68.5
31	0.984	-0.506	2.788	-5.989	8.107	-3.204	40.5	1.903	0.00232	-5.0	0.0	2500	0.0	68.5
32	0.748	-0.511	1.479	-5.645	5.196	-1.935	40.4	1.887	0.00232	-5.0	0.0	2000	0.0	68.6
33	0.688	-0.456	1.231	-5.188	4.461	-2.020	40.6	1.908	0.00232	-10.0	0.0	2000	0.0	68.5
34	0.918	-0.501	2.453	-5.752	7.211	-3.257	40.4	1.892	0.00232	-10.0	0.0	2499	0.0	68.6
35	1.129	-0.496	3.974	-5.597	10.260	-4.775	40.6	1.906	0.00232	-10.0	0.0	2999	0.0	68.5
37	0.953	-0.455	3.633	-5.623	9.168	-4.787	40.6	1.909	0.00232	-10.0	-3.0	3000	0.0	68.6
38	0.744	-0.446	2.177	-5.608	6.369	-3.271	40.5	1.903	0.00232	-10.0	-3.0	2500	0.0	68.6

Continued on next page

Table F.70: Testing conditions and rotor 4 loads in the hub coordinate system for run 125.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
39	0.523	-0.439	0.952	-4.872	3.910	-2.006	40.3	1.882	0.00232	-10.0	-3.0	1999	0.0	68.6
40	0.384	-0.484	1.213	-1.106	3.895	-1.874	20.4	0.482	0.00232	-0.0	0.0	2000	0.0	68.6
41	0.221	-0.490	0.965	1.311	-0.023	-1.859	3.4	0.014	0.00232	-0.0	0.0	2000	0.0	68.6
42	0.000	0.000	-0.000	0.000	0.000	0.000	2.4	0.007	0.00232	-0.0	0.0	0	-	68.7

Run 126: 2-bladed Concept Quadrotor

Table F.71: Run 126 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-60

Table F.72: Testing conditions and rotor 1 loads in the hub coordinate system for run 126.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.018	0.000	-0.010	0.000	-0.008	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	69.6
4	0.040	0.130	1.912	-1.482	0.772	-2.263	5.5	0.035	0.00231	0.0	0.0	2000	0.0	70.0
5	0.424	0.043	2.558	-1.667	6.767	-1.902	20.5	0.487	0.00231	0.0	0.0	1999	0.0	70.0
6	0.617	0.076	3.899	-1.569	10.143	-3.149	20.4	0.479	0.00231	0.0	0.0	2500	0.0	70.2
7	0.875	0.094	5.555	-0.935	13.472	-4.750	20.2	0.470	0.00231	0.0	0.0	3000	0.0	70.3
8	0.835	0.050	5.367	-1.470	12.958	-4.662	20.3	0.478	0.00231	0.1	-3.0	3000	0.0	70.4
9	0.610	0.041	3.772	-1.753	9.700	-3.162	20.4	0.481	0.00231	0.1	-3.0	2500	0.0	70.6
10	0.430	0.034	2.477	-1.824	6.518	-1.977	20.2	0.470	0.00231	0.0	-3.0	2000	0.0	70.6
11	0.399	0.035	2.458	-2.042	6.416	-1.989	20.5	0.487	0.00231	-1.0	-3.0	2000	0.0	70.7
12	0.568	0.037	3.728	-2.066	9.631	-3.160	20.6	0.488	0.00231	-1.0	-3.0	2499	0.0	70.7
13	0.831	0.048	5.317	-1.596	12.829	-4.645	20.5	0.483	0.00231	-1.0	-3.0	3000	0.0	70.9
14	0.899	0.098	5.440	-0.917	13.125	-4.753	20.1	0.465	0.00231	-1.0	0.0	3000	0.0	70.9
15	0.666	0.107	3.849	-1.503	10.052	-3.175	20.4	0.481	0.00231	-1.0	0.0	2500	0.0	71.0
16	0.470	0.072	2.492	-1.692	6.606	-1.946	20.3	0.477	0.00231	-1.0	0.0	2000	0.0	71.1
17	0.437	0.077	2.419	-1.879	6.387	-1.979	20.3	0.477	0.00231	-3.0	0.0	2000	0.0	71.1
18	0.610	0.087	3.707	-1.909	9.610	-3.174	20.4	0.478	0.00231	-3.0	0.0	2499	0.0	71.1
19	0.833	0.098	5.360	-1.335	12.978	-4.699	20.7	0.492	0.00231	-3.0	0.0	3000	0.0	71.1
20	0.820	0.028	5.211	-2.186	12.437	-4.620	20.4	0.480	0.00231	-3.0	-3.0	2999	0.0	71.3
21	0.603	0.031	3.640	-2.328	9.189	-3.171	20.3	0.474	0.00231	-3.0	-3.0	2500	0.0	71.3
22	0.374	0.042	2.362	-2.209	6.169	-2.018	20.4	0.481	0.00231	-3.0	-3.0	2000	0.0	71.3
23	0.356	0.048	2.311	-2.309	5.879	-2.063	20.4	0.482	0.00231	-5.0	-3.0	2000	0.0	71.3
24	0.523	0.037	3.595	-2.477	8.842	-3.225	20.7	0.492	0.00231	-5.0	-3.0	2499	0.0	71.4
25	0.786	0.035	5.152	-2.329	11.964	-4.707	20.5	0.483	0.00231	-5.0	-3.0	2999	0.0	71.5
26	0.844	0.082	5.177	-1.839	12.484	-4.652	20.4	0.480	0.00231	-5.0	0.0	3000	0.0	71.5
27	0.606	0.066	3.608	-2.135	9.302	-3.189	20.5	0.484	0.00231	-5.0	0.0	2500	0.0	71.6
28	0.443	0.077	2.310	-2.118	6.171	-2.022	20.4	0.479	0.00231	-5.0	0.0	2000	0.0	71.6
29	0.366	0.086	2.173	-2.250	5.489	-2.143	20.3	0.475	0.00231	-10.0	0.0	2000	0.0	71.6
30	0.514	0.080	3.537	-2.285	8.309	-3.347	20.6	0.487	0.00231	-10.0	0.0	2499	0.0	71.6
31	0.773	0.081	5.075	-2.214	11.197	-4.840	20.4	0.478	0.00230	-10.0	0.0	2999	0.0	71.7
32	0.693	0.061	5.090	-1.901	10.570	-5.019	20.5	0.482	0.00230	-10.0	-3.0	2999	0.0	71.8
34	0.457	0.056	3.468	-2.114	7.744	-3.474	20.5	0.484	0.00230	-10.0	-3.0	2500	0.0	71.8
35	0.280	0.061	2.130	-2.204	5.142	-2.233	20.5	0.486	0.00230	-10.0	-3.0	2000	0.0	71.9

Continued on next page

Table F.72: Testing conditions and rotor 1 loads in the hub coordinate system for run 126.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
36	0.398	0.096	2.504	-1.746	6.863	-1.972	20.5	0.484	0.00230	0.0	0.0	2000	0.0	72.0
37	0.103	0.177	1.945	-0.231	3.335	-2.275	4.4	0.022	0.00230	0.0	0.0	2000	0.0	72.0
38	-0.000	0.000	-0.000	0.000	0.000	0.000	2.7	0.008	0.00230	0.0	0.0	0	-	72.0

Table F.73: Testing conditions and rotor 2 loads in the hub coordinate system for run 126.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.012	0.000	0.004	0.000	-0.014	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	69.6
4	-0.118	-0.027	1.899	1.698	0.483	2.973	5.5	0.035	0.00231	0.0	0.0	2000	-60.0	70.0
5	-0.038	0.019	2.589	1.541	6.623	2.576	20.5	0.487	0.00231	0.0	0.0	1999	-60.0	70.0
6	0.038	0.012	3.993	1.126	10.002	3.846	20.4	0.479	0.00231	0.0	0.0	2499	-60.0	70.2
7	0.134	0.007	5.725	0.013	13.040	5.445	20.2	0.470	0.00231	0.0	0.0	2999	-60.0	70.3
8	0.230	0.069	5.383	0.909	12.751	5.308	20.3	0.478	0.00231	0.1	-3.0	3000	-60.0	70.4
9	0.136	0.061	3.762	1.645	9.586	3.788	20.4	0.481	0.00231	0.1	-3.0	2500	-60.0	70.6
10	0.070	0.054	2.403	1.706	6.376	2.560	20.2	0.470	0.00231	0.0	-3.0	2000	-60.0	70.6
11	0.055	0.058	2.400	1.919	6.240	2.571	20.5	0.487	0.00231	-1.0	-3.0	1999	-60.0	70.7
12	0.120	0.065	3.720	1.740	9.384	3.783	20.6	0.488	0.00231	-1.0	-3.0	2499	-60.0	70.7
13	0.246	0.078	5.309	1.228	12.680	5.252	20.5	0.483	0.00231	-1.0	-3.0	2999	-60.0	70.9
14	0.124	0.003	5.666	0.171	12.878	5.405	20.1	0.465	0.00231	-1.0	0.0	2999	-60.0	70.9
15	0.089	0.014	3.977	1.222	9.799	3.801	20.4	0.481	0.00231	-1.0	0.0	2500	-60.0	71.0
16	-0.030	-0.006	2.607	1.423	6.623	2.545	20.3	0.477	0.00231	-1.0	0.0	1999	-60.0	71.1
17	-0.049	0.002	2.567	1.751	6.379	2.569	20.3	0.477	0.00231	-3.0	0.0	2000	-60.0	71.1
18	0.035	0.013	3.900	1.415	9.568	3.794	20.4	0.478	0.00231	-3.0	0.0	2499	-60.0	71.1
19	0.171	0.015	5.482	0.592	12.800	5.325	20.7	0.492	0.00231	-3.0	0.0	2999	-60.0	71.1
20	0.238	0.081	5.231	1.453	12.363	5.216	20.4	0.480	0.00231	-3.0	-3.0	2999	-60.0	71.3
21	0.151	0.066	3.609	2.028	9.046	3.754	20.3	0.474	0.00231	-3.0	-3.0	2500	-60.0	71.3
22	0.043	0.054	2.286	2.105	6.028	2.567	20.4	0.481	0.00231	-3.0	-3.0	1999	-60.0	71.3
23	0.045	0.051	2.250	2.076	5.745	2.619	20.4	0.482	0.00231	-5.0	-3.0	2000	-60.0	71.3
24	0.098	0.063	3.610	2.079	8.624	3.844	20.7	0.492	0.00231	-5.0	-3.0	2499	-60.0	71.4
25	0.236	0.079	5.175	1.550	11.818	5.290	20.5	0.483	0.00231	-5.0	-3.0	2999	-60.0	71.5
26	0.138	0.029	5.406	1.218	12.458	5.247	20.4	0.480	0.00231	-5.0	0.0	2999	-60.0	71.5
27	0.036	0.016	3.777	1.902	9.298	3.762	20.5	0.484	0.00231	-5.0	0.0	2500	-60.0	71.6
28	-0.051	-0.000	2.452	2.021	6.176	2.559	20.4	0.479	0.00231	-5.0	0.0	2000	-60.0	71.6
29	-0.044	-0.010	2.317	2.042	5.467	2.676	20.3	0.475	0.00231	-10.0	0.0	1999	-60.0	71.6
30	0.053	-0.005	3.619	2.012	8.183	3.934	20.6	0.487	0.00231	-10.0	0.0	2499	-60.0	71.6
31	0.154	0.017	5.268	1.462	11.176	5.402	20.4	0.478	0.00230	-10.0	0.0	2999	-60.0	71.7
32	0.197	0.049	5.089	1.510	10.408	5.532	20.5	0.482	0.00230	-10.0	-3.0	3000	-60.0	71.8
34	0.102	0.039	3.462	1.944	7.540	4.005	20.5	0.484	0.00230	-10.0	-3.0	2500	-60.0	71.8
35	0.017	0.011	2.081	1.993	4.918	2.732	20.5	0.486	0.00230	-10.0	-3.0	1999	-60.0	71.9

Continued on next page

Table F.73: Testing conditions and rotor 2 loads in the hub coordinate system for run 126.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
36	0.040	-0.022	2.570	1.443	6.784	2.472	20.5	0.484	0.00230	0.0	0.0	2000	-60.0	72.0
37	0.034	-0.081	1.987	0.350	2.642	2.723	4.4	0.022	0.00230	0.0	0.0	2000	110.0	72.0
38	-0.000	0.000	-0.000	0.000	0.000	0.000	2.7	0.008	0.00230	0.0	0.0	0	-	72.0

Table F.74: Testing conditions and rotor 3 loads in the hub coordinate system for run 126.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.006	0.000	-0.005	0.000	-0.003	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	69.6
4	-0.203	-0.159	1.563	-1.627	0.343	3.015	5.5	0.035	0.00231	0.0	0.0	2000	-60.0	70.0
5	0.066	-0.006	1.644	1.565	4.472	3.004	20.5	0.487	0.00231	0.0	0.0	1999	-60.0	70.0
6	0.138	0.046	2.823	0.819	6.092	4.297	20.4	0.479	0.00231	0.0	0.0	2499	-60.0	70.2
7	0.165	0.072	4.325	-0.149	7.299	5.790	20.2	0.470	0.00231	0.0	0.0	2999	-60.0	70.3
8	0.315	0.082	4.207	0.703	7.004	5.881	20.3	0.478	0.00231	0.1	-3.0	2999	-60.0	70.4
9	0.247	0.055	2.713	1.090	5.465	4.329	20.4	0.481	0.00231	0.1	-3.0	2500	-60.0	70.6
10	0.173	0.018	1.592	1.533	3.819	3.014	20.2	0.470	0.00231	0.0	-3.0	2000	-60.0	70.6
11	0.181	0.024	1.598	1.538	3.908	3.024	20.5	0.487	0.00231	-1.0	-3.0	2000	-60.0	70.7
12	0.275	0.072	2.778	1.396	5.527	4.366	20.6	0.488	0.00231	-1.0	-3.0	2499	-60.0	70.7
13	0.358	0.118	4.247	0.971	7.114	5.908	20.5	0.483	0.00231	-1.0	-3.0	2999	-60.0	70.9
14	0.198	0.113	4.346	0.236	7.612	5.809	20.1	0.465	0.00231	-1.0	0.0	2999	-60.0	70.9
15	0.207	0.096	2.886	1.314	6.119	4.281	20.4	0.481	0.00231	-1.0	0.0	2500	-60.0	71.0
16	0.104	0.045	1.692	1.469	4.322	3.004	20.3	0.477	0.00231	-1.0	0.0	1999	-60.0	71.1
17	0.095	0.063	1.738	1.940	4.310	3.006	20.3	0.477	0.00231	-3.0	0.0	2000	-60.0	71.1
18	0.207	0.124	2.976	1.955	6.137	4.334	20.4	0.478	0.00231	-3.0	0.0	2499	-60.0	71.1
19	0.368	0.168	4.427	1.364	7.891	5.899	20.7	0.492	0.00231	-3.0	0.0	2999	-60.0	71.1
20	0.398	0.148	4.285	1.347	7.058	5.945	20.4	0.480	0.00231	-3.0	-3.0	2999	-60.0	71.3
21	0.328	0.110	2.777	1.679	5.433	4.359	20.3	0.474	0.00231	-3.0	-3.0	2500	-60.0	71.3
22	0.233	0.063	1.616	1.929	3.772	3.028	20.4	0.481	0.00231	-3.0	-3.0	2000	-60.0	71.3
23	0.244	0.076	1.628	2.139	3.773	3.032	20.4	0.482	0.00231	-5.0	-3.0	1999	-60.0	71.3
24	0.334	0.116	2.786	1.811	5.509	4.367	20.7	0.492	0.00231	-5.0	-3.0	2499	-60.0	71.4
25	0.417	0.147	4.213	1.036	6.958	5.943	20.5	0.483	0.00231	-5.0	-3.0	3000	-60.0	71.5
26	0.339	0.179	4.409	1.296	7.609	5.926	20.4	0.480	0.00231	-5.0	0.0	3000	-60.0	71.5
27	0.271	0.145	2.910	1.823	6.082	4.335	20.5	0.484	0.00231	-5.0	0.0	2500	-60.0	71.6
28	0.172	0.100	1.724	2.109	4.199	3.003	20.4	0.479	0.00231	-5.0	0.0	1999	-60.0	71.6
29	0.178	0.104	1.671	2.375	3.904	3.035	20.3	0.475	0.00231	-10.0	0.0	1999	-60.0	71.6
30	0.329	0.156	2.911	2.245	5.884	4.375	20.6	0.487	0.00231	-10.0	0.0	2499	-60.0	71.6
31	0.381	0.192	4.358	1.418	7.499	5.974	20.4	0.478	0.00230	-10.0	0.0	3000	-60.0	71.7
32	0.459	0.177	4.248	1.468	7.025	5.983	20.5	0.482	0.00230	-10.0	-3.0	2999	-60.0	71.8
34	0.373	0.150	2.799	2.309	5.284	4.376	20.5	0.484	0.00230	-10.0	-3.0	2500	-60.0	71.8
35	0.313	0.100	1.566	2.369	3.485	3.041	20.5	0.486	0.00230	-10.0	-3.0	2000	-60.0	71.9

Continued on next page

Table F.74: Testing conditions and rotor 3 loads in the hub coordinate system for run 126.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
36	0.335	0.091	1.656	1.297	4.280	2.980	20.5	0.484	0.00230	0.0	0.0	1999	-60.0	72.0
37	0.158	-0.035	1.541	-0.722	0.511	2.897	4.4	0.022	0.00230	0.0	0.0	2000	-60.0	72.0
38	-0.000	0.000	-0.000	0.000	0.000	0.000	2.7	0.008	0.00230	0.0	0.0	0	-	72.0

Table F.75: Testing conditions and rotor 4 loads in the hub coordinate system for run 126.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.005	0.000	0.021	0.000	-0.001	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	69.6
4	0.106	-0.468	1.247	2.860	-0.991	-1.859	5.5	0.035	0.00231	0.0	0.0	1999	0.0	70.0
5	0.321	-0.448	1.315	-1.095	3.823	-1.881	20.5	0.487	0.00231	0.0	0.0	1999	0.0	70.0
6	0.402	-0.467	2.493	-1.288	5.438	-3.052	20.4	0.479	0.00231	0.0	0.0	2499	0.0	70.2
7	0.457	-0.464	3.929	-0.059	6.292	-4.472	20.2	0.470	0.00231	0.0	0.0	3000	0.0	70.3
8	0.577	-0.409	3.541	-0.570	6.081	-4.549	20.3	0.478	0.00231	0.1	-3.0	3000	0.0	70.4
9	0.439	-0.402	2.135	-1.388	4.889	-3.102	20.4	0.481	0.00231	0.1	-3.0	2500	0.0	70.6
10	0.296	-0.387	1.062	-1.512	3.425	-1.879	20.2	0.470	0.00231	0.0	-3.0	2000	0.0	70.6
11	0.354	-0.384	1.136	-1.926	3.455	-1.896	20.5	0.487	0.00231	-1.0	-3.0	2000	0.0	70.7
12	0.484	-0.402	2.204	-1.971	4.878	-3.119	20.6	0.488	0.00231	-1.0	-3.0	2499	0.0	70.7
13	0.586	-0.407	3.575	-1.294	6.260	-4.579	20.5	0.483	0.00231	-1.0	-3.0	2999	0.0	70.9
14	0.404	-0.451	3.966	-0.417	6.579	-4.484	20.1	0.465	0.00231	-1.0	0.0	2999	0.0	70.9
15	0.398	-0.422	2.535	-1.426	5.523	-3.093	20.4	0.481	0.00231	-1.0	0.0	2500	0.0	71.0
16	0.249	-0.429	1.417	-1.699	3.933	-1.859	20.3	0.477	0.00231	-1.0	0.0	2000	0.0	71.1
17	0.238	-0.419	1.514	-1.987	3.903	-1.891	20.3	0.477	0.00231	-3.0	0.0	2000	0.0	71.1
18	0.390	-0.433	2.645	-2.158	5.529	-3.141	20.4	0.478	0.00231	-3.0	0.0	2500	0.0	71.1
19	0.609	-0.457	3.871	-1.523	6.970	-4.593	20.7	0.492	0.00231	-3.0	0.0	3000	0.0	71.1
20	0.594	-0.407	3.611	-1.887	6.328	-4.645	20.4	0.480	0.00231	-3.0	-3.0	2999	0.0	71.3
21	0.434	-0.414	2.168	-2.102	4.856	-3.135	20.3	0.474	0.00231	-3.0	-3.0	2500	0.0	71.3
22	0.341	-0.409	1.063	-1.972	3.401	-1.901	20.4	0.481	0.00231	-3.0	-3.0	2000	0.0	71.3
23	0.351	-0.406	1.074	-1.979	3.348	-1.913	20.4	0.482	0.00231	-5.0	-3.0	1999	0.0	71.3
24	0.508	-0.416	2.192	-1.967	4.993	-3.151	20.7	0.492	0.00231	-5.0	-3.0	2499	0.0	71.4
25	0.602	-0.410	3.519	-1.514	6.297	-4.650	20.5	0.483	0.00231	-5.0	-3.0	3000	0.0	71.5
26	0.533	-0.444	3.983	-1.694	6.997	-4.642	20.4	0.480	0.00231	-5.0	0.0	2999	0.0	71.5
27	0.409	-0.444	2.497	-1.940	5.546	-3.116	20.5	0.484	0.00231	-5.0	0.0	2500	0.0	71.6
28	0.253	-0.447	1.405	-1.917	3.837	-1.887	20.4	0.479	0.00231	-5.0	0.0	1999	0.0	71.6
29	0.266	-0.456	1.327	-2.010	3.506	-1.919	20.3	0.475	0.00231	-10.0	0.0	2000	0.0	71.6
30	0.473	-0.458	2.378	-2.179	5.221	-3.181	20.6	0.487	0.00231	-10.0	0.0	2499	0.0	71.6
31	0.554	-0.453	3.842	-1.540	6.858	-4.678	20.4	0.478	0.00230	-10.0	0.0	2999	0.0	71.7
32	0.612	-0.415	3.509	-1.577	6.204	-4.694	20.5	0.482	0.00230	-10.0	-3.0	3000	0.0	71.8
34	0.488	-0.413	2.153	-2.176	4.624	-3.194	20.5	0.484	0.00230	-10.0	-3.0	2500	0.0	71.8
35	0.385	-0.419	0.977	-2.101	2.991	-1.937	20.5	0.486	0.00230	-10.0	-3.0	2000	0.0	71.9

Continued on next page

Table F.75: Testing conditions and rotor 4 loads in the hub coordinate system for run 126.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
36	0.385	-0.444	1.179	-1.428	3.920	-1.834	20.5	0.484	0.00230	0.0	0.0	2000	0.0	72.0
37	0.240	-0.453	0.878	0.343	0.881	-1.835	4.4	0.022	0.00230	0.0	0.0	2000	0.0	72.0
38	-0.000	0.000	-0.000	0.000	0.000	0.000	2.7	0.008	0.00230	0.0	0.0	0	-	72.0

Run 127: 3-bladed Concept Quadrotor

Table F.76: Run 127 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-60

Table F.77: Testing conditions and rotor 1 loads in the hub coordinate system for run 127.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.016	0.000	-0.010	0.000	-0.006	0.000	0.1	0.000	0.00230	0.0	0.0	0	-	71.9
4	0.010	0.146	1.813	-0.885	0.389	-2.310	6.0	0.041	0.00230	0.0	0.0	1999	0.0	72.2
5	0.424	0.064	2.514	-1.584	6.786	-1.872	20.4	0.481	0.00230	0.0	0.0	1999	0.0	72.6
6	0.547	-0.024	3.320	-5.302	7.431	-1.975	40.8	1.905	0.00229	0.0	0.0	1999	0.0	74.1
7	0.752	0.006	5.065	-4.320	11.617	-3.138	40.6	1.891	0.00229	0.0	0.0	2499	0.0	74.2
9	1.268	-0.023	6.958	-3.333	17.018	-4.517	40.8	1.905	0.00229	0.1	0.0	2999	0.0	74.7
10	1.237	-0.062	6.535	-3.801	16.514	-4.641	40.9	1.916	0.00229	0.1	-3.0	2999	0.0	74.7
11	0.825	-0.051	4.653	-4.969	11.522	-3.245	40.7	1.897	0.00229	0.1	-3.0	2500	0.0	74.8
13	0.548	-0.041	3.007	-5.332	7.389	-2.106	40.8	1.904	0.00229	-0.0	-3.0	2000	0.0	75.3
14	0.538	-0.044	2.878	-5.397	7.365	-2.141	40.7	1.891	0.00229	-1.0	-3.0	2000	0.0	75.5
15	0.778	-0.059	4.476	-5.082	11.239	-3.318	40.9	1.910	0.00229	-1.0	-3.0	2499	0.0	75.5
17	1.197	-0.066	6.311	-4.149	15.989	-4.728	40.8	1.904	0.00229	-1.0	-3.0	2999	0.0	75.7
18	1.246	-0.025	6.751	-3.326	16.701	-4.549	40.7	1.892	0.00229	-1.0	0.0	2999	0.0	75.7
19	0.830	-0.011	4.831	-4.624	11.711	-3.202	40.8	1.900	0.00229	-1.0	0.0	2500	0.0	75.7
20	0.578	-0.013	3.196	-5.293	7.427	-2.057	40.9	1.912	0.00229	-1.0	0.0	2000	0.0	75.8
21	0.557	-0.012	3.010	-5.277	7.314	-2.123	40.7	1.897	0.00229	-3.0	0.0	2000	0.0	75.9
22	0.794	-0.009	4.603	-4.902	11.593	-3.269	41.0	1.919	0.00229	-3.0	0.0	2499	0.0	76.0
24	1.200	-0.024	6.401	-3.847	16.135	-4.689	40.8	1.897	0.00228	-3.0	0.0	3000	0.0	76.1
25	1.156	-0.076	6.051	-4.675	15.427	-4.707	40.9	1.910	0.00228	-3.0	-3.0	2999	0.0	76.1
26	0.781	-0.063	4.211	-5.275	10.841	-3.299	40.7	1.893	0.00228	-3.0	-3.0	2500	0.0	76.1
27	0.523	-0.050	2.674	-5.463	7.237	-2.197	40.9	1.906	0.00228	-3.0	-3.0	2000	0.0	76.7
28	0.506	-0.049	2.510	-5.239	6.944	-2.238	40.8	1.899	0.00228	-5.0	-3.0	1999	0.0	76.8
29	0.729	-0.064	4.087	-5.222	10.381	-3.356	40.7	1.888	0.00228	-5.0	-3.0	2499	0.0	76.9
31	1.097	-0.040	5.824	-4.502	14.635	-4.763	40.7	1.890	0.00228	-5.0	-3.0	2999	0.0	77.0
33	1.181	-0.016	6.143	-4.549	15.652	-4.688	40.8	1.899	0.00228	-5.0	0.0	2999	0.0	77.2
34	0.788	-0.006	4.325	-5.340	11.110	-3.305	40.7	1.884	0.00228	-5.0	0.0	2500	0.0	77.2
35	0.528	0.020	2.796	-5.481	7.306	-2.177	40.9	1.910	0.00228	-5.0	0.0	2000	0.0	77.6
36	0.491	0.024	2.368	-5.117	6.537	-2.281	40.9	1.908	0.00228	-10.0	0.0	2000	0.0	77.8
37	0.698	-0.010	3.886	-5.088	9.843	-3.459	40.9	1.909	0.00228	-10.0	0.0	2499	0.0	77.8
38	1.043	0.007	5.716	-4.778	14.204	-4.893	41.0	1.918	0.00228	-10.0	0.0	2999	0.0	77.9
39	0.948	-0.004	5.370	-4.582	12.887	-5.092	40.9	1.903	0.00228	-10.0	-3.0	2999	0.0	77.9
40	0.614	-0.002	3.532	-4.771	8.736	-3.614	40.9	1.903	0.00228	-10.0	-3.0	2500	0.0	78.0

Continued on next page

Table F.77: Testing conditions and rotor 1 loads in the hub coordinate system for run 127.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
41	0.419	0.017	2.108	-4.742	5.849	-2.380	40.8	1.890	0.00228	-10.0	-3.0	2000	0.0	78.3
42	0.407	0.125	2.530	-1.561	7.024	-1.937	20.6	0.484	0.00228	-0.0	0.0	2000	0.0	78.4
43	0.075	0.208	1.790	-0.649	2.651	-2.321	3.9	0.017	0.00228	0.0	0.0	1999	0.0	78.3
45	0.004	0.000	-0.008	0.000	0.006	0.000	1.4	0.002	0.00228	-0.0	0.0	0	-	78.2

Table F.78: Testing conditions and rotor 2 loads in the hub coordinate system for run 127.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.010	0.000	0.005	0.000	-0.013	0.000	0.1	0.000	0.00230	0.0	0.0	0	-	71.9
4	-0.078	-0.019	1.861	1.037	0.517	2.906	6.0	0.041	0.00230	0.0	0.0	1999	-60.0	72.2
5	-0.009	0.054	2.657	1.546	6.642	2.551	20.4	0.481	0.00230	0.0	0.0	1999	-60.0	72.6
6	0.088	0.124	3.329	5.040	7.573	2.581	40.8	1.905	0.00229	0.0	0.0	1999	-60.0	74.1
7	0.200	0.142	5.055	4.073	12.004	3.736	40.6	1.891	0.00229	0.0	0.0	2499	-60.0	74.2
9	0.452	0.175	7.039	2.386	17.504	5.131	40.8	1.905	0.00229	0.1	0.0	2999	-60.0	74.7
10	0.438	0.232	6.587	3.222	16.508	5.273	40.9	1.916	0.00229	0.1	-3.0	2999	-60.0	74.7
11	0.263	0.197	4.692	4.505	11.651	3.828	40.7	1.897	0.00229	0.1	-3.0	2500	-60.0	74.8
13	0.138	0.183	3.098	4.996	7.545	2.604	40.8	1.904	0.00229	-0.0	-3.0	2000	-60.0	75.3
14	0.148	0.181	2.974	4.989	7.441	2.641	40.7	1.891	0.00229	-1.0	-3.0	2000	-60.0	75.5
15	0.257	0.199	4.582	4.676	11.541	3.823	40.9	1.910	0.00229	-1.0	-3.0	2499	-60.0	75.5
17	0.449	0.232	6.451	3.262	16.303	5.268	40.8	1.904	0.00229	-1.0	-3.0	3000	-60.0	75.7
18	0.470	0.164	6.787	2.359	16.918	5.149	40.7	1.892	0.00229	-1.0	0.0	3000	-60.0	75.7
19	0.250	0.125	4.921	4.276	12.085	3.731	40.8	1.900	0.00229	-1.0	0.0	2500	-60.0	75.7
20	0.143	0.113	3.220	5.036	7.625	2.574	40.9	1.912	0.00229	-1.0	0.0	1999	-60.0	75.8
21	0.155	0.114	3.016	5.108	7.494	2.620	40.7	1.897	0.00229	-3.0	0.0	2000	-60.0	75.9
22	0.248	0.120	4.672	4.766	11.905	3.775	41.0	1.919	0.00229	-3.0	0.0	2499	-60.0	76.0
24	0.457	0.154	6.499	3.035	16.526	5.242	40.8	1.897	0.00228	-3.0	0.0	3000	-60.0	76.1
25	0.451	0.219	6.192	3.842	15.551	5.195	40.9	1.910	0.00228	-3.0	-3.0	2999	-60.0	76.1
26	0.295	0.187	4.297	4.902	10.905	3.796	40.7	1.893	0.00228	-3.0	-3.0	2500	-60.0	76.1
27	0.148	0.154	2.755	5.045	7.216	2.640	40.9	1.906	0.00228	-3.0	-3.0	2000	-60.0	76.7
28	0.155	0.146	2.584	4.927	6.927	2.667	40.8	1.899	0.00228	-5.0	-3.0	2000	-60.0	76.8
29	0.284	0.180	4.144	4.731	10.202	3.850	40.7	1.888	0.00228	-5.0	-3.0	2499	-60.0	76.9
31	0.442	0.199	5.949	3.874	14.664	5.311	40.7	1.890	0.00228	-5.0	-3.0	2999	-60.0	77.0
33	0.452	0.166	6.215	3.915	15.684	5.203	40.8	1.899	0.00228	-5.0	0.0	2999	-60.0	77.2
34	0.280	0.114	4.412	4.900	11.254	3.804	40.7	1.884	0.00228	-5.0	0.0	2500	-60.0	77.2
35	0.164	0.094	2.875	5.104	7.319	2.638	40.9	1.910	0.00228	-5.0	0.0	2000	-60.0	77.6
36	0.174	0.071	2.436	4.835	6.406	2.732	40.9	1.908	0.00228	-10.0	0.0	1999	-60.0	77.8
37	0.258	0.094	3.964	4.745	9.704	3.962	40.9	1.909	0.00228	-10.0	0.0	2499	-60.0	77.8
38	0.409	0.105	5.810	3.967	14.103	5.432	41.0	1.918	0.00228	-10.0	0.0	2999	-60.0	77.9
39	0.373	0.120	5.486	3.846	12.677	5.561	40.9	1.903	0.00228	-10.0	-3.0	2999	-60.0	77.9
40	0.248	0.099	3.691	4.440	8.746	4.043	40.9	1.903	0.00228	-10.0	-3.0	2500	-60.0	78.0

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Table F.78: Testing conditions and rotor 2 loads in the hub coordinate system for run 127.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
41	0.155	0.091	2.198	4.552	5.791	2.765	40.8	1.890	0.00228	-10.0	-3.0	2000	-60.0	78.3
42	0.107	-0.001	2.575	1.338	6.529	2.407	20.6	0.484	0.00228	-0.0	0.0	2000	-60.0	78.4
43	0.059	-0.072	1.890	0.616	2.124	2.729	3.9	0.017	0.00228	0.0	0.0	2000	130.0	78.3
45	0.009	0.000	0.013	0.000	-0.003	0.000	1.4	0.002	0.00228	-0.0	0.0	0	-	78.2

Table F.79: Testing conditions and rotor 3 loads in the hub coordinate system for run 127.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.007	0.000	-0.004	0.000	-0.000	0.000	0.1	0.000	0.00230	0.0	0.0	0	-	71.9
4	-0.205	-0.165	1.583	-1.540	-0.083	3.022	6.0	0.041	0.00230	0.0	0.0	1999	-60.0	72.2
5	0.050	0.018	1.609	1.619	4.413	3.006	20.4	0.481	0.00230	0.0	0.0	1999	-60.0	72.6
6	0.480	0.334	2.220	5.835	6.517	2.978	40.8	1.905	0.00229	0.0	0.0	1999	-60.0	74.1
7	0.626	0.361	3.380	4.500	9.215	4.316	40.6	1.891	0.00229	0.0	0.0	2499	-60.0	74.2
9	0.779	0.380	4.782	2.781	12.331	5.931	40.8	1.905	0.00229	0.1	0.0	3000	-60.0	74.7
10	0.767	0.381	4.579	3.750	11.234	6.020	40.9	1.916	0.00229	0.1	-3.0	3000	-60.0	74.7
11	0.637	0.329	3.128	4.511	8.441	4.421	40.7	1.897	0.00229	0.1	-3.0	2500	-60.0	74.8
13	0.562	0.347	1.997	5.622	5.766	3.068	40.8	1.904	0.00229	-0.0	-3.0	1999	-60.0	75.3
14	0.565	0.347	2.003	5.791	5.628	3.079	40.7	1.891	0.00229	-1.0	-3.0	1999	-60.0	75.5
15	0.701	0.382	3.140	5.263	8.240	4.433	40.9	1.910	0.00229	-1.0	-3.0	2499	-60.0	75.5
17	0.827	0.423	4.554	4.335	10.991	6.022	40.8	1.904	0.00229	-1.0	-3.0	3000	-60.0	75.7
18	0.839	0.417	4.829	3.320	12.297	5.938	40.7	1.892	0.00229	-1.0	0.0	3000	-60.0	75.7
19	0.725	0.409	3.424	5.149	9.334	4.333	40.8	1.900	0.00229	-1.0	0.0	2500	-60.0	75.7
20	0.582	0.367	2.192	5.746	6.343	2.979	40.9	1.912	0.00229	-1.0	0.0	2000	-60.0	75.8
21	0.592	0.377	2.165	6.056	6.111	3.004	40.7	1.897	0.00229	-3.0	0.0	2000	-60.0	75.9
22	0.782	0.455	3.468	5.907	9.245	4.335	41.0	1.919	0.00229	-3.0	0.0	2499	-60.0	76.0
24	0.910	0.491	4.936	4.822	12.362	5.954	40.8	1.897	0.00228	-3.0	0.0	2999	-60.0	76.1
25	0.885	0.461	4.623	5.116	11.081	6.041	40.9	1.910	0.00228	-3.0	-3.0	2999	-60.0	76.1
26	0.735	0.382	3.137	5.511	8.094	4.448	40.7	1.893	0.00228	-3.0	-3.0	2500	-60.0	76.1
27	0.641	0.352	1.930	5.874	5.352	3.099	40.9	1.906	0.00228	-3.0	-3.0	1999	-60.0	76.7
28	0.638	0.335	1.852	5.809	5.160	3.115	40.8	1.899	0.00228	-5.0	-3.0	1999	-60.0	76.8
29	0.777	0.408	3.141	5.893	7.931	4.432	40.7	1.888	0.00228	-5.0	-3.0	2500	-60.0	76.9
31	0.902	0.462	4.506	5.276	10.640	6.035	40.7	1.890	0.00228	-5.0	-3.0	2999	-60.0	77.0
33	0.925	0.499	4.922	5.122	12.255	5.953	40.8	1.899	0.00228	-5.0	0.0	2999	-60.0	77.2
34	0.776	0.430	3.384	5.735	8.864	4.352	40.7	1.884	0.00228	-5.0	0.0	2500	-60.0	77.2
35	0.662	0.376	2.104	6.001	5.862	3.030	40.9	1.910	0.00228	-5.0	0.0	2000	-60.0	77.6
36	0.652	0.338	1.856	5.666	5.081	3.116	40.9	1.908	0.00228	-10.0	0.0	1999	-60.0	77.8
37	0.794	0.408	3.142	5.894	7.961	4.432	40.9	1.909	0.00228	-10.0	0.0	2499	-60.0	77.8
38	0.968	0.497	4.696	5.366	11.218	6.010	41.0	1.918	0.00228	-10.0	0.0	2999	-60.0	77.9
39	0.919	0.465	4.317	5.406	9.891	6.041	40.9	1.903	0.00228	-10.0	-3.0	2999	-60.0	77.9
40	0.752	0.363	2.769	5.724	6.839	4.449	40.9	1.903	0.00228	-10.0	-3.0	2500	-60.0	78.0

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Table F.79: Testing conditions and rotor 3 loads in the hub coordinate system for run 127.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
41	0.632	0.294	1.595	5.337	4.417	3.116	40.8	1.890	0.00228	-10.0	-3.0	2000	-60.0	78.3
42	0.419	0.128	1.622	0.993	4.123	2.932	20.6	0.484	0.00228	-0.0	0.0	2000	-60.0	78.4
43	0.201	0.014	1.548	-0.014	0.694	2.945	3.9	0.017	0.00228	0.0	0.0	1999	130.0	78.3
45	-0.019	0.000	0.002	0.000	0.022	0.000	1.4	0.002	0.00228	-0.0	0.0	0	-	78.2

Table F.80: Testing conditions and rotor 4 loads in the hub coordinate system for run 127.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.005	0.000	0.019	0.000	-0.000	0.000	0.1	0.000	0.00230	0.0	0.0	0	-	71.9
4	0.092	-0.476	1.171	2.131	-1.022	-1.871	6.0	0.041	0.00230	0.0	0.0	1999	0.0	72.2
5	0.263	-0.429	1.331	-1.207	3.908	-1.880	20.4	0.481	0.00230	0.0	0.0	1999	0.0	72.6
6	0.566	-0.396	1.734	-6.054	5.570	-1.850	40.8	1.905	0.00229	0.0	0.0	1999	0.0	74.1
7	0.813	-0.415	2.901	-5.630	8.602	-3.081	40.6	1.891	0.00229	0.0	0.0	2500	0.0	74.2
9	0.993	-0.424	4.175	-3.955	11.478	-4.583	40.8	1.905	0.00229	0.1	0.0	3000	0.0	74.7
10	0.937	-0.383	3.921	-4.920	10.362	-4.659	40.9	1.916	0.00229	0.1	-3.0	3000	0.0	74.7
11	0.735	-0.394	2.584	-5.719	7.785	-3.176	40.7	1.897	0.00229	0.1	-3.0	2500	0.0	74.8
13	0.573	-0.362	1.466	-5.729	4.979	-1.947	40.8	1.904	0.00229	-0.0	-3.0	1999	0.0	75.3
14	0.561	-0.370	1.432	-5.778	4.876	-1.975	40.7	1.891	0.00229	-1.0	-3.0	1999	0.0	75.5
15	0.768	-0.395	2.566	-5.899	7.616	-3.205	40.9	1.910	0.00229	-1.0	-3.0	2499	0.0	75.5
17	0.964	-0.392	3.896	-5.277	10.262	-4.683	40.8	1.904	0.00229	-1.0	-3.0	3000	0.0	75.7
18	1.044	-0.431	4.182	-4.763	11.605	-4.604	40.7	1.892	0.00229	-1.0	0.0	2999	0.0	75.7
19	0.843	-0.447	2.803	-5.795	8.448	-3.102	40.8	1.900	0.00229	-1.0	0.0	2500	0.0	75.7
20	0.610	-0.419	1.678	-5.999	5.567	-1.883	40.9	1.912	0.00229	-1.0	0.0	2000	0.0	75.8
21	0.615	-0.431	1.604	-6.010	5.347	-1.915	40.7	1.897	0.00229	-3.0	0.0	2000	0.0	75.9
22	0.832	-0.459	2.801	-5.997	8.254	-3.117	41.0	1.919	0.00229	-3.0	0.0	2499	0.0	76.0
24	1.050	-0.460	4.208	-5.718	11.548	-4.625	40.8	1.897	0.00228	-3.0	0.0	3000	0.0	76.1
25	0.953	-0.404	3.912	-5.892	10.211	-4.701	40.9	1.910	0.00228	-3.0	-3.0	3000	0.0	76.1
26	0.726	-0.419	2.478	-5.983	7.316	-3.212	40.7	1.893	0.00228	-3.0	-3.0	2500	0.0	76.1
27	0.570	-0.400	1.343	-5.947	4.754	-1.975	40.9	1.906	0.00228	-3.0	-3.0	1999	0.0	76.7
28	0.542	-0.397	1.236	-5.652	4.497	-1.988	40.8	1.899	0.00228	-5.0	-3.0	2000	0.0	76.8
29	0.747	-0.401	2.458	-6.229	7.143	-3.227	40.7	1.888	0.00228	-5.0	-3.0	2500	0.0	76.9
31	0.942	-0.406	3.819	-6.003	9.928	-4.693	40.7	1.890	0.00228	-5.0	-3.0	2999	0.0	77.0
33	1.038	-0.434	4.167	-5.927	11.215	-4.643	40.8	1.899	0.00228	-5.0	0.0	3000	0.0	77.2
34	0.836	-0.448	2.676	-6.043	7.872	-3.138	40.7	1.884	0.00228	-5.0	0.0	2500	0.0	77.2
35	0.593	-0.416	1.508	-5.882	5.082	-1.914	40.9	1.910	0.00228	-5.0	0.0	2000	0.0	77.6
36	0.534	-0.378	1.180	-5.221	4.296	-1.989	40.9	1.908	0.00228	-10.0	0.0	2000	0.0	77.8
37	0.747	-0.419	2.445	-6.112	7.147	-3.216	40.9	1.909	0.00228	-10.0	0.0	2499	0.0	77.8
38	0.945	-0.439	3.861	-5.719	10.055	-4.693	41.0	1.918	0.00228	-10.0	0.0	3000	0.0	77.9
39	0.863	-0.388	3.537	-5.831	8.962	-4.683	40.9	1.903	0.00228	-10.0	-3.0	2999	0.0	77.9
40	0.670	-0.384	2.098	-5.842	6.259	-3.201	40.9	1.903	0.00228	-10.0	-3.0	2500	0.0	78.0

Continued on next page

Table F.80: Testing conditions and rotor 4 loads in the hub coordinate system for run 127.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
41	0.503	-0.358	0.938	-4.811	3.702	-1.971	40.8	1.890	0.00228	-10.0	-3.0	2000	0.0	78.3
42	0.369	-0.425	1.064	-1.117	3.705	-1.803	20.6	0.484	0.00228	-0.0	0.0	2000	0.0	78.4
43	0.205	-0.437	0.981	1.214	-0.039	-1.834	3.9	0.017	0.00228	0.0	0.0	1999	0.0	78.3
45	0.008	0.000	0.002	0.000	0.013	0.000	1.4	0.002	0.00228	-0.0	0.0	0	-	78.2

Run 128: 3-bladed Concept Quadrotor

Table F.81: Run 128 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	3
RPM	2000, 2500
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	0

Table F.82: Testing conditions and rotor 1 loads in the hub coordinate system for run 128.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.008	0.000	-0.009	0.000	-0.002	0.000	0.6	0.000	0.00226	-0.0	0.0	0	-	82.0
4	0.073	0.150	2.469	-2.095	1.131	-3.403	5.9	0.040	0.00226	0.0	0.0	1999	0.0	82.1
5	0.621	0.061	3.332	-1.991	10.197	-2.852	20.7	0.481	0.00226	0.0	0.0	2000	0.0	82.8
6	0.871	0.028	4.989	-1.435	14.502	-4.546	20.6	0.479	0.00226	0.0	0.0	2499	0.0	82.9
7	0.848	-0.011	4.836	-1.832	13.738	-4.619	20.9	0.491	0.00226	0.0	-3.0	2499	0.0	83.0
8	0.597	0.006	3.199	-2.063	9.517	-2.936	20.7	0.484	0.00225	0.0	-3.0	2000	0.0	83.1
9	0.574	0.008	3.162	-2.109	9.354	-2.941	20.9	0.493	0.00225	-1.0	-3.0	2000	0.0	83.2
10	0.809	-0.013	4.784	-1.950	13.441	-4.632	20.9	0.492	0.00225	-1.0	-3.0	2499	0.0	83.2
11	0.859	0.023	4.945	-1.614	14.278	-4.586	20.8	0.487	0.00225	-1.0	0.0	2499	0.0	83.3
12	0.615	0.031	3.283	-1.970	9.983	-2.887	20.6	0.477	0.00225	-1.0	0.0	2000	0.0	83.3
13	0.573	0.031	3.206	-2.095	9.516	-2.933	20.8	0.489	0.00225	-3.0	0.0	2000	0.0	83.4
14	0.809	0.017	4.830	-1.835	13.662	-4.635	20.8	0.487	0.00225	-3.0	0.0	2499	0.0	83.4
15	0.769	-0.017	4.625	-2.231	12.615	-4.604	20.7	0.481	0.00225	-3.0	-3.0	2499	0.0	83.6
16	0.534	-0.006	3.069	-2.220	8.820	-2.955	20.4	0.468	0.00225	-3.0	-3.0	2000	0.0	83.6
17	0.495	-0.010	2.988	-2.565	8.469	-2.949	20.8	0.487	0.00225	-5.0	-3.0	2000	0.0	83.6
19	0.726	-0.025	4.537	-2.612	12.205	-4.579	20.8	0.487	0.00225	-5.0	-3.0	2499	0.0	83.7
20	0.778	0.019	4.675	-2.091	12.855	-4.627	20.6	0.479	0.00225	-5.0	0.0	2499	0.0	83.7
21	0.516	0.038	3.106	-2.244	9.035	-2.956	20.8	0.488	0.00225	-5.0	0.0	2000	0.0	83.7
23	0.464	0.039	2.864	-2.707	7.871	-2.993	20.5	0.473	0.00225	-10.0	0.0	2000	0.0	83.7
24	0.671	0.012	4.429	-2.920	11.702	-4.583	20.8	0.487	0.00225	-10.0	0.0	2499	0.0	83.7
25	0.646	-0.017	4.357	-2.790	10.759	-4.720	20.7	0.482	0.00225	-10.0	-3.0	2499	0.0	83.7
27	0.409	0.006	2.797	-2.640	7.320	-3.119	20.9	0.490	0.00225	-10.0	-3.0	2000	0.0	83.7
28	0.619	-0.077	3.068	-5.525	8.935	-3.388	41.1	1.902	0.00225	-10.0	-3.0	2000	0.0	84.2
29	0.942	-0.105	4.903	-5.296	13.812	-5.036	41.2	1.905	0.00225	-10.0	-3.0	2499	0.0	84.3
30	1.047	-0.090	5.170	-5.436	15.124	-4.879	41.2	1.904	0.00225	-10.0	0.0	2499	0.0	84.4
32	0.705	-0.075	3.399	-5.710	9.996	-3.236	41.2	1.906	0.00225	-10.0	0.0	2000	0.0	84.4
33	0.783	-0.071	3.903	-5.451	11.695	-3.051	41.0	1.888	0.00225	-5.0	0.0	2000	0.0	84.5
35	1.203	-0.098	5.837	-4.593	17.428	-4.618	41.1	1.898	0.00225	-5.1	0.0	2499	0.0	84.6
36	1.126	-0.142	5.351	-5.447	16.132	-4.754	41.1	1.900	0.00225	-5.0	-3.0	2499	0.0	84.7
38	0.760	-0.127	3.530	-5.792	10.765	-3.172	41.1	1.894	0.00225	-5.0	-3.0	2000	0.0	84.6
39	0.800	-0.124	3.829	-5.693	11.607	-3.082	41.2	1.908	0.00225	-3.0	-3.0	2000	0.0	84.6
40	1.175	-0.142	5.594	-4.897	16.997	-4.694	41.2	1.904	0.00225	-3.0	-3.0	2499	0.0	84.8

Continued on next page

Table F.82: Testing conditions and rotor 1 loads in the hub coordinate system for run 128.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
41	1.260	-0.099	6.046	-4.387	18.150	-4.553	41.0	1.884	0.00225	-3.0	0.0	2499	0.0	84.8
43	0.860	-0.065	4.093	-5.516	12.326	-3.018	41.2	1.905	0.00225	-3.0	0.0	2000	0.0	84.9
45	0.879	-0.059	4.430	-5.501	12.584	-2.967	41.1	1.900	0.00225	-1.0	0.0	2000	0.0	85.0
46	1.308	-0.110	6.426	-4.565	19.387	-4.464	41.2	1.907	0.00225	-1.0	0.0	2499	0.0	85.0
47	1.251	-0.129	5.894	-4.338	17.709	-4.601	41.1	1.893	0.00224	-1.0	-3.0	2499	0.0	85.2
48	0.869	-0.102	4.000	-5.376	12.021	-3.051	41.2	1.903	0.00224	-1.0	-3.0	2000	0.0	85.2
49	0.862	-0.115	4.088	-5.661	12.345	-3.034	41.2	1.906	0.00224	-0.0	-3.0	2000	0.0	85.4
50	1.277	-0.131	6.074	-4.449	18.386	-4.552	41.2	1.903	0.00224	0.0	-3.0	2499	0.0	85.5
51	1.358	-0.088	6.549	-4.337	19.549	-4.446	41.2	1.901	0.00224	0.0	0.0	2499	0.0	85.7
52	0.897	-0.042	4.555	-5.506	12.631	-2.933	41.2	1.902	0.00224	0.0	0.0	2000	0.0	85.7
53	0.602	0.078	3.209	-1.989	10.418	-2.905	20.7	0.480	0.00224	0.0	0.0	2000	0.0	85.8
54	0.115	0.208	2.324	-0.816	3.236	-3.300	3.6	0.014	0.00224	0.0	0.0	2000	0.0	85.6
55	0.006	0.000	-0.008	0.000	0.007	0.000	1.8	0.003	0.00224	0.1	0.0	0	-	85.6

Table F.83: Testing conditions and rotor 2 loads in the hub coordinate system for run 128.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.003	0.000	0.008	0.000	-0.009	0.000	0.6	0.000	0.00226	-0.0	0.0	0	-	82.0
4	-0.049	-0.023	2.587	2.724	1.383	4.055	5.9	0.040	0.00226	0.0	0.0	2000	0.0	82.1
5	0.081	0.102	3.491	2.041	10.463	3.727	20.7	0.481	0.00226	0.0	0.0	1999	0.0	82.8
6	0.151	0.122	5.232	1.285	14.855	5.547	20.6	0.479	0.00226	0.0	0.0	2499	0.0	82.9
7	0.182	0.168	5.049	1.840	13.969	5.569	20.9	0.491	0.00226	0.0	-3.0	2500	0.0	83.0
8	0.107	0.140	3.308	2.211	9.676	3.742	20.7	0.484	0.00225	0.0	-3.0	2000	0.0	83.1
9	0.070	0.138	3.275	2.305	9.507	3.749	20.9	0.493	0.00225	-1.0	-3.0	2000	0.0	83.2
10	0.165	0.167	4.980	2.021	13.586	5.558	20.9	0.492	0.00225	-1.0	-3.0	2500	0.0	83.2
11	0.187	0.108	5.137	1.515	14.498	5.579	20.8	0.487	0.00225	-1.0	0.0	2499	0.0	83.3
12	0.078	0.080	3.431	2.164	10.152	3.738	20.6	0.477	0.00225	-1.0	0.0	2000	0.0	83.3
13	0.082	0.081	3.317	2.253	9.694	3.767	20.8	0.489	0.00225	-3.0	0.0	2000	0.0	83.4
14	0.154	0.109	5.025	1.885	13.865	5.596	20.8	0.487	0.00225	-3.0	0.0	2499	0.0	83.4
15	0.184	0.167	4.821	2.198	12.930	5.503	20.7	0.481	0.00225	-3.0	-3.0	2499	0.0	83.6
16	0.105	0.137	3.122	2.460	8.912	3.727	20.4	0.468	0.00225	-3.0	-3.0	1999	0.0	83.6
17	0.066	0.142	3.083	2.775	8.574	3.722	20.8	0.487	0.00225	-5.0	-3.0	1999	0.0	83.6
19	0.167	0.180	4.722	2.619	12.511	5.442	20.8	0.487	0.00225	-5.0	-3.0	2499	0.0	83.7
20	0.132	0.112	4.957	2.067	13.252	5.545	20.6	0.479	0.00225	-5.0	0.0	2499	0.0	83.7
21	0.069	0.084	3.253	2.360	9.254	3.752	20.8	0.488	0.00225	-5.0	0.0	2000	0.0	83.7
23	0.035	0.075	3.075	2.819	8.018	3.763	20.5	0.473	0.00225	-10.0	0.0	1999	0.0	83.7
24	0.162	0.116	4.654	2.870	11.992	5.448	20.8	0.487	0.00225	-10.0	0.0	2499	0.0	83.7
25	0.161	0.162	4.573	2.755	11.005	5.541	20.7	0.482	0.00225	-10.0	-3.0	2499	0.0	83.7
27	0.067	0.111	2.951	2.689	7.399	3.846	20.9	0.490	0.00225	-10.0	-3.0	2000	0.0	83.7
28	0.181	0.139	3.147	5.223	8.989	4.047	41.1	1.902	0.00225	-10.0	-3.0	2000	0.0	84.2
29	0.332	0.191	4.989	5.083	13.464	5.852	41.2	1.905	0.00225	-10.0	-3.0	2499	0.0	84.3
30	0.388	0.161	5.348	4.974	15.255	5.696	41.2	1.904	0.00225	-10.0	0.0	2499	0.0	84.4
32	0.261	0.139	3.403	5.649	9.816	3.981	41.2	1.906	0.00225	-10.0	0.0	1999	0.0	84.4
33	0.296	0.164	3.946	5.454	11.858	3.737	41.0	1.888	0.00225	-5.0	0.0	1999	0.0	84.5
35	0.477	0.201	5.972	4.130	17.598	5.417	41.1	1.898	0.00225	-5.1	0.0	2499	0.0	84.6
36	0.439	0.259	5.539	5.185	16.107	5.525	41.1	1.900	0.00225	-5.0	-3.0	2499	0.0	84.7
38	0.308	0.213	3.631	5.514	10.736	3.802	41.1	1.894	0.00225	-5.0	-3.0	2000	0.0	84.6
39	0.307	0.224	3.852	5.760	11.524	3.730	41.2	1.908	0.00225	-3.0	-3.0	2000	0.0	84.6
40	0.469	0.262	5.832	4.624	17.468	5.411	41.2	1.904	0.00225	-3.0	-3.0	2500	0.0	84.8

Continued on next page

Table F.83: Testing conditions and rotor 2 loads in the hub coordinate system for run 128.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
41	0.509	0.204	6.208	3.764	18.553	5.316	41.0	1.884	0.00225	-3.0	0.0	2499	0.0	84.8
43	0.327	0.153	4.237	4.976	12.574	3.633	41.2	1.905	0.00225	-3.0	0.0	2000	0.0	84.9
45	0.329	0.159	4.463	5.085	12.844	3.597	41.1	1.900	0.00225	-1.0	0.0	1999	0.0	85.0
46	0.500	0.207	6.498	3.642	19.288	5.227	41.2	1.907	0.00225	-1.0	0.0	2500	0.0	85.0
47	0.484	0.258	6.031	4.019	17.911	5.336	41.1	1.893	0.00224	-1.0	-3.0	2499	0.0	85.2
48	0.351	0.210	4.042	5.201	12.135	3.645	41.2	1.903	0.00224	-1.0	-3.0	1999	0.0	85.2
49	0.334	0.220	4.183	5.036	12.375	3.617	41.2	1.906	0.00224	-0.0	-3.0	1999	0.0	85.4
50	0.504	0.266	6.208	3.854	18.561	5.286	41.2	1.903	0.00224	0.0	-3.0	2499	0.0	85.5
51	0.522	0.213	6.693	3.360	19.885	5.208	41.2	1.901	0.00224	0.0	0.0	2499	0.0	85.7
52	0.347	0.168	4.671	4.687	12.924	3.538	41.2	1.902	0.00224	0.0	0.0	2000	0.0	85.7
53	0.189	0.071	3.394	1.933	10.250	3.576	20.7	0.480	0.00224	0.0	0.0	2000	0.0	85.8
54	0.071	-0.052	2.554	0.949	3.078	3.864	3.6	0.014	0.00224	0.0	0.0	2000	0.0	85.6
55	0.012	0.000	0.015	0.000	-0.003	0.000	1.8	0.003	0.00224	0.1	0.0	0	-	85.6

Table F.84: Testing conditions and rotor 3 loads in the hub coordinate system for run 128.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.011	0.000	-0.002	0.000	0.008	0.000	0.6	0.000	0.00226	-0.0	0.0	0	-	82.0
4	-0.019	-0.118	2.305	-2.364	0.121	4.168	5.9	0.040	0.00226	0.0	0.0	1999	0.0	82.1
5	0.100	0.092	2.169	1.382	6.166	4.086	20.7	0.481	0.00226	0.0	0.0	1999	0.0	82.8
6	0.160	0.129	3.547	0.592	7.927	5.801	20.6	0.479	0.00226	0.0	0.0	2500	0.0	82.9
7	0.206	0.161	3.518	1.624	7.508	5.867	20.9	0.491	0.00226	0.0	-3.0	2499	0.0	83.0
8	0.127	0.117	2.133	2.206	5.534	4.095	20.7	0.484	0.00225	0.0	-3.0	2000	0.0	83.1
9	0.138	0.111	2.166	2.646	5.613	4.132	20.9	0.493	0.00225	-1.0	-3.0	2000	0.0	83.2
10	0.234	0.175	3.616	2.494	7.608	5.918	20.9	0.492	0.00225	-1.0	-3.0	2499	0.0	83.2
11	0.227	0.156	3.603	1.173	8.186	5.821	20.8	0.487	0.00225	-1.0	0.0	2499	0.0	83.3
12	0.108	0.120	2.219	2.073	6.213	4.077	20.6	0.477	0.00225	-1.0	0.0	1999	0.0	83.3
13	0.158	0.134	2.284	2.803	6.243	4.121	20.8	0.489	0.00225	-3.0	0.0	1999	0.0	83.4
14	0.267	0.205	3.757	2.674	8.399	5.931	20.8	0.487	0.00225	-3.0	0.0	2500	0.0	83.4
15	0.269	0.187	3.635	2.538	7.636	5.974	20.7	0.481	0.00225	-3.0	-3.0	2499	0.0	83.6
16	0.168	0.119	2.167	2.607	5.503	4.131	20.4	0.468	0.00225	-3.0	-3.0	2000	0.0	83.6
17	0.169	0.106	2.144	2.762	5.451	4.151	20.8	0.487	0.00225	-5.0	-3.0	1999	0.0	83.6
19	0.284	0.153	3.561	1.911	7.744	5.971	20.8	0.487	0.00225	-5.0	-3.0	2499	0.0	83.7
20	0.259	0.195	3.788	2.742	8.326	5.974	20.6	0.479	0.00225	-5.0	0.0	2500	0.0	83.7
21	0.182	0.122	2.286	2.766	6.215	4.136	20.8	0.488	0.00225	-5.0	0.0	1999	0.0	83.7
23	0.166	0.119	2.265	2.992	5.652	4.164	20.5	0.473	0.00225	-10.0	0.0	1999	0.0	83.7
24	0.344	0.185	3.727	2.729	8.085	6.013	20.8	0.487	0.00225	-10.0	0.0	2500	0.0	83.7
25	0.329	0.175	3.611	2.701	7.288	6.010	20.7	0.482	0.00225	-10.0	-3.0	2499	0.0	83.7
27	0.218	0.109	2.158	3.038	5.066	4.165	20.9	0.490	0.00225	-10.0	-3.0	1999	0.0	83.7
28	0.603	0.284	2.284	6.601	7.008	4.321	41.1	1.902	0.00225	-10.0	-3.0	2000	0.0	84.2
29	0.801	0.417	3.858	6.859	10.433	6.189	41.2	1.905	0.00225	-10.0	-3.0	2499	0.0	84.3
30	0.880	0.471	4.256	6.766	11.838	6.202	41.2	1.904	0.00225	-10.0	0.0	2499	0.0	84.4
32	0.710	0.386	2.673	6.907	8.221	4.328	41.2	1.906	0.00225	-10.0	0.0	1999	0.0	84.4
33	0.750	0.423	2.949	6.885	9.208	4.260	41.0	1.888	0.00225	-5.0	0.0	1999	0.0	84.5
35	0.980	0.515	4.534	6.282	13.317	6.150	41.1	1.898	0.00225	-5.1	0.0	2499	0.0	84.6
36	0.930	0.477	4.137	6.409	11.321	6.181	41.1	1.900	0.00225	-5.0	-3.0	2499	0.0	84.7
38	0.761	0.395	2.658	6.700	8.050	4.309	41.1	1.894	0.00225	-5.0	-3.0	2000	0.0	84.6
39	0.793	0.407	2.775	6.703	8.498	4.304	41.2	1.908	0.00225	-3.0	-3.0	1999	0.0	84.6
40	0.973	0.484	4.187	6.171	11.685	6.173	41.2	1.904	0.00225	-3.0	-3.0	2499	0.0	84.8

Continued on next page

Table F.84: Testing conditions and rotor 3 loads in the hub coordinate system for run 128.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
41	1.011	0.516	4.512	5.761	13.275	6.118	41.0	1.884	0.00225	-3.0	0.0	2499	0.0	84.8
43	0.851	0.462	3.031	6.752	9.545	4.217	41.2	1.905	0.00225	-3.0	0.0	1999	0.0	84.9
45	0.875	0.454	3.028	6.057	9.797	4.203	41.1	1.900	0.00225	-1.0	0.0	1999	0.0	85.0
46	1.022	0.446	4.368	3.667	13.402	6.078	41.2	1.907	0.00225	-1.0	0.0	2499	0.0	85.0
47	0.984	0.445	4.038	4.553	11.796	6.142	41.1	1.893	0.00224	-1.0	-3.0	2500	0.0	85.2
48	0.842	0.413	2.727	5.761	8.601	4.283	41.2	1.903	0.00224	-1.0	-3.0	1999	0.0	85.2
49	0.831	0.396	2.733	5.427	8.700	4.261	41.2	1.906	0.00224	-0.0	-3.0	1999	0.0	85.4
50	0.980	0.418	4.028	3.740	12.006	6.107	41.2	1.903	0.00224	0.0	-3.0	2499	0.0	85.5
51	1.038	0.435	4.287	3.284	13.281	6.008	41.2	1.901	0.00224	0.0	0.0	2499	0.0	85.7
52	0.897	0.445	2.951	5.479	9.646	4.157	41.2	1.902	0.00224	0.0	0.0	1999	0.0	85.7
53	0.528	0.188	2.144	0.989	5.810	3.983	20.7	0.480	0.00224	0.0	0.0	2000	0.0	85.8
54	0.210	0.008	2.095	-0.525	0.382	3.998	3.6	0.014	0.00224	0.0	0.0	1999	0.0	85.6
55	-0.025	0.000	0.003	0.000	0.025	0.000	1.8	0.003	0.00224	0.1	0.0	0	-	85.6

Table F.85: Testing conditions and rotor 4 loads in the hub coordinate system for run 128.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.007	0.000	0.012	0.000	0.005	0.000	0.6	0.000	0.00226	-0.0	0.0	0	-	82.0
4	0.132	-0.448	1.734	3.161	-0.437	-2.992	5.9	0.040	0.00226	0.0	0.0	1999	0.0	82.1
5	0.271	-0.331	1.781	-1.280	5.589	-2.869	20.7	0.481	0.00226	0.0	0.0	2000	0.0	82.8
6	0.373	-0.368	3.165	-0.765	7.374	-4.528	20.6	0.479	0.00226	0.0	0.0	2500	0.0	82.9
7	0.455	-0.326	3.056	-1.308	6.887	-4.606	20.9	0.491	0.00226	0.0	-3.0	2500	0.0	83.0
8	0.315	-0.313	1.684	-1.931	5.014	-2.927	20.7	0.484	0.00225	0.0	-3.0	2000	0.0	83.1
9	0.343	-0.307	1.716	-2.215	5.006	-2.950	20.9	0.493	0.00225	-1.0	-3.0	2000	0.0	83.2
10	0.443	-0.322	3.149	-2.001	7.124	-4.680	20.9	0.492	0.00225	-1.0	-3.0	2500	0.0	83.2
11	0.426	-0.356	3.196	-1.153	7.592	-4.585	20.8	0.487	0.00225	-1.0	0.0	2499	0.0	83.3
12	0.263	-0.343	1.910	-1.899	5.721	-2.919	20.6	0.477	0.00225	-1.0	0.0	2000	0.0	83.3
13	0.320	-0.337	1.898	-2.452	5.661	-2.970	20.8	0.489	0.00225	-3.0	0.0	2000	0.0	83.4
14	0.457	-0.355	3.405	-2.596	7.834	-4.725	20.8	0.487	0.00225	-3.0	0.0	2500	0.0	83.4
15	0.452	-0.304	3.214	-2.819	7.006	-4.737	20.7	0.481	0.00225	-3.0	-3.0	2499	0.0	83.6
16	0.280	-0.306	1.700	-2.209	4.962	-2.954	20.4	0.468	0.00225	-3.0	-3.0	2000	0.0	83.6
17	0.330	-0.303	1.730	-2.328	4.993	-2.976	20.8	0.487	0.00225	-5.0	-3.0	2000	0.0	83.6
19	0.443	-0.303	3.175	-2.275	7.114	-4.728	20.8	0.487	0.00225	-5.0	-3.0	2499	0.0	83.7
20	0.387	-0.349	3.490	-2.719	7.748	-4.738	20.6	0.479	0.00225	-5.0	0.0	2500	0.0	83.7
21	0.306	-0.341	1.908	-2.326	5.680	-2.965	20.8	0.488	0.00225	-5.0	0.0	2000	0.0	83.7
23	0.280	-0.343	1.959	-2.504	5.232	-3.009	20.5	0.473	0.00225	-10.0	0.0	2000	0.0	83.7
24	0.478	-0.355	3.251	-2.291	7.662	-4.756	20.8	0.487	0.00225	-10.0	0.0	2499	0.0	83.7
25	0.433	-0.308	3.152	-2.341	6.866	-4.765	20.7	0.482	0.00225	-10.0	-3.0	2500	0.0	83.7
27	0.359	-0.308	1.740	-2.649	4.567	-3.021	20.9	0.490	0.00225	-10.0	-3.0	1999	0.0	83.7
28	0.529	-0.306	1.744	-6.806	6.303	-3.098	41.1	1.902	0.00225	-10.0	-3.0	2000	0.0	84.2
29	0.681	-0.321	3.253	-7.545	9.676	-4.898	41.2	1.905	0.00225	-10.0	-3.0	2499	0.0	84.3
30	0.717	-0.348	3.534	-7.535	10.800	-4.923	41.2	1.904	0.00225	-10.0	0.0	2499	0.0	84.4
32	0.543	-0.341	2.050	-6.987	7.211	-3.165	41.2	1.906	0.00225	-10.0	0.0	1999	0.0	84.4
33	0.615	-0.368	2.359	-7.077	8.400	-3.110	41.0	1.888	0.00225	-5.0	0.0	2000	0.0	84.5
35	0.819	-0.387	3.854	-7.274	12.420	-4.859	41.1	1.898	0.00225	-5.1	0.0	2499	0.0	84.6
36	0.761	-0.340	3.534	-7.587	10.806	-4.921	41.1	1.900	0.00225	-5.0	-3.0	2499	0.0	84.7
38	0.586	-0.330	2.046	-7.255	7.342	-3.162	41.1	1.894	0.00225	-5.0	-3.0	1999	0.0	84.6
39	0.621	-0.338	2.151	-7.216	7.724	-3.163	41.2	1.908	0.00225	-3.0	-3.0	2000	0.0	84.6
40	0.790	-0.361	3.576	-7.167	11.211	-4.903	41.2	1.904	0.00225	-3.0	-3.0	2499	0.0	84.8

Continued on next page

Table F.85: Testing conditions and rotor 4 loads in the hub coordinate system for run 128.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
41	0.857	-0.404	3.879	-6.912	12.740	-4.834	41.0	1.884	0.00225	-3.0	0.0	2499	0.0	84.8
43	0.675	-0.395	2.386	-7.316	8.846	-3.075	41.2	1.905	0.00225	-3.0	0.0	2000	0.0	84.9
45	0.699	-0.404	2.405	-7.119	9.057	-3.081	41.1	1.900	0.00225	-1.0	0.0	2000	0.0	85.0
46	0.870	-0.413	3.806	-6.358	12.942	-4.832	41.2	1.907	0.00225	-1.0	0.0	2499	0.0	85.0
47	0.842	-0.373	3.499	-6.681	11.605	-4.858	41.1	1.893	0.00224	-1.0	-3.0	2499	0.0	85.2
48	0.680	-0.359	2.135	-7.183	7.986	-3.122	41.2	1.903	0.00224	-1.0	-3.0	2000	0.0	85.2
49	0.702	-0.354	2.128	-7.045	8.076	-3.116	41.2	1.906	0.00224	-0.0	-3.0	2000	0.0	85.4
50	0.862	-0.376	3.492	-6.219	11.612	-4.840	41.2	1.903	0.00224	0.0	-3.0	2499	0.0	85.5
51	0.880	-0.430	3.673	-5.548	12.806	-4.765	41.2	1.901	0.00224	0.0	0.0	2499	0.0	85.7
52	0.742	-0.421	2.404	-7.112	9.098	-3.015	41.2	1.902	0.00224	0.0	0.0	2000	0.0	85.7
53	0.422	-0.449	1.574	-1.118	5.488	-2.856	20.7	0.480	0.00224	0.0	0.0	1999	0.0	85.8
54	0.230	-0.463	1.570	1.503	0.283	-2.899	3.6	0.014	0.00224	0.0	0.0	2000	0.0	85.6
55	0.006	0.000	-0.003	0.000	0.014	0.000	1.8	0.003	0.00224	0.1	0.0	0	-	85.6

Run 129: 3-bladed Concept Quadrotor

Table F.86: Run 129 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	3
RPM	2000, 2500
model pitch	0, -1, -3
rotor tilt	0
phase	-60

Table F.87: Testing conditions and rotor 1 loads in the hub coordinate system for run 129.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
5	-0.020	-0.002	-0.020	-0.003	0.000	-0.006	0.3	0.000	0.00225	0.0	0.0	0	-	84.5
6	0.038	0.143	2.221	-1.031	1.097	-3.396	6.9	0.054	0.00225	-0.0	0.0	2000	0.0	84.6
7	0.579	0.027	3.205	-1.947	10.251	-2.914	20.7	0.479	0.00225	0.0	0.0	2000	0.0	84.6
8	0.824	0.015	4.867	-1.451	14.575	-4.611	20.6	0.477	0.00225	0.0	0.0	2499	0.0	84.7
9	0.841	0.020	4.797	-1.628	14.248	-4.642	20.7	0.479	0.00224	-1.0	0.0	2499	0.0	85.0
10	0.590	0.027	3.157	-1.976	9.999	-2.949	20.6	0.477	0.00224	-1.0	0.0	1999	0.0	85.0
11	0.544	0.036	3.073	-2.189	9.547	-2.997	20.8	0.485	0.00224	-3.0	0.0	2000	0.0	85.2
12	0.777	0.020	4.704	-1.905	13.668	-4.687	20.8	0.483	0.00224	-3.0	0.0	2499	0.0	85.2
13	1.256	-0.112	6.078	-4.549	18.494	-4.512	41.2	1.904	0.00224	-3.0	0.0	2499	0.0	85.5
14	0.833	-0.079	4.087	-5.453	12.332	-2.999	41.1	1.894	0.00224	-3.0	0.0	2000	0.0	85.6
15	0.837	-0.062	4.402	-5.356	12.508	-2.967	41.3	1.905	0.00224	-1.0	0.0	2000	0.0	85.9
17	1.316	-0.089	6.349	-4.061	19.047	-4.486	41.3	1.909	0.00224	-1.0	0.0	2499	0.0	86.1
18	1.356	-0.097	6.562	-4.130	19.548	-4.443	41.2	1.898	0.00224	-0.0	0.0	2499	0.0	86.0
20	0.866	-0.053	4.560	-5.389	12.542	-2.941	41.3	1.909	0.00224	-0.0	0.0	1999	0.0	86.1
22	0.597	0.055	3.178	-2.054	10.356	-2.947	20.5	0.469	0.00224	0.0	0.0	2000	0.0	85.9
23	0.141	0.176	2.309	-0.974	3.700	-3.214	3.7	0.016	0.00224	-0.0	0.0	2000	0.0	85.8
24	-0.000	0.000	-0.000	0.000	0.000	0.000	2.5	0.007	0.00224	0.0	0.0	0	-	85.7

Table F.88: Testing conditions and rotor 2 loads in the hub coordinate system for run 129.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
5	-0.006	-0.003	0.003	-0.001	-0.017	-0.004	0.3	0.000	0.00225	0.0	0.0	0	-	84.5
6	0.015	-0.066	2.647	2.027	1.113	4.007	6.9	0.054	0.00225	-0.0	0.0	1999	-60.0	84.6
7	0.144	0.064	3.430	2.001	10.472	3.631	20.7	0.479	0.00225	0.0	0.0	1999	-60.0	84.6
8	0.204	0.080	5.145	1.399	14.843	5.469	20.6	0.477	0.00225	0.0	0.0	2500	-60.0	84.7
9	0.235	0.087	5.096	1.574	14.485	5.492	20.7	0.479	0.00224	-1.0	0.0	2499	-60.0	85.0
10	0.142	0.059	3.375	2.130	10.106	3.663	20.6	0.477	0.00224	-1.0	0.0	2000	-60.0	85.0
11	0.133	0.062	3.277	2.262	9.701	3.699	20.8	0.485	0.00224	-3.0	0.0	1999	-60.0	85.2
12	0.196	0.088	4.982	1.868	13.831	5.518	20.8	0.483	0.00224	-3.0	0.0	2499	-60.0	85.2
13	0.479	0.215	6.187	3.922	18.411	5.356	41.2	1.904	0.00224	-3.0	0.0	2499	-60.0	85.5
14	0.307	0.169	4.145	5.205	12.303	3.674	41.1	1.894	0.00224	-3.0	0.0	1999	-60.0	85.6
15	0.295	0.159	4.482	5.003	12.889	3.607	41.3	1.905	0.00224	-1.0	0.0	1999	-60.0	85.9
17	0.517	0.195	6.512	3.783	19.559	5.230	41.3	1.909	0.00224	-1.0	0.0	2500	-60.0	86.1
18	0.524	0.189	6.729	3.233	20.003	5.205	41.2	1.898	0.00224	-0.0	0.0	2499	-60.0	86.0
20	0.310	0.151	4.626	5.007	12.862	3.559	41.3	1.909	0.00224	-0.0	0.0	2000	-60.0	86.1
22	0.156	0.050	3.410	2.079	10.239	3.591	20.5	0.469	0.00224	0.0	0.0	2000	-60.0	85.9
23	0.095	-0.034	2.515	0.970	3.641	3.793	3.7	0.016	0.00224	-0.0	0.0	2000	-60.0	85.8
24	-0.000	0.000	-0.000	0.000	0.000	0.000	2.5	0.007	0.00224	0.0	0.0	0	-	85.7

Table F.89: Testing conditions and rotor 3 loads in the hub coordinate system for run 129.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
5	0.005	0.000	0.003	-0.001	-0.008	-0.003	0.3	0.000	0.00225	0.0	0.0	0	-	84.5
6	-0.048	-0.191	2.337	-2.206	-0.402	4.043	6.9	0.054	0.00225	-0.0	0.0	1999	-60.0	84.6
7	0.214	0.087	2.195	1.322	6.018	4.033	20.7	0.479	0.00225	0.0	0.0	1999	-60.0	84.6
8	0.310	0.147	3.622	0.801	7.914	5.759	20.6	0.477	0.00225	0.0	0.0	2499	-60.0	84.7
9	0.352	0.172	3.651	1.362	8.085	5.799	20.7	0.479	0.00224	-1.0	0.0	2499	-60.0	85.0
10	0.257	0.131	2.233	2.020	6.090	4.044	20.6	0.477	0.00224	-1.0	0.0	2000	-60.0	85.0
11	0.284	0.146	2.313	2.664	6.215	4.092	20.8	0.485	0.00224	-3.0	0.0	2000	-60.0	85.2
12	0.397	0.214	3.779	2.533	8.257	5.895	20.8	0.483	0.00224	-3.0	0.0	2499	-60.0	85.2
13	0.903	0.469	4.482	5.699	13.565	6.117	41.2	1.904	0.00224	-3.0	0.0	2499	-60.0	85.5
14	0.749	0.422	2.986	6.774	9.589	4.214	41.1	1.894	0.00224	-3.0	0.0	1999	-60.0	85.6
15	0.787	0.408	2.945	5.860	9.619	4.214	41.3	1.905	0.00224	-1.0	0.0	2000	-60.0	85.9
17	0.991	0.447	4.343	4.169	13.323	6.067	41.3	1.909	0.00224	-1.0	0.0	2499	-60.0	86.1
18	0.969	0.399	4.271	3.138	13.099	5.991	41.2	1.898	0.00224	-0.0	0.0	2499	-60.0	86.0
20	0.857	0.423	2.967	5.727	9.722	4.155	41.3	1.909	0.00224	-0.0	0.0	2000	-60.0	86.1
22	0.453	0.162	2.208	1.119	5.894	3.991	20.5	0.469	0.00224	0.0	0.0	2000	-60.0	85.9
23	0.226	0.019	2.261	-0.741	1.431	4.048	3.7	0.016	0.00224	-0.0	0.0	2000	-60.0	85.8
24	-0.000	0.000	-0.000	0.000	0.000	0.000	2.5	0.007	0.00224	0.0	0.0	0	-	85.7

Table F.90: Testing conditions and rotor 4 loads in the hub coordinate system for run 129.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
5	0.003	-0.001	0.013	-0.004	0.000	0.001	0.3	0.000	0.00225	0.0	0.0	0	-	84.5
6	0.046	-0.466	1.666	2.638	-0.656	-3.005	6.9	0.054	0.00225	-0.0	0.0	1999	0.0	84.6
7	0.283	-0.398	1.734	-1.240	5.651	-2.893	20.7	0.479	0.00225	0.0	0.0	1999	0.0	84.6
8	0.400	-0.407	3.149	-0.848	7.429	-4.565	20.6	0.477	0.00225	0.0	0.0	2500	0.0	84.7
9	0.430	-0.406	3.185	-1.220	7.669	-4.603	20.7	0.479	0.00224	-1.0	0.0	2499	0.0	85.0
10	0.316	-0.390	1.850	-1.967	5.740	-2.940	20.6	0.477	0.00224	-1.0	0.0	1999	0.0	85.0
11	0.361	-0.381	1.872	-2.437	5.697	-2.994	20.8	0.485	0.00224	-3.0	0.0	2000	0.0	85.2
12	0.491	-0.395	3.342	-2.598	7.761	-4.728	20.8	0.483	0.00224	-3.0	0.0	2499	0.0	85.2
13	0.866	-0.408	3.915	-6.999	12.835	-4.850	41.2	1.904	0.00224	-3.0	0.0	2499	0.0	85.5
14	0.703	-0.395	2.409	-7.179	8.760	-3.101	41.1	1.894	0.00224	-3.0	0.0	1999	0.0	85.6
15	0.718	-0.408	2.449	-7.177	9.045	-3.064	41.3	1.905	0.00224	-1.0	0.0	2000	0.0	85.9
17	0.902	-0.419	3.887	-6.415	13.044	-4.819	41.3	1.909	0.00224	-1.0	0.0	2500	0.0	86.1
18	0.874	-0.412	3.756	-5.644	12.687	-4.745	41.2	1.898	0.00224	-0.0	0.0	2500	0.0	86.0
20	0.726	-0.413	2.425	-6.920	9.140	-3.025	41.3	1.909	0.00224	-0.0	0.0	2000	0.0	86.1
22	0.344	-0.416	1.769	-1.385	5.645	-2.887	20.5	0.469	0.00224	0.0	0.0	2000	0.0	85.9
23	0.232	-0.439	1.586	1.226	0.872	-2.907	3.7	0.016	0.00224	-0.0	0.0	2000	0.0	85.8
24	-0.000	0.000	-0.000	0.000	0.000	0.000	2.5	0.007	0.00224	0.0	0.0	0	-	85.7

Run 130: 3-bladed Concept Quadrotor

Table F.91: Run 130 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	3
RPM	2000, 2500
model pitch	0, -1, -3
rotor tilt	0
phase	-30

Table F.92: Testing conditions and rotor 1 loads in the hub coordinate system for run 130.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.010	0.000	-0.009	0.000	-0.003	0.000	0.4	0.000	0.00233	-0.0	0.0	0	-	66.9
4	0.072	0.122	2.556	-2.459	1.035	-3.380	5.9	0.041	0.00233	-0.0	0.0	2000	0.0	66.9
5	0.641	-0.008	3.343	-2.123	10.247	-3.006	20.4	0.486	0.00233	-0.0	0.0	2000	0.0	66.5
6	0.888	-0.014	5.101	-1.566	14.733	-4.769	20.3	0.479	0.00233	-0.0	0.0	2499	0.0	66.3
7	0.856	-0.031	4.899	-2.439	13.652	-4.824	20.6	0.497	0.00234	-1.0	0.0	2499	0.0	66.1
8	0.632	0.010	3.318	-2.344	10.149	-3.044	20.4	0.485	0.00234	-1.0	0.0	2000	0.0	66.0
9	0.599	0.036	3.204	-2.067	9.623	-3.085	20.5	0.491	0.00234	-3.0	0.0	2000	0.0	66.0
10	0.832	0.026	4.901	-2.015	13.614	-4.879	20.4	0.487	0.00234	-3.0	0.0	2499	0.0	65.9
11	0.889	0.035	4.860	-2.291	13.625	-4.904	20.2	0.479	0.00234	-3.0	0.0	2499	0.0	65.9
12	1.313	-0.094	6.210	-4.425	18.594	-4.732	40.3	1.898	0.00234	-3.0	0.0	2499	0.0	65.9
13	0.880	-0.050	4.164	-5.374	12.526	-3.134	40.4	1.902	0.00234	-3.0	0.0	2000	0.0	65.9
14	0.898	-0.045	4.446	-5.404	12.981	-3.085	40.5	1.911	0.00233	-1.0	0.0	2000	0.0	65.9
15	1.384	-0.079	6.537	-4.237	19.559	-4.667	40.3	1.898	0.00233	-0.9	0.0	2500	0.0	65.9
16	1.411	-0.068	6.689	-4.127	19.923	-4.644	40.2	1.888	0.00233	0.0	0.0	2499	0.0	65.9
17	0.999	-0.031	4.611	-5.425	12.998	-3.080	40.3	1.899	0.00233	-0.0	0.0	2000	0.0	65.9
18	0.644	0.089	3.249	-2.102	10.366	-3.094	20.3	0.480	0.00234	-0.0	0.0	2000	0.0	65.9
19	0.040	0.259	2.365	-0.130	1.797	-3.481	7.3	0.062	0.00234	-0.0	0.0	2000	0.0	65.9
20	0.006	0.000	-0.008	0.000	0.007	0.000	1.5	0.003	0.00234	-0.0	0.0	0	-	65.9

Table F.93: Testing conditions and rotor 2 loads in the hub coordinate system for run 130.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.005	0.000	0.007	0.000	-0.010	0.000	0.4	0.000	0.00233	-0.0	0.0	0	-	66.9
4	-0.101	0.006	2.775	2.364	1.712	4.141	5.9	0.041	0.00233	-0.0	0.0	2000	-30.0	66.9
5	0.033	0.044	3.584	2.246	10.891	3.807	20.4	0.486	0.00233	-0.0	0.0	1999	-30.0	66.5
6	0.089	0.042	5.396	1.645	15.287	5.741	20.3	0.479	0.00233	-0.0	0.0	2499	-30.0	66.3
7	0.158	0.011	5.331	1.164	14.852	5.729	20.6	0.497	0.00234	-1.0	0.0	2500	-30.0	66.1
8	0.033	0.016	3.584	2.100	10.829	3.764	20.4	0.485	0.00234	-1.0	0.0	1999	-30.0	66.0
9	0.020	0.025	3.449	2.748	10.065	3.807	20.5	0.491	0.00234	-3.0	0.0	2000	-30.0	66.0
10	0.103	0.018	5.227	2.067	13.969	5.703	20.4	0.487	0.00234	-3.0	0.0	2499	-30.0	65.9
11	0.103	0.012	5.274	2.012	14.012	5.685	20.2	0.479	0.00234	-3.0	0.0	2499	-30.0	65.9
12	0.444	0.135	6.419	4.183	19.328	5.468	40.3	1.898	0.00234	-3.0	0.0	2499	-30.0	65.9
13	0.292	0.112	4.323	5.286	12.948	3.722	40.4	1.902	0.00234	-3.0	0.0	1999	-30.0	65.9
14	0.264	0.110	4.623	5.269	13.414	3.673	40.5	1.911	0.00233	-1.0	0.0	2000	-30.0	65.9
15	0.487	0.152	6.728	4.191	20.356	5.336	40.3	1.898	0.00233	-0.9	0.0	2500	-30.0	65.9
16	0.491	0.144	6.886	3.960	20.768	5.308	40.2	1.888	0.00233	0.0	0.0	2499	-30.0	65.9
17	0.302	0.108	4.815	5.267	13.519	3.600	40.3	1.899	0.00233	-0.0	0.0	1999	-30.0	65.9
18	0.089	0.012	3.601	2.343	11.004	3.637	20.3	0.480	0.00234	-0.0	0.0	1999	-30.0	65.9
19	0.023	-0.090	2.582	0.878	2.163	4.075	7.3	0.062	0.00234	-0.0	0.0	2000	-30.0	65.9
20	0.011	0.000	0.014	0.000	-0.003	0.000	1.5	0.003	0.00234	-0.0	0.0	0	-	65.9

Table F.94: Testing conditions and rotor 3 loads in the hub coordinate system for run 130.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.009	0.000	-0.003	0.000	0.006	0.000	0.4	0.000	0.00233	-0.0	0.0	0	-	66.9
4	-0.225	-0.209	2.186	-2.081	0.253	4.231	5.9	0.041	0.00233	-0.0	0.0	2000	-30.0	66.9
5	0.126	-0.046	2.247	1.585	6.438	4.183	20.4	0.486	0.00233	-0.0	0.0	2000	-30.0	66.5
6	0.195	0.001	3.805	0.764	8.242	5.954	20.3	0.479	0.00233	-0.0	0.0	2499	-30.0	66.3
7	0.308	0.015	3.702	1.332	8.345	6.091	20.6	0.497	0.00234	-1.0	0.0	2499	-30.0	66.1
8	0.195	0.012	2.381	2.161	6.456	4.186	20.4	0.485	0.00234	-1.0	0.0	2000	-30.0	66.0
9	0.241	0.049	2.433	3.102	6.437	4.221	20.5	0.491	0.00234	-3.0	0.0	2000	-30.0	66.0
10	0.347	0.090	3.935	2.507	8.578	6.073	20.4	0.487	0.00234	-3.0	0.0	2499	-30.0	65.9
11	0.336	0.106	3.989	2.602	8.481	6.081	20.2	0.479	0.00234	-3.0	0.0	2500	-30.0	65.9
12	0.936	0.433	4.644	6.223	13.655	6.272	40.3	1.898	0.00234	-3.0	0.0	2500	-30.0	65.9
13	0.838	0.425	3.117	6.963	9.524	4.304	40.4	1.902	0.00234	-3.0	0.0	2000	-30.0	65.9
14	0.872	0.425	3.093	6.627	9.745	4.316	40.5	1.911	0.00233	-1.0	0.0	2000	-30.0	65.9
15	1.083	0.488	4.585	4.717	13.664	6.231	40.3	1.898	0.00233	-0.9	0.0	2499	-30.0	65.9
16	1.059	0.456	4.517	4.065	13.517	6.164	40.2	1.888	0.00233	0.0	0.0	2499	-30.0	65.9
17	0.915	0.454	3.128	6.135	9.796	4.262	40.3	1.899	0.00233	-0.0	0.0	1999	-30.0	65.9
18	0.471	0.194	2.336	1.518	5.969	4.093	20.3	0.480	0.00234	-0.0	0.0	2000	-30.0	65.9
19	0.166	-0.014	2.106	-0.781	0.115	4.007	7.3	0.062	0.00234	-0.0	0.0	2000	-30.0	65.9
20	-0.020	0.000	0.002	0.000	0.024	0.000	1.5	0.003	0.00234	-0.0	0.0	0	-	65.9

Table F.95: Testing conditions and rotor 4 loads in the hub coordinate system for run 130.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.007	0.000	0.015	0.000	0.004	0.000	0.4	0.000	0.00233	-0.0	0.0	0	-	66.9
4	0.139	-0.510	1.704	2.432	-0.172	-3.153	5.9	0.041	0.00233	-0.0	0.0	2000	0.0	66.9
5	0.412	-0.503	1.927	-0.665	5.554	-2.976	20.4	0.486	0.00233	-0.0	0.0	2000	0.0	66.5
6	0.567	-0.499	3.490	-0.939	7.509	-4.761	20.3	0.479	0.00233	-0.0	0.0	2500	0.0	66.3
7	0.634	-0.496	3.341	-1.415	7.434	-4.682	20.6	0.497	0.00234	-1.0	0.0	2499	0.0	66.1
8	0.409	-0.472	2.090	-1.585	5.746	-3.015	20.4	0.485	0.00234	-1.0	0.0	2000	0.0	66.0
9	0.448	-0.454	2.127	-2.035	5.796	-3.090	20.5	0.491	0.00234	-3.0	0.0	2000	0.0	66.0
10	0.635	-0.444	3.699	-2.526	7.980	-4.904	20.4	0.487	0.00234	-3.0	0.0	2499	0.0	65.9
11	0.564	-0.426	3.747	-2.537	8.015	-4.897	20.2	0.479	0.00234	-3.0	0.0	2499	0.0	65.9
12	1.219	-0.446	4.065	-6.598	12.847	-5.050	40.3	1.898	0.00234	-3.0	0.0	2500	0.0	65.9
13	0.979	-0.428	2.511	-7.233	8.903	-3.225	40.4	1.902	0.00234	-3.0	0.0	2000	0.0	65.9
14	0.987	-0.455	2.451	-6.672	9.132	-3.180	40.5	1.911	0.00233	-1.0	0.0	2000	0.0	65.9
15	1.284	-0.410	3.951	-5.774	12.895	-5.036	40.3	1.898	0.00233	-0.9	0.0	2499	0.0	65.9
16	1.263	-0.408	3.826	-4.897	12.848	-4.976	40.2	1.888	0.00233	0.0	0.0	2499	0.0	65.9
17	1.030	-0.408	2.456	-6.348	9.137	-3.156	40.3	1.899	0.00233	-0.0	0.0	2000	0.0	65.9
18	0.471	-0.417	1.929	-0.781	5.643	-2.987	20.3	0.480	0.00234	-0.0	0.0	2000	0.0	65.9
19	0.222	-0.451	1.802	2.739	-1.271	-2.982	7.3	0.062	0.00234	-0.0	0.0	2000	0.0	65.9
20	0.008	0.000	-0.000	0.000	0.014	0.000	1.5	0.003	0.00234	-0.0	0.0	0	-	65.9

Run 132: 6-bladed Concept Quadrotor

Table F.96: Run 132 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	6
RPM	1500, 2000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	0

Table F.97: Testing conditions and rotor 1 loads in the hub coordinate system for run 132.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.019	0.000	-0.010	0.000	-0.008	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	71.6
4	0.152	0.076	3.498	-3.690	2.112	-5.974	7.5	0.065	0.00231	0.0	0.0	1999	0.0	72.0
5	0.656	0.036	2.793	-2.152	11.365	-3.130	20.5	0.486	0.00230	0.0	0.0	1500	0.0	73.4
6	0.944	-0.025	4.542	-2.671	16.774	-5.410	20.5	0.485	0.00230	0.0	0.0	1999	0.0	73.5
7	0.968	-0.067	4.359	-3.474	16.024	-5.420	20.4	0.480	0.00230	0.0	-3.0	1999	0.0	74.0
8	0.638	0.005	2.640	-2.740	10.575	-3.214	20.5	0.483	0.00230	0.0	-3.0	1500	0.0	74.5
9	0.620	0.010	2.589	-2.870	10.333	-3.257	20.5	0.484	0.00230	-1.0	-3.0	1500	0.0	74.8
10	0.933	-0.049	4.327	-3.593	15.795	-5.498	20.6	0.490	0.00230	-1.0	-3.0	1999	0.0	74.8
11	0.996	-0.016	4.441	-2.833	16.369	-5.398	20.5	0.483	0.00230	-1.0	0.0	1999	0.0	75.2
12	0.718	0.045	2.665	-2.336	11.017	-3.180	20.5	0.482	0.00230	-1.0	0.0	1500	0.0	75.2
13	0.673	0.048	2.560	-2.758	10.430	-3.227	20.4	0.477	0.00230	-3.0	0.0	1500	0.0	75.5
14	0.969	-0.014	4.267	-3.423	15.770	-5.438	20.3	0.474	0.00229	-3.0	0.0	1999	0.0	75.5
15	0.921	-0.039	4.208	-3.735	15.078	-5.646	20.8	0.498	0.00229	-3.0	-3.0	1999	0.0	75.6
16	0.593	0.015	2.447	-3.022	9.744	-3.359	20.5	0.483	0.00229	-3.0	-3.0	1500	0.0	75.8
17	0.554	0.026	2.355	-3.138	9.046	-3.406	20.4	0.478	0.00229	-5.0	-3.0	1500	0.0	75.9
18	0.821	-0.015	4.089	-3.831	13.891	-5.742	20.5	0.483	0.00229	-5.0	-3.0	1999	0.0	76.0
19	0.950	-0.005	4.188	-3.749	15.126	-5.593	20.6	0.485	0.00229	-5.0	0.0	1999	0.0	76.4
20	0.651	0.051	2.403	-3.017	9.759	-3.342	20.4	0.478	0.00229	-5.0	0.0	1500	0.0	76.5
21	0.512	0.081	2.207	-3.136	8.325	-3.417	20.4	0.478	0.00229	-10.0	0.0	1500	0.0	76.7
22	0.789	0.039	3.972	-3.739	12.878	-5.782	20.5	0.480	0.00229	-10.0	0.0	1999	0.0	77.1
23	0.714	0.021	3.816	-3.703	11.790	-5.779	20.6	0.485	0.00229	-10.0	-3.0	1999	0.0	77.1
24	0.473	0.059	2.081	-3.215	7.547	-3.425	20.3	0.474	0.00229	-10.0	-3.0	1500	0.0	77.1
25	0.941	0.041	4.390	-2.757	16.511	-5.472	20.4	0.475	0.00229	-0.0	0.0	1999	0.0	77.4
26	0.093	0.180	3.276	-3.115	1.335	-5.969	8.8	0.088	0.00229	0.0	0.0	2000	0.0	77.5
27	-0.000	0.000	-0.000	0.000	0.000	0.000	2.2	0.006	0.00229	0.0	0.0	0	-	77.4

Table F.98: Testing conditions and rotor 2 loads in the hub coordinate system for run 132.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.013	0.000	0.004	0.000	-0.014	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	71.6
4	-0.049	-0.049	3.558	3.495	1.143	6.882	7.5	0.065	0.00231	0.0	0.0	1999	0.0	72.0
5	0.052	0.035	2.873	2.293	11.534	3.928	20.5	0.486	0.00230	0.0	0.0	1500	0.0	73.4
6	0.106	0.092	4.689	2.840	17.025	6.387	20.5	0.485	0.00230	0.0	0.0	1999	0.0	73.5
7	0.164	0.131	4.407	3.424	16.235	6.423	20.4	0.480	0.00230	0.0	-3.0	1999	0.0	74.0
8	0.097	0.103	2.649	2.725	10.672	3.951	20.5	0.483	0.00230	0.0	-3.0	1500	0.0	74.5
9	0.102	0.101	2.608	2.920	10.389	3.974	20.5	0.484	0.00230	-1.0	-3.0	1500	0.0	74.8
10	0.137	0.138	4.408	3.559	16.001	6.478	20.6	0.490	0.00230	-1.0	-3.0	1999	0.0	74.8
11	0.104	0.085	4.599	2.882	16.707	6.389	20.5	0.483	0.00230	-1.0	0.0	1999	0.0	75.2
12	0.077	0.054	2.814	2.433	11.194	3.900	20.5	0.482	0.00230	-1.0	0.0	1500	0.0	75.2
13	0.018	0.049	2.743	2.781	10.673	3.947	20.4	0.477	0.00230	-3.0	0.0	1500	0.0	75.5
14	0.065	0.089	4.540	3.354	16.073	6.430	20.3	0.474	0.00229	-3.0	0.0	1999	0.0	75.5
15	0.172	0.129	4.311	3.730	15.315	6.516	20.8	0.498	0.00229	-3.0	-3.0	1999	0.0	75.6
16	0.113	0.087	2.459	3.059	9.702	3.983	20.5	0.483	0.00229	-3.0	-3.0	1500	0.0	75.8
17	0.103	0.081	2.361	3.102	9.017	3.995	20.4	0.478	0.00229	-5.0	-3.0	1500	0.0	75.9
18	0.141	0.106	4.165	3.598	14.261	6.557	20.5	0.483	0.00229	-5.0	-3.0	1999	0.0	76.0
19	0.087	0.075	4.369	3.664	15.463	6.501	20.6	0.485	0.00229	-5.0	0.0	1999	0.0	76.4
20	0.017	0.032	2.583	2.927	9.932	3.974	20.4	0.478	0.00229	-5.0	0.0	1500	0.0	76.5
21	0.022	0.017	2.330	3.139	8.353	4.015	20.4	0.478	0.00229	-10.0	0.0	1500	0.0	76.7
22	0.092	0.055	4.135	3.681	13.080	6.593	20.5	0.480	0.00229	-10.0	0.0	1999	0.0	77.1
23	0.147	0.097	3.921	3.734	11.738	6.533	20.6	0.485	0.00229	-10.0	-3.0	1999	0.0	77.1
24	0.104	0.058	2.111	3.202	7.442	3.952	20.3	0.474	0.00229	-10.0	-3.0	1500	0.0	77.1
25	0.122	0.078	4.601	2.845	16.779	6.269	20.4	0.475	0.00229	-0.0	0.0	1999	0.0	77.4
26	-0.005	-0.063	3.647	3.335	1.173	6.881	8.8	0.088	0.00229	0.0	0.0	2000	0.0	77.5
27	-0.000	0.000	-0.000	0.000	0.000	0.000	2.2	0.006	0.00229	0.0	0.0	0	-	77.4

Table F.99: Testing conditions and rotor 3 loads in the hub coordinate system for run 132.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.007	0.000	-0.005	0.000	-0.003	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	71.6
4	-0.153	-0.279	3.549	-4.623	-0.609	7.257	7.5	0.065	0.00231	0.0	0.0	1999	0.0	72.0
5	0.215	0.085	1.593	1.612	6.982	4.238	20.5	0.486	0.00230	0.0	0.0	1500	0.0	73.4
6	0.333	0.154	3.121	1.357	9.253	6.758	20.5	0.485	0.00230	0.0	0.0	1999	0.0	73.5
7	0.455	0.214	3.158	2.707	8.818	6.938	20.4	0.480	0.00230	0.0	-3.0	1999	0.0	74.0
8	0.326	0.122	1.494	1.981	6.177	4.289	20.5	0.483	0.00230	0.0	-3.0	1500	0.0	74.5
9	0.375	0.151	1.584	2.649	6.184	4.340	20.5	0.484	0.00230	-1.0	-3.0	1500	0.0	74.8
10	0.539	0.276	3.290	3.657	9.033	7.024	20.6	0.490	0.00230	-1.0	-3.0	1999	0.0	74.8
11	0.446	0.236	3.136	1.654	9.314	6.816	20.5	0.483	0.00230	-1.0	0.0	1999	0.0	75.2
12	0.369	0.185	1.593	1.898	6.933	4.268	20.5	0.482	0.00230	-1.0	0.0	1500	0.0	75.2
13	0.373	0.222	1.735	3.313	6.838	4.374	20.4	0.477	0.00230	-3.0	0.0	1500	0.0	75.5
14	0.497	0.336	3.451	3.837	9.810	6.996	20.3	0.474	0.00229	-3.0	0.0	1999	0.0	75.5
15	0.653	0.350	3.385	4.296	9.085	7.103	20.8	0.498	0.00229	-3.0	-3.0	1999	0.0	75.6
16	0.514	0.241	1.655	3.281	6.055	4.374	20.5	0.483	0.00229	-3.0	-3.0	1500	0.0	75.8
17	0.544	0.243	1.655	3.364	5.988	4.387	20.4	0.478	0.00229	-5.0	-3.0	1500	0.0	75.9
18	0.686	0.345	3.329	3.947	8.826	7.133	20.5	0.483	0.00229	-5.0	-3.0	1999	0.0	76.0
19	0.619	0.382	3.436	3.539	10.088	7.074	20.6	0.485	0.00229	-5.0	0.0	1999	0.0	76.4
20	0.467	0.284	1.748	3.338	6.749	4.380	20.4	0.478	0.00229	-5.0	0.0	1500	0.0	76.5
21	0.510	0.284	1.718	3.566	6.158	4.401	20.4	0.478	0.00229	-10.0	0.0	1500	0.0	76.7
22	0.663	0.402	3.374	3.555	9.230	7.100	20.5	0.480	0.00229	-10.0	0.0	1999	0.0	77.1
23	0.720	0.383	3.233	3.706	8.135	7.102	20.6	0.485	0.00229	-10.0	-3.0	1999	0.0	77.1
24	0.618	0.303	1.615	3.508	5.313	4.377	20.3	0.474	0.00229	-10.0	-3.0	1500	0.0	77.1
25	0.634	0.333	3.129	1.207	8.895	6.670	20.4	0.475	0.00229	-0.0	0.0	1999	0.0	77.4
26	0.104	-0.112	3.378	-4.907	-0.540	7.070	8.8	0.088	0.00229	0.0	0.0	1999	0.0	77.5
27	-0.000	0.000	-0.000	0.000	0.000	0.000	2.2	0.006	0.00229	0.0	0.0	0	-	77.4

Table F.100: Testing conditions and rotor 4 loads in the hub coordinate system for run 132.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.004	0.000	0.021	0.000	-0.002	0.000	0.0	0.000	0.00231	0.0	0.0	0	-	71.6
4	0.134	-0.509	2.934	4.740	-0.190	-5.802	7.5	0.065	0.00231	0.0	0.0	2000	0.0	72.0
5	0.415	-0.377	1.275	-1.524	6.570	-3.086	20.5	0.486	0.00230	0.0	0.0	1500	0.0	73.4
6	0.586	-0.411	2.732	-1.190	8.739	-5.380	20.5	0.485	0.00230	0.0	0.0	1999	0.0	73.5
7	0.625	-0.395	2.582	-2.409	8.033	-5.466	20.4	0.480	0.00230	0.0	-3.0	1999	0.0	74.0
8	0.467	-0.377	1.029	-2.142	5.794	-3.110	20.5	0.483	0.00230	0.0	-3.0	1500	0.0	74.5
9	0.505	-0.353	1.111	-2.693	5.750	-3.188	20.5	0.484	0.00230	-1.0	-3.0	1500	0.0	74.8
10	0.716	-0.386	2.680	-3.351	8.282	-5.577	20.6	0.490	0.00230	-1.0	-3.0	1999	0.0	74.8
11	0.604	-0.453	2.696	-1.573	8.877	-5.395	20.5	0.483	0.00230	-1.0	0.0	1999	0.0	75.2
12	0.460	-0.407	1.242	-1.922	6.535	-3.105	20.5	0.482	0.00230	-1.0	0.0	1500	0.0	75.2
13	0.443	-0.408	1.456	-2.991	6.587	-3.220	20.4	0.477	0.00230	-3.0	0.0	1500	0.0	75.5
14	0.610	-0.423	3.097	-3.747	9.222	-5.602	20.3	0.474	0.00229	-3.0	0.0	1999	0.0	75.5
15	0.799	-0.370	2.810	-4.433	8.338	-5.727	20.8	0.498	0.00229	-3.0	-3.0	1999	0.0	75.6
16	0.544	-0.365	1.068	-2.911	5.714	-3.218	20.5	0.483	0.00229	-3.0	-3.0	1500	0.0	75.8
17	0.539	-0.376	1.065	-3.051	5.585	-3.243	20.4	0.478	0.00229	-5.0	-3.0	1500	0.0	75.9
18	0.745	-0.384	2.696	-4.096	8.200	-5.745	20.5	0.483	0.00229	-5.0	-3.0	1999	0.0	76.0
19	0.672	-0.399	3.025	-3.930	9.287	-5.706	20.6	0.485	0.00229	-5.0	0.0	1999	0.0	76.4
20	0.424	-0.395	1.414	-3.088	6.493	-3.230	20.4	0.478	0.00229	-5.0	0.0	1500	0.0	76.5
21	0.479	-0.402	1.330	-3.223	5.827	-3.277	20.4	0.478	0.00229	-10.0	0.0	1500	0.0	76.7
22	0.662	-0.391	2.889	-3.525	8.700	-5.743	20.5	0.480	0.00229	-10.0	0.0	1999	0.0	77.1
23	0.709	-0.352	2.593	-3.585	7.617	-5.715	20.6	0.485	0.00229	-10.0	-3.0	1999	0.0	77.1
24	0.520	-0.349	0.999	-3.191	4.974	-3.243	20.3	0.474	0.00229	-10.0	-3.0	1500	0.0	77.1
25	0.635	-0.420	2.686	-1.389	8.612	-5.350	20.4	0.475	0.00229	-0.0	0.0	1999	0.0	77.4
26	0.267	-0.500	3.052	5.932	-1.841	-5.886	8.8	0.088	0.00229	0.0	0.0	1999	0.0	77.5
27	-0.000	0.000	-0.000	0.000	0.000	0.000	2.2	0.006	0.00229	0.0	0.0	0	-	77.4

Run 133: 6-bladed Concept Quadrotor

Table F.101: Run 133 operational settings for MTBII.

Feature	Value
number of rotors	NaN
rotors used	NaN
number of blades	NaN
RPM	NaN
model pitch	NaN
rotor tilt	NaN
phase	NaN

Run 134: 6-bladed Concept Quadrotor

Table F.102: Run 134 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	6
RPM	1500, 2000
model pitch	0, -1, -3
rotor tilt	0, -3
phase	-30

Table F.103: Testing conditions and rotor 1 loads in the hub coordinate system for run 134.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.004	0.000	-0.009	0.000	0.001	0.000	0.9	0.001	0.00224	-0.0	0.0	0	-	86.4
4	0.077	0.101	3.282	-3.010	0.822	-5.831	7.6	0.065	0.00224	-0.0	0.0	2000	0.0	86.6
5	0.130	0.092	3.514	-2.789	2.319	-5.947	7.5	0.062	0.00224	0.0	0.0	1999	0.0	86.7
6	0.570	0.024	2.746	-2.129	11.190	-3.059	20.8	0.484	0.00224	0.0	0.0	1500	0.0	86.9
7	0.861	-0.032	4.460	-2.531	16.622	-5.266	20.8	0.486	0.00224	0.0	0.0	1999	0.0	86.9
8	0.888	-0.082	4.264	-3.200	15.757	-5.321	20.7	0.480	0.00224	-0.0	-3.0	1999	0.0	87.0
9	0.600	-0.024	2.573	-2.539	10.424	-3.147	20.6	0.475	0.00224	0.0	-3.0	1500	0.0	87.0
10	0.579	-0.026	2.522	-2.711	10.193	-3.203	20.9	0.487	0.00224	-1.0	-3.0	1500	0.0	87.1
11	0.883	-0.088	4.192	-3.391	15.681	-5.394	21.1	0.497	0.00224	-1.0	-3.0	1999	0.0	87.2
12	0.913	-0.033	4.356	-2.725	16.162	-5.266	20.8	0.482	0.00224	-1.0	0.0	1999	0.0	87.4
13	0.626	0.019	2.650	-2.204	11.040	-3.096	20.9	0.488	0.00224	-1.0	0.0	1500	0.0	87.5
14	0.606	0.019	2.526	-2.594	10.416	-3.166	20.7	0.481	0.00224	-3.0	0.0	1500	0.0	87.5
15	0.015	0.158	3.168	-0.680	2.671	-5.693	8.8	0.086	0.00224	-3.0	0.0	1999	0.0	87.3
16	0.114	0.162	3.067	-0.975	2.004	-5.690	10.1	0.114	0.00224	-0.0	0.0	2000	0.0	87.2
17	0.588	0.029	2.693	-2.083	11.063	-3.083	20.6	0.476	0.00224	0.0	0.0	1500	0.0	87.2
18	0.880	-0.024	4.373	-2.523	16.263	-5.292	20.4	0.466	0.00224	0.0	0.0	1999	0.0	87.2
19	0.900	-0.037	4.207	-3.227	15.776	-5.328	20.8	0.484	0.00224	-3.0	0.0	1999	0.0	87.3
20	0.599	0.024	2.497	-2.586	10.351	-3.180	20.6	0.476	0.00224	-3.0	0.0	1500	0.0	87.3
21	0.548	0.000	2.387	-2.801	9.496	-3.286	20.4	0.467	0.00224	-3.0	-3.0	1500	0.0	87.4
22	0.822	-0.073	4.113	-3.441	14.589	-5.534	20.6	0.477	0.00224	-3.0	-3.0	1999	0.0	87.4
23	0.928	-0.021	4.379	-2.477	16.538	-5.335	20.8	0.483	0.00224	0.0	0.0	1999	0.0	87.7
24	0.213	0.161	3.197	-1.348	3.478	-5.746	7.5	0.062	0.00224	0.0	0.0	1999	0.0	87.9
25	0.145	0.167	2.988	-1.021	1.927	-5.778	9.2	0.095	0.00224	0.0	0.0	1999	0.0	87.9
28	-0.000	0.000	-0.000	0.000	0.000	0.000	2.9	0.009	0.00224	0.0	0.0	0	-	88.0

Table F.104: Testing conditions and rotor 2 loads in the hub coordinate system for run 134.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	0.001	0.000	0.010	0.000	-0.007	0.000	0.9	0.001	0.00224	-0.0	0.0	0	-	86.4
4	0.021	-0.013	3.457	2.944	1.771	6.735	7.6	0.065	0.00224	-0.0	0.0	2000	0.0	86.6
5	0.041	-0.029	3.513	1.887	1.339	6.751	7.5	0.062	0.00224	0.0	0.0	1999	-30.0	86.7
6	0.059	0.074	2.758	2.037	11.425	3.857	20.8	0.484	0.00224	0.0	0.0	1500	-30.0	86.9
7	0.154	0.149	4.529	2.499	16.917	6.270	20.8	0.486	0.00224	0.0	0.0	1999	-30.0	86.9
8	0.162	0.216	4.361	3.297	16.116	6.294	20.7	0.480	0.00224	-0.0	-3.0	1999	-30.0	87.0
9	0.096	0.145	2.584	2.648	10.508	3.879	20.6	0.475	0.00224	0.0	-3.0	1500	-30.0	87.0
10	0.080	0.147	2.566	2.820	10.312	3.917	20.9	0.487	0.00224	-1.0	-3.0	1500	-30.0	87.1
11	0.153	0.207	4.326	3.288	15.901	6.363	21.1	0.497	0.00224	-1.0	-3.0	1999	-30.0	87.2
12	0.184	0.162	4.471	2.792	16.505	6.249	20.8	0.482	0.00224	-1.0	0.0	1999	-30.0	87.4
13	0.120	0.093	2.658	2.337	11.130	3.839	20.9	0.488	0.00224	-1.0	0.0	1500	-30.0	87.5
14	0.063	0.084	2.600	2.732	10.508	3.900	20.7	0.481	0.00224	-3.0	0.0	1500	-30.0	87.5
15	-0.065	-0.048	3.235	0.486	2.578	6.508	8.8	0.086	0.00224	-3.0	0.0	2000	-30.0	87.3
16	0.057	-0.044	3.276	1.081	1.767	6.697	10.1	0.114	0.00224	-0.0	0.0	2000	-30.0	87.2
17	0.062	0.050	2.772	1.979	11.387	3.817	20.6	0.476	0.00224	0.0	0.0	1500	-30.0	87.2
18	0.122	0.119	4.565	2.554	16.610	6.232	20.4	0.466	0.00224	0.0	0.0	1999	-30.0	87.2
19	0.204	0.120	4.357	3.363	16.038	6.274	20.8	0.484	0.00224	-3.0	0.0	1999	-30.0	87.3
20	0.081	0.045	2.618	2.714	10.448	3.863	20.6	0.476	0.00224	-3.0	0.0	1500	-30.0	87.3
21	0.135	0.087	2.388	2.942	9.472	3.901	20.4	0.467	0.00224	-3.0	-3.0	1500	-30.0	87.4
22	0.210	0.156	4.178	3.508	14.781	6.373	20.6	0.477	0.00224	-3.0	-3.0	1999	-30.0	87.4
23	0.255	0.115	4.463	2.684	16.718	6.186	20.8	0.483	0.00224	0.0	0.0	1999	-30.0	87.7
24	0.127	-0.013	3.677	1.374	4.650	6.640	7.5	0.062	0.00224	0.0	0.0	2000	-30.0	87.9
25	0.096	-0.042	3.192	1.100	2.405	6.500	9.2	0.095	0.00224	0.0	0.0	1999	0.0	87.9
28	-0.000	0.000	-0.000	0.000	0.000	0.000	2.9	0.009	0.00224	0.0	0.0	0	-	88.0

Table F.105: Testing conditions and rotor 3 loads in the hub coordinate system for run 134.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.015	0.000	-0.001	0.000	0.013	0.000	0.9	0.001	0.00224	-0.0	0.0	0	-	86.4
4	-0.169	-0.237	3.405	-5.183	-0.410	7.100	7.6	0.065	0.00224	-0.0	0.0	1999	0.0	86.6
5	-0.122	-0.187	3.429	-3.678	-0.183	7.111	7.5	0.062	0.00224	0.0	0.0	1999	-30.0	86.7
6	0.167	0.119	1.537	1.473	7.143	4.187	20.8	0.484	0.00224	0.0	0.0	1500	-30.0	86.9
7	0.303	0.224	3.082	1.528	9.391	6.634	20.8	0.486	0.00224	0.0	0.0	1999	-30.0	86.9
8	0.361	0.316	3.152	3.177	8.947	6.801	20.7	0.480	0.00224	-0.0	-3.0	1999	-30.0	87.0
9	0.262	0.182	1.509	2.459	6.188	4.227	20.6	0.475	0.00224	0.0	-3.0	1500	-30.0	87.0
10	0.274	0.182	1.558	3.006	6.240	4.279	20.9	0.487	0.00224	-1.0	-3.0	1500	-30.0	87.1
11	0.442	0.302	3.176	3.779	9.340	6.886	21.1	0.497	0.00224	-1.0	-3.0	1999	-30.0	87.2
12	0.389	0.290	3.087	2.050	9.401	6.673	20.8	0.482	0.00224	-1.0	0.0	1999	-30.0	87.4
13	0.343	0.214	1.579	2.442	7.057	4.223	20.9	0.488	0.00224	-1.0	0.0	1500	-30.0	87.5
14	0.329	0.217	1.673	3.305	7.041	4.292	20.7	0.481	0.00224	-3.0	0.0	1500	-30.0	87.5
15	-0.194	-0.186	3.278	-3.236	-2.017	6.782	8.8	0.086	0.00224	-3.0	0.0	1999	-30.0	87.3
16	-0.096	-0.189	3.381	-3.686	-1.288	6.967	10.1	0.114	0.00224	-0.0	0.0	1999	-30.0	87.2
17	0.236	0.092	1.523	1.338	6.890	4.137	20.6	0.476	0.00224	0.0	0.0	1500	-30.0	87.2
18	0.325	0.199	3.091	1.499	9.020	6.580	20.4	0.466	0.00224	0.0	0.0	1999	-30.0	87.2
19	0.536	0.346	3.392	4.039	9.921	6.846	20.8	0.484	0.00224	-3.0	0.0	1999	-30.0	87.3
20	0.368	0.225	1.705	3.330	6.928	4.282	20.6	0.476	0.00224	-3.0	0.0	1500	-30.0	87.3
21	0.425	0.189	1.600	3.169	6.070	4.276	20.4	0.467	0.00224	-3.0	-3.0	1500	-30.0	87.4
22	0.548	0.306	3.228	3.516	8.990	6.904	20.6	0.477	0.00224	-3.0	-3.0	1999	-30.0	87.4
23	0.543	0.262	3.088	1.691	9.208	6.580	20.8	0.483	0.00224	0.0	0.0	1999	-30.0	87.7
24	0.109	-0.054	3.150	-1.368	-1.293	6.685	7.5	0.062	0.00224	0.0	0.0	1999	-30.0	87.9
25	0.030	-0.153	3.477	-4.409	-1.395	6.830	9.2	0.095	0.00224	0.0	0.0	1999	0.0	87.9
28	-0.000	0.000	-0.000	0.000	0.000	0.000	2.9	0.009	0.00224	0.0	0.0	0	-	88.0

Table F.106: Testing conditions and rotor 4 loads in the hub coordinate system for run 134.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.007	0.000	0.008	0.000	0.008	0.000	0.9	0.001	0.00224	-0.0	0.0	0	-	86.4
4	0.112	-0.471	2.873	5.184	-0.045	-5.694	7.6	0.065	0.00224	-0.0	0.0	2000	0.0	86.6
5	0.088	-0.470	3.031	5.441	-0.679	-5.783	7.5	0.062	0.00224	0.0	0.0	2000	0.0	86.7
6	0.299	-0.300	1.077	-1.582	6.612	-2.975	20.8	0.484	0.00224	0.0	0.0	1500	0.0	86.9
7	0.445	-0.318	2.543	-1.495	8.857	-5.231	20.8	0.486	0.00224	0.0	0.0	1999	0.0	86.9
8	0.469	-0.283	2.539	-2.384	8.234	-5.365	20.7	0.480	0.00224	-0.0	-3.0	1999	0.0	87.0
9	0.318	-0.279	0.994	-2.107	5.768	-3.046	20.6	0.475	0.00224	0.0	-3.0	1500	0.0	87.0
10	0.351	-0.286	1.059	-2.539	5.788	-3.111	20.9	0.487	0.00224	-1.0	-3.0	1500	0.0	87.1
11	0.532	-0.308	2.612	-3.261	8.385	-5.443	21.1	0.497	0.00224	-1.0	-3.0	1999	0.0	87.2
12	0.463	-0.362	2.606	-1.876	8.918	-5.310	20.8	0.482	0.00224	-1.0	0.0	1999	0.0	87.4
13	0.378	-0.340	1.065	-2.365	6.680	-3.065	20.9	0.488	0.00224	-1.0	0.0	1500	0.0	87.5
14	0.319	-0.335	1.230	-2.831	6.630	-3.136	20.7	0.481	0.00224	-3.0	0.0	1500	0.0	87.5
15	0.042	-0.444	2.607	2.881	-1.489	-5.358	8.8	0.086	0.00224	-3.0	0.0	1999	0.0	87.3
16	0.090	-0.463	2.880	4.912	-2.010	-5.477	10.1	0.114	0.00224	-0.0	0.0	2000	0.0	87.2
17	0.234	-0.316	1.124	-1.541	6.605	-2.951	20.6	0.476	0.00224	0.0	0.0	1500	0.0	87.2
18	0.318	-0.333	2.727	-1.515	8.674	-5.223	20.4	0.466	0.00224	0.0	0.0	1999	0.0	87.2
19	0.481	-0.322	2.877	-3.996	9.400	-5.511	20.8	0.484	0.00224	-3.0	0.0	1999	0.0	87.3
20	0.282	-0.330	1.276	-2.857	6.610	-3.117	20.6	0.476	0.00224	-3.0	0.0	1500	0.0	87.3
21	0.299	-0.299	1.009	-2.742	5.727	-3.125	20.4	0.467	0.00224	-3.0	-3.0	1500	0.0	87.4
22	0.503	-0.297	2.644	-3.925	8.194	-5.557	20.6	0.477	0.00224	-3.0	-3.0	1999	0.0	87.4
23	0.462	-0.376	2.486	-1.417	8.911	-5.251	20.8	0.483	0.00224	0.0	0.0	1999	0.0	87.7
24	0.225	-0.444	2.480	2.015	-1.189	-5.334	7.5	0.062	0.00224	0.0	0.0	2000	0.0	87.9
25	0.206	-0.473	2.631	3.634	-2.952	-5.348	9.2	0.095	0.00224	0.0	0.0	1999	0.0	87.9
28	-0.000	0.000	-0.000	0.000	0.000	0.000	2.9	0.009	0.00224	0.0	0.0	0	-	88.0

Run 135: 6-bladed Concept Quadrotor

Table F.107: Run 135 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	6
RPM	1500
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	0

Table F.108: Testing conditions and rotor 1 loads in the hub coordinate system for run 135.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.000	0.000	-0.000	0.000	0.000	0.000	0.4	0.000	0.00224	0.0	0.0	0	-	87.6
4	0.129	0.091	3.380	-3.520	2.209	-5.976	7.2	0.058	0.00224	-0.0	0.0	2000	0.0	87.4
5	0.583	0.013	2.618	-2.072	11.164	-3.122	20.7	0.478	0.00224	0.0	0.0	1500	0.0	87.2
8	0.907	-0.015	4.333	-2.450	16.506	-5.324	20.7	0.481	0.00224	0.0	0.0	2000	0.0	87.9
9	1.127	-0.102	4.269	-5.645	16.899	-3.189	41.1	1.888	0.00223	-0.0	0.0	1500	0.0	88.5
10	1.078	-0.108	4.097	-5.451	16.446	-3.271	41.3	1.901	0.00223	-1.0	0.0	1500	0.0	88.5
11	0.965	-0.100	3.802	-5.664	15.783	-3.346	41.3	1.900	0.00223	-3.0	0.0	1500	0.0	88.7
12	0.812	-0.111	3.422	-6.068	14.452	-3.464	41.2	1.889	0.00223	-5.0	0.0	1500	0.0	88.7
13	0.453	-0.076	2.741	-6.300	11.586	-3.624	41.4	1.910	0.00223	-10.0	0.0	1500	0.0	89.0
14	0.288	-0.078	2.264	-6.095	9.974	-3.671	41.3	1.897	0.00223	-10.0	-3.0	1500	0.0	89.0
15	0.634	-0.119	2.909	-6.088	12.453	-3.592	41.4	1.909	0.00223	-5.0	-3.0	1500	0.0	89.1
16	0.785	-0.133	3.248	-5.909	13.841	-3.506	41.2	1.892	0.00223	-3.0	-3.0	1500	0.0	89.1
17	0.925	-0.145	3.627	-5.761	15.148	-3.393	41.2	1.888	0.00223	-1.0	-3.0	1500	0.0	89.1
18	0.995	-0.144	3.676	-5.773	15.489	-3.377	41.2	1.894	0.00223	0.0	-3.0	1500	0.0	89.2
19	-0.000	0.000	-0.000	0.000	0.000	0.000	3.9	0.017	0.00223	0.0	0.0	0	-	88.4

Table F.109: Testing conditions and rotor 2 loads in the hub coordinate system for run 135.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.000	0.000	-0.000	0.000	0.000	0.000	0.4	0.000	0.00224	0.0	0.0	0	-	87.6
4	0.040	-0.034	3.655	4.305	1.541	6.734	7.2	0.058	0.00224	-0.0	0.0	1999	0.0	87.4
5	0.189	0.037	2.720	1.986	11.358	3.769	20.7	0.478	0.00224	0.0	0.0	1500	0.0	87.2
8	0.301	0.112	4.495	2.677	16.661	6.172	20.7	0.481	0.00224	0.0	0.0	2000	0.0	87.9
9	0.478	0.151	4.293	4.767	17.100	3.873	41.1	1.888	0.00223	-0.0	0.0	1500	0.0	88.5
10	0.442	0.150	4.139	4.817	16.540	3.927	41.3	1.901	0.00223	-1.0	0.0	1500	0.0	88.5
11	0.347	0.143	3.745	5.249	15.314	4.044	41.3	1.900	0.00223	-3.0	0.0	1500	0.0	88.7
12	0.249	0.125	3.386	5.308	13.993	4.125	41.2	1.889	0.00223	-5.0	0.0	1500	0.0	88.7
13	0.009	0.093	2.729	5.615	11.528	4.241	41.4	1.910	0.00223	-10.0	0.0	1500	0.0	89.0
14	-0.119	0.120	2.286	5.556	9.909	4.223	41.3	1.897	0.00223	-10.0	-3.0	1500	0.0	89.0
15	0.101	0.171	2.968	5.749	12.602	4.172	41.4	1.909	0.00223	-5.0	-3.0	1500	0.0	89.1
16	0.200	0.184	3.279	5.300	13.894	4.103	41.2	1.892	0.00223	-3.0	-3.0	1500	0.0	89.1
17	0.285	0.196	3.570	4.924	14.887	4.042	41.2	1.888	0.00223	-1.0	-3.0	1500	0.0	89.1
18	0.338	0.199	3.758	4.817	15.820	3.993	41.2	1.894	0.00223	0.0	-3.0	1500	0.0	89.2
19	-0.000	0.000	-0.000	0.000	0.000	0.000	3.9	0.017	0.00223	0.0	0.0	0	-	88.4

Table F.110: Testing conditions and rotor 3 loads in the hub coordinate system for run 135.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.000	0.000	-0.000	0.000	0.000	0.000	0.4	0.000	0.00224	0.0	0.0	0	-	87.6
4	0.111	-0.185	3.302	-3.643	0.495	7.027	7.2	0.058	0.00224	-0.0	0.0	2000	0.0	87.4
5	0.358	0.065	1.553	1.396	6.980	4.124	20.7	0.478	0.00224	0.0	0.0	1500	0.0	87.2
8	0.541	0.215	3.085	1.523	9.114	6.554	20.7	0.481	0.00224	0.0	0.0	1999	0.0	87.9
9	1.006	0.384	2.395	5.680	12.087	4.560	41.1	1.888	0.00223	-0.0	0.0	1500	0.0	88.5
10	0.990	0.407	2.413	6.326	12.077	4.577	41.3	1.901	0.00223	-1.0	0.0	1500	0.0	88.5
11	0.942	0.462	2.509	7.680	11.840	4.604	41.3	1.900	0.00223	-3.0	0.0	1500	0.0	88.7
12	0.851	0.454	2.459	7.502	11.274	4.623	41.2	1.889	0.00223	-5.0	0.0	1499	0.0	88.7
13	0.604	0.429	2.125	7.738	9.755	4.636	41.4	1.910	0.00223	-10.0	0.0	1500	0.0	89.0
14	0.408	0.380	1.657	7.436	8.034	4.478	41.3	1.897	0.00223	-10.0	-3.0	1500	0.0	89.0
15	0.660	0.425	2.074	7.939	9.767	4.633	41.4	1.909	0.00223	-5.0	-3.0	1500	0.0	89.1
16	0.740	0.425	2.195	7.584	10.270	4.631	41.2	1.892	0.00223	-3.0	-3.0	1500	0.0	89.1
17	0.790	0.391	2.133	6.216	10.611	4.629	41.2	1.888	0.00223	-1.0	-3.0	1499	0.0	89.1
18	0.815	0.379	2.080	6.162	10.600	4.613	41.2	1.894	0.00223	0.0	-3.0	1500	0.0	89.2
19	-0.000	0.000	-0.000	0.000	0.000	0.000	3.9	0.017	0.00223	0.0	0.0	0	-	88.4

Table F.111: Testing conditions and rotor 4 loads in the hub coordinate system for run 135.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	-0.000	0.000	-0.000	0.000	0.000	0.000	0.4	0.000	0.00224	0.0	0.0	0	-	87.6
4	0.089	-0.458	2.894	6.004	-0.189	-5.799	7.2	0.058	0.00224	-0.0	0.0	1999	0.0	87.4
5	0.244	-0.307	1.047	-1.489	6.692	-2.962	20.7	0.478	0.00224	0.0	0.0	1500	0.0	87.2
8	0.427	-0.349	2.529	-1.395	8.859	-5.238	20.7	0.481	0.00224	0.0	0.0	2000	0.0	87.9
9	0.752	-0.285	1.941	-8.093	11.643	-3.417	41.1	1.888	0.00223	-0.0	0.0	1500	0.0	88.5
10	0.724	-0.286	1.965	-8.157	11.555	-3.459	41.3	1.901	0.00223	-1.0	0.0	1500	0.0	88.5
11	0.648	-0.286	1.911	-8.613	11.062	-3.495	41.3	1.900	0.00223	-3.0	0.0	1500	0.0	88.7
12	0.547	-0.287	1.827	-8.631	10.586	-3.507	41.2	1.889	0.00223	-5.0	0.0	1500	0.0	88.7
13	0.302	-0.283	1.421	-8.259	8.734	-3.440	41.4	1.910	0.00223	-10.0	0.0	1500	0.0	89.0
14	0.157	-0.246	1.052	-8.031	7.387	-3.289	41.3	1.897	0.00223	-10.0	-3.0	1500	0.0	89.0
15	0.406	-0.250	1.506	-8.397	9.144	-3.460	41.4	1.909	0.00223	-5.0	-3.0	1500	0.0	89.1
16	0.503	-0.254	1.605	-8.370	9.657	-3.475	41.2	1.892	0.00223	-3.0	-3.0	1500	0.0	89.1
17	0.586	-0.259	1.609	-8.068	9.938	-3.476	41.2	1.888	0.00223	-1.0	-3.0	1500	0.0	89.1
18	0.637	-0.262	1.634	-8.007	10.129	-3.450	41.2	1.894	0.00223	0.0	-3.0	1500	0.0	89.2
19	-0.000	0.000	-0.000	0.000	0.000	0.000	3.9	0.017	0.00223	0.0	0.0	0	-	88.4

Run 136: 6-bladed Concept Quadrotor

Table F.112: Run 136 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	3000 to 200 (Δ200)
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	0, -90

Table F.113: Testing conditions and rotor 1 loads in the hub coordinate system for run 136.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.033	0.000	-0.069	0.000	0.026	0.000	0.5	0.000	0.00233	0.0	0.0	0	-	68.6
4	-0.139	0.139	-0.660	-0.091	0.361	0.259	0.8	0.001	0.00233	0.0	0.0	200	0.0	68.8
5	-0.101	0.120	-0.494	-0.101	0.320	0.128	0.3	0.000	0.00233	-0.0	0.0	400	0.0	68.8
6	-0.082	0.135	-0.362	-0.167	0.348	-0.040	0.6	0.000	0.00233	0.0	0.0	599	0.0	68.8
7	-0.050	0.134	-0.094	-0.212	0.355	-0.262	2.5	0.007	0.00233	-0.0	0.0	799	0.0	68.8
8	-0.052	0.144	0.052	-0.264	0.388	-0.497	3.6	0.015	0.00233	-0.0	0.0	999	0.0	68.8
9	-0.051	0.153	0.271	-0.365	0.326	-0.749	3.6	0.015	0.00233	-0.0	0.0	1199	0.0	68.8
10	-0.041	0.154	0.579	-0.618	0.225	-1.096	4.4	0.023	0.00233	0.0	0.0	1399	0.0	68.9
11	-0.018	0.156	0.885	-0.452	0.642	-1.463	5.2	0.031	0.00233	-0.0	0.0	1599	0.0	68.9
12	-0.033	0.136	1.280	-1.073	-0.166	-1.949	5.6	0.036	0.00233	0.0	0.0	1800	0.0	68.8
13	0.012	0.143	1.740	-1.819	0.579	-2.424	6.5	0.049	0.00233	-0.0	0.0	1999	0.0	68.9
14	0.007	0.166	2.107	-0.334	0.882	-2.937	6.9	0.055	0.00233	-0.0	0.0	2199	0.0	68.9
15	0.080	0.107	2.812	-2.479	1.378	-3.536	7.1	0.059	0.00233	0.0	0.0	2400	0.0	68.9
16	0.056	0.136	3.246	-2.473	0.543	-4.146	7.9	0.074	0.00233	-0.0	0.0	2600	0.0	68.9
17	0.067	0.133	3.851	-2.512	0.674	-4.800	8.8	0.090	0.00233	0.0	0.0	2800	0.0	68.9
18	0.167	0.102	4.670	-3.381	2.373	-5.630	10.2	0.121	0.00233	-0.0	0.0	2999	0.0	68.9
19	0.070	0.154	3.740	-0.838	1.213	-4.813	9.2	0.099	0.00233	-0.0	0.0	2799	0.0	69.0
20	0.086	0.128	3.286	-1.713	1.344	-4.171	9.0	0.095	0.00233	0.0	0.0	2600	0.0	69.0
21	0.049	0.160	2.630	0.308	1.513	-3.452	8.5	0.084	0.00233	-0.0	0.0	2400	0.0	69.0
22	0.025	0.135	2.098	-0.665	0.669	-2.897	7.6	0.067	0.00233	-0.0	0.0	2200	0.0	69.0
23	0.032	0.111	1.715	-1.181	0.915	-2.397	6.0	0.042	0.00233	-0.0	0.0	2000	0.0	69.1
24	0.003	0.121	1.292	-0.611	0.484	-1.956	6.0	0.042	0.00233	0.0	0.0	1799	0.0	69.1
25	0.005	0.128	0.919	-0.186	0.809	-1.481	5.6	0.036	0.00233	-0.0	0.0	1600	0.0	69.1
26	-0.024	0.124	0.589	-0.254	0.629	-1.101	4.9	0.028	0.00233	-0.0	0.0	1400	0.0	69.1
27	-0.035	0.120	0.322	-0.254	0.552	-0.750	3.7	0.016	0.00233	-0.0	0.0	1200	0.0	69.1
28	-0.046	0.115	0.107	-0.186	0.425	-0.470	3.3	0.013	0.00233	-0.0	0.0	1000	0.0	69.2
29	-0.048	0.110	-0.075	-0.069	0.452	-0.238	2.5	0.007	0.00233	0.0	0.0	800	0.0	69.2
30	-0.070	0.113	-0.333	-0.106	0.352	-0.011	1.7	0.004	0.00233	0.0	0.0	600	0.0	69.2
31	-0.112	0.106	-0.457	0.000	0.330	0.150	0.7	0.001	0.00233	0.0	0.0	400	0.0	69.2
32	-0.165	0.126	-0.608	-0.039	0.335	0.285	0.0	0.000	0.00233	0.0	0.0	200	0.0	69.2
33	-0.163	0.151	-0.593	-0.066	0.329	0.279	0.0	0.000	0.00233	0.0	0.0	200	0.0	69.4
34	-0.124	0.132	-0.436	-0.103	0.289	0.141	0.0	0.000	0.00233	-0.0	0.0	399	0.0	69.4

Continued on next page

Table F.113: Testing conditions and rotor 1 loads in the hub coordinate system for run 136.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	-0.099	0.156	-0.313	-0.129	0.416	-0.030	0.2	0.000	0.00233	-0.0	0.0	599	0.0	69.4
36	-0.063	0.160	-0.078	-0.094	0.309	-0.252	2.6	0.008	0.00233	0.0	0.0	799	0.0	69.4
37	-0.062	0.163	0.132	-0.460	0.238	-0.510	3.3	0.013	0.00233	0.0	0.0	999	0.0	69.4
38	-0.055	0.186	0.317	-0.212	0.433	-0.765	3.7	0.016	0.00233	-0.0	0.0	1200	0.0	69.4
39	-0.051	0.184	0.592	-0.250	0.492	-1.107	4.2	0.020	0.00233	-0.0	0.0	1399	0.0	69.5
40	-0.032	0.172	1.016	-1.066	0.346	-1.521	4.7	0.026	0.00233	-0.0	0.0	1599	0.0	69.5
41	-0.005	0.164	1.406	-1.582	0.351	-1.978	5.1	0.030	0.00233	0.0	0.0	1799	0.0	69.5
42	-0.007	0.179	1.673	-1.048	0.687	-2.376	5.6	0.036	0.00233	-0.0	0.0	1999	0.0	69.5
43	0.014	0.171	2.173	-1.532	0.725	-2.903	6.0	0.042	0.00233	-0.0	0.0	2199	0.0	69.6
44	0.024	0.179	2.645	-0.974	1.078	-3.503	7.1	0.059	0.00233	-0.0	0.0	2400	0.0	69.6
45	0.042	0.163	3.270	-2.194	0.725	-4.164	7.7	0.069	0.00233	-0.0	0.0	2599	0.0	69.6
46	0.058	0.190	3.722	-1.181	1.223	-4.799	8.2	0.079	0.00233	0.0	0.0	2800	0.0	69.6
47	0.035	0.200	4.285	-0.846	0.555	-5.481	9.8	0.111	0.00233	-0.0	0.0	2999	0.0	69.6
48	0.080	0.189	3.746	-0.400	1.995	-4.735	9.8	0.112	0.00233	-0.0	0.0	2800	0.0	69.6
49	0.052	0.188	3.113	-0.306	1.317	-4.153	8.7	0.087	0.00233	0.0	0.0	2600	0.0	69.7
50	0.042	0.183	2.713	-0.307	1.193	-3.591	8.1	0.075	0.00233	0.0	0.0	2400	0.0	69.7
51	0.026	0.158	2.150	-1.140	0.708	-2.989	7.3	0.062	0.00233	-0.0	0.0	2200	0.0	69.7
52	-0.007	0.190	1.786	0.726	0.952	-2.477	6.2	0.045	0.00233	-0.0	0.0	1999	0.0	69.7
53	-0.013	0.159	1.276	-0.535	0.597	-1.972	5.8	0.039	0.00233	-0.0	0.0	1799	0.0	69.8
54	-0.025	0.144	0.896	-0.337	0.705	-1.505	4.9	0.028	0.00233	-0.0	0.0	1599	0.0	69.8
55	-0.034	0.145	0.602	-0.300	0.719	-1.118	4.5	0.024	0.00233	0.0	0.0	1400	0.0	69.8
56	-0.050	0.148	0.347	-0.192	0.437	-0.808	4.4	0.022	0.00233	-0.0	0.0	1200	0.0	69.8
57	-0.060	0.148	0.106	-0.182	0.377	-0.536	3.8	0.016	0.00233	0.0	0.0	1000	0.0	69.9
58	-0.064	0.148	-0.071	-0.021	0.371	-0.287	2.3	0.006	0.00233	-0.0	0.0	800	0.0	69.9
59	-0.089	0.141	-0.308	-0.122	0.294	-0.088	1.5	0.002	0.00233	0.0	0.0	600	0.0	69.9
60	-0.117	0.133	-0.441	-0.063	0.313	0.091	0.8	0.001	0.00233	-0.0	0.0	400	0.0	69.9
61	-0.177	0.156	-0.589	-0.059	0.309	0.214	0.0	0.000	0.00233	-0.0	0.0	200	0.0	69.9
62	-0.044	0.000	-0.067	0.000	0.023	0.000	0.0	0.000	0.00233	0.0	0.0	0	-	70.0

Table F.114: Testing conditions and rotor 2 loads in the hub coordinate system for run 136.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	0.008	0.000	0.024	0.000	-0.001	0.000	0.5	0.000	0.00233	0.0	0.0	0	-	68.6
4	-0.042	-0.125	-0.492	0.296	0.109	0.294	0.8	0.001	0.00233	0.0	0.0	200	0.0	68.8
5	-0.098	-0.110	-0.462	0.284	0.181	0.380	0.3	0.000	0.00233	-0.0	0.0	399	0.0	68.8
6	-0.075	-0.094	-0.262	0.334	0.234	0.507	0.6	0.000	0.00233	0.0	0.0	600	0.0	68.8
7	-0.058	-0.080	-0.088	0.179	0.205	0.718	2.5	0.007	0.00233	-0.0	0.0	799	0.0	68.8
8	-0.059	-0.087	0.085	0.353	0.244	0.975	3.6	0.015	0.00233	-0.0	0.0	999	0.0	68.8
9	-0.054	-0.076	0.355	0.561	0.223	1.286	3.6	0.015	0.00233	-0.0	0.0	1200	0.0	68.8
10	-0.055	-0.071	0.688	0.884	0.358	1.629	4.4	0.023	0.00233	0.0	0.0	1399	0.0	68.9
11	-0.057	-0.080	0.993	0.874	0.578	1.969	5.2	0.031	0.00233	-0.0	0.0	1599	0.0	68.9
12	-0.021	-0.074	1.313	0.899	0.146	2.389	5.6	0.036	0.00233	0.0	0.0	1799	0.0	68.8
13	-0.024	-0.070	1.857	1.584	0.325	2.963	6.5	0.049	0.00233	-0.0	0.0	1999	0.0	68.9
14	-0.016	-0.074	2.357	1.072	0.586	3.383	6.9	0.055	0.00233	-0.0	0.0	2199	0.0	68.9
15	-0.043	-0.063	2.790	1.429	0.859	4.013	7.1	0.059	0.00233	0.0	0.0	2399	0.0	68.9
16	-0.019	-0.057	3.276	1.677	0.800	4.596	7.9	0.074	0.00233	-0.0	0.0	2599	0.0	68.9
17	-0.018	-0.063	3.917	1.017	1.035	5.344	8.8	0.090	0.00233	0.0	0.0	2799	0.0	68.9
18	-0.050	-0.044	4.541	2.559	0.679	6.032	10.2	0.121	0.00233	-0.0	0.0	2999	0.0	68.9
19	-0.027	-0.066	3.948	1.010	1.246	5.304	9.2	0.099	0.00233	-0.0	0.0	2800	0.0	69.0
20	-0.005	-0.074	3.284	0.047	1.286	4.665	9.0	0.095	0.00233	0.0	0.0	2600	0.0	69.0
21	-0.049	-0.059	2.869	1.263	0.777	4.029	8.5	0.084	0.00233	-0.0	0.0	2400	0.0	69.0
22	-0.039	-0.056	2.291	0.719	1.449	3.397	7.6	0.067	0.00233	-0.0	0.0	2200	0.0	69.0
23	-0.050	-0.053	1.790	1.076	0.872	2.891	6.0	0.042	0.00233	-0.0	0.0	2000	0.0	69.1
24	-0.079	-0.057	1.368	1.051	0.493	2.460	6.0	0.042	0.00233	0.0	0.0	1800	0.0	69.1
25	-0.087	-0.052	1.049	0.934	0.591	1.978	5.6	0.036	0.00233	-0.0	0.0	1600	0.0	69.1
26	-0.081	-0.068	0.640	0.359	0.457	1.617	4.9	0.028	0.00233	-0.0	0.0	1400	0.0	69.1
27	-0.091	-0.063	0.362	0.446	0.301	1.268	3.7	0.016	0.00233	-0.0	0.0	1200	0.0	69.1
28	-0.095	-0.066	0.122	0.277	0.291	0.995	3.3	0.013	0.00233	-0.0	0.0	1000	0.0	69.2
29	-0.095	-0.061	-0.046	0.423	0.202	0.750	2.5	0.007	0.00233	0.0	0.0	800	0.0	69.2
30	-0.103	-0.076	-0.245	0.250	0.309	0.536	1.7	0.004	0.00233	0.0	0.0	600	0.0	69.2
31	-0.132	-0.089	-0.428	0.229	0.170	0.415	0.7	0.001	0.00233	0.0	0.0	400	0.0	69.2
32	-0.098	-0.093	-0.442	0.283	0.133	0.321	0.0	0.000	0.00233	0.0	0.0	200	0.0	69.2
33	-0.081	-0.109	-0.422	0.286	0.124	0.312	0.0	0.000	0.00233	0.0	0.0	200	-90.0	69.4
34	-0.131	-0.099	-0.411	0.289	0.189	0.400	0.0	0.000	0.00233	-0.0	0.0	400	-90.0	69.4

Continued on next page

Table F.114: Testing conditions and rotor 2 loads in the hub coordinate system for run 136.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
35	-0.106	-0.080	-0.212	0.345	0.185	0.525	0.2	0.000	0.00233	-0.0	0.0	599	-90.0	69.4
36	-0.087	-0.073	-0.049	0.321	0.180	0.731	2.6	0.008	0.00233	0.0	0.0	799	-90.0	69.4
37	-0.089	-0.080	0.116	0.394	0.118	0.979	3.3	0.013	0.00233	0.0	0.0	999	-90.0	69.4
38	-0.070	-0.082	0.394	0.480	0.141	1.268	3.7	0.016	0.00233	-0.0	0.0	1200	-90.0	69.4
39	-0.072	-0.078	0.691	0.908	-0.021	1.607	4.2	0.020	0.00233	-0.0	0.0	1399	-90.0	69.5
40	-0.055	-0.085	0.973	0.613	0.116	1.986	4.7	0.026	0.00233	-0.0	0.0	1599	-90.0	69.5
41	-0.039	-0.071	1.459	1.382	0.240	2.428	5.1	0.030	0.00233	0.0	0.0	1799	-90.0	69.5
42	-0.035	-0.077	1.894	1.373	0.827	2.876	5.6	0.036	0.00233	-0.0	0.0	1999	-90.0	69.5
43	-0.042	-0.084	2.227	1.113	0.691	3.418	6.0	0.042	0.00233	-0.0	0.0	2199	-90.0	69.6
44	-0.038	-0.065	2.872	1.991	0.545	3.978	7.1	0.059	0.00233	-0.0	0.0	2399	-90.0	69.6
45	-0.016	-0.088	3.284	1.755	0.340	4.607	7.7	0.069	0.00233	-0.0	0.0	2599	-90.0	69.6
46	-0.023	-0.061	4.097	2.616	0.761	5.226	8.2	0.079	0.00233	0.0	0.0	2799	-90.0	69.6
47	-0.011	-0.073	4.611	2.135	1.154	6.021	9.8	0.111	0.00233	-0.0	0.0	2999	-90.0	69.6
48	-0.002	-0.087	3.844	1.533	0.772	5.171	9.8	0.112	0.00233	-0.0	0.0	2800	-90.0	69.6
49	-0.003	-0.084	3.360	1.085	0.959	4.521	8.7	0.087	0.00233	0.0	0.0	2600	-90.0	69.7
50	-0.024	-0.076	2.885	1.642	0.978	3.975	8.1	0.075	0.00233	0.0	0.0	2399	-90.0	69.7
51	-0.028	-0.084	2.272	1.097	1.046	3.390	7.3	0.062	0.00233	-0.0	0.0	2200	-90.0	69.7
52	-0.016	-0.093	1.921	0.728	0.798	2.902	6.2	0.045	0.00233	-0.0	0.0	2000	-90.0	69.7
53	-0.017	-0.087	1.389	0.841	0.427	2.392	5.8	0.039	0.00233	-0.0	0.0	1800	-90.0	69.8
54	-0.043	-0.092	1.019	0.803	0.306	1.960	4.9	0.028	0.00233	-0.0	0.0	1600	-90.0	69.8
55	-0.036	-0.093	0.619	0.439	0.220	1.550	4.5	0.024	0.00233	0.0	0.0	1400	-90.0	69.8
56	-0.037	-0.099	0.364	0.291	0.460	1.235	4.4	0.022	0.00233	-0.0	0.0	1200	-90.0	69.8
57	-0.047	-0.092	0.142	0.425	0.233	0.949	3.8	0.016	0.00233	0.0	0.0	1000	-90.0	69.9
58	-0.040	-0.090	-0.036	0.224	0.333	0.681	2.3	0.006	0.00233	-0.0	0.0	800	-90.0	69.9
59	-0.051	-0.104	-0.235	0.295	0.147	0.483	1.5	0.002	0.00233	0.0	0.0	600	-90.0	69.9
60	-0.072	-0.120	-0.433	0.274	0.142	0.357	0.8	0.001	0.00233	-0.0	0.0	400	-90.0	69.9
61	-0.037	-0.121	-0.426	0.272	0.085	0.261	0.0	0.000	0.00233	-0.0	0.0	200	-90.0	69.9
62	0.002	0.000	0.029	0.000	-0.005	0.000	0.0	0.000	0.00233	0.0	0.0	0	-	70.0

Table F.115: Testing conditions and rotor 3 loads in the hub coordinate system for run 136.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	0.043	0.000	0.025	0.000	0.009	0.000	0.5	0.000	0.00233	0.0	0.0	0	-	68.6
4	0.093	-0.168	-0.708	0.187	0.132	0.587	0.8	0.001	0.00233	0.0	0.0	200	0.0	68.8
5	0.052	-0.140	-0.619	0.164	0.201	0.602	0.3	0.000	0.00233	-0.0	0.0	399	0.0	68.8
6	0.061	-0.133	-0.507	0.105	0.085	0.780	0.6	0.000	0.00233	0.0	0.0	599	0.0	68.8
7	0.049	-0.111	-0.331	-0.099	0.076	0.958	2.5	0.007	0.00233	-0.0	0.0	799	0.0	68.8
8	0.058	-0.115	-0.147	-0.219	-0.035	1.208	3.6	0.015	0.00233	-0.0	0.0	999	0.0	68.8
9	0.071	-0.108	0.090	-0.453	-0.057	1.515	3.6	0.015	0.00233	-0.0	0.0	1200	0.0	68.8
10	0.077	-0.105	0.379	-0.705	-0.142	1.846	4.4	0.023	0.00233	0.0	0.0	1399	0.0	68.9
11	0.072	-0.102	0.755	-1.061	-0.453	2.237	5.2	0.031	0.00233	-0.0	0.0	1599	0.0	68.9
12	0.068	-0.102	1.200	-1.089	-0.697	2.628	5.6	0.036	0.00233	0.0	0.0	1799	0.0	68.8
13	0.068	-0.104	1.553	-1.465	-0.341	3.153	6.5	0.049	0.00233	-0.0	0.0	1999	0.0	68.9
14	0.077	-0.117	2.145	-2.006	-0.880	3.551	6.9	0.055	0.00233	-0.0	0.0	2199	0.0	68.9
15	0.084	-0.104	2.521	-2.306	-0.034	4.250	7.1	0.059	0.00233	0.0	0.0	2399	0.0	68.9
16	0.042	-0.133	3.203	-2.921	-1.313	4.854	7.9	0.074	0.00233	-0.0	0.0	2599	0.0	68.9
17	0.035	-0.151	3.809	-3.851	-1.420	5.518	8.8	0.090	0.00233	0.0	0.0	2799	0.0	68.9
18	0.037	-0.162	4.422	-4.279	-1.079	6.166	10.2	0.121	0.00233	-0.0	0.0	3000	0.0	68.9
19	0.028	-0.156	3.818	-3.039	-1.637	5.378	9.2	0.099	0.00233	-0.0	0.0	2800	0.0	69.0
20	0.036	-0.142	3.208	-2.930	-0.381	4.819	9.0	0.095	0.00233	0.0	0.0	2600	0.0	69.0
21	0.002	-0.125	2.540	-1.286	-1.702	4.148	8.5	0.084	0.00233	-0.0	0.0	2400	0.0	69.0
22	0.012	-0.134	2.022	-1.676	-1.051	3.514	7.6	0.067	0.00233	-0.0	0.0	2200	0.0	69.0
23	0.007	-0.131	1.615	-1.465	-0.548	3.063	6.0	0.042	0.00233	-0.0	0.0	2000	0.0	69.1
24	0.014	-0.140	1.140	-1.263	-0.430	2.547	6.0	0.042	0.00233	0.0	0.0	1800	0.0	69.1
25	0.019	-0.113	0.729	-0.549	-0.458	2.183	5.6	0.036	0.00233	-0.0	0.0	1599	0.0	69.1
26	0.010	-0.129	0.380	-0.674	-0.094	1.801	4.9	0.028	0.00233	-0.0	0.0	1400	0.0	69.1
27	0.008	-0.124	0.112	-0.405	0.058	1.495	3.7	0.016	0.00233	-0.0	0.0	1200	0.0	69.1
28	-0.010	-0.123	-0.154	-0.244	-0.035	1.211	3.3	0.013	0.00233	-0.0	0.0	1000	0.0	69.2
29	-0.012	-0.109	-0.346	0.027	-0.052	0.953	2.5	0.007	0.00233	0.0	0.0	800	0.0	69.2
30	-0.012	-0.133	-0.584	0.129	0.162	0.775	1.7	0.004	0.00233	0.0	0.0	600	0.0	69.2
31	-0.005	-0.137	-0.642	0.143	0.149	0.602	0.7	0.001	0.00233	0.0	0.0	400	0.0	69.2
32	0.057	-0.151	-0.695	0.186	0.125	0.586	0.0	0.000	0.00233	0.0	0.0	200	0.0	69.2
33	0.099	-0.149	-0.692	0.172	0.090	0.582	0.0	0.000	0.00233	0.0	0.0	200	-90.0	69.4
34	0.056	-0.114	-0.618	0.165	0.142	0.599	0.0	0.000	0.00233	-0.0	0.0	399	-90.0	69.4

Continued on next page

Table F.115: Testing conditions and rotor 3 loads in the hub coordinate system for run 136.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	0.075	-0.104	-0.507	0.097	-0.018	0.771	0.2	0.000	0.00233	-0.0	0.0	599	-90.0	69.4
36	0.065	-0.088	-0.303	-0.150	-0.013	0.951	2.6	0.008	0.00233	0.0	0.0	800	-90.0	69.4
37	0.089	-0.087	-0.117	-0.281	-0.105	1.213	3.3	0.013	0.00233	0.0	0.0	1000	-90.0	69.4
38	0.114	-0.085	0.108	-0.546	-0.195	1.494	3.7	0.016	0.00233	-0.0	0.0	1200	-90.0	69.4
39	0.137	-0.082	0.387	-0.717	-0.212	1.828	4.2	0.020	0.00233	-0.0	0.0	1399	-90.0	69.5
40	0.160	-0.082	0.756	-1.230	-0.151	2.228	4.7	0.026	0.00233	-0.0	0.0	1599	-90.0	69.5
41	0.154	-0.083	1.216	-1.429	-0.394	2.648	5.1	0.030	0.00233	0.0	0.0	1799	-90.0	69.5
42	0.170	-0.093	1.574	-1.911	-0.496	3.085	5.6	0.036	0.00233	-0.0	0.0	1999	-90.0	69.5
43	0.184	-0.078	2.008	-1.824	-0.359	3.668	6.0	0.042	0.00233	-0.0	0.0	2199	-90.0	69.6
44	0.162	-0.096	2.595	-2.040	-1.824	4.140	7.1	0.059	0.00233	-0.0	0.0	2399	-90.0	69.6
45	0.161	-0.095	3.160	-2.610	-1.521	4.806	7.7	0.069	0.00233	-0.0	0.0	2599	-90.0	69.6
46	0.179	-0.109	3.750	-3.232	-1.591	5.347	8.2	0.079	0.00233	0.0	0.0	2800	-90.0	69.6
47	0.138	-0.125	4.473	-3.626	-2.496	6.035	9.8	0.111	0.00233	-0.0	0.0	2999	-90.0	69.6
48	0.142	-0.120	3.900	-2.888	-2.559	5.332	9.8	0.112	0.00233	-0.0	0.0	2800	-90.0	69.6
49	0.169	-0.106	3.314	-2.445	-1.784	4.682	8.7	0.087	0.00233	0.0	0.0	2600	-90.0	69.7
50	0.169	-0.091	2.656	-1.703	-1.743	4.042	8.1	0.075	0.00233	0.0	0.0	2400	-90.0	69.7
51	0.175	-0.086	2.069	-1.737	-1.080	3.554	7.3	0.062	0.00233	-0.0	0.0	2200	-90.0	69.7
52	0.164	-0.074	1.550	-1.122	-0.756	3.085	6.2	0.045	0.00233	-0.0	0.0	2000	-90.0	69.7
53	0.176	-0.083	1.192	-1.219	-0.659	2.557	5.8	0.039	0.00233	-0.0	0.0	1800	-90.0	69.8
54	0.180	-0.071	0.780	-0.756	-0.243	2.179	4.9	0.028	0.00233	-0.0	0.0	1599	-90.0	69.8
55	0.184	-0.071	0.456	-0.623	-0.170	1.804	4.5	0.024	0.00233	0.0	0.0	1400	-90.0	69.8
56	0.170	-0.066	0.142	-0.424	-0.343	1.474	4.4	0.022	0.00233	-0.0	0.0	1200	-90.0	69.8
57	0.172	-0.066	-0.076	-0.320	-0.074	1.196	3.8	0.016	0.00233	0.0	0.0	1000	-90.0	69.9
58	0.165	-0.055	-0.270	-0.014	-0.086	0.946	2.3	0.006	0.00233	-0.0	0.0	800	-90.0	69.9
59	0.171	-0.070	-0.485	-0.004	-0.014	0.730	1.5	0.002	0.00233	0.0	0.0	600	-90.0	69.9
60	0.173	-0.072	-0.582	0.098	0.026	0.565	0.8	0.001	0.00233	-0.0	0.0	400	-90.0	69.9
61	0.233	-0.092	-0.634	0.146	0.010	0.551	0.0	0.000	0.00233	-0.0	0.0	200	-90.0	69.9
62	0.052	0.000	0.041	0.000	-0.004	0.000	0.0	0.000	0.00233	0.0	0.0	0	-	70.0

Table F.116: Testing conditions and rotor 4 loads in the hub coordinate system for run 136.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.007	0.000	0.030	0.000	-0.006	0.000	0.5	0.000	0.00233	0.0	0.0	0	-	68.6
4	-0.093	-0.397	-1.058	0.550	-0.045	0.494	0.8	0.001	0.00233	0.0	0.0	200	0.0	68.8
5	-0.122	-0.371	-0.869	0.544	0.021	0.320	0.3	0.000	0.00233	-0.0	0.0	399	0.0	68.8
6	-0.074	-0.406	-0.777	0.611	-0.045	0.196	0.6	0.000	0.00233	0.0	0.0	599	0.0	68.8
7	-0.028	-0.350	-0.573	0.711	-0.231	0.014	2.5	0.007	0.00233	-0.0	0.0	799	0.0	68.8
8	-0.012	-0.375	-0.397	0.886	-0.448	-0.198	3.6	0.015	0.00233	-0.0	0.0	999	0.0	68.8
9	0.008	-0.382	-0.175	1.159	-0.320	-0.445	3.6	0.015	0.00233	-0.0	0.0	1199	0.0	68.8
10	0.042	-0.381	0.111	1.273	-0.287	-0.763	4.4	0.023	0.00233	0.0	0.0	1399	0.0	68.9
11	0.051	-0.395	0.415	1.816	-0.454	-1.119	5.2	0.031	0.00233	-0.0	0.0	1599	0.0	68.9
12	0.076	-0.374	0.796	1.834	-0.408	-1.525	5.6	0.036	0.00233	0.0	0.0	1800	0.0	68.8
13	0.091	-0.379	1.267	2.016	-1.182	-1.906	6.5	0.049	0.00233	-0.0	0.0	1999	0.0	68.9
14	0.114	-0.381	1.604	2.184	-1.041	-2.444	6.9	0.055	0.00233	-0.0	0.0	2199	0.0	68.9
15	0.138	-0.377	2.159	2.529	-0.900	-2.940	7.1	0.059	0.00233	0.0	0.0	2399	0.0	68.9
16	0.155	-0.358	2.733	2.505	-1.602	-3.509	7.9	0.074	0.00233	-0.0	0.0	2600	0.0	68.9
17	0.153	-0.355	3.462	4.162	-2.282	-4.083	8.8	0.090	0.00233	0.0	0.0	2799	0.0	68.9
18	0.162	-0.363	4.054	4.322	-2.248	-4.746	10.2	0.121	0.00233	-0.0	0.0	3000	0.0	68.9
19	0.126	-0.364	3.338	3.582	-2.529	-4.016	9.2	0.099	0.00233	-0.0	0.0	2800	0.0	69.0
20	0.112	-0.353	2.727	2.754	-2.204	-3.338	9.0	0.095	0.00233	0.0	0.0	2600	0.0	69.0
21	0.073	-0.381	2.136	2.902	-0.985	-2.917	8.5	0.084	0.00233	-0.0	0.0	2400	0.0	69.0
22	0.065	-0.366	1.703	2.476	-1.055	-2.386	7.6	0.067	0.00233	-0.0	0.0	2200	0.0	69.0
23	0.055	-0.361	1.277	2.172	-0.563	-1.919	6.0	0.042	0.00233	-0.0	0.0	2000	0.0	69.1
24	0.026	-0.380	0.774	1.873	-0.700	-1.455	6.0	0.042	0.00233	0.0	0.0	1799	0.0	69.1
25	0.025	-0.373	0.467	1.566	-0.109	-1.160	5.6	0.036	0.00233	-0.0	0.0	1600	0.0	69.1
26	0.001	-0.383	0.167	1.265	-0.523	-0.758	4.9	0.028	0.00233	-0.0	0.0	1400	0.0	69.1
27	-0.014	-0.381	-0.160	0.905	-0.461	-0.467	3.7	0.016	0.00233	-0.0	0.0	1200	0.0	69.1
28	-0.014	-0.379	-0.394	0.879	-0.222	-0.193	3.3	0.013	0.00233	-0.0	0.0	1000	0.0	69.2
29	-0.019	-0.368	-0.537	0.760	-0.216	0.002	2.5	0.007	0.00233	0.0	0.0	800	0.0	69.2
30	-0.064	-0.428	-0.761	0.699	-0.110	0.204	1.7	0.004	0.00233	0.0	0.0	600	0.0	69.2
31	-0.099	-0.395	-0.827	0.587	-0.027	0.310	0.7	0.001	0.00233	0.0	0.0	400	0.0	69.2
32	-0.057	-0.409	-1.004	0.564	-0.115	0.485	0.0	0.000	0.00233	0.0	0.0	200	0.0	69.2
33	-0.035	-0.394	-0.985	0.563	-0.121	0.484	0.0	0.000	0.00233	0.0	0.0	200	0.0	69.4
34	-0.065	-0.364	-0.807	0.586	-0.029	0.310	0.0	0.000	0.00233	-0.0	0.0	400	0.0	69.4

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Table F.116: Testing conditions and rotor 4 loads in the hub coordinate system for run 136.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
35	-0.020	-0.396	-0.729	0.661	-0.137	0.193	0.2	0.000	0.00233	-0.0	0.0	599	0.0	69.4
36	0.022	-0.350	-0.547	0.806	-0.242	0.001	2.6	0.008	0.00233	0.0	0.0	799	0.0	69.4
37	0.051	-0.372	-0.385	0.951	-0.246	-0.209	3.3	0.013	0.00233	0.0	0.0	999	0.0	69.4
38	0.079	-0.372	-0.151	1.110	-0.254	-0.474	3.7	0.016	0.00233	-0.0	0.0	1199	0.0	69.4
39	0.101	-0.380	0.191	1.543	-0.694	-0.782	4.2	0.020	0.00233	-0.0	0.0	1399	0.0	69.5
40	0.127	-0.377	0.408	1.603	-0.343	-1.065	4.7	0.026	0.00233	-0.0	0.0	1599	0.0	69.5
41	0.151	-0.371	0.839	1.920	-0.289	-1.535	5.1	0.030	0.00233	0.0	0.0	1799	0.0	69.5
42	0.162	-0.374	1.229	2.515	-0.122	-1.978	5.6	0.036	0.00233	-0.0	0.0	1999	0.0	69.5
43	0.177	-0.372	1.764	2.480	-1.280	-2.364	6.0	0.042	0.00233	-0.0	0.0	2199	0.0	69.6
44	0.186	-0.374	2.170	3.196	-0.942	-2.944	7.1	0.059	0.00233	-0.0	0.0	2399	0.0	69.6
45	0.207	-0.366	2.693	3.427	-1.232	-3.472	7.7	0.069	0.00233	-0.0	0.0	2599	0.0	69.6
46	0.212	-0.355	3.335	4.136	-1.296	-4.156	8.2	0.079	0.00233	0.0	0.0	2800	0.0	69.6
47	0.220	-0.348	3.983	4.668	-2.079	-4.708	9.8	0.111	0.00233	-0.0	0.0	3000	0.0	69.6
48	0.182	-0.353	3.360	4.027	-2.171	-4.097	9.8	0.112	0.00233	-0.0	0.0	2800	0.0	69.6
49	0.163	-0.361	2.636	3.026	-0.876	-3.477	8.7	0.087	0.00233	0.0	0.0	2600	0.0	69.7
50	0.134	-0.358	2.146	3.190	-0.627	-2.923	8.1	0.075	0.00233	0.0	0.0	2400	0.0	69.7
51	0.117	-0.364	1.702	2.233	-1.513	-2.364	7.3	0.062	0.00233	-0.0	0.0	2200	0.0	69.7
52	0.103	-0.353	1.276	1.740	-1.381	-1.881	6.2	0.045	0.00233	-0.0	0.0	2000	0.0	69.7
53	0.093	-0.360	0.828	1.926	-0.484	-1.501	5.8	0.039	0.00233	-0.0	0.0	1800	0.0	69.8
54	0.075	-0.361	0.455	1.353	-0.517	-1.092	4.9	0.028	0.00233	-0.0	0.0	1599	0.0	69.8
55	0.071	-0.359	0.115	1.284	-0.457	-0.761	4.5	0.024	0.00233	0.0	0.0	1400	0.0	69.8
56	0.060	-0.354	-0.171	0.791	-0.650	-0.446	4.4	0.022	0.00233	-0.0	0.0	1200	0.0	69.8
57	0.054	-0.360	-0.395	0.878	-0.307	-0.215	3.8	0.016	0.00233	0.0	0.0	1000	0.0	69.9
58	0.045	-0.340	-0.541	0.608	-0.297	-0.009	2.3	0.006	0.00233	-0.0	0.0	800	0.0	69.9
59	0.011	-0.393	-0.732	0.710	-0.039	0.194	1.5	0.002	0.00233	0.0	0.0	600	0.0	69.9
60	-0.037	-0.370	-0.828	0.565	-0.067	0.312	0.8	0.001	0.00233	-0.0	0.0	400	0.0	69.9
61	0.007	-0.390	-1.009	0.534	-0.150	0.482	0.0	0.000	0.00233	-0.0	0.0	200	0.0	69.9
62	0.007	0.000	0.029	0.000	-0.014	0.000	0.0	0.000	0.00233	0.0	0.0	0	-	70.0

Run 137: Equal Height Quadrotor, Weight Tare

Table F.117: Run 137 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	0
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	0

Table F.118: Testing conditions and rotor 1 loads in the hub coordinate system for run 137.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
4	-0.063	0.000	0.069	0.000	-0.110	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	71.1
5	-0.027	-0.041	-0.064	0.038	-0.016	-0.008	0.0	0.000	0.00232	0.0	-3.0	0	-	71.1
6	-0.025	-0.033	-0.073	0.031	-0.030	-0.006	0.0	0.000	0.00232	-1.0	-3.0	0	-	71.1
7	-0.055	0.001	0.089	-0.004	-0.149	0.000	0.0	0.000	0.00232	-1.0	0.0	0	-	71.2
8	-0.056	0.003	0.105	-0.003	-0.182	0.002	0.0	0.000	0.00232	-3.0	0.0	0	-	71.2
9	-0.031	-0.035	-0.077	0.034	-0.041	-0.004	0.0	0.000	0.00232	-3.0	-3.0	0	-	71.3
10	-0.030	-0.036	-0.078	0.027	-0.064	-0.005	0.0	0.000	0.00232	-5.0	-3.0	0	-	71.3
11	-0.063	0.001	0.109	-0.005	-0.206	0.002	0.0	0.000	0.00232	-5.0	0.0	0	-	71.3
12	-0.076	0.003	0.133	-0.011	-0.263	0.003	0.0	0.000	0.00232	-10.0	0.0	0	-	71.4
13	-0.036	-0.035	-0.075	0.025	-0.117	-0.004	0.0	0.000	0.00232	-10.0	-3.0	0	-	71.4
14	-0.035	-0.036	-0.078	0.030	-0.057	-0.009	0.0	0.000	0.00232	-5.0	-3.0	0	-	71.5
15	-0.069	-0.003	0.110	0.001	-0.200	-0.001	0.0	0.000	0.00232	-5.0	0.0	0	-	71.5
16	-0.073	-0.002	0.102	0.000	-0.159	-0.004	0.0	0.000	0.00232	-3.0	0.0	0	-	71.6
17	-0.043	-0.038	-0.078	0.035	-0.023	-0.010	0.0	0.000	0.00232	-3.0	-3.0	0	-	71.6
18	-0.035	-0.038	-0.076	0.037	-0.009	-0.009	0.0	0.000	0.00232	-1.0	-3.0	0	-	71.7
19	-0.060	0.000	0.088	0.000	-0.134	-0.001	0.0	0.000	0.00232	-1.0	0.0	0	-	71.7
20	-0.063	-0.002	0.073	0.002	-0.109	-0.002	0.0	0.000	0.00232	-0.0	0.0	0	-	71.8
21	-0.039	-0.041	-0.069	0.038	0.016	-0.008	0.0	0.000	0.00232	-0.0	-3.0	0	-	71.8
22	-0.062	0.000	0.069	0.000	-0.110	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	71.8

Table F.119: Testing conditions and rotor 2 loads in the hub coordinate system for run 137.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
4	-0.127	0.000	0.018	0.000	-0.043	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	71.1
5	0.010	0.048	0.036	-0.031	-0.057	-0.040	0.0	0.000	0.00232	0.0	-3.0	0	-	71.1
6	0.017	0.048	0.038	-0.030	-0.071	-0.037	0.0	0.000	0.00232	-1.0	-3.0	0	-	71.1
7	-0.131	0.003	0.033	-0.005	-0.064	0.007	0.0	0.000	0.00232	-1.0	0.0	0	-	71.2
8	-0.138	0.005	0.047	-0.004	-0.082	0.005	0.0	0.000	0.00232	-3.0	0.0	0	-	71.2
9	0.016	0.049	0.038	-0.029	-0.085	-0.040	0.0	0.000	0.00232	-3.0	-3.0	0	-	71.3
10	0.016	0.053	0.038	-0.031	-0.109	-0.042	0.0	0.000	0.00232	-5.0	-3.0	0	-	71.3
11	-0.144	0.011	0.033	-0.004	-0.113	0.006	0.0	0.000	0.00232	-5.0	0.0	0	-	71.3
12	-0.150	0.010	0.041	-0.000	-0.171	0.000	0.0	0.000	0.00232	-10.0	0.0	0	-	71.4
13	0.017	0.055	0.026	-0.024	-0.166	-0.044	0.0	0.000	0.00232	-10.0	-3.0	0	-	71.4
14	0.022	0.053	0.036	-0.031	-0.114	-0.043	0.0	0.000	0.00232	-5.0	-3.0	0	-	71.5
15	-0.141	0.009	0.025	-0.002	-0.113	0.005	0.0	0.000	0.00232	-5.0	0.0	0	-	71.5
16	-0.136	0.002	0.040	0.001	-0.075	-0.001	0.0	0.000	0.00232	-3.0	0.0	0	-	71.6
17	0.019	0.048	0.032	-0.024	-0.081	-0.046	0.0	0.000	0.00232	-3.0	-3.0	0	-	71.6
18	0.017	0.046	0.030	-0.028	-0.061	-0.044	0.0	0.000	0.00232	-1.0	-3.0	0	-	71.7
19	-0.131	0.004	0.030	-0.004	-0.053	0.003	0.0	0.000	0.00232	-1.0	0.0	0	-	71.7
20	-0.123	-0.004	0.020	0.004	-0.045	0.000	0.0	0.000	0.00232	-0.0	0.0	0	-	71.8
21	0.016	0.043	0.024	-0.025	-0.040	-0.047	0.0	0.000	0.00232	-0.0	-3.0	0	-	71.8
22	-0.127	0.000	0.018	0.000	-0.043	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	71.8

Table F.120: Testing conditions and rotor 3 loads in the hub coordinate system for run 137.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
4	-0.147	0.000	-0.026	0.000	-0.065	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	71.1
5	0.048	-0.000	0.035	0.001	-0.021	0.014	0.0	0.000	0.00232	0.0	-3.0	0	-	71.1
6	0.051	-0.002	0.035	0.007	-0.034	0.011	0.0	0.000	0.00232	-1.0	-3.0	0	-	71.1
7	-0.143	0.004	-0.018	0.002	-0.094	0.006	0.0	0.000	0.00232	-1.0	0.0	0	-	71.2
8	-0.143	0.003	-0.012	0.005	-0.119	0.007	0.0	0.000	0.00232	-3.0	0.0	0	-	71.2
9	0.056	-0.003	0.024	0.003	-0.064	0.013	0.0	0.000	0.00232	-3.0	-3.0	0	-	71.3
10	0.052	-0.003	0.020	0.008	-0.085	0.012	0.0	0.000	0.00232	-5.0	-3.0	0	-	71.3
11	-0.144	0.004	-0.015	0.003	-0.153	0.009	0.0	0.000	0.00232	-5.0	0.0	0	-	71.3
12	-0.148	-0.001	0.004	0.015	-0.221	0.010	0.0	0.000	0.00232	-10.0	0.0	0	-	71.4
13	0.039	-0.004	0.020	0.016	-0.129	0.009	0.0	0.000	0.00232	-10.0	-3.0	0	-	71.4
14	0.052	-0.005	0.025	0.010	-0.073	0.003	0.0	0.000	0.00232	-5.0	-3.0	0	-	71.5
15	-0.149	0.001	-0.014	0.007	-0.149	0.002	0.0	0.000	0.00232	-5.0	0.0	0	-	71.5
16	-0.142	0.001	-0.020	0.008	-0.116	0.002	0.0	0.000	0.00232	-3.0	0.0	0	-	71.6
17	0.051	-0.005	0.023	0.007	-0.052	0.006	0.0	0.000	0.00232	-3.0	-3.0	0	-	71.6
18	0.046	-0.003	0.032	0.006	-0.020	0.006	0.0	0.000	0.00232	-1.0	-3.0	0	-	71.7
19	-0.145	-0.001	-0.018	0.008	-0.079	-0.001	0.0	0.000	0.00232	-1.0	0.0	0	-	71.7
20	-0.142	-0.001	-0.028	0.002	-0.070	0.000	0.0	0.000	0.00232	-0.0	0.0	0	-	71.8
21	0.045	-0.008	0.027	0.006	-0.008	0.003	0.0	0.000	0.00232	-0.0	-3.0	0	-	71.8
22	-0.147	0.000	-0.026	0.000	-0.065	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	71.8

Table F.121: Testing conditions and rotor 4 loads in the hub coordinate system for run 137.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
4	-0.099	0.000	0.013	0.000	-0.086	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	71.1
5	-0.006	0.022	0.036	-0.013	-0.039	-0.012	0.0	0.000	0.00232	0.0	-3.0	0	-	71.1
6	-0.011	0.022	0.036	-0.006	-0.046	-0.011	0.0	0.000	0.00232	-1.0	-3.0	0	-	71.1
7	-0.107	0.003	0.035	0.002	-0.115	-0.001	0.0	0.000	0.00232	-1.0	0.0	0	-	71.2
8	-0.098	0.002	0.051	0.013	-0.149	-0.002	0.0	0.000	0.00232	-3.0	0.0	0	-	71.2
9	-0.015	0.024	0.031	-0.002	-0.068	-0.014	0.0	0.000	0.00232	-3.0	-3.0	0	-	71.3
10	-0.024	0.028	0.033	0.005	-0.088	-0.013	0.0	0.000	0.00232	-5.0	-3.0	0	-	71.3
11	-0.099	0.010	0.045	0.014	-0.180	-0.002	0.0	0.000	0.00232	-5.0	0.0	0	-	71.3
12	-0.111	0.010	0.063	0.037	-0.250	-0.007	0.0	0.000	0.00232	-10.0	0.0	0	-	71.4
13	-0.028	0.033	0.029	0.019	-0.139	-0.017	0.0	0.000	0.00232	-10.0	-3.0	0	-	71.4
14	-0.027	0.030	0.032	0.001	-0.080	-0.013	0.0	0.000	0.00232	-5.0	-3.0	0	-	71.5
15	-0.102	0.011	0.045	0.013	-0.173	-0.001	0.0	0.000	0.00232	-5.0	0.0	0	-	71.5
16	-0.105	0.004	0.047	0.008	-0.137	-0.003	0.0	0.000	0.00232	-3.0	0.0	0	-	71.6
17	-0.022	0.025	0.031	-0.003	-0.058	-0.014	0.0	0.000	0.00232	-3.0	-3.0	0	-	71.6
18	-0.026	0.015	0.033	-0.006	-0.026	-0.016	0.0	0.000	0.00232	-1.0	-3.0	0	-	71.7
19	-0.109	-0.000	0.032	0.003	-0.100	-0.002	0.0	0.000	0.00232	-1.0	0.0	0	-	71.7
20	-0.109	-0.007	0.014	0.006	-0.075	-0.005	0.0	0.000	0.00232	-0.0	0.0	0	-	71.8
21	-0.007	0.015	0.036	-0.009	-0.021	-0.012	0.0	0.000	0.00232	-0.0	-3.0	0	-	71.8
22	-0.099	0.000	0.013	0.000	-0.086	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	71.8

Run 140: Equal Height Quadrotor

Table F.122: Run 140 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R4
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	none

Table F.123: Testing conditions and rotor 4 loads in the hub coordinate system for run 140.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	-0.099	0.000	0.013	0.000	-0.085	0.000	0.5	0.000	0.00232	-0.0	0.0	0	-	67.9
4	0.204	-0.355	1.334	1.485	-0.250	-1.973	2.3	0.006	0.00232	-0.0	0.0	1999	-	67.9
5	0.370	-0.381	1.737	-1.855	5.827	-1.744	20.5	0.487	0.00232	-0.0	0.0	1999	-	67.5
6	0.545	-0.396	2.978	-2.112	8.505	-2.909	20.7	0.497	0.00232	-0.0	0.0	2499	-	67.4
7	0.772	-0.463	4.553	-2.275	10.512	-4.417	20.3	0.480	0.00232	-0.0	0.0	3000	-	67.2
8	0.809	-0.423	4.392	-1.854	10.090	-4.546	20.4	0.486	0.00232	-0.0	-3.0	3000	-	67.2
9	0.573	-0.380	2.925	-2.181	7.864	-3.038	20.2	0.475	0.00232	-0.0	-3.0	2500	-	67.2
10	0.422	-0.378	1.658	-1.887	5.282	-1.860	20.4	0.483	0.00232	-0.0	-3.0	1999	-	67.2
11	0.400	-0.393	1.685	-1.860	5.271	-1.859	20.2	0.476	0.00232	-1.0	-3.0	1999	-	67.1
12	0.581	-0.395	2.930	-1.816	7.707	-3.043	20.3	0.478	0.00232	-1.0	-3.0	2499	-	67.1
13	0.770	-0.418	4.453	-1.713	10.227	-4.538	20.3	0.479	0.00232	-1.0	-3.0	2999	-	67.1
14	0.722	-0.429	4.537	-1.640	10.576	-4.413	20.1	0.469	0.00232	-1.0	0.0	2999	-	67.1
15	0.520	-0.384	2.991	-2.119	8.027	-2.980	20.3	0.480	0.00232	-1.0	0.0	2500	-	67.1
16	0.368	-0.390	1.803	-1.844	5.661	-1.769	20.4	0.486	0.00232	-1.0	0.0	2000	-	67.1
17	0.369	-0.390	1.742	-1.998	5.122	-1.876	20.5	0.487	0.00232	-3.0	0.0	2000	-	67.1
18	0.538	-0.396	3.007	-2.122	7.748	-3.045	20.5	0.487	0.00232	-3.0	0.0	2499	-	67.1
19	0.735	-0.416	4.513	-1.576	10.342	-4.495	20.3	0.480	0.00232	-3.0	0.0	3000	-	67.2
20	0.750	-0.388	4.357	-1.639	9.792	-4.640	20.3	0.477	0.00232	-3.0	-3.0	3000	-	67.1
21	0.540	-0.360	2.879	-1.916	7.295	-3.149	20.3	0.478	0.00232	-3.0	-3.0	2500	-	67.2
22	0.374	-0.367	1.614	-2.002	4.939	-1.926	20.3	0.480	0.00232	-3.0	-3.0	2000	-	67.1
23	0.371	-0.358	1.604	-1.852	4.682	-1.982	20.4	0.485	0.00232	-5.0	-3.0	2000	-	67.1
24	0.501	-0.357	2.791	-2.028	6.884	-3.215	20.3	0.479	0.00232	-5.0	-3.0	2499	-	67.2
25	0.699	-0.374	4.290	-1.795	9.266	-4.731	20.5	0.487	0.00232	-5.0	-3.0	2999	-	67.3
26	0.683	-0.385	4.460	-1.531	9.871	-4.607	20.4	0.485	0.00232	-5.0	0.0	2999	-	67.2
27	0.490	-0.367	2.982	-2.039	7.486	-3.090	20.4	0.482	0.00232	-5.0	0.0	2500	-	67.2
28	0.315	-0.375	1.663	-1.880	4.955	-1.906	20.4	0.485	0.00232	-5.0	0.0	2000	-	67.2
29	0.304	-0.379	1.622	-1.885	4.281	-1.995	20.5	0.487	0.00232	-10.0	0.0	2000	-	67.3
30	0.459	-0.368	2.857	-2.029	6.475	-3.246	20.6	0.493	0.00232	-10.0	0.0	2500	-	67.3
31	0.627	-0.368	4.305	-1.770	8.795	-4.760	20.4	0.482	0.00232	-10.0	0.0	2999	-	67.3
32	0.617	-0.352	4.176	-1.780	8.492	-4.802	20.5	0.487	0.00232	-10.0	-3.0	3000	-	67.3
33	0.398	-0.334	2.673	-1.980	6.021	-3.300	20.2	0.476	0.00232	-10.0	-3.0	2500	-	67.4
34	0.221	-0.327	1.405	-2.052	4.111	-2.054	19.9	0.462	0.00232	-10.0	-3.0	2000	-	67.3

Continued on next page

Table F.123: Testing conditions and rotor 4 loads in the hub coordinate system for run 140.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
35	0.511	-0.337	1.423	-4.889	4.581	-2.143	40.3	1.890	0.00232	-10.0	-3.0	1999	-	67.4
36	0.710	-0.355	2.768	-5.443	7.423	-3.388	40.4	1.897	0.00232	-10.0	-3.0	2499	-	67.4
37	0.982	-0.354	4.371	-5.365	11.006	-4.870	40.5	1.904	0.00232	-10.0	-3.0	2999	-	67.4
38	1.034	-0.374	4.786	-5.305	12.082	-4.767	40.4	1.899	0.00232	-10.0	0.0	3000	-	67.5
39	0.770	-0.357	3.136	-5.562	8.160	-3.314	40.3	1.889	0.00232	-10.0	0.0	2500	-	67.6
40	0.555	-0.380	1.708	-5.191	5.137	-2.090	40.3	1.889	0.00232	-10.0	0.0	2000	-	67.6
41	0.616	-0.405	2.065	-5.464	6.052	-1.970	40.3	1.882	0.00232	-5.0	0.0	1999	-	67.7
42	0.884	-0.420	3.541	-5.822	9.516	-3.087	40.4	1.894	0.00232	-5.0	0.0	2499	-	67.6
43	1.214	-0.413	5.224	-5.319	13.997	-4.490	40.5	1.905	0.00232	-5.0	0.0	2999	-	67.6
44	1.191	-0.361	4.914	-5.385	12.802	-4.721	40.4	1.898	0.00232	-5.0	-3.0	2999	-	67.6
45	0.900	-0.357	3.241	-5.588	8.671	-3.256	40.5	1.901	0.00232	-5.0	-3.0	2500	-	67.6
46	0.608	-0.342	1.780	-5.088	5.385	-2.056	40.2	1.872	0.00232	-5.0	-3.0	1999	-	67.7
47	0.631	-0.358	1.948	-5.379	5.806	-1.993	40.5	1.909	0.00232	-3.0	-3.0	2000	-	67.7
48	0.916	-0.389	3.418	-5.785	9.282	-3.157	40.6	1.913	0.00232	-3.0	-3.0	2499	-	67.7
49	1.221	-0.394	5.060	-5.271	13.596	-4.580	40.5	1.901	0.00232	-3.0	-3.0	2999	-	67.7
50	1.232	-0.415	5.351	-5.151	14.534	-4.363	40.4	1.894	0.00232	-3.0	0.0	3000	-	67.8
51	0.928	-0.384	3.724	-5.813	9.927	-2.989	40.3	1.886	0.00232	-3.0	0.0	2500	-	67.8
52	0.611	-0.366	2.266	-5.549	6.318	-1.898	40.4	1.892	0.00232	-3.0	0.0	2000	-	67.7
53	0.648	-0.359	2.383	-5.635	6.537	-1.856	40.6	1.917	0.00232	-1.0	0.0	1999	-	67.9
54	0.643	-0.364	2.395	-5.588	6.545	-1.859	40.4	1.898	0.00232	-1.0	0.0	2000	-	67.9
55	0.942	-0.399	3.870	-5.781	10.527	-2.935	40.6	1.908	0.00232	-1.0	0.0	2499	-	68.0
56	1.262	-0.407	5.506	-5.019	15.335	-4.287	40.5	1.903	0.00232	-1.0	0.0	2999	-	68.0
57	1.271	-0.380	5.215	-5.219	14.336	-4.443	40.6	1.909	0.00232	-1.0	-3.0	2999	-	68.0
58	0.953	-0.362	3.548	-5.810	9.763	-3.060	40.6	1.909	0.00232	-1.0	-3.0	2500	-	68.0
59	0.661	-0.317	2.125	-5.438	6.090	-1.937	40.3	1.885	0.00232	-1.0	-3.0	2000	-	68.0
60	0.683	-0.330	2.153	-5.472	6.223	-1.891	40.3	1.884	0.00232	-0.0	-3.0	1999	-	68.2
61	0.969	-0.368	3.609	-5.750	9.986	-2.995	40.2	1.879	0.00232	-0.0	-3.0	2499	-	68.2
62	1.283	-0.380	5.286	-5.239	14.686	-4.371	40.6	1.916	0.00232	-0.0	-3.0	2999	-	68.2
63	1.289	-0.384	5.589	-4.991	15.741	-4.259	40.7	1.925	0.00232	-0.0	0.0	3000	-	68.2
64	0.944	-0.360	3.954	-5.636	10.766	-2.914	40.5	1.899	0.00232	-0.0	0.0	2500	-	68.3
65	0.648	-0.338	2.471	-5.459	6.555	-1.821	40.5	1.901	0.00232	-0.0	0.0	2000	-	68.3
66	0.449	-0.355	1.724	-1.898	5.860	-1.717	20.4	0.482	0.00232	-0.0	0.0	2000	-	68.3
67	0.281	-0.325	1.400	-0.151	1.281	-2.020	3.5	0.014	0.00232	-0.0	0.0	2000	-	68.4

Continued on next page

Table F.123: Testing conditions and rotor 4 loads in the hub coordinate system for run 140.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
68	0.000	0.000	-0.000	0.000	0.000	0.000	2.2	0.006	0.00232	-0.0	0.0	0	-	68.4

Run 141: Equal Height Quadrotor

Table F.124: Run 141 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	none

Table F.125: Testing conditions and rotor 3 loads in the hub coordinate system for run 141.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.150	0.000	-0.026	0.000	-0.067	0.000	0.0	0.000	0.00232	0.1	0.0	0	-	68.6
4	0.166	-0.077	1.627	-0.948	-0.393	2.965	2.6	0.008	0.00232	0.1	0.0	1999	-	68.6
5	0.333	0.129	1.999	2.132	6.295	2.750	20.3	0.480	0.00232	-0.0	0.0	1999	-	68.5
6	0.459	0.222	3.316	1.823	9.146	3.964	20.4	0.482	0.00232	-0.0	0.0	2499	-	68.6
7	0.587	0.330	4.859	1.314	11.814	5.492	20.3	0.477	0.00232	-0.0	0.0	2999	-	68.7
8	0.679	0.317	4.775	1.534	11.165	5.609	20.4	0.481	0.00232	-0.0	-3.0	2999	-	68.7
9	0.555	0.229	3.190	2.059	8.525	4.055	20.3	0.478	0.00232	-0.0	-3.0	2500	-	68.7
10	0.433	0.137	1.867	2.253	5.784	2.813	20.2	0.475	0.00232	-0.0	-3.0	2000	-	68.8
11	0.367	0.128	1.905	2.331	5.743	2.847	20.6	0.490	0.00232	-1.0	-3.0	2000	-	68.8
13	0.497	0.212	3.171	2.049	8.390	4.103	20.4	0.484	0.00232	-1.0	-3.0	2499	-	68.9
14	0.574	0.282	4.757	1.530	11.172	5.642	20.6	0.491	0.00232	-1.0	-3.0	2999	-	69.1
15	0.504	0.301	4.823	1.508	11.773	5.521	20.5	0.488	0.00232	-1.0	0.0	2999	-	69.1
16	0.380	0.212	3.287	2.001	9.119	3.989	20.6	0.493	0.00232	-1.0	0.0	2500	-	69.1
17	0.225	0.120	1.966	2.171	6.298	2.773	20.3	0.478	0.00232	-1.0	0.0	2000	-	69.2
18	0.245	0.125	1.946	2.243	5.932	2.821	20.4	0.482	0.00231	-3.0	0.0	1999	-	69.3
19	0.370	0.205	3.239	2.078	8.582	4.078	20.4	0.481	0.00231	-3.0	0.0	2499	-	69.3
20	0.506	0.291	4.811	1.455	11.292	5.604	20.4	0.482	0.00231	-3.0	0.0	3000	-	69.3
21	0.603	0.274	4.691	1.498	10.700	5.737	20.4	0.484	0.00231	-3.0	-3.0	3000	-	69.3
22	0.481	0.189	3.088	2.087	8.057	4.187	20.4	0.482	0.00231	-3.0	-3.0	2500	-	69.3
23	0.395	0.106	1.796	2.336	5.360	2.923	20.3	0.476	0.00231	-3.0	-3.0	2000	-	69.3
24	0.393	0.096	1.777	2.363	5.079	2.970	20.3	0.479	0.00231	-5.0	-3.0	2000	-	69.4
25	0.495	0.175	3.072	2.212	7.645	4.257	20.4	0.482	0.00231	-5.0	-3.0	2499	-	69.4
26	0.608	0.267	4.677	1.560	10.317	5.802	20.5	0.489	0.00231	-5.0	-3.0	2999	-	69.4
27	0.534	0.278	4.760	1.497	10.958	5.687	20.4	0.482	0.00231	-5.0	0.0	3000	-	69.5
28	0.410	0.197	3.195	2.035	8.253	4.145	20.2	0.473	0.00231	-5.0	0.0	2500	-	69.5
29	0.298	0.117	1.931	2.320	5.598	2.880	20.3	0.475	0.00231	-5.0	0.0	2000	-	69.5
30	0.263	0.101	1.801	2.323	4.822	3.013	20.5	0.484	0.00231	-10.0	0.0	2000	-	69.7
31	0.386	0.184	3.129	2.191	7.430	4.294	20.5	0.489	0.00231	-10.0	0.0	2499	-	69.7
32	0.527	0.273	4.639	1.784	9.870	5.874	20.5	0.487	0.00231	-10.0	0.0	2999	-	69.8
33	0.643	0.243	4.497	1.842	9.227	5.953	20.5	0.488	0.00231	-10.0	-3.0	2999	-	69.8
34	0.536	0.164	2.958	2.190	6.683	4.356	20.4	0.484	0.00231	-10.0	-3.0	2500	-	69.8
35	0.471	0.089	1.687	2.353	4.450	3.041	20.2	0.473	0.00231	-10.0	-3.0	2000	-	69.8

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Table F.125: Testing conditions and rotor 3 loads in the hub coordinate system for run 141.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
36	0.602	0.272	1.711	5.001	4.993	3.169	40.7	1.913	0.00231	-10.0	-3.0	2000	-	70.2
37	0.803	0.378	3.130	5.413	8.167	4.476	40.7	1.915	0.00231	-10.0	-3.0	2499	-	70.2
38	1.001	0.510	4.771	5.058	11.814	6.054	40.8	1.924	0.00231	-10.0	-3.0	3000	-	70.2
39	1.043	0.562	5.170	4.994	13.316	5.914	40.6	1.907	0.00231	-10.0	0.0	2999	-	70.4
40	0.833	0.446	3.466	5.550	9.104	4.368	40.4	1.886	0.00231	-10.0	0.0	2500	-	70.5
41	0.614	0.320	2.026	5.177	5.735	3.088	40.0	1.849	0.00231	-10.0	0.0	2000	-	70.5
42	0.673	0.396	2.371	5.586	6.818	2.948	40.6	1.905	0.00231	-5.0	0.0	2000	-	70.7
43	0.910	0.550	3.884	5.794	10.619	4.120	40.8	1.921	0.00231	-5.0	0.0	2499	-	70.7
44	1.130	0.656	5.558	4.832	15.177	5.614	40.6	1.906	0.00231	-5.0	0.0	2999	-	70.9
45	1.086	0.600	5.273	5.014	13.977	5.829	40.8	1.918	0.00231	-5.0	-3.0	3000	-	70.9
46	0.877	0.478	3.575	5.476	9.620	4.283	40.6	1.903	0.00231	-5.0	-3.0	2500	-	71.0
47	0.655	0.370	2.084	5.397	6.114	3.042	40.8	1.920	0.00231	-5.0	-3.0	2000	-	71.0
48	0.709	0.428	2.262	5.441	6.457	2.938	40.8	1.916	0.00230	-3.0	-3.0	2000	-	71.5
50	0.933	0.544	3.719	5.587	10.066	4.190	40.7	1.907	0.00230	-3.0	-3.0	2499	-	71.6
51	1.143	0.656	5.435	4.871	14.671	5.697	40.9	1.925	0.00230	-3.0	-3.0	2999	-	71.7
52	1.177	0.709	5.761	4.635	15.925	5.414	40.7	1.911	0.00230	-3.0	0.0	3000	-	71.8
53	0.934	0.575	3.998	5.528	11.013	3.999	40.6	1.902	0.00230	-3.0	0.0	2500	-	71.8
54	0.698	0.459	2.485	5.697	7.014	2.880	40.7	1.903	0.00230	-3.0	0.0	2000	-	72.0
55	0.728	0.478	2.668	5.647	7.284	2.817	40.8	1.915	0.00230	-1.0	0.0	2000	-	72.3
56	0.950	0.616	4.174	5.375	11.585	3.941	40.5	1.890	0.00230	-1.0	0.0	2499	-	72.3
57	1.322	0.738	5.854	4.363	16.623	5.361	40.8	1.910	0.00230	-1.0	-3.0	3000	-	72.5
58	1.117	0.688	5.548	4.726	15.385	5.528	40.7	1.905	0.00230	-1.0	-3.0	3000	-	72.7
59	0.899	0.563	3.886	5.414	10.772	4.025	40.8	1.917	0.00230	-1.0	-3.0	2500	-	72.8
60	0.681	0.447	2.346	5.557	6.851	2.875	40.8	1.909	0.00230	-1.0	-3.0	2000	-	73.0
61	0.710	0.470	2.471	5.423	6.953	2.841	40.6	1.896	0.00230	-0.0	-3.0	2000	-	73.1
62	0.961	0.613	3.955	5.422	10.943	3.981	40.8	1.912	0.00230	-0.0	-3.0	2499	-	73.4
63	1.170	0.725	5.620	4.561	15.617	5.427	40.7	1.905	0.00230	-0.0	-3.0	2999	-	73.6
64	1.187	0.757	5.954	4.266	16.901	5.354	40.7	1.900	0.00230	-0.0	0.0	2999	-	73.6
65	0.944	0.622	4.242	5.317	11.710	3.931	40.7	1.902	0.00230	-0.0	0.0	2500	-	73.6
66	0.685	0.480	2.729	5.571	7.349	2.797	40.8	1.910	0.00229	-0.0	0.0	2000	-	73.8
67	0.409	0.235	1.995	2.055	6.147	2.724	20.6	0.486	0.00230	-0.0	0.0	2000	-	74.0
68	0.248	0.053	1.640	0.456	1.618	2.985	3.5	0.014	0.00230	-0.0	0.0	2000	-	73.9
69	0.000	0.000	-0.000	0.000	0.000	0.000	2.3	0.006	0.00230	-0.0	0.0	0	-	73.9

Run 143: Equal Height Quadrotor, Tandem

Table F.126: Run 143 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	0

Table F.127: Testing conditions and rotor 1 loads in the hub coordinate system for run 143.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.063	0.000	0.069	0.000	-0.110	0.000	0.2	0.000	0.00227	0.0	0.0	0	-	80.2
4	0.103	-0.036	2.175	-1.487	1.091	-2.435	3.8	0.016	0.00226	0.0	0.0	2000	0.0	80.8
5	0.341	-0.017	2.771	-1.652	6.423	-1.907	20.5	0.475	0.00226	0.0	0.0	2000	0.0	81.7
6	0.484	-0.002	4.039	-1.465	9.471	-3.035	20.7	0.483	0.00226	0.0	0.0	2499	0.0	82.3
7	0.710	0.001	5.550	-1.036	12.367	-4.449	20.7	0.481	0.00226	0.0	0.0	2999	0.0	82.4
8	0.762	-0.037	5.498	-1.289	11.668	-4.546	20.8	0.490	0.00226	0.0	-3.0	2999	0.0	82.4
9	0.558	-0.056	3.969	-1.697	8.920	-3.074	20.7	0.484	0.00225	0.0	-3.0	2500	0.0	82.8
10	0.388	-0.069	2.691	-1.922	6.148	-1.909	20.8	0.488	0.00225	0.0	-3.0	2000	0.0	82.9
11	0.361	-0.061	2.679	-1.901	5.948	-1.918	20.6	0.480	0.00225	-1.0	-3.0	2000	0.0	83.2
12	0.495	-0.056	3.957	-1.710	8.611	-3.093	20.6	0.479	0.00225	-1.0	-3.0	2499	0.0	83.4
13	0.706	-0.038	5.501	-1.199	11.395	-4.570	20.6	0.480	0.00225	-1.0	-3.0	2999	0.0	83.6
14	0.694	-0.001	5.579	-1.011	12.094	-4.442	20.6	0.478	0.00225	-1.0	0.0	2999	0.0	83.6
15	0.461	-0.018	4.032	-1.493	9.220	-3.033	20.5	0.471	0.00225	-1.0	0.0	2500	0.0	83.7
16	0.295	-0.017	2.814	-1.723	6.462	-1.874	20.7	0.484	0.00225	-1.0	0.0	2000	0.0	83.9
17	0.277	-0.009	2.801	-1.967	6.067	-1.899	20.8	0.488	0.00225	-3.0	0.0	2000	0.0	84.3
18	0.407	-0.003	4.059	-1.734	8.818	-3.066	20.8	0.487	0.00225	-3.0	0.0	2499	0.0	84.3
19	0.632	0.004	5.595	-1.287	11.617	-4.519	20.9	0.489	0.00225	-3.0	0.0	3000	0.0	84.4
20	0.694	-0.022	5.449	-1.181	10.967	-4.695	20.7	0.480	0.00225	-3.0	-3.0	2999	0.0	84.6
21	0.489	-0.034	3.899	-1.654	8.162	-3.214	20.5	0.474	0.00225	-3.0	-3.0	2500	0.0	84.7
22	0.330	-0.043	2.625	-1.904	5.739	-2.007	20.8	0.485	0.00225	-3.0	-3.0	2000	0.0	84.7
23	0.301	-0.034	2.592	-1.886	5.394	-2.059	20.7	0.479	0.00224	-5.0	-3.0	2000	0.0	84.9
24	0.430	-0.030	3.860	-1.761	7.874	-3.290	20.7	0.483	0.00224	-5.0	-3.0	2499	0.0	85.0
25	0.646	-0.008	5.393	-1.182	10.492	-4.798	20.7	0.480	0.00224	-5.0	-3.0	3000	0.0	85.1
26	0.627	0.011	5.561	-1.218	10.985	-4.648	20.6	0.475	0.00224	-5.0	0.0	3000	0.0	85.1
27	0.396	-0.004	4.037	-1.766	8.326	-3.163	20.8	0.484	0.00224	-5.0	0.0	2500	0.0	85.4
28	0.248	-0.017	2.764	-1.965	5.723	-1.979	20.7	0.479	0.00224	-5.0	0.0	2000	0.0	85.4
29	0.192	0.019	2.668	-1.933	5.024	-2.128	20.8	0.485	0.00224	-10.0	0.0	2000	0.0	85.6
30	0.325	0.015	3.937	-1.752	7.387	-3.365	20.9	0.489	0.00224	-10.0	0.0	2499	0.0	85.6
31	0.528	0.042	5.455	-1.263	9.884	-4.889	20.7	0.480	0.00224	-10.0	0.0	2999	0.0	85.7
32	0.558	0.002	5.199	-1.311	9.350	-4.976	20.7	0.482	0.00224	-10.0	-3.0	3000	0.0	85.8
33	0.385	-0.019	3.665	-1.699	6.844	-3.453	20.6	0.474	0.00224	-10.0	-3.0	2500	0.0	85.9
34	0.233	-0.011	2.411	-1.884	4.648	-2.198	20.8	0.484	0.00224	-10.0	-3.0	2000	0.0	86.0

Continued on next page

Table F.127: Testing conditions and rotor 1 loads in the hub coordinate system for run 143.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	0.409	-0.084	2.557	-4.450	5.409	-2.309	41.3	1.903	0.00224	-10.0	-3.0	2000	0.0	86.6
36	0.570	-0.119	3.993	-4.814	8.489	-3.554	41.2	1.895	0.00224	-10.0	-3.0	2499	0.0	86.6
37	0.884	-0.123	5.626	-4.414	12.161	-5.020	41.4	1.915	0.00224	-10.0	-3.0	2999	0.0	86.7
38	0.975	-0.083	5.968	-4.438	13.371	-4.885	41.2	1.900	0.00223	-10.0	0.0	3000	0.0	87.0
39	0.643	-0.111	4.248	-4.898	9.306	-3.448	41.2	1.898	0.00223	-10.0	0.0	2500	0.0	87.1
40	0.454	-0.081	2.770	-4.862	6.098	-2.278	41.0	1.880	0.00223	-10.0	0.0	2000	0.0	87.2
41	0.495	-0.103	3.180	-5.352	7.061	-2.162	41.2	1.895	0.00223	-5.0	0.0	2000	0.0	87.7
42	0.669	-0.109	4.706	-5.240	10.722	-3.283	41.3	1.900	0.00223	-5.0	0.0	2499	0.0	87.7
44	1.112	-0.131	6.376	-4.396	15.053	-4.631	41.2	1.894	0.00223	-5.0	0.0	2999	0.0	88.0
45	1.121	-0.162	6.122	-4.542	14.339	-4.765	41.4	1.908	0.00223	-5.0	-3.0	2999	0.0	88.0
46	0.772	-0.170	4.394	-5.168	10.039	-3.361	41.3	1.901	0.00223	-5.0	-3.0	2500	0.0	88.1
47	0.557	-0.141	2.871	-5.150	6.590	-2.236	41.0	1.873	0.00223	-5.0	-3.0	1999	0.0	88.1
48	0.555	-0.138	3.011	-5.309	6.922	-2.195	41.1	1.886	0.00223	-3.0	-3.0	2000	0.0	88.3
49	0.756	-0.170	4.529	-5.171	10.456	-3.295	41.2	1.887	0.00223	-3.0	-3.0	2499	0.0	88.3
50	1.157	-0.176	6.244	-4.498	14.947	-4.652	41.2	1.891	0.00223	-3.0	-3.0	2999	0.0	88.4
51	1.153	-0.148	6.480	-4.331	16.006	-4.646	41.1	1.882	0.00223	-3.0	0.0	3000	0.0	88.4
52	0.738	-0.133	4.773	-5.291	11.285	-3.294	41.4	1.905	0.00223	-3.0	0.0	2500	0.0	88.5
53	0.535	-0.117	3.263	-5.288	7.237	-2.168	41.3	1.901	0.00223	-3.0	0.0	2000	0.0	88.5
54	0.507	-0.110	3.413	-5.351	7.427	-2.108	41.4	1.906	0.00223	-1.0	0.0	2000	0.0	88.7
55	0.701	-0.122	4.914	-5.065	11.617	-3.254	41.4	1.910	0.00223	-1.0	0.0	2499	0.0	88.7
56	1.162	-0.138	6.636	-3.835	16.574	-4.600	41.3	1.895	0.00222	-1.0	0.0	3000	0.0	88.8
57	1.178	-0.193	6.309	-4.505	15.594	-4.653	41.3	1.897	0.00222	-1.0	-3.0	3000	0.0	88.8
58	0.802	-0.186	4.633	-5.309	11.007	-3.339	41.4	1.907	0.00222	-1.0	-3.0	2500	0.0	88.9
59	0.580	-0.165	3.090	-5.264	7.136	-2.223	41.4	1.904	0.00222	-1.0	-3.0	2000	0.0	88.8
60	0.567	-0.159	3.189	-5.256	7.140	-2.201	41.2	1.888	0.00222	0.0	-3.0	2000	0.0	89.1
61	0.794	-0.185	4.725	-5.235	11.314	-3.329	41.4	1.904	0.00222	0.0	-3.0	2499	0.0	89.1
62	1.195	-0.199	6.401	-4.386	15.997	-4.688	41.3	1.897	0.00222	0.0	-3.0	3000	0.0	89.2
63	1.186	-0.148	6.712	-3.812	16.737	-4.598	41.3	1.899	0.00222	-0.0	0.0	2999	0.0	89.2
64	0.763	-0.137	4.957	-4.772	11.692	-3.269	41.2	1.889	0.00222	-0.0	0.0	2500	0.0	89.2
65	0.535	-0.138	3.399	-5.348	7.387	-2.132	41.4	1.901	0.00222	-0.0	0.0	2000	0.0	89.3
66	0.348	-0.014	2.562	-1.752	6.462	-2.051	20.9	0.485	0.00222	-0.0	0.0	1999	0.0	89.2
67	0.084	0.075	1.975	-0.395	1.851	-2.361	3.1	0.011	0.00222	-0.0	0.0	1999	0.0	89.2
68	0.000	0.000	-0.000	0.000	0.000	0.000	2.2	0.006	0.00222	-0.0	0.0	0	-	89.2

Table F.128: Testing conditions and rotor 3 loads in the hub coordinate system for run 143.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.148	0.000	-0.026	0.000	-0.065	0.000	0.2	0.000	0.00227	0.0	0.0	0	-	80.2
4	-0.141	-0.154	1.863	-1.649	-0.186	2.829	3.8	0.016	0.00226	0.0	0.0	0	0.0	80.8
5	-0.194	0.203	1.626	2.569	3.089	2.822	20.5	0.475	0.00226	0.0	0.0	0	0.0	81.7
6	-0.185	0.289	2.762	2.951	4.511	4.113	20.7	0.483	0.00226	0.0	0.0	0	0.0	82.3
7	-0.089	0.348	4.195	2.516	6.023	5.693	20.7	0.481	0.00226	0.0	0.0	0	0.0	82.4
8	-0.079	0.338	4.047	2.764	5.269	5.670	20.8	0.490	0.00226	0.0	-3.0	0	0.0	82.4
9	-0.198	0.262	2.581	2.990	3.979	4.103	20.7	0.484	0.00225	0.0	-3.0	0	0.0	82.8
10	-0.273	0.186	1.432	2.629	2.828	2.800	20.8	0.488	0.00225	0.0	-3.0	0	0.0	82.9
11	-0.243	0.156	1.432	2.641	2.765	2.823	20.6	0.480	0.00225	-1.0	-3.0	0	0.0	83.2
12	-0.165	0.225	2.596	2.982	3.959	4.109	20.6	0.479	0.00225	-1.0	-3.0	0	0.0	83.4
13	-0.056	0.297	4.021	2.874	5.173	5.672	20.6	0.480	0.00225	-1.0	-3.0	0	0.0	83.6
14	-0.076	0.322	4.209	2.691	6.036	5.667	20.6	0.478	0.00225	-1.0	0.0	0	0.0	83.6
15	-0.175	0.254	2.762	2.928	4.440	4.099	20.5	0.471	0.00225	-1.0	0.0	0	0.0	83.7
16	-0.239	0.185	1.598	2.663	3.168	2.812	20.7	0.484	0.00225	-1.0	0.0	0	0.0	83.9
17	-0.214	0.173	1.630	2.655	3.077	2.822	20.8	0.488	0.00225	-3.0	0.0	0	0.0	84.3
18	-0.134	0.235	2.812	2.932	4.409	4.108	20.8	0.487	0.00225	-3.0	0.0	0	0.0	84.3
19	-0.008	0.325	4.279	2.855	5.956	5.680	20.9	0.489	0.00225	-3.0	0.0	0	0.0	84.4
20	0.022	0.311	4.126	2.853	5.244	5.674	20.7	0.480	0.00225	-3.0	-3.0	0	0.0	84.6
21	-0.058	0.223	2.665	2.819	3.821	4.093	20.5	0.474	0.00225	-3.0	-3.0	0	0.0	84.7
22	-0.149	0.156	1.543	2.611	2.713	2.820	20.8	0.485	0.00225	-3.0	-3.0	0	0.0	84.7
23	-0.100	0.134	1.556	2.541	2.638	2.825	20.7	0.479	0.00224	-5.0	-3.0	0	0.0	84.9
24	-0.064	0.199	2.740	2.841	3.939	4.113	20.7	0.483	0.00224	-5.0	-3.0	0	0.0	85.0
25	0.090	0.293	4.183	3.006	5.419	5.677	20.7	0.480	0.00224	-5.0	-3.0	0	0.0	85.1
26	0.029	0.307	4.332	2.909	5.897	5.666	20.6	0.475	0.00224	-5.0	0.0	0	0.0	85.1
27	-0.115	0.213	2.862	2.810	4.334	4.107	20.8	0.484	0.00224	-5.0	0.0	0	0.0	85.4
28	-0.181	0.149	1.705	2.481	2.962	2.805	20.7	0.479	0.00224	-5.0	0.0	0	0.0	85.4
29	-0.160	0.137	1.680	2.523	2.897	2.827	20.8	0.485	0.00224	-10.0	0.0	0	0.0	85.6
30	-0.085	0.192	2.871	2.748	4.243	4.112	20.9	0.489	0.00224	-10.0	0.0	0	0.0	85.6
31	0.051	0.269	4.314	2.711	5.818	5.678	20.7	0.480	0.00224	-10.0	0.0	0	0.0	85.7
32	0.146	0.253	4.165	2.714	5.373	5.664	20.7	0.482	0.00224	-10.0	-3.0	0	0.0	85.8
33	0.049	0.177	2.746	2.714	3.875	4.103	20.6	0.474	0.00224	-10.0	-3.0	0	0.0	85.9
34	-0.040	0.110	1.623	2.506	2.613	2.817	20.8	0.484	0.00224	-10.0	-3.0	0	0.0	86.0

Continued on next page

Table F.128: Testing conditions and rotor 3 loads in the hub coordinate system for run 143.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	0.178	0.288	1.525	5.180	3.991	2.885	41.3	1.903	0.00224	-10.0	-3.0	0	0.0	86.6
36	0.347	0.363	2.634	5.606	5.797	4.165	41.2	1.895	0.00224	-10.0	-3.0	0	0.0	86.6
37	0.503	0.461	3.940	5.836	7.955	5.729	41.4	1.915	0.00224	-10.0	-3.0	0	0.0	86.7
38	0.581	0.524	4.306	5.662	8.940	5.730	41.2	1.900	0.00223	-10.0	0.0	0	0.0	87.0
39	0.445	0.435	2.953	5.741	6.560	4.184	41.2	1.898	0.00223	-10.0	0.0	0	0.0	87.1
40	0.287	0.336	1.839	5.220	4.460	2.882	41.0	1.880	0.00223	-10.0	0.0	0	0.0	87.2
41	0.365	0.376	1.963	5.365	4.824	2.878	41.2	1.895	0.00223	-5.0	0.0	0	0.0	87.7
42	0.524	0.439	3.049	5.344	6.917	4.185	41.3	1.900	0.00223	-5.0	0.0	0	0.0	87.7
44	0.705	0.545	4.340	5.467	9.047	5.714	41.2	1.894	0.00223	-5.0	0.0	0	0.0	88.0
45	0.638	0.499	4.003	5.347	7.950	5.660	41.4	1.908	0.00223	-5.0	-3.0	0	0.0	88.0
46	0.525	0.430	2.765	5.719	6.094	4.147	41.3	1.901	0.00223	-5.0	-3.0	0	0.0	88.1
47	0.367	0.331	1.732	5.080	4.281	2.850	41.0	1.873	0.00223	-5.0	-3.0	0	0.0	88.1
48	0.398	0.336	1.756	5.364	4.581	2.852	41.1	1.886	0.00223	-3.0	-3.0	0	0.0	88.3
49	0.548	0.395	2.730	5.401	6.221	4.139	41.2	1.887	0.00223	-3.0	-3.0	0	0.0	88.3
50	0.700	0.507	3.937	5.502	8.065	5.657	41.2	1.891	0.00223	-3.0	-3.0	0	0.0	88.4
51	0.736	0.515	4.251	5.127	9.014	5.668	41.1	1.882	0.00223	-3.0	0.0	0	0.0	88.4
52	0.621	0.439	2.978	5.433	7.075	4.130	41.4	1.905	0.00223	-3.0	0.0	0	0.0	88.5
53	0.472	0.359	1.973	5.440	5.144	2.821	41.3	1.901	0.00223	-3.0	0.0	0	0.0	88.5
54	0.486	0.409	1.999	5.959	5.605	2.790	41.4	1.906	0.00223	-1.0	0.0	0	0.0	88.7
55	0.620	0.439	2.932	5.247	7.321	4.087	41.4	1.910	0.00223	-1.0	0.0	0	0.0	88.7
56	0.784	0.530	4.119	5.150	9.242	5.617	41.3	1.895	0.00222	-1.0	0.0	0	0.0	88.8
57	0.746	0.486	3.743	5.175	7.901	5.548	41.3	1.897	0.00222	-1.0	-3.0	0	0.0	88.8
58	0.672	0.430	2.666	5.606	6.690	4.064	41.4	1.907	0.00222	-1.0	-3.0	0	0.0	88.9
59	0.550	0.398	1.804	6.054	5.241	2.790	41.4	1.904	0.00222	-1.0	-3.0	0	0.0	88.8
60	0.585	0.398	1.785	6.067	5.559	2.761	41.2	1.888	0.00222	0.0	-3.0	0	0.0	89.1
61	0.721	0.448	2.664	5.646	7.062	4.028	41.4	1.904	0.00222	0.0	-3.0	0	0.0	89.1
62	0.804	0.480	3.755	5.104	8.182	5.520	41.3	1.897	0.00222	0.0	-3.0	0	0.0	89.2
63	0.833	0.494	4.010	4.434	9.183	5.546	41.3	1.899	0.00222	-0.0	0.0	0	0.0	89.2
64	0.756	0.460	2.852	5.606	7.586	4.020	41.2	1.889	0.00222	-0.0	0.0	0	0.0	89.2
65	0.638	0.445	2.027	6.217	5.953	2.723	41.4	1.901	0.00222	-0.0	0.0	0	0.0	89.3
66	0.292	0.183	1.656	2.545	2.846	2.729	20.9	0.485	0.00222	-0.0	0.0	0	0.0	89.2
67	0.150	0.052	1.711	0.246	0.349	2.690	3.1	0.011	0.00222	-0.0	0.0	0	0.0	89.2
68	0.000	0.000	-0.000	0.000	0.000	0.000	2.2	0.006	0.00222	-0.0	0.0	0	-	89.2

Run 144: Equal Height Quadrotor, Tandem

Table F.129: Run 144 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	-90

Table F.130: Testing conditions and rotor 1 loads in the hub coordinate system for run 144.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.062	0.000	0.069	0.000	-0.109	0.000	0.0	0.000	0.00223	-0.0	0.0	0	-	88.0
4	0.081	-0.030	2.076	-1.672	0.870	-2.461	3.5	0.013	0.00223	-0.0	0.0	1999	0.0	88.0
5	0.369	-0.042	2.588	-1.694	6.471	-1.989	20.9	0.487	0.00223	-0.0	0.0	1999	0.0	88.3
7	0.382	-0.042	2.599	-1.652	6.465	-1.990	20.9	0.484	0.00222	-0.0	0.0	1999	0.0	89.0
8	0.537	-0.028	3.823	-1.492	9.429	-3.137	20.8	0.482	0.00222	-0.0	0.0	2499	0.0	89.1
9	0.762	-0.015	5.312	-1.005	12.231	-4.544	20.6	0.471	0.00222	-0.0	0.0	2999	0.0	89.2
10	0.727	-0.064	5.218	-1.300	11.498	-4.610	20.9	0.483	0.00222	-0.0	-3.0	3000	0.0	89.4
11	0.505	-0.073	3.677	-1.805	8.725	-3.159	20.8	0.478	0.00222	-0.0	-3.0	2500	0.0	89.7
12	0.353	-0.070	2.446	-1.949	6.053	-2.003	21.0	0.491	0.00222	-0.0	-3.0	2000	0.0	89.7
13	0.283	-0.057	2.425	-1.954	5.838	-2.008	20.9	0.483	0.00222	-1.0	-3.0	2000	0.0	89.9
14	0.431	-0.058	3.695	-1.808	8.466	-3.188	21.0	0.488	0.00222	-1.0	-3.0	2499	0.0	90.0
15	0.639	-0.037	5.227	-1.275	11.272	-4.645	20.9	0.487	0.00222	-1.0	-3.0	2999	0.0	90.0
16	0.768	-0.006	5.312	-1.189	12.079	-4.517	20.9	0.484	0.00222	-1.0	0.0	3000	0.0	90.1
17	0.533	-0.031	3.816	-1.589	9.260	-3.126	20.9	0.486	0.00222	-1.0	0.0	2500	0.0	90.1
18	0.384	-0.025	2.584	-1.765	6.373	-1.983	21.0	0.487	0.00222	-1.0	0.0	2000	0.0	90.1
19	0.339	-0.017	2.570	-1.984	6.027	-2.000	20.9	0.484	0.00222	-3.0	0.0	2000	0.0	90.3
20	0.489	-0.020	3.803	-1.784	8.710	-3.160	20.8	0.479	0.00222	-3.0	0.0	2499	0.0	90.4
21	0.718	0.001	5.341	-1.343	11.410	-4.607	20.9	0.483	0.00222	-3.0	0.0	3000	0.0	90.5
22	0.554	-0.029	5.216	-1.253	10.801	-4.751	20.9	0.484	0.00222	-3.0	-3.0	3000	0.0	90.5
23	0.341	-0.031	3.682	-1.811	8.027	-3.289	21.0	0.490	0.00222	-3.0	-3.0	2500	0.0	90.5
24	0.192	-0.049	2.421	-1.936	5.480	-2.101	21.0	0.487	0.00222	-3.0	-3.0	2000	0.0	90.5
25	0.084	-0.029	2.393	-1.989	5.146	-2.155	21.0	0.487	0.00222	-5.0	-3.0	2000	0.0	90.5
26	0.209	-0.014	3.652	-1.812	7.616	-3.367	21.0	0.488	0.00222	-5.0	-3.0	2500	0.0	90.5
27	0.421	-0.009	5.160	-1.256	10.131	-4.864	20.6	0.472	0.00222	-5.0	-3.0	3000	0.0	90.6
28	0.685	0.004	5.314	-1.296	10.909	-4.712	20.8	0.477	0.00221	-5.0	0.0	3000	0.0	90.7
29	0.466	-0.004	3.777	-1.765	8.201	-3.258	20.6	0.472	0.00221	-5.0	0.0	2500	0.0	90.7
30	0.322	-0.016	2.534	-2.036	5.666	-2.068	20.9	0.486	0.00221	-5.0	0.0	2000	0.0	90.7
31	0.254	0.010	2.444	-1.965	4.937	-2.217	20.8	0.480	0.00221	-10.0	0.0	2000	0.0	90.7
32	0.375	0.023	3.708	-1.757	7.336	-3.441	21.0	0.488	0.00221	-10.0	0.0	2499	0.0	90.8
33	0.587	0.036	5.207	-1.360	9.814	-4.944	21.0	0.486	0.00221	-10.0	0.0	2999	0.0	90.8
34	0.147	0.004	5.029	-1.387	8.893	-5.028	21.1	0.493	0.00221	-10.0	-3.0	2999	0.0	90.8
35	-0.045	-0.003	3.503	-1.782	6.416	-3.523	20.8	0.478	0.00221	-10.0	-3.0	2500	0.0	90.8

Continued on next page

Table F.130: Testing conditions and rotor 1 loads in the hub coordinate system for run 144.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
36	-0.169	-0.022	2.269	-1.903	4.163	-2.284	20.7	0.474	0.00221	-10.0	-3.0	2000	0.0	90.9
37	0.001	-0.109	2.320	-4.654	5.181	-2.409	41.5	1.905	0.00221	-10.0	-3.0	2000	0.0	91.2
38	0.143	-0.125	3.731	-4.679	8.215	-3.628	41.6	1.910	0.00221	-10.0	-3.0	2499	0.0	91.2
39	0.502	-0.127	5.383	-4.482	11.925	-5.096	41.5	1.904	0.00221	-10.0	-3.0	3000	0.0	91.5
40	0.979	-0.106	5.720	-4.425	13.185	-4.964	41.4	1.893	0.00221	-10.0	0.0	2999	0.0	91.5
41	0.660	-0.126	4.050	-4.937	9.315	-3.531	41.2	1.877	0.00221	-10.0	0.0	2500	0.0	91.5
42	0.485	-0.112	2.657	-4.973	6.202	-2.345	41.5	1.900	0.00221	-10.0	0.0	2000	0.0	91.6
43	0.514	-0.129	3.002	-5.245	6.996	-2.251	41.5	1.904	0.00221	-5.0	0.0	1999	0.0	91.8
44	0.678	-0.145	4.459	-5.391	10.631	-3.355	41.5	1.901	0.00221	-5.0	0.0	2499	0.0	91.7
45	1.097	-0.144	6.186	-4.526	15.016	-4.675	41.6	1.914	0.00221	-5.0	0.0	3000	0.0	91.7
46	0.875	-0.176	5.845	-4.445	14.128	-4.804	41.4	1.893	0.00221	-5.0	-3.0	3000	0.0	91.9
48	0.517	-0.170	4.145	-5.224	9.828	-3.425	41.5	1.905	0.00221	-5.0	-3.0	2500	0.0	92.0
49	0.310	-0.165	2.655	-4.977	6.422	-2.300	41.4	1.891	0.00221	-5.0	-3.0	2000	0.0	92.1
50	0.395	-0.171	2.822	-5.212	6.867	-2.255	41.4	1.893	0.00221	-3.0	-3.0	1999	0.0	92.1
51	0.586	-0.191	4.318	-5.249	10.393	-3.347	41.5	1.900	0.00221	-3.0	-3.0	2499	0.0	92.1
52	1.000	-0.185	5.984	-4.614	14.757	-4.691	41.6	1.908	0.00221	-3.0	-3.0	2999	0.0	92.1
53	1.180	-0.142	6.312	-4.305	15.788	-4.685	41.5	1.903	0.00221	-3.0	0.0	2999	0.0	92.1
54	0.746	-0.134	4.668	-5.181	11.201	-3.336	41.6	1.906	0.00221	-3.0	0.0	2500	0.0	92.1
55	0.552	-0.129	3.157	-5.324	7.228	-2.208	41.4	1.893	0.00221	-3.0	0.0	1999	0.0	92.2
56	0.534	-0.121	3.326	-5.316	7.353	-2.149	41.6	1.907	0.00221	-1.0	0.0	2000	0.0	92.2
58	0.738	-0.108	4.783	-5.018	11.566	-3.308	41.6	1.905	0.00221	-1.0	0.0	2499	0.0	92.3
59	1.185	-0.144	6.566	-3.952	16.676	-4.621	41.6	1.906	0.00221	-1.0	0.0	3000	0.0	92.3
60	1.095	-0.187	6.131	-4.482	15.526	-4.691	41.5	1.903	0.00221	-1.0	-3.0	2999	0.0	92.4
61	0.703	-0.170	4.428	-5.024	10.864	-3.387	41.6	1.908	0.00221	-1.0	-3.0	2500	0.0	92.5
62	0.480	-0.170	2.940	-5.213	7.047	-2.257	41.4	1.889	0.00221	-1.0	-3.0	1999	0.0	92.4
63	0.508	-0.169	3.043	-5.372	7.218	-2.227	41.5	1.897	0.00221	0.0	-3.0	2000	0.0	92.4
64	0.716	-0.168	4.515	-5.264	11.298	-3.346	41.4	1.891	0.00221	0.0	-3.0	2499	0.0	92.4
65	1.152	-0.174	6.242	-4.212	16.124	-4.690	41.6	1.907	0.00220	0.0	-3.0	3000	0.0	92.4
66	1.204	-0.137	6.654	-3.765	16.846	-4.622	41.6	1.905	0.00220	0.0	0.0	3000	0.0	92.4
67	0.757	-0.119	4.901	-4.749	11.631	-3.271	41.3	1.884	0.00220	0.0	0.0	2500	0.0	92.5
68	0.546	-0.142	3.370	-5.295	7.384	-2.150	41.5	1.899	0.00220	0.0	0.0	2000	0.0	92.5
69	0.333	0.003	2.501	-1.782	6.412	-2.063	20.9	0.480	0.00221	0.0	0.0	2000	0.0	92.3
70	0.037	0.110	1.945	0.973	1.037	-2.427	4.7	0.025	0.00221	0.0	0.0	1999	0.0	92.1

Continued on next page

Table F.130: Testing conditions and rotor 1 loads in the hub coordinate system for run 144.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
71	-0.000	0.000	-0.000	0.000	0.000	0.000	2.7	0.008	0.00221	0.0	0.0	0	-	92.0

Table F.131: Testing conditions and rotor 3 loads in the hub coordinate system for run 144.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.147	0.000	-0.026	0.000	-0.065	0.000	0.0	0.000	0.00223	-0.0	0.0	0	-	88.0
4	-0.021	-0.167	1.893	-1.435	-0.478	2.750	3.5	0.013	0.00223	-0.0	0.0	0	-90.0	88.0
5	0.006	0.181	1.685	2.606	3.005	2.737	20.9	0.487	0.00223	-0.0	0.0	0	-90.0	88.3
7	0.060	0.142	1.640	2.675	3.034	2.735	20.9	0.484	0.00222	-0.0	0.0	0	-90.0	89.0
8	0.134	0.206	2.789	2.905	4.301	4.020	20.8	0.482	0.00222	-0.0	0.0	0	-90.0	89.1
9	0.227	0.292	4.211	2.424	5.680	5.563	20.6	0.471	0.00222	-0.0	0.0	0	-90.0	89.2
10	0.217	0.284	4.094	2.713	4.849	5.558	20.9	0.483	0.00222	-0.0	-3.0	0	-90.0	89.4
11	0.125	0.180	2.646	2.943	3.610	4.041	20.8	0.478	0.00222	-0.0	-3.0	0	-90.0	89.7
12	0.046	0.130	1.527	2.694	2.562	2.736	21.0	0.491	0.00222	-0.0	-3.0	0	-90.0	89.7
13	0.025	0.093	1.516	2.698	2.488	2.768	20.9	0.483	0.00222	-1.0	-3.0	0	-90.0	89.9
14	0.098	0.170	2.675	2.948	3.676	4.037	21.0	0.488	0.00222	-1.0	-3.0	0	-90.0	90.0
15	0.193	0.261	4.092	2.837	4.908	5.565	20.9	0.487	0.00222	-1.0	-3.0	0	-90.0	90.0
16	0.238	0.288	4.206	2.557	5.801	5.570	20.9	0.484	0.00222	-1.0	0.0	0	-90.0	90.1
17	0.124	0.211	2.796	2.784	4.259	4.021	20.9	0.486	0.00222	-1.0	0.0	0	-90.0	90.1
18	0.066	0.134	1.636	2.569	2.939	2.742	21.0	0.487	0.00222	-1.0	0.0	0	-90.0	90.1
19	0.083	0.120	1.654	2.588	2.885	2.764	20.9	0.484	0.00222	-3.0	0.0	0	-90.0	90.3
20	0.168	0.195	2.835	2.868	4.192	4.040	20.8	0.479	0.00222	-3.0	0.0	0	-90.0	90.4
21	0.256	0.280	4.284	2.765	5.733	5.590	20.9	0.483	0.00222	-3.0	0.0	0	-90.0	90.5
22	0.122	0.256	4.169	2.745	4.841	5.564	20.9	0.484	0.00222	-3.0	-3.0	0	-90.0	90.5
23	0.038	0.171	2.724	2.751	3.507	4.036	21.0	0.490	0.00222	-3.0	-3.0	0	-90.0	90.5
24	-0.031	0.102	1.615	2.611	2.380	2.763	21.0	0.487	0.00222	-3.0	-3.0	0	-90.0	90.5
25	-0.112	0.090	1.639	2.509	2.225	2.769	21.0	0.487	0.00222	-5.0	-3.0	0	-90.0	90.5
26	-0.045	0.162	2.779	2.859	3.484	4.047	21.0	0.488	0.00222	-5.0	-3.0	0	-90.0	90.5
27	0.081	0.246	4.212	2.891	4.923	5.588	20.6	0.472	0.00222	-5.0	-3.0	0	-90.0	90.6
28	0.248	0.274	4.312	2.900	5.715	5.591	20.8	0.477	0.00221	-5.0	0.0	0	-90.0	90.7
29	0.129	0.183	2.848	2.681	4.053	4.033	20.6	0.472	0.00221	-5.0	0.0	0	-90.0	90.7
30	0.075	0.111	1.688	2.507	2.859	2.772	20.9	0.486	0.00221	-5.0	0.0	0	-90.0	90.7
31	0.102	0.092	1.694	2.514	2.728	2.778	20.8	0.480	0.00221	-10.0	0.0	0	-90.0	90.7
32	0.161	0.164	2.862	2.770	4.040	4.054	21.0	0.488	0.00221	-10.0	0.0	0	-90.0	90.8
33	0.297	0.257	4.285	2.768	5.699	5.599	21.0	0.486	0.00221	-10.0	0.0	0	-90.0	90.8
34	-0.100	0.248	4.201	2.724	4.825	5.582	21.1	0.493	0.00221	-10.0	-3.0	0	-90.0	90.8
35	-0.192	0.153	2.792	2.685	3.258	4.058	20.8	0.478	0.00221	-10.0	-3.0	0	-90.0	90.8

Continued on next page

Table F.131: Testing conditions and rotor 3 loads in the hub coordinate system for run 144.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
36	-0.264	0.080	1.678	2.466	2.034	2.767	20.7	0.474	0.00221	-10.0	-3.0	0	-90.0	90.9
37	0.074	0.297	1.665	5.057	3.557	2.821	41.5	1.905	0.00221	-10.0	-3.0	0	-90.0	91.2
38	0.230	0.383	2.717	5.646	5.380	4.112	41.6	1.910	0.00221	-10.0	-3.0	0	-90.0	91.2
39	0.389	0.490	4.074	5.619	7.553	5.616	41.5	1.904	0.00221	-10.0	-3.0	0	-90.0	91.5
40	0.775	0.526	4.322	5.710	8.768	5.637	41.4	1.893	0.00221	-10.0	0.0	0	-90.0	91.5
41	0.638	0.432	2.949	5.527	6.381	4.113	41.2	1.877	0.00221	-10.0	0.0	0	-90.0	91.5
42	0.483	0.340	1.908	5.278	4.433	2.847	41.5	1.900	0.00221	-10.0	0.0	0	-90.0	91.6
43	0.542	0.374	1.976	5.451	4.799	2.838	41.5	1.904	0.00221	-5.0	0.0	0	-90.0	91.8
44	0.687	0.442	3.029	5.567	6.747	4.133	41.5	1.901	0.00221	-5.0	0.0	0	-90.0	91.7
45	0.830	0.531	4.337	5.213	8.959	5.646	41.6	1.914	0.00221	-5.0	0.0	0	-90.0	91.7
46	0.627	0.492	4.038	5.187	7.641	5.602	41.4	1.893	0.00221	-5.0	-3.0	0	-90.0	91.9
48	0.498	0.425	2.811	5.568	5.817	4.103	41.5	1.905	0.00221	-5.0	-3.0	0	-90.0	92.0
49	0.352	0.348	1.796	5.350	4.044	2.819	41.4	1.891	0.00221	-5.0	-3.0	0	-90.0	92.1
50	0.466	0.356	1.806	5.328	4.361	2.805	41.4	1.893	0.00221	-3.0	-3.0	0	-90.0	92.1
51	0.607	0.423	2.805	5.517	6.044	4.101	41.5	1.900	0.00221	-3.0	-3.0	0	-90.0	92.1
52	0.739	0.500	3.964	5.123	7.780	5.592	41.6	1.908	0.00221	-3.0	-3.0	0	-90.0	92.1
53	0.861	0.528	4.196	5.046	8.860	5.590	41.5	1.903	0.00221	-3.0	0.0	0	-90.0	92.1
54	0.721	0.444	2.982	5.251	6.987	4.089	41.6	1.906	0.00221	-3.0	0.0	0	-90.0	92.1
55	0.591	0.376	1.969	5.376	4.970	2.788	41.4	1.893	0.00221	-3.0	0.0	0	-90.0	92.2
56	0.647	0.429	2.016	5.735	5.676	2.741	41.6	1.907	0.00221	-1.0	0.0	0	-90.0	92.2
58	0.788	0.457	2.905	5.452	7.237	4.036	41.6	1.905	0.00221	-1.0	0.0	0	-90.0	92.3
59	0.919	0.537	4.127	5.007	9.208	5.553	41.6	1.906	0.00221	-1.0	0.0	0	-90.0	92.3
60	0.837	0.485	3.793	4.882	7.960	5.491	41.5	1.903	0.00221	-1.0	-3.0	0	-90.0	92.4
61	0.749	0.442	2.714	5.619	6.813	4.032	41.6	1.908	0.00221	-1.0	-3.0	0	-90.0	92.5
62	0.623	0.397	1.818	5.842	5.180	2.748	41.4	1.889	0.00221	-1.0	-3.0	0	-90.0	92.4
63	0.681	0.420	1.842	5.968	5.443	2.716	41.5	1.897	0.00221	0.0	-3.0	0	-90.0	92.4
64	0.800	0.442	2.679	5.619	6.988	3.996	41.4	1.891	0.00221	0.0	-3.0	0	-90.0	92.4
65	0.911	0.509	3.769	5.120	8.472	5.465	41.6	1.907	0.00220	0.0	-3.0	0	-90.0	92.4
66	0.920	0.540	3.995	5.008	9.310	5.486	41.6	1.905	0.00220	0.0	0.0	0	-90.0	92.4
67	0.809	0.473	2.890	5.563	7.516	3.997	41.3	1.884	0.00220	0.0	0.0	0	-90.0	92.5
68	0.682	0.455	2.007	6.169	5.925	2.689	41.5	1.899	0.00220	0.0	0.0	0	-90.0	92.5
69	0.339	0.194	1.648	2.384	2.773	2.700	20.9	0.480	0.00221	0.0	0.0	0	-90.0	92.3
70	0.111	-0.047	1.815	-0.620	-1.205	2.624	4.7	0.025	0.00221	0.0	0.0	0	0.0	92.1

Continued on next page

Table F.131: Testing conditions and rotor 3 loads in the hub coordinate system for run 144.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
71	-0.000	0.000	-0.000	0.000	0.000	0.000	2.7	0.008	0.00221	0.0	0.0	0	-	92.0

Run 145: Equal Height Quadrotor, Aero and Weight Tare

Table F.132: Run 145 operational settings for MTB 2.

Feature	Value
number of rotors	0
rotors used	0
number of blades	0
RPM	0
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	none

Table F.133: Testing conditions and rotor 1 loads in the hub coordinate system for run 145.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.063	0.000	0.068	0.000	-0.110	0.000	0.0	0.000	0.00221	0.0	0.0	0	-	90.7
4	-0.064	0.004	0.073	-0.003	-0.111	0.003	0.3	0.000	0.00221	0.0	0.0	0	-	90.7
5	-0.092	-0.028	0.003	0.027	-0.107	0.014	0.2	0.000	0.00221	0.0	-3.0	0	-	90.6
6	-0.130	-0.031	0.014	0.034	-0.144	0.014	0.8	0.001	0.00221	-1.0	-3.0	0	-	90.6
7	-0.076	0.011	0.106	-0.008	-0.124	0.018	0.9	0.001	0.00221	-1.0	0.0	0	-	90.5
8	-0.076	0.008	0.129	-0.005	-0.134	0.019	0.7	0.001	0.00221	-3.0	0.0	0	-	90.6
9	-0.210	-0.029	0.039	0.031	-0.212	0.021	1.0	0.001	0.00221	-3.0	-3.0	0	-	90.6
10	-0.280	-0.026	0.054	0.031	-0.287	0.023	1.0	0.001	0.00221	-5.0	-3.0	0	-	90.6
11	-0.065	0.012	0.150	-0.006	-0.155	0.025	1.1	0.001	0.00221	-5.0	0.0	0	-	90.5
12	-0.081	0.009	0.172	-0.003	-0.148	0.025	1.0	0.001	0.00221	-10.0	0.0	0	-	90.4
13	-0.482	-0.030	0.103	0.032	-0.449	0.027	1.0	0.001	0.00221	-10.0	-3.0	0	-	90.4
14	-0.478	-0.047	0.051	0.015	-0.396	-0.005	20.8	0.480	0.00221	-10.0	-3.0	0	-	90.4
15	-0.074	-0.008	0.133	-0.016	-0.103	-0.003	20.8	0.478	0.00221	-10.0	0.0	0	-	90.4
16	-0.075	-0.007	0.106	-0.012	-0.099	-0.014	20.8	0.479	0.00221	-5.0	0.0	0	-	90.5
17	-0.290	-0.044	0.015	0.022	-0.228	-0.019	20.8	0.477	0.00221	-5.0	-3.0	0	-	90.5
18	-0.212	-0.044	-0.004	0.026	-0.163	-0.023	20.7	0.475	0.00221	-3.0	-3.0	0	-	90.5
19	-0.076	-0.001	0.095	-0.014	-0.092	-0.023	20.7	0.474	0.00221	-3.0	0.0	0	-	90.6
20	-0.075	-0.002	0.069	-0.018	-0.082	-0.025	20.7	0.472	0.00221	-1.0	0.0	0	-	90.6
21	-0.132	-0.041	-0.016	0.023	-0.096	-0.027	20.7	0.473	0.00221	-1.0	-3.0	0	-	90.7
22	-0.086	-0.041	-0.027	0.026	-0.069	-0.027	20.7	0.473	0.00221	-0.0	-3.0	0	-	90.8
23	-0.070	-0.001	0.056	-0.013	-0.082	-0.025	20.7	0.474	0.00221	0.0	0.0	0	-	90.9
24	-0.041	-0.012	-0.005	-0.039	0.009	-0.036	41.5	1.902	0.00221	0.0	0.0	0	-	91.5
25	-0.061	-0.053	-0.079	-0.003	0.032	-0.038	41.4	1.893	0.00221	0.0	-3.0	0	-	91.6
26	-0.098	-0.048	-0.067	-0.008	-0.009	-0.031	41.2	1.876	0.00221	-1.0	-3.0	0	-	91.6
27	-0.039	-0.006	0.030	-0.033	0.001	-0.028	41.4	1.887	0.00221	-1.0	0.0	0	-	91.7
28	-0.037	-0.011	0.045	-0.042	0.000	-0.024	41.6	1.911	0.00221	-3.0	0.0	0	-	91.8
29	-0.170	-0.053	-0.043	-0.007	-0.066	-0.023	41.7	1.914	0.00221	-3.0	-3.0	0	-	91.8
30	-0.241	-0.049	-0.034	-0.001	-0.135	-0.020	41.5	1.903	0.00221	-5.0	-3.0	0	-	91.8
31	-0.029	-0.009	0.068	-0.042	-0.007	-0.014	41.4	1.888	0.00221	-5.0	0.0	0	-	91.9
32	-0.032	-0.008	0.080	-0.039	-0.001	-0.009	41.6	1.909	0.00220	-10.0	0.0	0	-	92.0
33	-0.436	-0.049	-0.000	0.003	-0.288	-0.008	41.6	1.904	0.00220	-10.0	-3.0	0	-	92.0
34	-0.039	-0.054	-0.059	0.001	0.021	-0.014	41.3	1.882	0.00220	-0.0	-3.0	0	-	92.1

Continued on next page

Table F.133: Testing conditions and rotor 1 loads in the hub coordinate system for run 145.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	-0.012	-0.012	0.016	-0.030	-0.004	-0.007	41.7	1.920	0.00220	0.0	0.0	0	-	92.1
36	-0.052	-0.008	0.046	-0.009	-0.079	-0.001	20.8	0.477	0.00220	0.0	0.0	0	-	92.0
37	0.000	0.000	0.000	0.000	0.000	0.000	3.7	0.015	0.00221	0.0	0.0	0	-	91.9

Table F.134: Testing conditions and rotor 2 loads in the hub coordinate system for run 145.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.127	0.000	0.018	0.000	-0.044	0.000	0.0	0.000	0.00221	0.0	0.0	0	-	90.7
4	-0.128	0.002	0.016	0.003	-0.045	-0.002	0.3	0.000	0.00221	0.0	0.0	0	-	90.7
5	-0.112	0.054	-0.015	-0.036	-0.058	-0.049	0.2	0.000	0.00221	0.0	-3.0	0	-	90.6
6	-0.153	0.060	-0.013	-0.041	-0.095	-0.043	0.8	0.001	0.00221	-1.0	-3.0	0	-	90.6
7	-0.144	0.008	0.034	-0.009	-0.039	0.009	0.9	0.001	0.00221	-1.0	0.0	0	-	90.5
8	-0.147	0.005	0.033	-0.004	-0.034	0.005	0.7	0.001	0.00221	-3.0	0.0	0	-	90.6
9	-0.233	0.059	-0.008	-0.039	-0.165	-0.046	1.0	0.001	0.00221	-3.0	-3.0	0	-	90.6
10	-0.312	0.058	-0.006	-0.033	-0.240	-0.044	1.0	0.001	0.00221	-5.0	-3.0	0	-	90.6
11	-0.156	0.007	0.019	-0.002	-0.044	0.007	1.1	0.001	0.00221	-5.0	0.0	0	-	90.5
12	-0.161	0.006	0.032	0.001	-0.045	0.005	1.0	0.001	0.00221	-10.0	0.0	0	-	90.4
13	-0.500	0.057	0.036	-0.027	-0.422	-0.047	1.0	0.001	0.00221	-10.0	-3.0	0	-	90.4
14	-0.464	0.046	0.033	-0.031	-0.406	-0.050	20.8	0.480	0.00221	-10.0	-3.0	0	-	90.4
15	-0.124	-0.005	0.026	-0.000	-0.031	-0.001	20.8	0.478	0.00221	-10.0	0.0	0	-	90.4
16	-0.109	-0.016	0.018	0.002	-0.036	-0.010	20.8	0.479	0.00221	-5.0	0.0	0	-	90.5
17	-0.269	0.036	-0.005	-0.030	-0.230	-0.062	20.8	0.477	0.00221	-5.0	-3.0	0	-	90.5
18	-0.184	0.039	-0.017	-0.034	-0.165	-0.060	20.7	0.475	0.00221	-3.0	-3.0	0	-	90.5
19	-0.106	-0.011	0.028	-0.003	-0.030	-0.012	20.7	0.474	0.00221	-3.0	0.0	0	-	90.6
20	-0.098	-0.017	0.020	0.001	-0.032	-0.014	20.7	0.472	0.00221	-1.0	0.0	0	-	90.6
21	-0.107	0.037	-0.021	-0.035	-0.091	-0.064	20.7	0.473	0.00221	-1.0	-3.0	0	-	90.7
22	-0.068	0.040	-0.027	-0.040	-0.058	-0.062	20.7	0.473	0.00221	-0.0	-3.0	0	-	90.8
23	-0.088	-0.011	0.006	-0.004	-0.045	-0.012	20.7	0.474	0.00221	0.0	0.0	0	-	90.9
24	-0.049	-0.009	0.011	0.004	0.018	-0.014	41.5	1.902	0.00221	0.0	0.0	0	-	91.5
25	-0.030	0.036	-0.025	-0.035	0.010	-0.062	41.4	1.893	0.00221	0.0	-3.0	0	-	91.6
26	-0.070	0.044	-0.022	-0.042	-0.030	-0.058	41.2	1.876	0.00221	-1.0	-3.0	0	-	91.6
27	-0.056	-0.002	0.023	-0.007	0.026	-0.007	41.4	1.887	0.00221	-1.0	0.0	0	-	91.7
28	-0.063	-0.009	0.025	-0.006	0.034	-0.008	41.6	1.911	0.00221	-3.0	0.0	0	-	91.8
29	-0.143	0.041	-0.022	-0.037	-0.094	-0.061	41.7	1.914	0.00221	-3.0	-3.0	0	-	91.8
30	-0.217	0.050	0.003	-0.039	-0.160	-0.056	41.5	1.903	0.00221	-5.0	-3.0	0	-	91.8
31	-0.063	-0.002	0.027	-0.005	0.031	-0.005	41.4	1.888	0.00221	-5.0	0.0	0	-	91.9
32	-0.068	-0.005	0.029	0.001	0.037	-0.010	41.6	1.909	0.00220	-10.0	0.0	0	-	92.0
33	-0.408	0.041	0.026	-0.033	-0.334	-0.061	41.6	1.904	0.00220	-10.0	-3.0	0	-	92.0
34	-0.033	0.053	-0.013	-0.042	0.009	-0.052	41.3	1.882	0.00220	-0.0	-3.0	0	-	92.1

Continued on next page

Table F.134: Testing conditions and rotor 2 loads in the hub coordinate system for run 145.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
35	-0.063	-0.002	0.004	-0.004	0.031	-0.003	41.7	1.920	0.00220	0.0	0.0	0	-	92.1
36	-0.112	0.002	0.010	0.002	-0.024	-0.002	20.8	0.477	0.00220	0.0	0.0	0	-	92.0
37	0.000	0.000	0.000	0.000	0.000	0.000	3.7	0.015	0.00221	0.0	0.0	0	-	91.9

Table F.135: Testing conditions and rotor 3 loads in the hub coordinate system for run 145.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.148	0.000	-0.026	0.000	-0.066	0.000	0.0	0.000	0.00221	0.0	0.0	0	-	90.7
4	-0.146	-0.000	-0.024	-0.004	-0.067	0.000	0.3	0.000	0.00221	0.0	0.0	0	-	90.7
5	-0.122	-0.003	-0.001	0.001	-0.098	0.015	0.2	0.000	0.00221	0.0	-3.0	0	-	90.6
6	-0.159	-0.001	0.007	0.004	-0.136	0.015	0.8	0.001	0.00221	-1.0	-3.0	0	-	90.6
7	-0.141	0.005	-0.005	-0.005	-0.092	0.002	0.9	0.001	0.00221	-1.0	0.0	0	-	90.5
8	-0.141	0.003	-0.012	0.001	-0.099	0.004	0.7	0.001	0.00221	-3.0	0.0	0	-	90.6
9	-0.241	-0.003	0.009	0.001	-0.216	0.015	1.0	0.001	0.00221	-3.0	-3.0	0	-	90.6
10	-0.325	-0.004	0.025	0.006	-0.289	0.013	1.0	0.001	0.00221	-5.0	-3.0	0	-	90.6
11	-0.152	0.003	-0.012	0.000	-0.112	0.004	1.1	0.001	0.00221	-5.0	0.0	0	-	90.5
12	-0.156	-0.005	0.001	0.014	-0.118	0.003	1.0	0.001	0.00221	-10.0	0.0	0	-	90.4
13	-0.514	-0.011	0.055	0.018	-0.485	0.014	1.0	0.001	0.00221	-10.0	-3.0	0	-	90.4
14	-0.437	-0.032	0.058	0.015	-0.468	0.010	20.8	0.480	0.00221	-10.0	-3.0	0	-	90.4
15	-0.080	-0.027	0.006	0.017	-0.106	-0.002	20.8	0.478	0.00221	-10.0	0.0	0	-	90.4
16	-0.053	-0.018	0.001	-0.000	-0.093	-0.003	20.8	0.479	0.00221	-5.0	0.0	0	-	90.5
17	-0.224	-0.022	0.035	0.001	-0.274	0.005	20.8	0.477	0.00221	-5.0	-3.0	0	-	90.5
18	-0.155	-0.014	0.037	-0.002	-0.197	0.005	20.7	0.475	0.00221	-3.0	-3.0	0	-	90.5
19	-0.059	-0.013	0.017	0.003	-0.085	-0.005	20.7	0.474	0.00221	-3.0	0.0	0	-	90.6
20	-0.060	-0.016	0.026	0.003	-0.077	-0.005	20.7	0.472	0.00221	-1.0	0.0	0	-	90.6
21	-0.082	-0.018	0.036	0.004	-0.109	0.005	20.7	0.473	0.00221	-1.0	-3.0	0	-	90.7
22	-0.049	-0.018	0.034	0.005	-0.075	0.007	20.7	0.473	0.00221	-0.0	-3.0	0	-	90.8
23	-0.069	-0.011	0.019	-0.001	-0.075	-0.003	20.7	0.474	0.00221	0.0	0.0	0	-	90.9
24	-0.031	-0.010	0.022	-0.010	0.007	0.011	41.5	1.902	0.00221	0.0	0.0	0	-	91.5
25	-0.008	-0.017	0.040	-0.002	-0.003	0.012	41.4	1.893	0.00221	0.0	-3.0	0	-	91.6
26	-0.050	-0.016	0.038	0.001	-0.036	0.013	41.2	1.876	0.00221	-1.0	-3.0	0	-	91.6
27	-0.035	-0.008	0.021	-0.009	0.014	0.009	41.4	1.887	0.00221	-1.0	0.0	0	-	91.7
28	-0.037	-0.002	0.018	-0.007	0.018	0.013	41.6	1.911	0.00221	-3.0	0.0	0	-	91.8
29	-0.131	-0.011	0.035	-0.003	-0.094	0.017	41.7	1.914	0.00221	-3.0	-3.0	0	-	91.8
30	-0.204	-0.011	0.036	-0.003	-0.174	0.017	41.5	1.903	0.00221	-5.0	-3.0	0	-	91.8
31	-0.040	-0.002	0.009	-0.010	0.013	0.012	41.4	1.888	0.00221	-5.0	0.0	0	-	91.9
32	-0.047	-0.002	0.013	-0.005	0.014	0.012	41.6	1.909	0.00220	-10.0	0.0	0	-	92.0
33	-0.413	-0.012	0.055	-0.004	-0.328	0.022	41.6	1.904	0.00220	-10.0	-3.0	0	-	92.0
34	-0.050	-0.007	-0.000	-0.015	-0.005	0.010	41.3	1.882	0.00220	-0.0	-3.0	0	-	92.1

Continued on next page

Table F.135: Testing conditions and rotor 3 loads in the hub coordinate system for run 145.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	-0.076	-0.001	-0.028	-0.021	0.008	0.009	41.7	1.920	0.00220	0.0	0.0	0	-	92.1
36	-0.126	-0.002	-0.033	-0.005	-0.051	0.003	20.8	0.477	0.00220	0.0	0.0	0	-	92.0
37	0.000	0.000	0.000	0.000	0.000	0.000	3.7	0.015	0.00221	0.0	0.0	0	-	91.9

Table F.136: Testing conditions and rotor 4 loads in the hub coordinate system for run 145.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	-0.100	0.000	0.013	0.000	-0.086	0.000	0.0	0.000	0.00221	0.0	0.0	0	-	90.7
4	-0.103	-0.002	0.012	0.002	-0.082	0.001	0.3	0.000	0.00221	0.0	0.0	0	-	90.7
5	-0.093	0.031	-0.012	-0.023	-0.090	-0.008	0.2	0.000	0.00221	0.0	-3.0	0	-	90.6
6	-0.134	0.032	-0.009	-0.019	-0.123	-0.008	0.8	0.001	0.00221	-1.0	-3.0	0	-	90.6
7	-0.094	0.006	0.027	-0.000	-0.110	0.002	0.9	0.001	0.00221	-1.0	0.0	0	-	90.5
8	-0.085	0.009	0.045	0.004	-0.121	0.001	0.7	0.001	0.00221	-3.0	0.0	0	-	90.6
9	-0.207	0.036	-0.006	-0.016	-0.196	-0.010	1.0	0.001	0.00221	-3.0	-3.0	0	-	90.6
10	-0.285	0.037	0.002	-0.009	-0.268	-0.009	1.0	0.001	0.00221	-5.0	-3.0	0	-	90.6
11	-0.079	0.010	0.034	0.011	-0.135	-0.001	1.1	0.001	0.00221	-5.0	0.0	0	-	90.5
12	-0.079	0.014	0.052	0.026	-0.152	-0.006	1.0	0.001	0.00221	-10.0	0.0	0	-	90.4
13	-0.476	0.041	0.037	0.008	-0.447	-0.015	1.0	0.001	0.00221	-10.0	-3.0	0	-	90.4
14	-0.457	0.036	0.049	0.003	-0.421	-0.015	20.8	0.480	0.00221	-10.0	-3.0	0	-	90.4
15	-0.062	0.009	0.061	0.019	-0.125	-0.003	20.8	0.478	0.00221	-10.0	0.0	0	-	90.4
16	-0.085	0.006	0.042	0.005	-0.089	-0.002	20.8	0.479	0.00221	-5.0	0.0	0	-	90.5
17	-0.293	0.032	0.012	-0.015	-0.219	-0.013	20.8	0.477	0.00221	-5.0	-3.0	0	-	90.5
18	-0.222	0.026	0.003	-0.018	-0.148	-0.010	20.7	0.475	0.00221	-3.0	-3.0	0	-	90.5
19	-0.097	0.005	0.054	-0.008	-0.079	0.002	20.7	0.474	0.00221	-3.0	0.0	0	-	90.6
20	-0.116	-0.002	0.037	-0.005	-0.060	-0.003	20.7	0.472	0.00221	-1.0	0.0	0	-	90.6
21	-0.153	0.030	-0.002	-0.029	-0.078	-0.009	20.7	0.473	0.00221	-1.0	-3.0	0	-	90.7
22	-0.119	0.024	-0.009	-0.029	-0.038	-0.007	20.7	0.473	0.00221	-0.0	-3.0	0	-	90.8
23	-0.115	0.002	0.015	-0.013	-0.056	0.002	20.7	0.474	0.00221	0.0	0.0	0	-	90.9
24	-0.073	-0.005	0.022	-0.018	-0.004	-0.006	41.5	1.902	0.00221	0.0	0.0	0	-	91.5
25	-0.077	0.026	-0.002	-0.038	0.013	-0.015	41.4	1.893	0.00221	0.0	-3.0	0	-	91.6
26	-0.109	0.026	-0.002	-0.034	-0.028	-0.014	41.2	1.876	0.00221	-1.0	-3.0	0	-	91.6
27	-0.075	-0.002	0.038	-0.011	-0.008	-0.008	41.4	1.887	0.00221	-1.0	0.0	0	-	91.7
28	-0.051	-0.001	0.048	-0.008	-0.012	-0.006	41.6	1.911	0.00221	-3.0	0.0	0	-	91.8
29	-0.174	0.028	-0.005	-0.029	-0.088	-0.017	41.7	1.914	0.00221	-3.0	-3.0	0	-	91.8
30	-0.242	0.030	0.002	-0.020	-0.155	-0.018	41.5	1.903	0.00221	-5.0	-3.0	0	-	91.8
31	-0.046	0.002	0.041	-0.000	-0.013	-0.008	41.4	1.888	0.00221	-5.0	0.0	0	-	91.9
32	-0.015	0.006	0.059	0.009	-0.028	-0.010	41.6	1.909	0.00220	-10.0	0.0	0	-	92.0
33	-0.411	0.033	0.044	-0.009	-0.322	-0.022	41.6	1.904	0.00220	-10.0	-3.0	0	-	92.0
34	-0.052	0.021	-0.017	-0.036	0.004	-0.013	41.3	1.882	0.00220	-0.0	-3.0	0	-	92.1

Continued on next page

Table F.136: Testing conditions and rotor 4 loads in the hub coordinate system for run 145.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
35	-0.052	-0.005	0.009	-0.016	-0.022	-0.005	41.7	1.920	0.00220	0.0	0.0	0	-	92.1
36	-0.087	0.003	0.005	-0.007	-0.073	0.001	20.8	0.477	0.00220	0.0	0.0	0	-	92.0
37	0.000	0.000	0.000	0.000	0.000	0.000	3.7	0.015	0.00221	0.0	0.0	0	-	91.9

Run 146: Tall Quadrotor, Aero and Weight Tare

Table F.137: Run 146 operational settings for MTB 2.

Feature	Value
number of rotors	0
rotors used	0
number of blades	0
RPM	0
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	none

Table F.138: Testing conditions and rotor 1 loads in the hub coordinate system for run 146.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.063	0.000	0.069	0.000	-0.110	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	67.4
4	-0.065	-0.002	0.105	0.001	-0.115	0.006	0.0	0.000	0.00232	-1.0	0.0	0	-	67.4
5	-0.069	0.002	0.134	0.006	-0.124	0.011	0.0	0.000	0.00232	-3.0	0.0	0	-	67.4
6	-0.074	0.007	0.153	0.006	-0.128	0.017	0.0	0.000	0.00232	-5.0	0.0	0	-	67.4
7	-0.087	0.010	0.185	0.002	-0.133	0.024	0.0	0.000	0.00232	-10.0	0.0	0	-	67.5
8	-0.089	-0.012	0.127	-0.015	-0.066	-0.003	20.4	0.481	0.00232	-10.0	0.0	0	-	66.9
9	-0.081	-0.016	0.111	-0.002	-0.070	-0.009	20.3	0.480	0.00232	-5.0	0.0	0	-	67.0
10	-0.077	-0.016	0.112	0.001	-0.070	-0.008	20.6	0.493	0.00232	-3.0	0.0	0	-	67.0
11	-0.055	-0.015	0.091	0.006	-0.084	-0.011	20.3	0.479	0.00232	-1.0	0.0	0	-	66.9
12	-0.053	-0.015	0.080	0.006	-0.084	-0.010	20.3	0.478	0.00232	0.0	0.0	0	-	66.9
14	-0.003	-0.024	0.036	-0.035	-0.011	-0.023	40.5	1.900	0.00232	0.0	0.0	0	-	67.1
15	-0.006	-0.020	0.051	-0.037	-0.005	-0.021	40.6	1.913	0.00232	-1.0	0.0	0	-	67.2
16	-0.005	-0.016	0.077	-0.035	-0.014	-0.016	40.6	1.909	0.00232	-3.0	0.0	0	-	67.2
17	-0.008	-0.015	0.084	-0.033	-0.010	-0.011	40.5	1.903	0.00232	-5.0	0.0	0	-	67.2
18	-0.008	-0.006	0.101	-0.033	-0.013	-0.006	40.4	1.890	0.00232	-10.0	0.0	0	-	67.3
19	0.000	0.000	0.000	0.000	0.000	0.000	3.8	0.017	0.00232	-0.0	0.0	0	-	67.4

Table F.139: Testing conditions and rotor 2 loads in the hub coordinate system for run 146.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.127	0.000	0.018	0.000	-0.044	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	67.4
4	-0.138	0.002	0.040	0.005	-0.029	0.004	0.0	0.000	0.00232	-1.0	0.0	0	-	67.4
5	-0.155	0.003	0.052	0.007	-0.020	0.006	0.0	0.000	0.00232	-3.0	0.0	0	-	67.4
6	-0.161	0.005	0.044	0.010	-0.027	0.009	0.0	0.000	0.00232	-5.0	0.0	0	-	67.4
7	-0.185	0.015	0.063	0.005	-0.016	0.015	0.0	0.000	0.00232	-10.0	0.0	0	-	67.5
8	-0.112	-0.021	0.046	0.010	-0.010	-0.007	20.4	0.481	0.00232	-10.0	0.0	0	-	66.9
9	-0.099	-0.017	0.036	0.007	-0.021	-0.013	20.3	0.480	0.00232	-5.0	0.0	0	-	67.0
10	-0.096	-0.015	0.049	0.003	-0.012	-0.014	20.6	0.493	0.00232	-3.0	0.0	0	-	67.0
11	-0.085	-0.018	0.048	0.001	-0.024	-0.016	20.3	0.479	0.00232	-1.0	0.0	0	-	66.9
12	-0.080	-0.017	0.031	0.004	-0.029	-0.016	20.3	0.478	0.00232	0.0	0.0	0	-	66.9
14	-0.024	-0.021	0.016	-0.001	0.016	-0.024	40.5	1.900	0.00232	0.0	0.0	0	-	67.1
15	-0.033	-0.019	0.028	0.001	0.023	-0.021	40.6	1.913	0.00232	-1.0	0.0	0	-	67.2
16	-0.043	-0.014	0.035	0.001	0.030	-0.018	40.6	1.909	0.00232	-3.0	0.0	0	-	67.2
17	-0.050	-0.008	0.043	-0.001	0.034	-0.017	40.5	1.903	0.00232	-5.0	0.0	0	-	67.2
18	-0.058	-0.002	0.050	-0.001	0.039	-0.015	40.4	1.890	0.00232	-10.0	0.0	0	-	67.3
19	0.000	0.000	0.000	0.000	0.000	0.000	3.8	0.017	0.00232	-0.0	0.0	0	-	67.4

Table F.140: Testing conditions and rotor 3 loads in the hub coordinate system for run 146.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.147	0.000	-0.026	0.000	-0.065	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	67.4
4	-0.154	-0.002	-0.020	0.002	-0.062	0.001	0.0	0.000	0.00232	-1.0	0.0	0	-	67.4
5	-0.167	0.006	-0.012	-0.004	-0.061	0.003	0.0	0.000	0.00232	-3.0	0.0	0	-	67.4
6	-0.179	0.005	-0.014	-0.001	-0.064	0.002	0.0	0.000	0.00232	-5.0	0.0	0	-	67.4
7	-0.189	0.005	0.004	0.005	-0.071	0.003	0.0	0.000	0.00232	-10.0	0.0	0	-	67.5
8	-0.113	-0.044	-0.007	0.020	-0.042	-0.001	20.4	0.481	0.00232	-10.0	0.0	0	-	66.9
9	-0.116	-0.035	-0.005	0.010	-0.039	0.003	20.3	0.480	0.00232	-5.0	0.0	0	-	67.0
10	-0.114	-0.034	-0.000	0.015	-0.032	0.001	20.6	0.493	0.00232	-3.0	0.0	0	-	67.0
11	-0.107	-0.040	0.002	0.019	-0.029	0.002	20.3	0.479	0.00232	-1.0	0.0	0	-	66.9
12	-0.104	-0.034	0.004	0.012	-0.033	0.003	20.3	0.478	0.00232	0.0	0.0	0	-	66.9
14	-0.026	-0.016	0.000	0.004	0.005	0.008	40.5	1.900	0.00232	0.0	0.0	0	-	67.1
15	-0.033	-0.013	-0.001	0.007	0.011	0.009	40.6	1.913	0.00232	-1.0	0.0	0	-	67.2
16	-0.044	-0.015	0.010	-0.004	0.016	0.008	40.6	1.909	0.00232	-3.0	0.0	0	-	67.2
17	-0.050	-0.015	0.006	-0.009	0.017	0.010	40.5	1.903	0.00232	-5.0	0.0	0	-	67.2
18	-0.059	-0.010	0.010	0.001	0.021	0.016	40.4	1.890	0.00232	-10.0	0.0	0	-	67.3
19	0.000	0.000	0.000	0.000	0.000	0.000	3.8	0.017	0.00232	-0.0	0.0	0	-	67.4

Table F.141: Testing conditions and rotor 4 loads in the hub coordinate system for run 146.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	-0.099	0.000	0.013	0.000	-0.086	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	67.4
4	-0.092	0.012	0.044	0.006	-0.101	0.008	0.0	0.000	0.00232	-1.0	0.0	0	-	67.4
5	-0.096	0.018	0.068	0.021	-0.106	0.010	0.0	0.000	0.00232	-3.0	0.0	0	-	67.4
6	-0.106	0.017	0.076	0.041	-0.106	0.009	0.0	0.000	0.00232	-5.0	0.0	0	-	67.4
7	-0.118	0.028	0.100	0.066	-0.121	0.009	0.0	0.000	0.00232	-10.0	0.0	0	-	67.5
8	-0.080	-0.005	0.099	0.034	-0.088	0.007	20.4	0.481	0.00232	-10.0	0.0	0	-	66.9
9	-0.093	-0.006	0.085	0.011	-0.061	0.010	20.3	0.480	0.00232	-5.0	0.0	0	-	67.0
10	-0.103	0.001	0.102	0.005	-0.051	0.010	20.6	0.493	0.00232	-3.0	0.0	0	-	67.0
11	-0.095	0.003	0.082	-0.011	-0.050	0.011	20.3	0.479	0.00232	-1.0	0.0	0	-	66.9
12	-0.082	0.004	0.061	-0.013	-0.055	0.009	20.3	0.478	0.00232	0.0	0.0	0	-	66.9
14	-0.009	-0.008	0.033	-0.044	-0.005	0.002	40.5	1.900	0.00232	0.0	0.0	0	-	67.1
15	0.000	-0.009	0.040	-0.037	-0.013	0.002	40.6	1.913	0.00232	-1.0	0.0	0	-	67.2
16	-0.012	-0.001	0.070	-0.028	-0.012	0.005	40.6	1.909	0.00232	-3.0	0.0	0	-	67.2
17	-0.008	-0.000	0.070	-0.022	-0.016	0.007	40.5	1.903	0.00232	-5.0	0.0	0	-	67.2
18	-0.012	0.012	0.086	0.006	-0.017	0.007	40.4	1.890	0.00232	-10.0	0.0	0	-	67.3
19	0.000	0.000	0.000	0.000	0.000	0.000	3.8	0.017	0.00232	-0.0	0.0	0	-	67.4

Run 147: Tall Quadrotor, Isolated Rotor

Table F.142: Run 147 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	none

Table F.143: Testing conditions and rotor 3 loads in the hub coordinate system for run 147.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.148	0.000	-0.026	0.000	-0.066	0.000	0.0	0.000	0.00232	0.0	0.0	0	-	67.9
4	0.129	-0.058	1.694	-1.159	-0.368	2.918	2.3	0.006	0.00232	0.0	0.0	1999	-	67.9
5	0.321	0.221	2.097	2.357	6.188	2.720	20.5	0.485	0.00232	0.0	0.0	1999	-	68.0
6	0.455	0.296	3.382	2.047	9.393	3.912	20.5	0.489	0.00232	0.0	0.0	2499	-	67.9
7	0.608	0.399	4.939	1.157	12.267	5.452	20.5	0.488	0.00232	0.0	0.0	2999	-	67.9
8	0.595	0.394	4.909	1.217	12.030	5.472	20.5	0.489	0.00232	-1.0	0.0	3000	-	68.0
9	0.447	0.297	3.364	1.966	9.217	3.944	20.6	0.491	0.00232	-1.0	0.0	2500	-	68.1
10	0.294	0.203	2.089	2.169	6.381	2.728	20.6	0.493	0.00232	-1.0	0.0	2000	-	68.2
11	0.249	0.182	2.047	2.302	5.958	2.762	20.4	0.480	0.00232	-3.0	0.0	2000	-	68.3
12	0.375	0.254	3.339	1.964	8.779	3.995	20.3	0.478	0.00232	-3.0	0.0	2499	-	68.4
13	0.517	0.351	4.891	1.262	11.547	5.554	20.3	0.479	0.00232	-3.0	0.0	3000	-	68.4
14	0.509	0.333	4.844	1.263	11.196	5.633	20.2	0.475	0.00232	-5.0	0.0	3000	-	68.5
15	0.368	0.236	3.274	1.951	8.388	4.102	20.2	0.473	0.00232	-5.0	0.0	2500	-	68.5
16	0.234	0.145	1.987	2.209	5.769	2.832	20.3	0.478	0.00231	-5.0	0.0	2000	-	68.6
17	0.205	0.132	1.873	2.283	4.895	2.959	20.6	0.491	0.00231	-10.0	0.0	2000	-	68.8
18	0.325	0.208	3.175	2.115	7.403	4.253	20.3	0.478	0.00231	-10.0	0.0	2499	-	68.9
19	0.457	0.286	4.675	1.518	9.956	5.850	20.2	0.474	0.00231	-10.0	0.0	2999	-	68.9
20	0.474	0.295	1.989	5.292	5.655	3.085	40.7	1.918	0.00231	-10.0	0.0	2000	-	69.3
21	0.523	0.320	2.049	5.404	5.751	3.061	40.6	1.899	0.00231	-10.0	0.0	2000	-	69.7
22	0.714	0.444	3.559	5.299	9.167	4.297	40.6	1.901	0.00231	-10.0	0.0	2500	-	69.9
23	0.950	0.585	5.196	4.748	13.068	5.880	40.6	1.907	0.00231	-10.0	0.0	2999	-	69.9
24	1.053	0.697	5.699	4.716	15.199	5.518	40.6	1.897	0.00231	-5.0	0.0	2999	-	70.2
25	0.804	0.543	3.964	5.553	10.472	4.077	40.4	1.883	0.00231	-5.0	0.0	2500	-	70.3
26	0.604	0.399	2.409	5.614	6.671	2.924	40.4	1.882	0.00231	-5.0	0.0	2000	-	70.4
27	0.632	0.428	2.620	5.845	7.067	2.885	40.6	1.898	0.00231	-3.0	0.0	2000	-	70.7
28	0.844	0.561	4.104	5.623	10.932	4.025	40.7	1.904	0.00231	-3.0	0.0	2499	-	70.8
29	1.104	0.722	5.870	4.552	15.778	5.465	40.8	1.915	0.00230	-3.0	0.0	2999	-	71.0
30	1.108	0.724	6.029	4.186	16.776	5.424	40.5	1.891	0.00230	-1.0	0.0	3000	-	71.2
31	0.847	0.575	4.307	5.331	11.664	3.978	40.5	1.889	0.00230	-1.0	0.0	2500	-	71.4
32	0.646	0.446	2.763	5.767	7.302	2.818	40.6	1.895	0.00230	-1.0	0.0	2000	-	71.5
33	0.678	0.461	2.851	5.745	7.301	2.781	40.8	1.912	0.00230	0.0	0.0	1999	-	71.7
34	0.899	0.597	4.417	5.317	11.948	3.952	40.8	1.915	0.00230	0.0	0.0	2499	-	71.8

Continued on next page

Table F.143: Testing conditions and rotor 3 loads in the hub coordinate system for run 147.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	0.925	0.601	4.405	5.339	11.940	3.955	40.7	1.908	0.00230	0.0	0.0	2499	-	71.9
36	1.176	0.750	6.184	3.961	17.169	5.381	40.8	1.909	0.00230	0.0	0.0	3000	-	72.1
37	0.554	0.321	3.361	1.863	9.455	3.897	20.7	0.491	0.00230	0.0	0.0	2500	-	72.3
38	0.408	0.232	2.077	2.043	6.461	2.701	20.5	0.485	0.00230	0.0	0.0	2000	-	72.3
39	0.243	0.049	1.660	0.364	1.608	2.962	3.3	0.012	0.00230	0.0	0.0	2000	-	72.3
40	-0.148	0.000	-0.026	0.000	-0.066	0.000	1.7	0.003	0.00230	0.0	0.0	0	-	72.3

Run 148: Tall Quadrotor, Isolated Rotor

Table F.144: Run 148 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R4
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	none

Table F.145: Testing conditions and rotor 4 loads in the hub coordinate system for run 148.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
4	-0.099	0.000	0.013	0.000	-0.085	0.000	0.0	0.000	0.00230	-0.0	0.0	0	-	71.9
5	0.192	-0.422	1.249	1.635	-0.686	-1.881	2.1	0.005	0.00230	-0.0	0.0	1999	-	71.9
6	0.269	-0.433	1.741	-1.924	5.836	-1.705	20.5	0.486	0.00230	-0.0	0.0	1999	-	72.0
7	0.452	-0.443	3.004	-2.032	8.697	-2.838	20.6	0.487	0.00230	-0.0	0.0	2499	-	72.0
8	0.642	-0.479	4.472	-1.531	11.488	-4.254	20.4	0.478	0.00230	-0.0	0.0	2999	-	72.1
9	0.625	-0.470	4.474	-1.523	11.296	-4.274	20.6	0.486	0.00230	-1.0	0.0	3000	-	72.3
10	0.430	-0.437	3.014	-1.988	8.456	-2.853	20.6	0.489	0.00230	-1.0	0.0	2500	-	72.5
11	0.233	-0.425	1.743	-1.990	5.641	-1.712	20.5	0.481	0.00230	-1.0	0.0	1999	-	72.5
12	0.229	-0.420	1.767	-2.010	5.317	-1.768	20.6	0.488	0.00230	-3.0	0.0	1999	-	72.7
13	0.407	-0.445	3.014	-1.952	7.868	-2.961	20.4	0.479	0.00230	-3.0	0.0	2499	-	72.8
14	0.598	-0.469	4.469	-1.599	10.674	-4.406	20.6	0.486	0.00230	-3.0	0.0	2999	-	72.9
15	0.591	-0.460	4.439	-1.625	10.321	-4.474	20.6	0.488	0.00230	-5.0	0.0	3000	-	73.0
16	0.407	-0.439	2.941	-1.987	7.610	-3.008	20.6	0.488	0.00230	-5.0	0.0	2500	-	73.1
17	0.221	-0.425	1.687	-2.019	5.021	-1.833	20.7	0.492	0.00230	-5.0	0.0	1999	-	73.1
18	0.194	-0.419	1.565	-1.971	4.149	-1.956	20.5	0.484	0.00230	-10.0	0.0	1999	-	73.3
19	0.374	-0.440	2.813	-2.084	6.596	-3.173	20.7	0.492	0.00230	-10.0	0.0	2499	-	73.3
20	0.558	-0.454	4.278	-1.623	9.147	-4.624	20.5	0.483	0.00230	-10.0	0.0	2999	-	73.5
21	0.465	-0.415	1.669	-5.175	4.892	-2.040	40.8	1.901	0.00229	-10.0	0.0	2000	-	74.7
22	0.692	-0.442	3.051	-5.661	7.954	-3.222	40.6	1.884	0.00229	-10.0	0.0	2499	-	74.8
23	0.940	-0.446	4.693	-5.444	12.000	-4.660	40.7	1.897	0.00229	-10.0	0.0	2999	-	74.9
24	1.027	-0.471	5.142	-5.512	13.908	-4.388	40.6	1.885	0.00229	-5.0	0.0	3000	-	75.3
25	0.754	-0.455	3.488	-5.970	9.489	-3.014	40.7	1.896	0.00229	-5.0	0.0	2500	-	75.4
26	0.523	-0.432	2.037	-5.646	5.943	-1.925	40.7	1.896	0.00228	-5.0	0.0	2000	-	75.7
27	0.537	-0.446	2.188	-5.684	6.113	-1.889	40.8	1.905	0.00228	-3.0	0.0	2000	-	75.8
28	0.793	-0.478	3.618	-6.003	9.912	-2.952	40.8	1.898	0.00228	-3.0	0.0	2499	-	75.9
29	1.071	-0.504	5.324	-5.526	14.446	-4.288	41.0	1.915	0.00228	-3.0	0.0	2999	-	75.9
30	1.056	-0.497	5.281	-5.380	14.377	-4.288	40.9	1.913	0.00228	-3.0	0.0	3000	-	76.1
31	1.069	-0.484	5.398	-5.389	15.035	-4.267	40.7	1.892	0.00228	-1.0	0.0	2999	-	76.2
32	0.790	-0.454	3.807	-5.954	10.406	-2.924	40.8	1.896	0.00228	-1.0	0.0	2500	-	76.3
33	0.521	-0.432	2.314	-5.868	6.409	-1.830	40.7	1.892	0.00228	-1.0	0.0	2000	-	76.4
34	0.550	-0.447	2.358	-5.713	6.541	-1.809	40.9	1.906	0.00228	-0.0	0.0	1999	-	76.6
35	0.819	-0.471	3.807	-5.818	10.753	-2.893	40.6	1.882	0.00228	-0.0	0.0	2499	-	76.8

Continued on next page

Table F.145: Testing conditions and rotor 4 loads in the hub coordinate system for run 148.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
36	0.823	-0.464	3.851	-5.920	10.771	-2.891	40.8	1.895	0.00228	-0.0	0.0	2499	-	76.9
37	1.102	-0.478	5.518	-5.191	15.711	-4.240	40.7	1.891	0.00228	-0.0	0.0	2999	-	76.9
38	0.300	-0.431	1.689	-2.231	5.669	-1.711	20.4	0.473	0.00228	-0.0	0.0	1999	-	77.1
40	0.077	-0.420	1.274	0.646	0.313	-1.977	0.0	0.000	0.00228	-0.0	0.0	2000	-	76.8
41	-0.099	0.000	0.013	0.000	-0.086	0.000	0.0	0.000	0.00228	-0.0	0.0	0	-	76.8

Run 149: Tall Quadrotor

Table F.146: Run 149 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	0

Table F.147: Testing conditions and rotor 1 loads in the hub coordinate system for run 149.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.062	0.000	0.069	0.000	-0.109	0.000	0.2	0.000	0.00225	-0.0	0.0	0	-	82.9
4	0.045	0.130	1.814	-1.812	0.466	-2.303	5.0	0.028	0.00225	-0.0	0.0	2000	0.0	83.2
5	0.291	0.113	2.662	-1.421	6.527	-1.775	20.8	0.486	0.00225	0.0	0.0	2000	0.0	84.3
7	0.459	0.129	3.938	-1.132	9.865	-2.982	20.6	0.477	0.00224	-0.0	0.0	2500	0.0	84.7
8	0.696	0.149	5.562	-0.194	13.135	-4.520	20.7	0.479	0.00224	-0.0	0.0	2999	0.0	84.8
9	0.689	0.129	5.523	-0.340	12.938	-4.499	20.6	0.478	0.00224	-1.0	0.0	3000	0.0	85.1
10	0.454	0.110	3.879	-1.231	9.673	-2.998	20.6	0.475	0.00224	-1.0	0.0	2500	0.0	85.3
11	0.258	0.103	2.596	-1.441	6.489	-1.793	20.7	0.481	0.00224	-1.0	0.0	2000	0.0	85.5
12	0.236	0.100	2.527	-1.645	6.269	-1.820	20.7	0.478	0.00224	-3.0	0.0	2000	0.0	85.6
13	0.380	0.096	3.784	-1.507	9.418	-2.986	20.8	0.482	0.00224	-3.0	0.0	2499	0.0	85.7
14	0.626	0.110	5.343	-0.720	12.482	-4.453	20.6	0.476	0.00224	-3.0	0.0	3000	0.0	86.0
15	0.620	0.082	5.266	-1.193	12.124	-4.423	20.6	0.473	0.00224	-5.0	0.0	2999	0.0	86.2
16	0.383	0.088	3.723	-1.793	9.086	-2.991	20.7	0.478	0.00224	-5.0	0.0	2500	0.0	86.4
17	0.214	0.081	2.439	-1.905	6.053	-1.858	20.7	0.477	0.00224	-5.0	0.0	2000	0.0	86.4
18	0.168	0.099	2.347	-2.022	5.388	-1.985	20.8	0.483	0.00224	-10.0	0.0	2000	0.0	86.5
19	0.330	0.092	3.639	-1.952	8.111	-3.162	20.9	0.488	0.00224	-10.0	0.0	2500	0.0	86.7
20	0.539	0.108	5.139	-1.544	10.988	-4.599	20.7	0.478	0.00224	-10.0	0.0	2999	0.0	86.8
21	0.358	0.012	2.603	-5.061	6.433	-2.137	41.5	1.917	0.00223	-10.0	0.0	2000	0.0	88.2
22	0.552	-0.011	4.066	-4.852	9.768	-3.294	41.4	1.910	0.00223	-10.0	0.0	2499	0.0	88.5
23	0.914	0.001	5.800	-4.292	13.913	-4.700	41.4	1.906	0.00222	-10.0	0.0	3000	0.0	88.7
24	1.024	-0.027	6.292	-4.101	15.682	-4.514	41.3	1.892	0.00222	-5.0	0.0	2999	0.0	89.0
25	0.618	-0.014	4.519	-5.218	10.972	-3.162	41.1	1.880	0.00222	-5.0	0.0	2500	0.0	89.1
26	0.417	0.017	3.007	-5.365	7.192	-2.045	41.4	1.905	0.00222	-5.0	0.0	2000	0.0	89.6
27	0.422	0.034	3.171	-5.195	7.209	-1.992	41.2	1.885	0.00222	-3.0	0.0	2000	0.0	89.7
28	0.627	0.033	4.691	-4.927	11.454	-3.148	41.5	1.907	0.00222	-3.0	0.0	2499	0.0	90.0
30	1.053	-0.007	6.493	-3.451	16.108	-4.493	41.2	1.888	0.00222	-3.0	0.0	3000	0.0	90.0
31	0.468	0.035	3.235	-5.338	7.355	-1.977	41.4	1.901	0.00222	-1.0	0.0	1999	0.0	90.8
32	0.646	0.016	4.986	-4.634	11.360	-3.084	41.5	1.909	0.00222	-1.0	0.0	2499	0.0	90.8
33	1.114	0.018	6.792	-3.447	16.709	-4.454	41.5	1.912	0.00221	-1.0	0.0	3000	0.0	90.9
34	1.136	0.022	6.935	-3.192	16.825	-4.408	41.5	1.909	0.00221	-0.0	0.0	3000	0.0	90.9
35	0.718	0.010	5.025	-4.488	11.276	-3.128	41.5	1.904	0.00221	0.0	0.0	2500	0.0	90.9
37	0.480	0.016	3.244	-5.425	7.176	-1.971	41.5	1.908	0.00222	0.0	0.0	2000	0.0	90.8

Continued on next page

Table F.147: Testing conditions and rotor 1 loads in the hub coordinate system for run 149.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
38	0.300	0.125	2.464	-1.601	6.550	-1.908	20.8	0.477	0.00222	-0.0	0.0	2000	0.0	90.7
39	0.087	0.183	1.882	-0.569	2.730	-2.199	3.5	0.014	0.00222	-0.0	0.0	2000	0.0	90.5
40	-0.000	0.000	-0.000	0.000	0.000	0.000	2.4	0.006	0.00222	0.0	0.0	0	-	90.5

Table F.148: Testing conditions and rotor 2 loads in the hub coordinate system for run 149.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.127	0.000	0.019	0.000	-0.043	0.000	0.2	0.000	0.00225	-0.0	0.0	0	-	82.9
4	-0.030	-0.012	2.008	1.965	0.813	2.883	5.0	0.028	0.00225	-0.0	0.0	2000	0.0	83.2
5	-0.094	0.104	2.665	1.518	6.634	2.546	20.8	0.486	0.00225	0.0	0.0	2000	0.0	84.3
7	0.016	0.100	3.985	1.199	9.899	3.819	20.6	0.477	0.00224	-0.0	0.0	2500	0.0	84.7
8	0.102	0.093	5.648	0.083	13.049	5.392	20.7	0.479	0.00224	-0.0	0.0	2999	0.0	84.8
9	0.111	0.102	5.568	0.341	12.856	5.365	20.6	0.478	0.00224	-1.0	0.0	3000	0.0	85.1
10	0.031	0.090	3.920	1.296	9.631	3.810	20.6	0.475	0.00224	-1.0	0.0	2500	0.0	85.3
11	-0.095	0.093	2.580	1.581	6.447	2.574	20.7	0.481	0.00224	-1.0	0.0	2000	0.0	85.5
12	-0.106	0.095	2.505	1.836	6.247	2.601	20.7	0.478	0.00224	-3.0	0.0	2000	0.0	85.6
13	-0.017	0.099	3.820	1.612	9.377	3.792	20.8	0.482	0.00224	-3.0	0.0	2499	0.0	85.7
14	0.084	0.091	5.412	0.790	12.476	5.284	20.6	0.476	0.00224	-3.0	0.0	2999	0.0	86.0
15	0.075	0.107	5.294	1.421	12.094	5.228	20.6	0.473	0.00224	-5.0	0.0	2999	0.0	86.2
16	-0.006	0.089	3.721	2.004	9.003	3.777	20.7	0.478	0.00224	-5.0	0.0	2500	0.0	86.4
17	-0.101	0.066	2.404	2.091	5.980	2.602	20.7	0.477	0.00224	-5.0	0.0	1999	0.0	86.4
18	-0.110	0.053	2.297	2.114	5.200	2.734	20.8	0.483	0.00224	-10.0	0.0	1999	0.0	86.5
19	-0.030	0.053	3.637	2.045	7.918	3.943	20.9	0.488	0.00224	-10.0	0.0	2499	0.0	86.7
20	0.069	0.075	5.237	1.489	10.776	5.414	20.7	0.478	0.00224	-10.0	0.0	2999	0.0	86.8
21	0.022	0.112	2.512	4.771	6.302	2.797	41.5	1.917	0.00223	-10.0	0.0	2000	0.0	88.2
22	0.151	0.133	4.045	4.746	9.449	4.004	41.4	1.910	0.00223	-10.0	0.0	2499	0.0	88.5
23	0.274	0.170	5.828	3.872	13.574	5.473	41.4	1.906	0.00222	-10.0	0.0	2999	0.0	88.7
24	0.312	0.211	6.257	3.663	15.297	5.215	41.3	1.892	0.00222	-5.0	0.0	3000	0.0	89.0
25	0.164	0.176	4.464	4.882	10.859	3.823	41.1	1.880	0.00222	-5.0	0.0	2500	0.0	89.1
26	0.053	0.143	2.920	5.109	7.226	2.692	41.4	1.905	0.00222	-5.0	0.0	2000	0.0	89.6
27	0.054	0.131	3.097	5.071	7.301	2.649	41.2	1.885	0.00222	-3.0	0.0	2000	0.0	89.7
28	0.206	0.138	4.766	4.211	11.475	3.820	41.5	1.907	0.00222	-3.0	0.0	2499	0.0	90.0
30	0.377	0.178	6.554	2.898	16.131	5.215	41.2	1.888	0.00222	-3.0	0.0	3000	0.0	90.0
31	0.115	0.127	3.321	4.896	7.455	2.553	41.4	1.901	0.00222	-1.0	0.0	1999	0.0	90.8
32	0.228	0.145	4.957	4.208	11.624	3.716	41.5	1.909	0.00222	-1.0	0.0	2499	0.0	90.8
33	0.431	0.173	6.853	2.240	16.723	5.106	41.5	1.912	0.00221	-1.0	0.0	3000	0.0	90.9
34	0.459	0.165	7.008	1.962	16.956	5.051	41.5	1.909	0.00221	-0.0	0.0	2999	0.0	90.9
35	0.303	0.136	5.078	4.026	11.650	3.653	41.5	1.904	0.00221	0.0	0.0	2500	0.0	90.9
37	0.150	0.104	3.307	5.134	7.391	2.497	41.5	1.908	0.00222	0.0	0.0	2000	0.0	90.8

Continued on next page

Table F.148: Testing conditions and rotor 2 loads in the hub coordinate system for run 149.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
38	0.060	0.029	2.538	1.434	6.411	2.415	20.8	0.477	0.00222	-0.0	0.0	2000	0.0	90.7
39	0.102	-0.034	2.025	0.637	2.513	2.701	3.5	0.014	0.00222	-0.0	0.0	1999	0.0	90.5
40	-0.000	0.000	-0.000	0.000	0.000	0.000	2.4	0.006	0.00222	0.0	0.0	0	-	90.5

Table F.149: Testing conditions and rotor 3 loads in the hub coordinate system for run 149.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.147	0.000	-0.026	0.000	-0.065	0.000	0.2	0.000	0.00225	-0.0	0.0	0	-	82.9
4	0.029	-0.116	1.603	-1.698	-0.453	2.979	5.0	0.028	0.00225	-0.0	0.0	1999	0.0	83.2
5	-0.046	0.307	1.746	2.134	5.075	2.931	20.8	0.486	0.00225	0.0	0.0	2000	0.0	84.3
7	0.033	0.381	2.887	1.773	7.090	4.213	20.6	0.477	0.00224	-0.0	0.0	2500	0.0	84.7
8	0.127	0.455	4.361	1.232	8.834	5.728	20.7	0.479	0.00224	-0.0	0.0	3000	0.0	84.8
9	0.127	0.435	4.356	1.331	8.906	5.756	20.6	0.478	0.00224	-1.0	0.0	2999	0.0	85.1
10	-0.009	0.346	2.834	1.406	7.065	4.196	20.6	0.475	0.00224	-1.0	0.0	2500	0.0	85.3
11	-0.084	0.259	1.640	1.997	5.042	2.925	20.7	0.481	0.00224	-1.0	0.0	1999	0.0	85.5
12	-0.070	0.254	1.635	2.246	4.907	2.958	20.7	0.478	0.00224	-3.0	0.0	1999	0.0	85.6
13	0.043	0.276	2.812	1.614	7.048	4.219	20.8	0.482	0.00224	-3.0	0.0	2499	0.0	85.7
14	0.161	0.367	4.305	1.044	8.722	5.774	20.6	0.476	0.00224	-3.0	0.0	3000	0.0	86.0
15	0.169	0.339	4.277	1.042	8.705	5.801	20.6	0.473	0.00224	-5.0	0.0	3000	0.0	86.2
16	0.052	0.289	2.852	1.929	6.819	4.234	20.7	0.478	0.00224	-5.0	0.0	2500	0.0	86.4
17	-0.023	0.218	1.631	2.269	4.704	2.966	20.7	0.477	0.00224	-5.0	0.0	1999	0.0	86.4
18	-0.022	0.189	1.574	2.369	4.164	3.008	20.8	0.483	0.00224	-10.0	0.0	2000	0.0	86.5
19	0.112	0.263	2.833	2.161	6.183	4.274	20.9	0.488	0.00224	-10.0	0.0	2499	0.0	86.7
20	0.240	0.314	4.264	1.475	8.192	5.832	20.7	0.478	0.00224	-10.0	0.0	2999	0.0	86.8
21	0.436	0.354	1.880	5.343	5.401	3.073	41.5	1.917	0.00223	-10.0	0.0	2000	0.0	88.2
22	0.631	0.460	3.211	5.376	8.307	4.332	41.4	1.910	0.00223	-10.0	0.0	2499	0.0	88.5
23	0.846	0.594	4.718	4.583	11.711	5.886	41.4	1.906	0.00222	-10.0	0.0	2999	0.0	88.7
24	0.911	0.642	5.073	4.222	13.358	5.740	41.3	1.892	0.00222	-5.0	0.0	3000	0.0	89.0
25	0.696	0.544	3.524	5.299	9.690	4.192	41.1	1.880	0.00222	-5.0	0.0	2500	0.0	89.1
26	0.540	0.451	2.186	5.637	6.333	2.940	41.4	1.905	0.00222	-5.0	0.0	2000	0.0	89.6
27	0.581	0.478	2.309	5.775	6.681	2.869	41.2	1.885	0.00222	-3.0	0.0	1999	0.0	89.7
28	0.815	0.569	3.638	5.403	10.025	4.105	41.5	1.907	0.00222	-3.0	0.0	2499	0.0	90.0
30	1.061	0.665	5.193	4.093	13.901	5.632	41.2	1.888	0.00222	-3.0	0.0	3000	0.0	90.0
31	0.694	0.495	2.383	5.898	6.852	2.815	41.4	1.901	0.00222	-1.0	0.0	2000	0.0	90.8
32	0.903	0.594	3.787	5.580	10.470	3.985	41.5	1.909	0.00222	-1.0	0.0	2499	0.0	90.8
33	1.144	0.697	5.321	4.168	14.271	5.552	41.5	1.912	0.00221	-1.0	0.0	2999	0.0	90.9
34	1.167	0.695	5.357	4.098	14.397	5.543	41.5	1.909	0.00221	-0.0	0.0	2999	0.0	90.9
35	0.935	0.601	3.800	5.544	10.482	3.952	41.5	1.904	0.00221	0.0	0.0	2500	0.0	90.9
37	0.731	0.479	2.402	5.888	6.983	2.786	41.5	1.908	0.00222	0.0	0.0	2000	0.0	90.8

Continued on next page

Table F.149: Testing conditions and rotor 3 loads in the hub coordinate system for run 149.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
38	0.426	0.213	1.779	2.056	4.867	2.883	20.8	0.477	0.00222	-0.0	0.0	2000	0.0	90.7
39	0.272	0.034	1.578	-0.472	1.456	2.953	3.5	0.014	0.00222	-0.0	0.0	1999	0.0	90.5
40	-0.000	0.000	-0.000	0.000	0.000	0.000	2.4	0.006	0.00222	0.0	0.0	0	-	90.5

Table F.150: Testing conditions and rotor 4 loads in the hub coordinate system for run 149.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	-0.099	0.000	0.013	0.000	-0.085	0.000	0.2	0.000	0.00225	-0.0	0.0	0	-	82.9
4	0.092	-0.368	1.301	2.538	-0.485	-1.908	5.0	0.028	0.00225	-0.0	0.0	1999	0.0	83.2
5	0.045	-0.240	1.602	-1.810	4.604	-1.792	20.8	0.486	0.00225	0.0	0.0	2000	0.0	84.3
7	0.172	-0.261	2.753	-1.679	6.647	-3.010	20.6	0.477	0.00224	-0.0	0.0	2500	0.0	84.7
8	0.260	-0.273	4.134	-1.122	8.270	-4.417	20.7	0.479	0.00224	-0.0	0.0	3000	0.0	84.8
9	0.252	-0.253	4.226	-1.460	8.320	-4.467	20.6	0.478	0.00224	-1.0	0.0	2999	0.0	85.1
10	0.124	-0.239	2.748	-1.470	6.677	-3.008	20.6	0.475	0.00224	-1.0	0.0	2500	0.0	85.3
11	0.007	-0.242	1.599	-1.790	4.564	-1.800	20.7	0.481	0.00224	-1.0	0.0	2000	0.0	85.5
12	0.028	-0.246	1.596	-1.876	4.404	-1.821	20.7	0.478	0.00224	-3.0	0.0	1999	0.0	85.6
13	0.142	-0.265	2.712	-1.344	6.535	-3.034	20.8	0.482	0.00224	-3.0	0.0	2499	0.0	85.7
14	0.260	-0.262	4.142	-1.014	8.322	-4.497	20.6	0.476	0.00224	-3.0	0.0	3000	0.0	86.0
15	0.239	-0.239	4.109	-0.997	8.146	-4.513	20.6	0.473	0.00224	-5.0	0.0	2999	0.0	86.2
16	0.139	-0.233	2.750	-1.761	6.309	-3.058	20.7	0.478	0.00224	-5.0	0.0	2500	0.0	86.4
17	0.040	-0.240	1.565	-1.872	4.168	-1.849	20.7	0.477	0.00224	-5.0	0.0	2000	0.0	86.4
18	0.053	-0.237	1.512	-1.883	3.610	-1.900	20.8	0.483	0.00224	-10.0	0.0	2000	0.0	86.5
19	0.181	-0.251	2.678	-1.866	5.639	-3.104	20.9	0.488	0.00224	-10.0	0.0	2499	0.0	86.7
20	0.264	-0.254	4.069	-1.383	7.679	-4.554	20.7	0.478	0.00224	-10.0	0.0	3000	0.0	86.8
21	0.247	-0.261	1.656	-5.308	4.578	-1.956	41.5	1.917	0.00223	-10.0	0.0	1999	0.0	88.2
22	0.426	-0.275	2.938	-5.891	7.450	-3.152	41.4	1.910	0.00223	-10.0	0.0	2499	0.0	88.5
23	0.591	-0.296	4.345	-5.611	10.593	-4.584	41.4	1.906	0.00222	-10.0	0.0	3000	0.0	88.7
24	0.674	-0.306	4.727	-5.745	12.371	-4.446	41.3	1.892	0.00222	-5.0	0.0	3000	0.0	89.0
25	0.494	-0.323	3.243	-6.169	8.545	-3.030	41.1	1.880	0.00222	-5.0	0.0	2500	0.0	89.1
26	0.336	-0.299	1.933	-5.991	5.390	-1.872	41.4	1.905	0.00222	-5.0	0.0	1999	0.0	89.6
27	0.349	-0.316	2.013	-6.150	5.712	-1.824	41.2	1.885	0.00222	-3.0	0.0	2000	0.0	89.7
28	0.568	-0.361	3.343	-6.386	9.128	-2.937	41.5	1.907	0.00222	-3.0	0.0	2499	0.0	90.0
30	0.762	-0.350	4.771	-5.758	12.821	-4.389	41.2	1.888	0.00222	-3.0	0.0	3000	0.0	90.0
31	0.380	-0.362	2.093	-6.439	6.038	-1.773	41.4	1.901	0.00222	-1.0	0.0	1999	0.0	90.8
32	0.609	-0.396	3.407	-6.619	9.495	-2.897	41.5	1.909	0.00222	-1.0	0.0	2499	0.0	90.8
33	0.808	-0.379	4.873	-5.878	13.402	-4.321	41.5	1.912	0.00221	-1.0	0.0	3000	0.0	90.9
34	0.831	-0.375	4.891	-5.871	13.638	-4.283	41.5	1.909	0.00221	-0.0	0.0	2999	0.0	90.9
35	0.635	-0.371	3.436	-6.588	9.631	-2.869	41.5	1.904	0.00221	0.0	0.0	2500	0.0	90.9
37	0.406	-0.382	2.043	-6.567	6.027	-1.752	41.5	1.908	0.00222	0.0	0.0	2000	0.0	90.8

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Table F.150: Testing conditions and rotor 4 loads in the hub coordinate system for run 149.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
38	0.209	-0.372	1.453	-1.928	4.476	-1.798	20.8	0.477	0.00222	-0.0	0.0	1999	0.0	90.7
39	0.174	-0.374	1.181	1.017	1.280	-1.897	3.5	0.014	0.00222	-0.0	0.0	2000	0.0	90.5
40	-0.000	0.000	-0.000	0.000	0.000	0.000	2.4	0.006	0.00222	0.0	0.0	0	-	90.5

Run 150: Tall Quadrotor

Table F.151: Run 150 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	-90

Table F.152: Testing conditions and rotor 1 loads in the hub coordinate system for run 150.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.063	0.000	0.069	0.000	-0.110	0.000	0.4	0.000	0.00222	0.0	0.0	0	-	89.0
4	-0.002	0.143	1.724	-1.123	0.643	-2.360	5.9	0.038	0.00222	-0.0	0.0	1999	0.0	88.8
5	0.317	0.083	2.424	-1.451	6.532	-1.904	20.8	0.481	0.00222	-0.0	0.0	1999	0.0	88.8
6	0.470	0.089	3.748	-1.250	9.790	-3.112	20.8	0.480	0.00222	-0.0	0.0	2499	0.0	88.8
7	0.755	0.124	5.336	-0.427	13.168	-4.618	20.9	0.486	0.00222	-0.0	0.0	3000	0.0	88.9
8	0.777	0.090	5.281	-0.564	13.039	-4.612	21.0	0.488	0.00222	-1.0	0.0	2999	0.0	89.0
9	0.492	0.080	3.700	-1.255	9.605	-3.132	20.8	0.482	0.00222	-1.0	0.0	2500	0.0	89.0
10	0.331	0.088	2.367	-1.466	6.450	-1.930	20.6	0.473	0.00222	-1.0	0.0	2000	0.0	89.0
11	0.287	0.085	2.327	-1.734	6.233	-1.950	20.9	0.487	0.00222	-3.0	0.0	1999	0.0	89.2
12	0.416	0.073	3.616	-1.539	9.297	-3.113	21.0	0.490	0.00222	-3.0	0.0	2500	0.0	89.3
13	0.728	0.096	5.130	-0.949	12.462	-4.547	20.8	0.482	0.00222	-3.0	0.0	2999	0.0	89.5
14	0.706	0.063	5.072	-1.516	12.092	-4.511	20.8	0.478	0.00222	-5.0	0.0	2999	0.0	89.6
15	0.404	0.060	3.535	-1.905	8.947	-3.102	20.7	0.475	0.00222	-5.0	0.0	2500	0.0	89.8
16	0.284	0.072	2.273	-1.955	5.975	-1.961	20.7	0.476	0.00222	-5.0	0.0	2000	0.0	89.8
17	0.229	0.092	2.165	-2.098	5.320	-2.075	20.8	0.481	0.00222	-10.0	0.0	2000	0.0	89.9
18	0.351	0.067	3.467	-2.040	8.078	-3.238	21.2	0.499	0.00222	-10.0	0.0	2499	0.0	89.9
19	0.632	0.083	4.966	-1.808	11.000	-4.666	20.9	0.484	0.00222	-10.0	0.0	2999	0.0	90.1
20	0.993	-0.027	5.652	-4.548	13.968	-4.735	41.6	1.920	0.00221	-10.0	0.0	2999	0.0	90.4
21	0.560	-0.033	3.891	-5.142	9.738	-3.371	41.4	1.899	0.00221	-10.0	0.0	2500	0.0	90.6
22	0.413	-0.010	2.387	-4.981	6.328	-2.221	41.2	1.878	0.00221	-10.0	0.0	2000	0.0	90.6
23	0.403	-0.004	2.375	-5.079	6.348	-2.224	41.4	1.896	0.00221	-10.0	0.0	2000	0.0	90.9
24	0.456	-0.002	2.812	-5.323	7.128	-2.138	41.5	1.902	0.00221	-5.0	0.0	1999	0.0	91.1
25	0.608	-0.007	4.334	-5.134	10.861	-3.266	41.5	1.905	0.00221	-5.0	0.0	2499	0.0	91.2
26	1.071	-0.017	6.127	-4.274	15.627	-4.626	41.6	1.914	0.00221	-5.0	0.0	3000	0.0	91.3
27	1.127	-0.022	6.383	-3.743	15.964	-4.540	41.6	1.913	0.00221	-3.0	0.0	2999	0.0	91.2
28	0.677	-0.007	4.564	-4.920	11.246	-3.229	41.4	1.891	0.00221	-3.0	0.0	2500	0.0	91.3
29	0.499	-0.017	2.984	-5.203	7.236	-2.101	41.3	1.884	0.00221	-3.0	0.0	2000	0.0	91.3
30	0.484	-0.020	3.140	-5.343	7.260	-2.020	41.5	1.904	0.00221	-1.0	0.0	1999	0.0	91.3
31	0.662	0.006	4.801	-4.665	11.366	-3.157	41.7	1.920	0.00221	-1.0	0.0	2499	0.0	91.3
32	1.149	-0.001	6.713	-3.304	16.594	-4.436	41.4	1.896	0.00221	-0.9	0.0	2999	0.0	91.3
33	1.201	-0.006	6.769	-3.460	16.806	-4.451	41.6	1.913	0.00221	-0.0	0.0	3000	0.0	91.4
34	0.719	-0.026	4.939	-4.828	11.393	-3.124	41.6	1.909	0.00221	-0.0	0.0	2500	0.0	91.3

Continued on next page

Table F.152: Testing conditions and rotor 1 loads in the hub coordinate system for run 150.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	0.499	-0.007	3.177	-5.201	7.269	-1.997	41.2	1.881	0.00221	-0.0	0.0	2000	0.0	91.3
36	0.486	-0.014	3.180	-5.383	7.351	-1.990	41.4	1.892	0.00221	-0.0	0.0	2000	0.0	91.3
37	0.309	0.117	2.408	-1.585	6.566	-1.932	20.8	0.477	0.00221	-0.0	0.0	1999	0.0	91.2
39	0.008	0.211	1.615	-0.198	1.351	-2.259	6.7	0.050	0.00221	-0.0	0.0	1999	0.0	90.9
40	-0.063	0.000	0.068	0.000	-0.110	0.000	1.6	0.003	0.00221	0.0	0.0	0	-	90.9

Table F.153: Testing conditions and rotor 2 loads in the hub coordinate system for run 150.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	-0.127	0.000	0.018	0.000	-0.044	0.000	0.4	0.000	0.00222	0.0	0.0	0	-	89.0
4	0.093	-0.088	1.909	1.202	0.567	2.782	5.9	0.038	0.00222	-0.0	0.0	1999	-90.0	88.8
5	0.125	0.020	2.567	1.416	6.498	2.407	20.8	0.481	0.00222	-0.0	0.0	2000	-90.0	88.8
6	0.186	0.035	3.924	1.024	9.741	3.652	20.8	0.480	0.00222	-0.0	0.0	2499	-90.0	88.8
7	0.315	0.029	5.573	0.101	13.002	5.240	20.9	0.486	0.00222	-0.0	0.0	2999	-90.0	88.9
8	0.328	0.035	5.482	0.351	12.824	5.212	21.0	0.488	0.00222	-1.0	0.0	2999	-90.0	89.0
9	0.222	0.035	3.865	1.190	9.478	3.664	20.8	0.482	0.00222	-1.0	0.0	2500	-90.0	89.0
10	0.137	0.018	2.503	1.542	6.257	2.423	20.6	0.473	0.00222	-1.0	0.0	2000	-90.0	89.0
11	0.102	0.030	2.472	1.752	6.149	2.453	20.9	0.487	0.00222	-3.0	0.0	2000	-90.0	89.2
12	0.153	0.051	3.783	1.495	9.230	3.654	21.0	0.490	0.00222	-3.0	0.0	2499	-90.0	89.3
13	0.282	0.053	5.345	0.790	12.347	5.150	20.8	0.482	0.00222	-3.0	0.0	2999	-90.0	89.5
14	0.260	0.075	5.247	1.270	11.987	5.117	20.8	0.478	0.00222	-5.0	0.0	2999	-90.0	89.6
15	0.138	0.080	3.671	1.866	8.905	3.663	20.7	0.475	0.00222	-5.0	0.0	2500	-90.0	89.8
16	0.064	0.050	2.375	2.021	5.890	2.492	20.7	0.476	0.00222	-5.0	0.0	2000	-90.0	89.8
17	0.030	0.026	2.253	2.064	5.174	2.623	20.8	0.481	0.00222	-10.0	0.0	1999	-90.0	89.9
18	0.086	0.053	3.595	1.892	7.912	3.833	21.2	0.499	0.00222	-10.0	0.0	2499	-90.0	89.9
19	0.237	0.056	5.138	1.440	10.688	5.325	20.9	0.484	0.00222	-10.0	0.0	2999	-90.0	90.1
20	0.409	0.112	5.718	3.856	13.429	5.434	41.6	1.920	0.00221	-10.0	0.0	3000	-90.0	90.4
21	0.276	0.104	3.967	4.526	9.428	3.918	41.4	1.899	0.00221	-10.0	0.0	2500	-90.0	90.6
22	0.154	0.065	2.405	4.596	6.007	2.721	41.2	1.878	0.00221	-10.0	0.0	2000	-90.0	90.6
23	0.135	0.060	2.450	4.701	6.321	2.695	41.4	1.896	0.00221	-10.0	0.0	1999	-90.0	90.9
24	0.174	0.077	2.874	4.991	7.252	2.586	41.5	1.902	0.00221	-5.0	0.0	2000	-90.0	91.1
25	0.299	0.105	4.437	4.448	11.090	3.745	41.5	1.905	0.00221	-5.0	0.0	2499	-90.0	91.2
26	0.480	0.141	6.250	3.406	15.507	5.161	41.6	1.914	0.00221	-5.0	0.0	2999	-90.0	91.3
27	0.501	0.144	6.497	2.965	16.065	5.162	41.6	1.913	0.00221	-3.0	0.0	3000	-90.0	91.2
28	0.316	0.119	4.661	4.341	11.390	3.723	41.4	1.891	0.00221	-3.0	0.0	2500	-90.0	91.3
29	0.207	0.097	3.069	4.882	7.210	2.543	41.3	1.884	0.00221	-3.0	0.0	1999	-90.0	91.3
30	0.171	0.090	3.211	4.982	7.503	2.498	41.5	1.904	0.00221	-1.0	0.0	1999	-90.0	91.3
31	0.311	0.124	4.880	3.990	11.621	3.661	41.7	1.920	0.00221	-1.0	0.0	2499	-90.0	91.3
32	0.510	0.139	6.741	2.342	16.467	5.069	41.4	1.896	0.00221	-0.9	0.0	2999	-90.0	91.3
33	0.532	0.133	6.885	2.056	16.757	5.050	41.6	1.913	0.00221	-0.0	0.0	2999	-90.0	91.4
34	0.334	0.131	4.991	4.032	11.524	3.648	41.6	1.909	0.00221	-0.0	0.0	2500	-90.0	91.3

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Table F.153: Testing conditions and rotor 2 loads in the hub coordinate system for run 150.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
35	0.205	0.098	3.296	4.895	7.439	2.473	41.2	1.881	0.00221	-0.0	0.0	2000	-90.0	91.3
36	0.188	0.102	3.266	5.110	7.409	2.479	41.4	1.892	0.00221	-0.0	0.0	1999	-90.0	91.3
37	0.118	0.017	2.510	1.395	6.411	2.396	20.8	0.477	0.00221	-0.0	0.0	2000	-90.0	91.2
39	0.090	-0.078	1.781	0.517	0.905	2.761	6.7	0.050	0.00221	-0.0	0.0	2000	-90.0	90.9
40	-0.127	0.000	0.018	0.000	-0.044	0.000	1.6	0.003	0.00221	0.0	0.0	0	-	90.9

Table F.154: Testing conditions and rotor 3 loads in the hub coordinate system for run 150.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.148	0.000	-0.026	0.000	-0.066	0.000	0.4	0.000	0.00222	0.0	0.0	0	-	89.0
4	0.157	-0.164	1.653	-1.848	-0.356	2.920	5.9	0.038	0.00222	-0.0	0.0	2000	-90.0	88.8
5	0.283	0.184	1.835	2.175	4.872	2.858	20.8	0.481	0.00222	-0.0	0.0	1999	-90.0	88.8
6	0.373	0.266	3.029	1.758	6.734	4.104	20.8	0.480	0.00222	-0.0	0.0	2499	-90.0	88.8
7	0.504	0.337	4.497	1.295	8.597	5.595	20.9	0.486	0.00222	-0.0	0.0	3000	-90.0	88.9
8	0.538	0.323	4.499	1.630	8.694	5.648	21.0	0.488	0.00222	-1.0	0.0	2999	-90.0	89.0
9	0.406	0.252	2.976	1.820	6.860	4.117	20.8	0.482	0.00222	-1.0	0.0	2500	-90.0	89.0
10	0.289	0.192	1.770	2.174	4.878	2.852	20.6	0.473	0.00222	-1.0	0.0	2000	-90.0	89.0
11	0.261	0.189	1.769	2.261	4.671	2.878	20.9	0.487	0.00222	-3.0	0.0	2000	-90.0	89.2
12	0.368	0.244	2.930	1.713	6.869	4.145	21.0	0.490	0.00222	-3.0	0.0	2499	-90.0	89.3
13	0.487	0.318	4.413	1.300	8.597	5.678	20.8	0.482	0.00222	-3.0	0.0	2999	-90.0	89.5
14	0.459	0.296	4.370	1.219	8.537	5.703	20.8	0.478	0.00222	-5.0	0.0	2999	-90.0	89.6
15	0.324	0.255	2.918	1.882	6.568	4.167	20.7	0.475	0.00222	-5.0	0.0	2500	-90.0	89.8
16	0.227	0.202	1.725	2.297	4.515	2.910	20.7	0.476	0.00222	-5.0	0.0	2000	-90.0	89.8
17	0.218	0.170	1.664	2.378	4.007	2.956	20.8	0.481	0.00222	-10.0	0.0	1999	-90.0	89.9
18	0.338	0.237	2.894	2.305	6.091	4.218	21.2	0.499	0.00222	-10.0	0.0	2499	-90.0	89.9
19	0.471	0.300	4.361	1.765	8.114	5.747	20.9	0.484	0.00222	-10.0	0.0	2999	-90.0	90.1
20	0.934	0.500	4.732	4.594	11.722	5.798	41.6	1.920	0.00221	-10.0	0.0	2999	-90.0	90.4
21	0.761	0.441	3.193	5.445	8.169	4.276	41.4	1.899	0.00221	-10.0	0.0	2500	-90.0	90.6
22	0.589	0.335	1.860	5.212	5.247	3.013	41.2	1.878	0.00221	-10.0	0.0	2000	-90.0	90.6
23	0.621	0.340	1.877	5.326	5.293	3.014	41.4	1.896	0.00221	-10.0	0.0	2000	-90.0	90.9
24	0.723	0.420	2.198	5.706	6.100	2.889	41.5	1.902	0.00221	-5.0	0.0	2000	-90.0	91.1
25	0.940	0.539	3.551	5.573	9.265	4.122	41.5	1.905	0.00221	-5.0	0.0	2499	-90.0	91.2
26	1.151	0.636	5.157	4.677	13.321	5.629	41.6	1.914	0.00221	-5.0	0.0	2999	-90.0	91.3
27	1.191	0.647	5.251	4.406	13.720	5.563	41.6	1.913	0.00221	-3.0	0.0	2999	-90.0	91.2
28	0.973	0.566	3.672	5.470	9.865	4.021	41.4	1.891	0.00221	-3.0	0.0	2500	-90.0	91.3
29	0.769	0.468	2.326	5.691	6.397	2.803	41.3	1.884	0.00221	-3.0	0.0	2000	-90.0	91.3
30	0.779	0.478	2.395	5.864	6.822	2.764	41.5	1.904	0.00221	-1.0	0.0	2000	-90.0	91.3
31	0.989	0.586	3.769	5.513	10.288	3.937	41.7	1.920	0.00221	-1.0	0.0	2500	-90.0	91.3
32	1.236	0.678	5.339	4.301	14.167	5.479	41.4	1.896	0.00221	-0.9	0.0	3000	-90.0	91.3
33	1.249	0.678	5.369	4.321	14.367	5.480	41.6	1.913	0.00221	-0.0	0.0	2999	-90.0	91.4
34	1.019	0.604	3.813	5.443	10.549	3.889	41.6	1.909	0.00221	-0.0	0.0	2500	-90.0	91.3

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Table F.154: Testing conditions and rotor 3 loads in the hub coordinate system for run 150.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	0.801	0.499	2.405	5.849	6.899	2.729	41.2	1.881	0.00221	-0.0	0.0	2000	-90.0	91.3
36	0.796	0.493	2.428	5.790	6.965	2.722	41.4	1.892	0.00221	-0.0	0.0	2000	-90.0	91.3
37	0.503	0.249	1.786	2.010	4.797	2.839	20.8	0.477	0.00221	-0.0	0.0	2000	-90.0	91.2
39	0.220	-0.032	1.506	-0.956	-0.727	2.831	6.7	0.050	0.00221	-0.0	0.0	1999	-90.0	90.9
40	-0.148	0.000	-0.026	0.000	-0.066	0.000	1.6	0.003	0.00221	0.0	0.0	0	-	90.9

Table F.155: Testing conditions and rotor 4 loads in the hub coordinate system for run 150.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	-0.100	0.000	0.013	0.000	-0.086	0.000	0.4	0.000	0.00222	0.0	0.0	0	-	89.0
4	0.053	-0.380	1.294	2.704	-0.659	-1.856	5.9	0.038	0.00222	-0.0	0.0	2000	0.0	88.8
5	0.092	-0.308	1.507	-1.940	4.589	-1.810	20.8	0.481	0.00222	-0.0	0.0	1999	0.0	88.8
6	0.223	-0.329	2.654	-1.856	6.591	-3.023	20.8	0.480	0.00222	-0.0	0.0	2499	0.0	88.8
7	0.354	-0.347	4.060	-1.423	8.326	-4.445	20.9	0.486	0.00222	-0.0	0.0	3000	0.0	88.9
8	0.356	-0.351	4.087	-1.538	8.366	-4.492	21.0	0.488	0.00222	-1.0	0.0	3000	0.0	89.0
9	0.229	-0.332	2.629	-1.628	6.552	-3.037	20.8	0.482	0.00222	-1.0	0.0	2500	0.0	89.0
10	0.104	-0.327	1.496	-1.897	4.401	-1.834	20.6	0.473	0.00222	-1.0	0.0	2000	0.0	89.0
11	0.125	-0.322	1.521	-2.082	4.383	-1.851	20.9	0.487	0.00222	-3.0	0.0	1999	0.0	89.2
12	0.244	-0.344	2.607	-1.552	6.513	-3.051	21.0	0.490	0.00222	-3.0	0.0	2499	0.0	89.3
13	0.359	-0.345	4.038	-1.256	8.269	-4.521	20.8	0.482	0.00222	-3.0	0.0	2999	0.0	89.5
14	0.353	-0.325	4.001	-1.165	8.187	-4.535	20.8	0.478	0.00222	-5.0	0.0	2999	0.0	89.6
15	0.256	-0.312	2.610	-1.792	6.213	-3.076	20.7	0.475	0.00222	-5.0	0.0	2500	0.0	89.8
16	0.164	-0.308	1.467	-1.983	4.073	-1.877	20.7	0.476	0.00222	-5.0	0.0	2000	0.0	89.8
17	0.176	-0.307	1.402	-1.992	3.540	-1.929	20.8	0.481	0.00222	-10.0	0.0	2000	0.0	89.9
18	0.282	-0.313	2.574	-2.023	5.643	-3.135	21.2	0.499	0.00222	-10.0	0.0	2499	0.0	89.9
19	0.375	-0.308	3.967	-1.527	7.601	-4.593	20.9	0.484	0.00222	-10.0	0.0	2999	0.0	90.1
20	0.687	-0.359	4.285	-6.118	10.741	-4.632	41.6	1.920	0.00221	-10.0	0.0	2999	0.0	90.4
21	0.493	-0.325	2.820	-6.023	7.389	-3.199	41.4	1.899	0.00221	-10.0	0.0	2500	0.0	90.6
22	0.331	-0.317	1.514	-5.461	4.436	-1.993	41.2	1.878	0.00221	-10.0	0.0	1999	0.0	90.6
23	0.334	-0.328	1.495	-5.279	4.414	-1.991	41.4	1.896	0.00221	-10.0	0.0	1999	0.0	90.9
24	0.369	-0.352	1.847	-6.067	5.362	-1.895	41.5	1.902	0.00221	-5.0	0.0	2000	0.0	91.1
25	0.565	-0.375	3.148	-6.282	8.627	-3.044	41.5	1.905	0.00221	-5.0	0.0	2500	0.0	91.2
26	0.768	-0.388	4.585	-5.995	12.399	-4.490	41.6	1.914	0.00221	-5.0	0.0	3000	0.0	91.3
27	0.797	-0.398	4.775	-5.890	13.002	-4.372	41.6	1.913	0.00221	-3.0	0.0	3000	0.0	91.2
28	0.578	-0.385	3.245	-6.347	9.084	-2.965	41.4	1.891	0.00221	-3.0	0.0	2500	0.0	91.3
29	0.385	-0.345	1.969	-6.327	5.671	-1.841	41.3	1.884	0.00221	-3.0	0.0	1999	0.0	91.3
30	0.373	-0.374	2.030	-6.430	6.017	-1.763	41.5	1.904	0.00221	-1.0	0.0	2000	0.0	91.3
31	0.609	-0.393	3.351	-6.690	9.427	-2.884	41.7	1.920	0.00221	-1.0	0.0	2499	0.0	91.3
32	0.852	-0.409	4.793	-6.020	13.478	-4.331	41.4	1.896	0.00221	-0.9	0.0	2999	0.0	91.3
33	0.861	-0.402	4.823	-6.072	13.631	-4.298	41.6	1.913	0.00221	-0.0	0.0	3000	0.0	91.4
34	0.642	-0.395	3.339	-6.705	9.559	-2.856	41.6	1.909	0.00221	-0.0	0.0	2500	0.0	91.3

Continued on next page

Table F.155: Testing conditions and rotor 4 loads in the hub coordinate system for run 150.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
35	0.418	-0.363	2.038	-6.501	6.062	-1.755	41.2	1.881	0.00221	-0.0	0.0	1999	0.0	91.3
36	0.418	-0.371	2.020	-6.445	6.082	-1.765	41.4	1.892	0.00221	-0.0	0.0	2000	0.0	91.3
37	0.214	-0.352	1.425	-1.972	4.434	-1.808	20.8	0.477	0.00221	-0.0	0.0	2000	0.0	91.2
39	0.162	-0.374	1.177	2.123	-1.166	-1.744	6.7	0.050	0.00221	-0.0	0.0	1999	0.0	90.9
40	-0.100	0.000	0.013	0.000	-0.086	0.000	1.6	0.003	0.00221	0.0	0.0	0	-	90.9

Run 151: Tall Quadrotor, Tandem

Table F.156: Run 151 operational settings for MTB 2.

Feature	Value
number of rotors	2
rotors used	R1, R3
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	0, -90

Table F.157: Testing conditions and rotor 1 loads in the hub coordinate system for run 151.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.000	0.000	-0.000	0.000	0.000	0.000	0.3	0.000	0.00233	0.0	0.0	0	-	66.5
4	0.111	-0.014	2.175	-1.409	0.732	-2.476	3.0	0.010	0.00233	-0.0	0.0	1999	0.0	66.5
5	0.511	-0.143	2.597	-1.745	6.725	-2.102	20.3	0.481	0.00234	0.0	0.0	2000	0.0	65.5
6	0.692	-0.140	3.894	-1.504	9.765	-3.304	20.3	0.481	0.00234	0.0	0.0	2499	0.0	65.5
7	0.893	-0.127	5.412	-1.266	12.280	-4.789	20.0	0.465	0.00234	0.0	0.0	3000	0.0	65.5
8	0.893	-0.151	5.446	-1.428	12.098	-4.821	20.2	0.479	0.00234	-1.0	0.0	3000	0.0	65.4
9	0.697	-0.164	3.844	-1.759	9.222	-3.322	20.1	0.474	0.00234	-1.0	0.0	2500	0.0	65.4
10	0.525	-0.165	2.559	-1.773	6.494	-2.112	20.2	0.476	0.00234	-1.0	0.0	1999	0.0	65.4
11	0.391	-0.162	2.555	-2.078	6.024	-2.146	20.5	0.493	0.00234	-3.0	0.0	2000	0.0	65.4
12	0.541	-0.148	3.845	-1.952	8.797	-3.345	20.2	0.476	0.00234	-3.0	0.0	2499	0.0	65.4
13	0.729	-0.142	5.452	-1.595	11.418	-4.893	20.1	0.472	0.00234	-3.0	0.0	2999	0.0	65.4
14	0.661	-0.132	5.444	-1.426	10.991	-5.016	20.4	0.488	0.00234	-5.0	0.0	3000	0.0	65.4
15	0.481	-0.147	3.838	-1.908	8.371	-3.435	20.5	0.493	0.00234	-5.0	0.0	2500	0.0	65.4
16	0.316	-0.156	2.498	-1.993	5.729	-2.210	20.4	0.485	0.00234	-5.0	0.0	2000	0.0	65.4
17	0.037	-0.125	2.412	-1.953	4.794	-2.351	20.5	0.489	0.00234	-10.0	0.0	2000	0.0	65.3
18	0.161	-0.112	3.757	-1.834	7.316	-3.635	20.6	0.495	0.00234	-10.0	0.0	2499	0.0	65.3
19	0.384	-0.110	5.351	-1.392	9.820	-5.235	20.4	0.486	0.00234	-10.0	0.0	2999	0.0	65.4
20	0.241	-0.231	2.599	-4.925	6.116	-2.440	40.4	1.910	0.00234	-10.0	0.0	2000	0.0	65.4
21	0.409	-0.246	4.146	-5.016	9.319	-3.681	40.5	1.921	0.00234	-10.0	0.0	2500	0.0	65.4
22	0.805	-0.234	5.904	-4.375	13.448	-5.190	40.3	1.902	0.00234	-10.0	0.0	3000	0.0	65.4
23	1.158	-0.252	6.290	-4.422	15.403	-4.867	40.2	1.887	0.00234	-5.0	0.0	3000	0.0	65.5
24	0.762	-0.256	4.530	-5.223	10.838	-3.488	40.3	1.895	0.00234	-5.0	0.0	2500	0.0	65.5
25	0.560	-0.235	2.976	-5.210	7.172	-2.339	40.2	1.887	0.00234	-5.0	0.0	2000	0.0	65.5
26	0.601	-0.218	3.137	-5.286	7.475	-2.325	40.3	1.894	0.00234	-3.0	0.0	2000	0.0	65.5
27	0.812	-0.214	4.699	-5.158	11.542	-3.507	40.2	1.893	0.00234	-3.0	0.0	2499	0.0	65.6
28	1.232	-0.237	6.461	-4.209	16.340	-4.916	40.2	1.892	0.00234	-3.0	0.0	3000	0.0	65.6
29	0.714	-0.203	3.315	-5.207	7.633	-2.271	40.4	1.910	0.00234	-1.0	0.0	1999	0.0	65.6
30	0.940	-0.189	4.908	-4.792	12.029	-3.450	40.4	1.903	0.00234	-1.0	0.0	2500	0.0	65.6
31	1.362	-0.223	6.698	-3.655	17.093	-4.839	40.4	1.905	0.00234	-1.0	0.0	3000	0.0	65.6
32	0.762	-0.197	3.399	-5.146	7.673	-2.241	40.1	1.881	0.00234	0.0	0.0	2000	0.0	65.7
33	0.973	-0.184	5.035	-4.563	12.151	-3.411	40.2	1.889	0.00234	0.0	0.0	2499	0.0	65.6
34	1.399	-0.218	6.840	-3.378	17.353	-4.805	40.1	1.883	0.00234	0.1	0.0	3000	0.0	65.7

Continued on next page

Table F.157: Testing conditions and rotor 1 loads in the hub coordinate system for run 151.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	0.517	-0.104	2.568	-1.762	6.741	-2.161	20.3	0.483	0.00234	0.0	0.0	2000	0.0	65.7
36	0.506	-0.101	2.563	-1.670	6.714	-2.159	20.3	0.482	0.00234	0.0	0.0	1999	0.0	65.7
37	0.684	-0.087	3.855	-1.645	9.781	-3.356	20.3	0.483	0.00234	0.0	0.0	2499	0.0	65.7
38	0.896	-0.071	5.443	-1.113	12.525	-4.848	20.2	0.475	0.00234	0.0	0.0	2999	0.0	65.7
39	0.868	-0.088	5.414	-1.301	12.192	-4.852	20.1	0.473	0.00234	-1.0	0.0	2999	0.0	65.8
40	0.675	-0.099	3.827	-1.770	9.458	-3.364	20.2	0.476	0.00234	-1.0	0.0	2500	0.0	65.7
41	0.490	-0.094	2.527	-1.848	6.585	-2.159	20.2	0.478	0.00234	-1.0	0.0	2000	0.0	65.8
42	0.361	-0.092	2.487	-2.049	6.170	-2.176	20.2	0.478	0.00234	-3.0	0.0	2000	0.0	65.8
43	0.509	-0.089	3.813	-1.941	8.858	-3.402	20.2	0.476	0.00234	-3.0	0.0	2499	0.0	65.8
44	0.724	-0.092	5.444	-1.497	11.610	-4.946	20.4	0.486	0.00234	-3.0	0.0	2999	0.0	65.8
45	0.655	-0.098	5.442	-1.444	11.098	-5.042	20.4	0.486	0.00234	-5.0	0.0	2999	0.0	65.8
46	0.450	-0.103	3.823	-1.927	8.364	-3.480	20.4	0.487	0.00234	-5.0	0.0	2500	0.0	65.8
47	0.288	-0.115	2.498	-2.050	5.777	-2.228	20.3	0.482	0.00234	-5.0	0.0	2000	0.0	65.8
48	0.012	-0.083	2.420	-2.027	4.895	-2.367	20.5	0.491	0.00234	-10.0	0.0	2000	0.0	65.8
49	0.131	-0.075	3.766	-1.900	7.354	-3.661	20.6	0.497	0.00234	-10.0	0.0	2499	0.0	65.9
50	0.354	-0.061	5.382	-1.430	9.861	-5.255	20.4	0.484	0.00234	-10.0	0.0	3000	0.0	65.9
51	0.212	-0.175	2.623	-4.983	6.110	-2.476	40.4	1.907	0.00234	-10.0	0.0	1999	0.0	66.0
52	0.383	-0.158	4.137	-5.044	9.308	-3.729	40.3	1.894	0.00234	-10.0	0.0	2499	0.0	66.0
53	0.795	-0.178	5.941	-4.545	13.565	-5.239	40.4	1.910	0.00233	-10.0	0.0	2999	0.0	66.0
55	0.461	-0.176	2.993	-5.303	7.220	-2.375	40.3	1.897	0.00233	-5.0	0.0	2000	0.0	66.1
56	0.655	-0.178	4.550	-5.328	10.868	-3.520	40.3	1.900	0.00233	-5.0	0.0	2499	0.0	66.1
57	1.058	-0.200	6.326	-4.587	15.483	-4.905	40.4	1.909	0.00233	-5.0	0.0	2999	0.0	66.1
58	0.554	-0.164	3.157	-5.330	7.487	-2.351	40.4	1.904	0.00233	-3.0	0.0	2000	0.0	66.2
59	0.760	-0.174	4.730	-5.221	11.558	-3.536	40.4	1.903	0.00233	-3.0	0.0	2499	0.0	66.2
60	1.198	-0.180	6.489	-4.347	16.390	-4.939	40.3	1.900	0.00233	-3.0	0.0	2999	0.0	66.2
61	0.636	-0.156	3.340	-5.221	7.674	-2.287	40.4	1.902	0.00233	-1.0	0.0	1999	0.0	66.3
62	0.866	-0.141	4.961	-4.829	12.059	-3.468	40.4	1.906	0.00233	-1.0	0.0	2499	0.0	66.3
63	1.290	-0.171	6.730	-3.658	17.093	-4.861	40.4	1.902	0.00233	-1.0	0.0	3000	0.0	66.3
64	0.673	-0.146	3.434	-5.197	7.723	-2.266	40.3	1.897	0.00233	0.0	0.0	2000	0.0	66.4
65	0.905	-0.144	5.062	-4.700	12.213	-3.435	40.4	1.906	0.00233	0.0	0.0	2500	0.0	66.4
66	1.348	-0.169	6.877	-3.571	17.428	-4.836	40.4	1.901	0.00233	0.0	0.0	2999	0.0	66.4
67	0.438	-0.039	2.606	-1.771	6.789	-2.169	20.3	0.482	0.00233	-0.0	0.0	2000	0.0	66.4
68	0.433	-0.038	2.610	-1.810	6.786	-2.174	20.4	0.484	0.00233	-0.0	0.0	2000	0.0	66.4

Continued on next page

Table F.157: Testing conditions and rotor 1 loads in the hub coordinate system for run 151.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
69	0.069	0.079	2.075	0.111	1.475	-2.520	4.1	0.019	0.00233	-0.0	0.0	2000	0.0	66.5
70	0.000	0.000	-0.000	0.000	0.000	0.000	1.3	0.002	0.00233	-0.0	0.0	0	-	66.5

Table F.158: Testing conditions and rotor 3 loads in the hub coordinate system for run 151.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	-0.000	0.000	-0.000	0.000	0.000	0.000	0.3	0.000	0.00233	0.0	0.0	0	-	66.5
4	-0.042	-0.186	2.042	-1.996	-0.161	2.822	3.0	0.010	0.00233	-0.0	0.0	0	0.0	66.5
5	0.366	0.035	2.203	2.610	4.632	2.758	20.3	0.481	0.00234	0.0	0.0	0	0.0	65.5
6	0.472	0.129	3.524	2.883	6.616	4.101	20.3	0.481	0.00234	0.0	0.0	0	0.0	65.5
7	0.626	0.257	5.116	2.736	8.592	5.770	20.0	0.465	0.00234	0.0	0.0	0	0.0	65.5
8	0.586	0.262	5.063	2.657	8.501	5.791	20.2	0.479	0.00234	-1.0	0.0	0	0.0	65.4
9	0.459	0.188	3.517	2.987	6.492	4.128	20.1	0.474	0.00234	-1.0	0.0	0	0.0	65.4
10	0.369	0.100	2.203	2.697	4.481	2.769	20.2	0.476	0.00234	-1.0	0.0	0	0.0	65.4
11	0.291	0.114	2.208	3.054	4.394	2.803	20.5	0.493	0.00234	-3.0	0.0	0	0.0	65.4
12	0.361	0.187	3.497	3.203	6.490	4.150	20.2	0.476	0.00234	-3.0	0.0	0	0.0	65.4
13	0.478	0.260	5.067	2.753	8.409	5.805	20.1	0.472	0.00234	-3.0	0.0	0	0.0	65.4
14	0.419	0.259	4.994	2.905	8.069	5.817	20.4	0.488	0.00234	-5.0	0.0	0	0.0	65.4
15	0.297	0.173	3.437	2.871	6.039	4.165	20.5	0.493	0.00234	-5.0	0.0	0	0.0	65.4
16	0.209	0.096	2.132	2.704	3.933	2.811	20.4	0.485	0.00234	-5.0	0.0	0	0.0	65.4
17	-0.003	0.087	2.083	2.767	3.462	2.852	20.5	0.489	0.00234	-10.0	0.0	0	0.0	65.3
18	0.051	0.146	3.353	2.716	5.316	4.191	20.6	0.495	0.00234	-10.0	0.0	0	0.0	65.3
19	0.173	0.215	4.882	2.497	7.191	5.836	20.4	0.486	0.00234	-10.0	0.0	0	0.0	65.4
20	0.249	0.219	2.189	5.437	4.698	2.908	40.4	1.910	0.00234	-10.0	0.0	0	0.0	65.4
21	0.393	0.337	3.575	5.822	7.587	4.222	40.5	1.921	0.00234	-10.0	0.0	0	0.0	65.4
22	0.665	0.536	5.136	5.388	10.640	5.861	40.3	1.902	0.00234	-10.0	0.0	0	0.0	65.4
23	0.947	0.621	5.492	5.323	12.229	5.751	40.2	1.887	0.00234	-5.0	0.0	0	0.0	65.5
24	0.750	0.494	3.902	5.805	8.806	4.110	40.3	1.895	0.00234	-5.0	0.0	0	0.0	65.5
25	0.592	0.391	2.528	5.735	5.619	2.779	40.2	1.887	0.00234	-5.0	0.0	0	0.0	65.5
26	0.720	0.421	2.611	5.871	6.006	2.734	40.3	1.894	0.00234	-3.0	0.0	0	0.0	65.5
27	0.872	0.522	4.022	5.910	9.288	4.042	40.2	1.893	0.00234	-3.0	0.0	0	0.0	65.6
28	1.100	0.686	5.633	5.267	12.853	5.678	40.2	1.892	0.00234	-3.0	0.0	0	0.0	65.6
29	0.827	0.463	2.720	6.039	6.405	2.675	40.4	1.910	0.00234	-1.0	0.0	0	0.0	65.6
30	1.003	0.572	4.105	5.914	9.804	3.972	40.4	1.903	0.00234	-1.0	0.0	0	0.0	65.6
31	1.207	0.706	5.751	5.142	13.514	5.602	40.4	1.905	0.00234	-1.0	0.0	0	0.0	65.6
32	0.884	0.483	2.756	6.009	6.566	2.632	40.1	1.881	0.00234	0.0	0.0	0	0.0	65.7
33	1.035	0.584	4.151	5.930	10.020	3.927	40.2	1.889	0.00234	0.0	0.0	0	0.0	65.6
34	1.242	0.707	5.785	5.085	13.782	5.564	40.1	1.883	0.00234	0.1	0.0	0	0.0	65.7

Continued on next page

Table F.158: Testing conditions and rotor 3 loads in the hub coordinate system for run 151.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	0.549	0.243	2.229	2.576	4.548	2.725	20.3	0.483	0.00234	0.0	0.0	0	0.0	65.7
36	0.544	0.246	2.234	2.644	4.555	2.722	20.3	0.482	0.00234	0.0	0.0	0	-90.0	65.7
37	0.625	0.317	3.532	2.683	6.553	4.078	20.3	0.483	0.00234	0.0	0.0	0	-90.0	65.7
38	0.726	0.391	5.125	2.441	8.596	5.710	20.2	0.475	0.00234	0.0	0.0	0	-90.0	65.7
39	0.692	0.389	5.105	2.449	8.460	5.723	20.1	0.473	0.00234	-1.0	0.0	0	-90.0	65.8
40	0.580	0.302	3.509	2.608	6.361	4.090	20.2	0.476	0.00234	-1.0	0.0	0	-90.0	65.7
41	0.480	0.220	2.200	2.485	4.449	2.746	20.2	0.478	0.00234	-1.0	0.0	0	-90.0	65.8
42	0.367	0.210	2.165	2.563	4.188	2.770	20.2	0.478	0.00234	-3.0	0.0	0	-90.0	65.8
43	0.441	0.280	3.457	2.653	6.134	4.122	20.2	0.476	0.00234	-3.0	0.0	0	-90.0	65.8
44	0.552	0.360	5.052	2.498	8.230	5.752	20.4	0.486	0.00234	-3.0	0.0	0	-90.0	65.8
45	0.440	0.339	5.009	2.447	7.943	5.763	20.4	0.486	0.00234	-5.0	0.0	0	-90.0	65.8
46	0.327	0.264	3.424	2.638	5.869	4.131	20.4	0.487	0.00234	-5.0	0.0	0	-90.0	65.8
47	0.237	0.184	2.154	2.538	3.972	2.775	20.3	0.482	0.00234	-5.0	0.0	0	-90.0	65.8
48	0.018	0.166	2.082	2.504	3.377	2.826	20.5	0.491	0.00234	-10.0	0.0	0	-90.0	65.8
49	0.092	0.235	3.346	2.663	5.269	4.177	20.6	0.497	0.00234	-10.0	0.0	0	-90.0	65.9
50	0.216	0.315	4.896	2.361	7.219	5.792	20.4	0.484	0.00234	-10.0	0.0	0	-90.0	65.9
51	0.351	0.334	2.216	5.304	4.608	2.875	40.4	1.907	0.00234	-10.0	0.0	0	-90.0	66.0
52	0.511	0.453	3.576	5.615	7.405	4.207	40.3	1.894	0.00234	-10.0	0.0	0	-90.0	66.0
53	0.693	0.577	5.180	5.408	10.660	5.819	40.4	1.910	0.00233	-10.0	0.0	0	-90.0	66.0
55	0.607	0.410	2.528	5.703	5.625	2.767	40.3	1.897	0.00233	-5.0	0.0	0	-90.0	66.1
56	0.766	0.523	3.929	5.822	8.743	4.086	40.3	1.900	0.00233	-5.0	0.0	0	-90.0	66.1
57	0.963	0.640	5.546	5.374	12.270	5.714	40.4	1.909	0.00233	-5.0	0.0	0	-90.0	66.1
58	0.731	0.447	2.642	5.822	6.009	2.709	40.4	1.904	0.00233	-3.0	0.0	0	-90.0	66.2
59	0.886	0.554	4.032	5.875	9.259	4.028	40.4	1.903	0.00233	-3.0	0.0	0	-90.0	66.2
60	1.087	0.660	5.662	5.322	12.883	5.652	40.3	1.900	0.00233	-3.0	0.0	0	-90.0	66.2
61	0.825	0.468	2.745	5.972	6.410	2.647	40.4	1.902	0.00233	-1.0	0.0	0	-90.0	66.3
62	0.995	0.583	4.128	5.910	9.786	3.955	40.4	1.906	0.00233	-1.0	0.0	0	-90.0	66.3
63	1.189	0.684	5.773	5.228	13.542	5.577	40.4	1.902	0.00233	-1.0	0.0	0	-90.0	66.3
64	0.881	0.474	2.783	6.024	6.599	2.618	40.3	1.897	0.00233	0.0	0.0	0	-90.0	66.4
65	1.045	0.586	4.178	5.883	10.019	3.914	40.4	1.906	0.00233	0.0	0.0	0	-90.0	66.4
66	1.240	0.685	5.826	5.156	13.811	5.543	40.4	1.901	0.00233	0.0	0.0	0	-90.0	66.4
67	0.565	0.248	2.258	2.484	4.586	2.712	20.3	0.482	0.00233	-0.0	0.0	0	0.0	66.4
68	0.554	0.245	2.261	2.508	4.569	2.710	20.4	0.484	0.00233	-0.0	0.0	0	0.0	66.4

Continued on next page

Table F.158: Testing conditions and rotor 3 loads in the hub coordinate system for run 151.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
69	0.128	-0.003	1.835	-0.188	-0.501	2.624	4.1	0.019	0.00233	-0.0	0.0	0	0.0	66.5
70	0.000	0.000	-0.000	0.000	0.000	0.000	1.3	0.002	0.00233	-0.0	0.0	0	-	66.5

Run 152: Equal Height Quadrotor

Table F.159: Run 152 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	0

Table F.160: Testing conditions and rotor 1 loads in the hub coordinate system for run 152.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	-0.035	0.000	-0.068	0.000	0.026	0.000	0.4	0.000	0.00232	-0.0	0.0	0	-	70.6
4	-0.011	0.157	1.692	0.097	0.421	-2.287	6.4	0.048	0.00232	-0.0	0.0	2000	0.0	71.0
5	0.400	0.085	2.498	-1.524	6.785	-1.843	20.3	0.478	0.00231	-0.0	0.0	2000	0.0	72.2
6	0.517	0.087	3.753	-1.324	10.164	-3.091	20.1	0.466	0.00231	-0.0	0.0	2499	0.0	72.3
7	0.781	0.095	5.359	-0.658	13.552	-4.648	20.1	0.466	0.00231	-0.0	0.0	3000	0.0	72.4
8	0.870	0.081	5.455	-0.758	13.439	-4.624	20.7	0.493	0.00231	-1.0	0.0	3000	0.0	72.9
9	0.637	0.049	3.835	-1.384	9.981	-3.105	20.7	0.493	0.00231	-1.0	0.0	2500	0.0	73.0
10	0.425	0.056	2.425	-1.570	6.706	-1.879	20.5	0.487	0.00231	-1.0	0.0	2000	0.0	73.1
11	0.358	0.064	2.289	-1.774	6.502	-1.907	20.4	0.481	0.00231	-3.0	0.0	2000	0.0	73.5
12	0.520	0.036	3.584	-1.671	9.618	-3.100	20.4	0.479	0.00231	-3.0	0.0	2499	0.0	73.5
13	0.757	0.055	5.207	-1.238	12.922	-4.589	20.6	0.487	0.00230	-3.0	0.0	2999	0.0	73.6
14	0.780	0.031	5.076	-1.667	12.632	-4.547	20.5	0.482	0.00230	-5.0	0.0	2999	0.0	74.0
15	0.530	0.033	3.527	-2.092	9.339	-3.096	20.5	0.481	0.00230	-5.0	0.0	2500	0.0	74.4
16	0.341	0.054	2.217	-2.066	6.268	-1.937	20.5	0.483	0.00230	-5.0	0.0	2000	0.0	74.4
17	0.271	0.074	2.055	-2.193	5.579	-2.058	20.4	0.481	0.00230	-10.0	0.0	2000	0.0	74.6
18	0.453	0.029	3.467	-2.183	8.363	-3.271	20.7	0.492	0.00230	-10.0	0.0	2499	0.0	74.7
19	0.674	0.050	4.953	-1.764	11.338	-4.755	20.4	0.480	0.00230	-10.0	0.0	3000	0.0	75.1
20	0.503	-0.011	2.518	-5.209	6.477	-2.209	40.8	1.903	0.00229	-10.0	0.0	2000	0.0	76.7
21	0.729	-0.069	4.055	-5.113	9.793	-3.375	40.8	1.903	0.00229	-10.0	0.0	2499	0.0	76.8
22	1.045	-0.039	5.854	-4.579	14.163	-4.814	40.8	1.906	0.00229	-10.0	0.0	2999	0.0	76.9
23	0.556	-0.004	2.899	-5.398	7.206	-2.125	40.8	1.902	0.00229	-5.0	0.0	1999	0.0	77.2
24	0.801	-0.053	4.504	-5.429	11.282	-3.269	40.9	1.916	0.00229	-5.0	0.0	2499	0.0	77.3
25	1.181	-0.046	6.297	-4.340	15.894	-4.693	40.7	1.889	0.00229	-5.0	0.0	2999	0.0	77.4
26	0.551	0.012	3.063	-5.274	7.332	-2.071	40.6	1.886	0.00228	-3.0	0.0	2000	0.0	77.9
27	0.797	-0.036	4.712	-4.865	11.465	-3.231	40.8	1.897	0.00228	-3.0	0.0	2499	0.0	78.0
28	1.198	-0.029	6.494	-3.522	16.142	-4.660	40.7	1.889	0.00228	-3.0	0.0	2999	0.0	78.2
29	0.563	0.003	3.250	-5.491	7.458	-2.017	40.9	1.909	0.00228	-1.0	0.0	1999	0.0	78.4
30	0.834	-0.036	4.940	-4.755	11.829	-3.169	40.8	1.902	0.00228	-1.0	0.0	2499	0.0	78.7
31	1.202	-0.039	6.816	-3.321	16.822	-4.559	40.9	1.909	0.00228	-1.0	0.0	3000	0.0	78.7
32	0.553	0.004	3.348	-5.326	7.292	-2.023	40.9	1.905	0.00228	0.0	0.0	1999	0.0	78.8
33	0.810	-0.033	5.056	-4.597	11.560	-3.183	41.0	1.912	0.00228	-0.0	0.0	2499	0.0	79.1
34	1.229	-0.028	6.985	-3.231	17.020	-4.525	40.8	1.894	0.00228	0.0	0.0	2999	0.0	79.1

Continued on next page

Table F.160: Testing conditions and rotor 1 loads in the hub coordinate system for run 152.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
35	0.378	0.103	2.434	-1.544	6.899	-1.947	20.5	0.479	0.00228	-0.0	0.0	2000	0.0	79.1
36	0.052	0.164	1.827	-1.113	2.123	-2.309	3.2	0.011	0.00228	-0.0	0.0	2000	0.0	79.0
37	-0.011	0.000	-0.073	0.000	0.030	0.000	1.6	0.003	0.00228	0.0	0.0	0	-	78.9

Table F.161: Testing conditions and rotor 2 loads in the hub coordinate system for run 152.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	0.007	0.000	0.026	0.000	-0.001	0.000	0.4	0.000	0.00232	-0.0	0.0	0	-	70.6
4	-0.035	-0.013	2.002	1.423	0.968	2.994	6.4	0.048	0.00232	-0.0	0.0	2000	0.0	71.0
5	0.009	0.065	2.742	1.529	6.682	2.594	20.3	0.478	0.00231	-0.0	0.0	1999	0.0	72.2
6	0.037	0.070	4.141	1.359	10.179	3.878	20.1	0.466	0.00231	-0.0	0.0	2499	0.0	72.3
7	0.168	0.073	5.768	0.429	13.522	5.459	20.1	0.466	0.00231	-0.0	0.0	2999	0.0	72.4
8	0.238	0.071	5.631	0.636	13.400	5.419	20.7	0.493	0.00231	-1.0	0.0	2999	0.0	72.9
9	0.106	0.058	3.980	1.449	10.032	3.861	20.7	0.493	0.00231	-1.0	0.0	2500	0.0	73.0
10	0.031	0.040	2.616	1.672	6.646	2.601	20.5	0.487	0.00231	-1.0	0.0	1999	0.0	73.1
11	-0.004	0.048	2.574	1.910	6.455	2.629	20.4	0.481	0.00231	-3.0	0.0	2000	0.0	73.5
12	0.027	0.054	3.921	1.748	9.694	3.844	20.4	0.479	0.00231	-3.0	0.0	2499	0.0	73.5
13	0.183	0.064	5.517	1.006	13.084	5.343	20.6	0.487	0.00230	-3.0	0.0	3000	0.0	73.6
14	0.182	0.088	5.437	1.643	12.639	5.302	20.5	0.482	0.00230	-5.0	0.0	3000	0.0	74.0
15	0.061	0.066	3.881	2.025	9.313	3.834	20.5	0.481	0.00230	-5.0	0.0	2500	0.0	74.4
16	0.017	0.036	2.515	2.147	6.176	2.629	20.5	0.483	0.00230	-5.0	0.0	2000	0.0	74.4
17	0.001	0.020	2.399	2.117	5.424	2.753	20.4	0.481	0.00230	-10.0	0.0	2000	0.0	74.6
18	0.061	0.029	3.721	2.062	8.210	3.995	20.7	0.492	0.00230	-10.0	0.0	2500	0.0	74.7
19	0.171	0.063	5.365	1.593	11.234	5.501	20.4	0.480	0.00230	-10.0	0.0	3000	0.0	75.1
20	0.076	0.089	2.567	4.746	6.504	2.814	40.8	1.903	0.00229	-10.0	0.0	1999	0.0	76.7
21	0.173	0.115	4.115	4.660	9.735	4.036	40.8	1.903	0.00229	-10.0	0.0	2499	0.0	76.8
22	0.303	0.139	5.930	3.868	13.954	5.559	40.8	1.906	0.00229	-10.0	0.0	2999	0.0	76.9
23	0.099	0.111	2.953	5.185	7.397	2.692	40.8	1.902	0.00229	-5.0	0.0	2000	0.0	77.2
24	0.188	0.124	4.586	4.988	11.418	3.854	40.9	1.916	0.00229	-5.0	0.0	2499	0.0	77.3
25	0.369	0.170	6.400	3.795	15.926	5.297	40.7	1.889	0.00229	-5.0	0.0	2999	0.0	77.4
26	0.087	0.098	3.171	5.069	7.613	2.630	40.6	1.886	0.00228	-3.0	0.0	2000	0.0	77.9
27	0.198	0.119	4.775	4.704	11.723	3.829	40.8	1.897	0.00228	-3.0	0.0	2499	0.0	78.0
28	0.413	0.156	6.705	2.581	16.595	5.254	40.7	1.889	0.00228	-3.0	0.0	2999	0.0	78.2
29	0.101	0.090	3.326	5.014	7.658	2.573	40.9	1.909	0.00228	-1.0	0.0	2000	0.0	78.4
30	0.245	0.109	5.012	4.178	11.986	3.747	40.8	1.902	0.00228	-1.0	0.0	2499	0.0	78.7
31	0.421	0.146	6.941	2.323	17.177	5.166	40.9	1.909	0.00228	-1.0	0.0	3000	0.0	78.7
32	0.131	0.097	3.403	5.165	7.578	2.516	40.9	1.905	0.00228	0.0	0.0	2000	0.0	78.8
33	0.263	0.113	5.107	4.233	12.066	3.712	41.0	1.912	0.00228	-0.0	0.0	2499	0.0	79.1
34	0.456	0.155	7.017	2.319	17.244	5.115	40.8	1.894	0.00228	0.0	0.0	2999	0.0	79.1

Continued on next page

Table F.161: Testing conditions and rotor 2 loads in the hub coordinate system for run 152.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
35	0.135	0.020	2.626	1.406	6.638	2.449	20.5	0.479	0.00228	-0.0	0.0	1999	0.0	79.1
36	0.090	-0.052	1.980	0.686	2.165	2.776	3.2	0.011	0.00228	-0.0	0.0	2000	0.0	79.0
37	0.019	0.000	0.014	0.000	0.006	0.000	1.6	0.003	0.00228	0.0	0.0	0	-	78.9

Table F.162: Testing conditions and rotor 3 loads in the hub coordinate system for run 152.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	0.047	0.000	0.030	0.000	0.006	0.000	0.4	0.000	0.00232	-0.0	0.0	0	-	70.6
4	-0.094	-0.139	0.941	-1.315	-0.783	2.950	6.4	0.048	0.00232	-0.0	0.0	2000	0.0	71.0
5	-0.102	-0.009	0.660	1.279	2.914	2.887	20.3	0.478	0.00231	-0.0	0.0	2000	0.0	72.2
6	-0.107	-0.021	1.242	-0.500	3.456	4.002	20.1	0.466	0.00231	-0.0	0.0	2500	0.0	72.3
7	-0.104	-0.024	2.238	-1.550	4.128	5.592	20.1	0.466	0.00231	-0.0	0.0	3000	0.0	72.4
8	-0.057	-0.051	2.343	-1.310	4.310	5.694	20.7	0.493	0.00231	-1.0	0.0	2999	0.0	72.9
9	-0.053	-0.066	1.300	-0.357	3.474	4.052	20.7	0.493	0.00231	-1.0	0.0	2499	0.0	73.0
10	-0.064	-0.049	0.610	1.258	2.802	2.894	20.5	0.487	0.00231	-1.0	0.0	2000	0.0	73.1
11	-0.069	-0.059	0.562	0.909	2.574	2.854	20.4	0.481	0.00231	-3.0	0.0	1999	0.0	73.5
12	-0.030	-0.062	1.284	-0.213	3.408	4.066	20.4	0.479	0.00231	-3.0	0.0	2499	0.0	73.5
13	0.000	-0.037	2.401	-0.912	4.519	5.771	20.6	0.487	0.00230	-3.0	0.0	2999	0.0	73.6
14	0.023	0.003	2.574	-0.007	5.014	5.991	20.5	0.482	0.00230	-5.0	0.0	3000	0.0	74.0
15	0.001	-0.028	1.406	0.300	3.627	4.183	20.5	0.481	0.00230	-5.0	0.0	2500	0.0	74.4
16	-0.046	-0.050	0.613	0.917	2.525	2.865	20.5	0.483	0.00230	-5.0	0.0	1999	0.0	74.4
17	0.033	-0.018	0.712	1.583	2.653	2.951	20.4	0.481	0.00230	-10.0	0.0	2000	0.0	74.6
18	0.141	0.025	1.593	1.303	3.985	4.314	20.7	0.492	0.00230	-10.0	0.0	2499	0.0	74.7
19	0.152	0.051	2.717	0.758	5.350	6.174	20.4	0.480	0.00230	-10.0	0.0	3000	0.0	75.1
20	0.402	0.267	0.901	4.555	4.049	3.123	40.8	1.903	0.00229	-10.0	0.0	1999	0.0	76.7
21	0.563	0.340	1.786	4.674	6.103	4.560	40.8	1.903	0.00229	-10.0	0.0	2499	0.0	76.8
22	0.653	0.345	2.924	4.106	8.455	6.506	40.8	1.906	0.00229	-10.0	0.0	3000	0.0	76.9
23	0.463	0.281	1.008	4.388	4.419	3.177	40.8	1.902	0.00229	-5.0	0.0	2000	0.0	77.2
24	0.581	0.311	1.864	3.746	6.312	4.571	40.9	1.916	0.00229	-5.0	0.0	2499	0.0	77.3
25	0.612	0.268	2.838	2.388	7.963	6.423	40.7	1.889	0.00229	-5.0	0.0	2999	0.0	77.4
26	0.516	0.342	1.101	4.885	4.795	3.200	40.6	1.886	0.00228	-3.0	0.0	2000	0.0	77.9
27	0.650	0.357	1.905	3.978	7.025	4.619	40.8	1.897	0.00228	-3.0	0.0	2500	0.0	78.0
28	0.678	0.299	2.823	2.601	8.769	6.485	40.7	1.889	0.00228	-3.0	0.0	3000	0.0	78.2
29	0.574	0.394	1.183	5.550	5.224	3.237	40.9	1.909	0.00228	-1.0	0.0	2000	0.0	78.4
30	0.731	0.432	1.965	5.099	7.764	4.645	40.8	1.902	0.00228	-1.0	0.0	2499	0.0	78.7
31	0.781	0.365	2.905	3.471	10.062	6.515	40.9	1.909	0.00228	-1.0	0.0	2999	0.0	78.7
32	0.641	0.436	1.286	6.083	5.405	3.237	40.9	1.905	0.00228	0.0	0.0	2000	0.0	78.8
33	0.798	0.466	2.019	5.605	8.161	4.654	41.0	1.912	0.00228	-0.0	0.0	2500	0.0	79.1
34	0.860	0.379	3.014	3.600	10.954	6.592	40.8	1.894	0.00228	0.0	0.0	3000	0.0	79.1

Continued on next page

Table F.162: Testing conditions and rotor 3 loads in the hub coordinate system for run 152.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
35	0.312	0.090	0.700	1.335	2.711	2.837	20.5	0.479	0.00228	-0.0	0.0	1999	0.0	79.1
36	0.226	0.030	0.872	0.156	1.019	2.844	3.2	0.011	0.00228	-0.0	0.0	2000	0.0	79.0
37	0.025	0.000	-0.006	0.000	0.033	0.000	1.6	0.003	0.00228	0.0	0.0	0	-	78.9

Table F.163: Testing conditions and rotor 4 loads in the hub coordinate system for run 152.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.008	0.000	0.030	0.000	-0.007	0.000	0.4	0.000	0.00232	-0.0	0.0	0	-	70.6
4	0.056	-0.336	1.356	2.503	-0.864	-1.923	6.4	0.048	0.00232	-0.0	0.0	1999	0.0	71.0
5	0.323	-0.236	1.185	-1.635	3.268	-1.888	20.3	0.478	0.00231	-0.0	0.0	2000	0.0	72.2
6	0.417	-0.272	2.083	-0.307	3.719	-2.994	20.1	0.466	0.00231	-0.0	0.0	2500	0.0	72.3
7	0.514	-0.307	3.318	0.972	4.430	-4.390	20.1	0.466	0.00231	-0.0	0.0	3000	0.0	72.4
8	0.410	-0.310	3.271	0.787	4.608	-4.403	20.7	0.493	0.00231	-1.0	0.0	3000	0.0	72.9
9	0.298	-0.299	2.005	-0.395	3.912	-3.003	20.7	0.493	0.00231	-1.0	0.0	2500	0.0	73.0
10	0.272	-0.303	1.071	-1.467	3.183	-1.873	20.5	0.487	0.00231	-1.0	0.0	2000	0.0	73.1
11	0.305	-0.301	1.086	-1.330	2.820	-1.856	20.4	0.481	0.00231	-3.0	0.0	2000	0.0	73.5
12	0.400	-0.311	2.075	-0.678	3.729	-3.043	20.4	0.479	0.00231	-3.0	0.0	2499	0.0	73.5
13	0.480	-0.337	3.348	0.158	4.799	-4.471	20.6	0.487	0.00230	-3.0	0.0	3000	0.0	73.6
14	0.474	-0.319	3.490	-0.495	5.093	-4.541	20.5	0.482	0.00230	-5.0	0.0	3000	0.0	74.0
15	0.390	-0.288	2.185	-1.179	3.878	-3.089	20.5	0.481	0.00230	-5.0	0.0	2500	0.0	74.4
16	0.305	-0.294	1.134	-1.314	2.755	-1.875	20.5	0.483	0.00230	-5.0	0.0	2000	0.0	74.4
17	0.339	-0.304	1.208	-1.887	2.687	-1.939	20.4	0.481	0.00230	-10.0	0.0	2000	0.0	74.6
18	0.400	-0.306	2.275	-1.823	4.143	-3.174	20.7	0.492	0.00230	-10.0	0.0	2499	0.0	74.7
19	0.524	-0.322	3.642	-1.419	5.244	-4.657	20.4	0.480	0.00230	-10.0	0.0	3000	0.0	75.1
20	0.540	-0.298	1.340	-5.706	4.041	-2.012	40.8	1.903	0.00229	-10.0	0.0	2000	0.0	76.7
21	0.674	-0.248	2.491	-6.352	6.166	-3.252	40.8	1.903	0.00229	-10.0	0.0	2499	0.0	76.8
22	0.874	-0.291	3.780	-6.086	8.713	-4.706	40.8	1.906	0.00229	-10.0	0.0	3000	0.0	76.9
23	0.555	-0.286	1.515	-6.126	4.681	-1.977	40.8	1.902	0.00229	-5.0	0.0	1999	0.0	77.2
24	0.675	-0.299	2.518	-6.070	6.856	-3.214	40.9	1.916	0.00229	-5.0	0.0	2499	0.0	77.3
25	0.867	-0.312	3.744	-5.075	8.934	-4.607	40.7	1.889	0.00229	-5.0	0.0	3000	0.0	77.4
26	0.621	-0.300	1.547	-6.659	5.198	-1.974	40.6	1.886	0.00228	-3.0	0.0	1999	0.0	77.9
27	0.769	-0.296	2.619	-6.862	7.465	-3.219	40.8	1.897	0.00228	-3.0	0.0	2499	0.0	78.0
28	0.940	-0.309	3.729	-6.192	9.889	-4.662	40.7	1.889	0.00228	-3.0	0.0	2999	0.0	78.2
29	0.597	-0.286	1.596	-7.564	5.876	-1.927	40.9	1.909	0.00228	-1.0	0.0	2000	0.0	78.4
30	0.804	-0.291	2.604	-7.646	8.316	-3.183	40.8	1.902	0.00228	-1.0	0.0	2500	0.0	78.7
31	0.971	-0.327	3.779	-6.779	10.974	-4.654	40.9	1.909	0.00228	-1.0	0.0	2999	0.0	78.7
32	0.624	-0.283	1.694	-7.841	6.144	-1.924	40.9	1.905	0.00228	0.0	0.0	1999	0.0	78.8
33	0.842	-0.301	2.596	-8.596	8.994	-3.156	41.0	1.912	0.00228	-0.0	0.0	2499	0.0	79.1
34	1.017	-0.324	3.795	-7.064	11.613	-4.643	40.8	1.894	0.00228	0.0	0.0	2999	0.0	79.1

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Table F.163: Testing conditions and rotor 4 loads in the hub coordinate system for run 152.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
35	0.392	-0.320	1.047	-1.811	3.345	-1.904	20.5	0.479	0.00228	-0.0	0.0	2000	0.0	79.1
36	0.202	-0.356	1.188	1.189	-0.175	-1.910	3.2	0.011	0.00228	-0.0	0.0	2000	0.0	79.0
37	0.006	0.000	0.033	0.000	0.009	0.000	1.6	0.003	0.00228	0.0	0.0	0	-	78.9

Run 153: Equal Height Quadrotor

Table F.164: Run 153 operational settings for MTB 2.

Feature	Value
number of rotors	4
rotors used	all
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	-90

Table F.165: Testing conditions and rotor 1 loads in the hub coordinate system for run 153.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
6	-0.044	0.000	-0.067	0.000	0.023	0.000	0.0	0.000	0.00227	0.0	0.0	0	-	82.2
7	0.039	0.113	1.785	-0.997	0.496	-2.290	6.8	0.052	0.00226	-0.0	0.0	1999	0.0	82.8
8	0.360	0.090	2.639	-1.417	6.695	-1.782	20.7	0.484	0.00226	-0.0	0.0	1999	0.0	83.5
9	0.496	0.140	3.847	-1.253	10.042	-2.984	20.5	0.477	0.00226	0.0	0.0	2499	0.0	83.6
10	0.769	0.183	5.409	-0.594	13.403	-4.496	20.6	0.479	0.00226	0.0	0.0	2999	0.0	83.6
11	0.812	0.184	5.352	-0.734	13.245	-4.482	20.8	0.487	0.00226	-1.0	0.0	3000	0.0	83.7
12	0.571	0.141	3.838	-1.389	9.903	-3.016	20.9	0.495	0.00226	-1.0	0.0	2500	0.0	83.8
13	0.365	0.107	2.530	-1.500	6.611	-1.833	20.9	0.491	0.00226	-1.0	0.0	2000	0.0	83.9
14	0.317	0.103	2.402	-1.736	6.439	-1.853	20.8	0.488	0.00226	-3.0	0.0	1999	0.0	84.2
15	0.502	0.102	3.644	-1.611	9.588	-3.008	20.8	0.487	0.00226	-3.0	0.0	2499	0.0	84.3
16	0.758	0.119	5.256	-1.153	12.974	-4.445	21.1	0.501	0.00226	-3.0	0.0	3000	0.0	84.4
17	0.733	0.093	5.028	-1.634	12.549	-4.428	20.7	0.481	0.00225	-5.0	0.0	2999	0.0	84.7
18	0.455	0.100	3.386	-1.908	9.264	-3.027	20.4	0.468	0.00225	-5.0	0.0	2500	0.0	84.8
19	0.268	0.110	2.219	-1.998	6.221	-1.877	20.6	0.478	0.00225	-5.0	0.0	2000	0.0	85.3
20	0.235	0.107	2.130	-2.051	5.519	-2.021	20.7	0.484	0.00225	-10.0	0.0	2000	0.0	85.5
21	0.385	0.089	3.496	-1.944	8.277	-3.213	21.0	0.496	0.00225	-10.0	0.0	2499	0.0	85.5
22	0.633	0.111	4.913	-1.725	11.266	-4.645	20.6	0.479	0.00225	-10.0	0.0	3000	0.0	85.9
23	1.020	0.020	5.655	-4.596	13.795	-4.737	41.0	1.889	0.00225	-10.0	0.0	3000	0.0	86.3
25	0.559	0.015	3.939	-5.007	9.695	-3.351	41.2	1.904	0.00224	-10.0	0.0	2500	0.0	87.7
26	0.409	0.021	2.464	-4.995	6.473	-2.147	41.2	1.896	0.00224	-10.0	0.0	1999	0.0	87.8
27	0.448	0.030	2.872	-5.195	7.098	-2.087	41.4	1.919	0.00224	-5.0	0.0	1999	0.0	88.3
28	0.648	0.029	4.452	-5.101	11.030	-3.218	41.3	1.905	0.00224	-4.9	0.0	2499	0.0	88.5
29	1.107	-0.008	6.227	-4.372	15.850	-4.590	41.3	1.905	0.00224	-4.9	0.0	3000	0.0	88.5
30	0.487	0.040	3.085	-5.301	7.233	-2.019	41.3	1.903	0.00224	-3.0	0.0	2000	0.0	88.8
31	0.693	0.022	4.639	-4.773	11.172	-3.187	41.3	1.907	0.00223	-3.0	0.0	2499	0.0	88.9
32	1.167	0.022	6.447	-3.569	16.232	-4.511	41.2	1.894	0.00223	-3.0	0.0	2999	0.0	89.1
33	0.509	0.031	3.196	-5.469	7.497	-1.976	41.3	1.902	0.00223	-1.0	0.0	2000	0.0	89.3
34	0.712	0.006	4.909	-4.523	11.412	-3.109	41.3	1.905	0.00223	-1.0	0.0	2499	0.0	89.3
35	1.217	0.021	6.680	-3.394	16.708	-4.500	41.3	1.904	0.00223	-1.0	0.0	2999	0.0	89.6
36	0.523	0.042	3.256	-5.233	7.295	-1.977	41.2	1.894	0.00223	-0.0	0.0	1999	0.0	89.6
37	0.733	0.002	5.018	-4.727	11.439	-3.113	41.4	1.914	0.00223	-0.0	0.0	2499	0.0	89.6
38	1.201	0.014	6.845	-3.352	16.939	-4.457	41.2	1.894	0.00223	-0.0	0.0	3000	0.0	89.8

Continued on next page

Table F.165: Testing conditions and rotor 1 loads in the hub coordinate system for run 153.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
39	0.381	0.112	2.437	-1.700	6.710	-1.937	20.8	0.483	0.00223	-0.0	0.0	2000	0.0	89.7
40	0.029	0.199	1.708	-0.283	2.200	-2.260	2.9	0.009	0.00223	-0.0	0.0	1999	0.0	89.5
41	-0.025	0.000	-0.070	0.000	0.027	0.000	0.9	0.001	0.00223	-0.0	0.0	0	-	89.4

Table F.166: Testing conditions and rotor 2 loads in the hub coordinate system for run 153.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
6	0.002	0.000	0.029	0.000	-0.005	0.000	0.0	0.000	0.00227	0.0	0.0	0	-	82.2
7	-0.063	0.029	2.052	1.941	0.777	2.972	6.8	0.052	0.00226	-0.0	0.0	1999	-90.0	82.8
8	-0.003	0.119	2.683	1.484	6.710	2.553	20.7	0.484	0.00226	-0.0	0.0	1999	-90.0	83.5
9	0.051	0.130	4.027	1.200	10.164	3.805	20.5	0.477	0.00226	0.0	0.0	2500	-90.0	83.6
10	0.218	0.102	5.617	0.441	13.571	5.368	20.6	0.479	0.00226	0.0	0.0	3000	-90.0	83.6
11	0.257	0.097	5.500	0.629	13.251	5.336	20.8	0.487	0.00226	-1.0	0.0	3000	-90.0	83.7
12	0.156	0.107	3.894	1.355	9.878	3.789	20.9	0.495	0.00226	-1.0	0.0	2500	-90.0	83.8
13	0.068	0.089	2.567	1.640	6.540	2.545	20.9	0.491	0.00226	-1.0	0.0	2000	-90.0	83.9
14	0.038	0.096	2.500	1.921	6.357	2.575	20.8	0.488	0.00226	-3.0	0.0	2000	-90.0	84.2
15	0.093	0.112	3.806	1.705	9.532	3.770	20.8	0.487	0.00226	-3.0	0.0	2499	-90.0	84.3
16	0.245	0.103	5.340	1.128	12.948	5.235	21.1	0.501	0.00226	-3.0	0.0	2999	-90.0	84.4
17	0.205	0.107	5.301	1.587	12.446	5.202	20.7	0.481	0.00225	-5.0	0.0	2999	-90.0	84.7
18	0.092	0.099	3.766	2.005	9.075	3.748	20.4	0.468	0.00225	-5.0	0.0	2500	-90.0	84.8
19	0.021	0.081	2.449	2.102	6.100	2.585	20.6	0.478	0.00225	-5.0	0.0	2000	-90.0	85.3
20	0.032	0.067	2.317	2.125	5.331	2.710	20.7	0.484	0.00225	-10.0	0.0	1999	-90.0	85.5
21	0.113	0.078	3.617	2.021	8.070	3.926	21.0	0.496	0.00225	-10.0	0.0	2499	-90.0	85.5
22	0.228	0.075	5.244	1.558	10.963	5.433	20.6	0.479	0.00225	-10.0	0.0	2999	-90.0	85.9
23	0.342	0.124	5.725	3.849	13.535	5.564	41.0	1.889	0.00225	-10.0	0.0	2999	-90.0	86.3
25	0.217	0.152	4.056	4.494	9.667	3.972	41.2	1.904	0.00224	-10.0	0.0	2500	-90.0	87.7
26	0.100	0.101	2.440	4.748	6.287	2.784	41.2	1.896	0.00224	-10.0	0.0	2000	-90.0	87.8
27	0.131	0.131	2.922	5.052	7.268	2.665	41.4	1.919	0.00224	-5.0	0.0	2000	-90.0	88.3
28	0.241	0.172	4.479	4.865	11.044	3.801	41.3	1.905	0.00224	-4.9	0.0	2500	-90.0	88.5
29	0.418	0.196	6.276	3.832	15.535	5.231	41.3	1.905	0.00224	-4.9	0.0	2999	-90.0	88.5
30	0.159	0.128	3.079	5.168	7.316	2.610	41.3	1.903	0.00224	-3.0	0.0	2000	-90.0	88.8
31	0.272	0.152	4.721	4.233	11.532	3.788	41.3	1.907	0.00223	-3.0	0.0	2499	-90.0	88.9
32	0.479	0.166	6.481	3.263	16.183	5.236	41.2	1.894	0.00223	-3.0	0.0	3000	-90.0	89.1
33	0.180	0.116	3.247	5.184	7.393	2.552	41.3	1.902	0.00223	-1.0	0.0	2000	-90.0	89.3
34	0.287	0.158	4.934	4.059	11.707	3.701	41.3	1.905	0.00223	-1.0	0.0	2499	-90.0	89.3
35	0.529	0.149	6.809	2.331	16.736	5.117	41.3	1.904	0.00223	-1.0	0.0	2999	-90.0	89.6
36	0.215	0.101	3.323	4.949	7.530	2.502	41.2	1.894	0.00223	-0.0	0.0	2000	-90.0	89.6
37	0.342	0.138	5.015	4.081	11.888	3.673	41.4	1.914	0.00223	-0.0	0.0	2499	-90.0	89.6
38	0.535	0.147	6.931	2.242	16.931	5.066	41.2	1.894	0.00223	-0.0	0.0	2999	-90.0	89.8

Continued on next page

Table F.166: Testing conditions and rotor 2 loads in the hub coordinate system for run 153.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
39	0.202	0.023	2.531	1.454	6.536	2.409	20.8	0.483	0.00223	-0.0	0.0	2000	-90.0	89.7
40	0.103	-0.062	1.920	0.551	2.147	2.722	2.9	0.009	0.00223	-0.0	0.0	2000	-90.0	89.5
41	0.012	0.000	0.021	0.000	0.002	0.000	0.9	0.001	0.00223	-0.0	0.0	0	-	89.4

Table F.167: Testing conditions and rotor 3 loads in the hub coordinate system for run 153.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
6	0.052	0.000	0.041	0.000	-0.004	0.000	0.0	0.000	0.00227	0.0	0.0	0	-	82.2
7	-0.196	-0.180	0.882	-1.262	-0.147	2.857	6.8	0.052	0.00226	-0.0	0.0	1999	-90.0	82.8
8	-0.183	0.035	0.707	1.457	2.974	2.864	20.7	0.484	0.00226	-0.0	0.0	1999	-90.0	83.5
9	-0.209	0.021	1.294	-0.071	3.487	3.992	20.5	0.477	0.00226	0.0	0.0	2499	-90.0	83.6
10	-0.220	0.035	2.307	-1.328	4.229	5.588	20.6	0.479	0.00226	0.0	0.0	2999	-90.0	83.6
11	-0.223	0.049	2.373	-0.986	4.359	5.663	20.8	0.487	0.00226	-1.0	0.0	3000	-90.0	83.7
12	-0.227	0.045	1.353	0.076	3.529	4.031	20.9	0.495	0.00226	-1.0	0.0	2500	-90.0	83.8
13	-0.204	0.034	0.665	1.360	2.824	2.852	20.9	0.491	0.00226	-1.0	0.0	2000	-90.0	83.9
14	-0.205	0.000	0.618	1.085	2.655	2.821	20.8	0.488	0.00226	-3.0	0.0	2000	-90.0	84.2
15	-0.157	-0.019	1.337	0.189	3.553	4.063	20.8	0.487	0.00226	-3.0	0.0	2499	-90.0	84.3
16	-0.147	0.033	2.438	-0.744	4.600	5.751	21.1	0.501	0.00226	-3.0	0.0	3000	-90.0	84.4
17	-0.113	0.076	2.586	0.250	5.064	6.008	20.7	0.481	0.00225	-5.0	0.0	2999	-90.0	84.7
18	-0.149	0.023	1.384	0.798	3.816	4.179	20.4	0.468	0.00225	-5.0	0.0	2500	-90.0	84.8
19	-0.153	-0.002	0.625	1.242	2.641	2.843	20.6	0.478	0.00225	-5.0	0.0	2000	-90.0	85.3
20	-0.060	0.022	0.747	1.774	2.702	2.902	20.7	0.484	0.00225	-10.0	0.0	2000	-90.0	85.5
21	0.056	0.049	1.634	1.512	4.042	4.273	21.0	0.496	0.00225	-10.0	0.0	2499	-90.0	85.5
22	0.059	0.098	2.765	0.881	5.474	6.192	20.6	0.479	0.00225	-10.0	0.0	3000	-90.0	85.9
23	0.444	0.299	2.912	4.640	8.917	6.646	41.0	1.889	0.00225	-10.0	0.0	2999	-90.0	86.3
25	0.466	0.333	1.866	5.017	6.285	4.599	41.2	1.904	0.00224	-10.0	0.0	2500	-90.0	87.7
26	0.329	0.254	0.950	4.747	4.188	3.129	41.2	1.896	0.00224	-10.0	0.0	1999	-90.0	87.8
27	0.416	0.299	1.089	4.559	4.563	3.156	41.4	1.919	0.00224	-5.0	0.0	2000	-90.0	88.3
28	0.571	0.337	1.900	4.007	6.392	4.610	41.3	1.905	0.00224	-4.9	0.0	2500	-90.0	88.5
29	0.630	0.325	2.945	2.823	8.303	6.499	41.3	1.905	0.00224	-4.9	0.0	3000	-90.0	88.5
30	0.512	0.350	1.218	5.100	5.075	3.215	41.3	1.903	0.00224	-3.0	0.0	2000	-90.0	88.8
31	0.663	0.365	1.955	4.112	7.092	4.637	41.3	1.907	0.00223	-3.0	0.0	2499	-90.0	88.9
32	0.700	0.326	2.981	2.766	8.913	6.630	41.2	1.894	0.00223	-3.0	0.0	2999	-90.0	89.1
33	0.570	0.420	1.241	5.644	5.314	3.204	41.3	1.902	0.00223	-1.0	0.0	1999	-90.0	89.3
34	0.745	0.438	2.059	5.077	7.837	4.671	41.3	1.905	0.00223	-1.0	0.0	2499	-90.0	89.3
35	0.833	0.399	2.948	3.734	10.072	6.554	41.3	1.904	0.00223	-1.0	0.0	2999	-90.0	89.6
36	0.644	0.443	1.310	6.206	5.526	3.225	41.2	1.894	0.00223	-0.0	0.0	2000	-90.0	89.6
37	0.822	0.453	2.126	5.482	8.141	4.702	41.4	1.914	0.00223	-0.0	0.0	2499	-90.0	89.6
38	0.910	0.433	3.043	3.974	10.832	6.632	41.2	1.894	0.00223	-0.0	0.0	3000	-90.0	89.8

Continued on next page

Table F.167: Testing conditions and rotor 3 loads in the hub coordinate system for run 153.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
39	0.358	0.101	0.739	1.143	2.643	2.812	20.8	0.483	0.00223	-0.0	0.0	2000	-90.0	89.7
40	0.221	0.014	0.910	-0.163	0.540	2.826	2.9	0.009	0.00223	-0.0	0.0	2000	90.0	89.5
41	0.037	0.000	0.014	0.000	0.018	0.000	0.9	0.001	0.00223	-0.0	0.0	0	-	89.4

Table F.168: Testing conditions and rotor 4 loads in the hub coordinate system for run 153.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
6	0.008	0.000	0.029	0.000	-0.014	0.000	0.0	0.000	0.00227	0.0	0.0	0	-	82.2
7	0.146	-0.356	1.437	2.641	-0.934	-1.905	6.8	0.052	0.00226	-0.0	0.0	1999	0.0	82.8
8	0.295	-0.215	1.179	-1.649	3.239	-1.864	20.7	0.484	0.00226	-0.0	0.0	1999	0.0	83.5
9	0.301	-0.206	2.046	-0.302	3.714	-2.949	20.5	0.477	0.00226	0.0	0.0	2499	0.0	83.6
10	0.403	-0.246	3.250	0.879	4.479	-4.304	20.6	0.479	0.00226	0.0	0.0	2999	0.0	83.6
11	0.389	-0.246	3.254	0.736	4.576	-4.338	20.8	0.487	0.00226	-1.0	0.0	3000	0.0	83.7
12	0.245	-0.224	1.988	-0.259	3.768	-2.962	20.9	0.495	0.00226	-1.0	0.0	2500	0.0	83.8
13	0.219	-0.231	1.099	-1.294	3.110	-1.870	20.9	0.491	0.00226	-1.0	0.0	2000	0.0	83.9
14	0.241	-0.244	1.092	-1.063	2.778	-1.845	20.8	0.488	0.00226	-3.0	0.0	2000	0.0	84.2
15	0.284	-0.234	2.053	-0.489	3.685	-3.003	20.8	0.487	0.00226	-3.0	0.0	2499	0.0	84.3
16	0.335	-0.267	3.287	0.098	4.879	-4.402	21.1	0.501	0.00226	-3.0	0.0	3000	0.0	84.4
17	0.447	-0.253	3.464	-0.748	5.070	-4.483	20.7	0.481	0.00225	-5.0	0.0	2999	0.0	84.7
18	0.360	-0.228	2.151	-0.999	3.633	-3.061	20.4	0.468	0.00225	-5.0	0.0	2500	0.0	84.8
19	0.314	-0.239	1.148	-1.253	2.660	-1.863	20.6	0.478	0.00225	-5.0	0.0	1999	0.0	85.3
20	0.304	-0.256	1.200	-1.779	2.628	-1.924	20.7	0.484	0.00225	-10.0	0.0	2000	0.0	85.5
21	0.294	-0.204	2.243	-1.678	3.986	-3.124	21.0	0.496	0.00225	-10.0	0.0	2499	0.0	85.5
22	0.444	-0.226	3.601	-1.362	5.190	-4.575	20.6	0.479	0.00225	-10.0	0.0	2999	0.0	85.9
23	0.724	-0.246	3.703	-5.852	8.455	-4.634	41.0	1.889	0.00225	-10.0	0.0	3000	0.0	86.3
25	0.573	-0.222	2.462	-6.183	6.132	-3.217	41.2	1.904	0.00224	-10.0	0.0	2500	0.0	87.7
26	0.332	-0.233	1.309	-5.435	4.095	-1.986	41.2	1.896	0.00224	-10.0	0.0	2000	0.0	87.8
27	0.382	-0.201	1.547	-6.002	4.887	-1.976	41.4	1.919	0.00224	-5.0	0.0	2000	0.0	88.3
28	0.532	-0.235	2.535	-5.942	6.755	-3.169	41.3	1.905	0.00224	-4.9	0.0	2500	0.0	88.5
29	0.717	-0.259	3.719	-5.384	8.938	-4.545	41.3	1.905	0.00224	-4.9	0.0	2999	0.0	88.5
30	0.444	-0.227	1.598	-6.519	5.351	-1.947	41.3	1.903	0.00224	-3.0	0.0	1999	0.0	88.8
31	0.622	-0.246	2.621	-7.294	7.809	-3.179	41.3	1.907	0.00223	-3.0	0.0	2499	0.0	88.9
32	0.768	-0.284	3.679	-5.443	9.565	-4.576	41.2	1.894	0.00223	-3.0	0.0	3000	0.0	89.1
33	0.512	-0.252	1.613	-7.045	5.880	-1.901	41.3	1.902	0.00223	-1.0	0.0	2000	0.0	89.3
34	0.692	-0.280	2.692	-7.822	8.484	-3.148	41.3	1.905	0.00223	-1.0	0.0	2499	0.0	89.3
35	0.845	-0.291	3.732	-6.536	10.819	-4.605	41.3	1.904	0.00223	-1.0	0.0	2999	0.0	89.6
36	0.512	-0.287	1.642	-7.830	6.093	-1.870	41.2	1.894	0.00223	-0.0	0.0	2000	0.0	89.6
37	0.711	-0.288	2.657	-8.229	8.833	-3.126	41.4	1.914	0.00223	-0.0	0.0	2499	0.0	89.6
38	0.901	-0.307	3.723	-7.282	11.650	-4.585	41.2	1.894	0.00223	-0.0	0.0	3000	0.0	89.8

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Table F.168: Testing conditions and rotor 4 loads in the hub coordinate system for run 153.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
39	0.297	-0.310	1.032	-1.831	3.394	-1.867	20.8	0.483	0.00223	-0.0	0.0	2000	0.0	89.7
40	0.173	-0.347	1.180	1.219	0.206	-1.884	2.9	0.009	0.00223	-0.0	0.0	1999	0.0	89.5
41	0.007	0.000	0.031	0.000	-0.000	0.000	0.9	0.001	0.00223	-0.0	0.0	0	-	89.4

Run 154: Concept Quadrotor, Aero and Weight Tare

Table F.169: Run 154 operational settings for MTB 2.

Feature	Value
number of rotors	0
rotors used	0
number of blades	0
RPM	0
model pitch	0, -1, -3, -5, -10
rotor tilt	0, -3
phase	none

Table F.170: Testing conditions and rotor 1 loads in the hub coordinate system for run 154.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	0.000	0.000	0.000	0.000	0.000	0.000	0.8	0.001	0.00224	0.0	0.0	0	-	87.6
4	-0.096	-0.030	0.001	0.031	-0.114	0.011	0.8	0.001	0.00224	0.0	-3.0	0	-	87.6
5	-0.138	-0.031	0.006	0.031	-0.146	0.009	0.9	0.001	0.00224	-1.0	-3.0	0	-	87.6
6	-0.057	0.009	0.005	-0.012	-0.045	0.005	1.0	0.001	0.00224	-1.0	0.0	0	-	87.6
7	-0.140	0.006	0.005	-0.007	-0.106	0.007	1.1	0.001	0.00224	-3.0	0.0	0	-	87.7
8	-0.223	-0.030	0.012	0.027	-0.210	0.011	0.8	0.001	0.00224	-3.0	-3.0	0	-	87.6
9	-0.308	-0.033	0.021	0.027	-0.267	0.008	1.1	0.001	0.00224	-5.0	-3.0	0	-	87.6
10	-0.221	0.004	0.014	-0.009	-0.172	0.005	0.6	0.000	0.00224	-5.0	0.0	0	-	87.6
11	-0.423	0.002	0.044	-0.007	-0.336	0.007	0.0	0.000	0.00224	-10.0	0.0	0	-	87.7
12	-0.503	-0.034	0.060	0.028	-0.436	0.013	0.5	0.000	0.00224	-10.0	-3.0	0	-	87.7
13	-0.492	-0.034	0.037	0.014	-0.395	-0.006	20.8	0.482	0.00224	-10.0	-3.0	0	-	88.0
14	-0.413	-0.001	0.024	-0.018	-0.297	-0.010	20.8	0.482	0.00224	-10.0	0.0	0	-	88.0
15	-0.215	-0.000	-0.011	-0.017	-0.128	-0.011	20.9	0.489	0.00224	-5.0	0.0	0	-	88.0
16	-0.298	-0.036	-0.005	0.018	-0.227	-0.009	20.9	0.489	0.00224	-5.0	-3.0	0	-	88.1
17	-0.214	-0.036	-0.011	0.021	-0.161	-0.009	20.9	0.488	0.00224	-3.0	-3.0	0	-	88.1
18	-0.128	0.001	-0.020	-0.015	-0.067	-0.011	20.9	0.489	0.00224	-3.0	0.0	0	-	88.1
19	-0.050	0.001	-0.025	-0.014	0.000	-0.013	20.8	0.484	0.00224	-1.0	0.0	0	-	88.2
20	-0.135	-0.034	-0.028	0.023	-0.096	-0.009	20.8	0.481	0.00223	-1.0	-3.0	0	-	88.2
21	-0.095	-0.038	-0.024	0.026	-0.063	-0.008	20.8	0.484	0.00223	-0.0	-3.0	0	-	88.3
22	-0.001	-0.002	-0.023	-0.011	0.028	-0.014	20.8	0.482	0.00223	-0.0	0.0	0	-	88.3
23	0.031	-0.013	-0.052	-0.032	0.111	-0.012	41.2	1.892	0.00223	-0.0	0.0	0	-	89.0
24	-0.049	-0.048	-0.052	0.001	0.012	-0.008	41.4	1.914	0.00223	-0.0	-3.0	0	-	89.1
25	-0.077	-0.050	-0.034	0.002	-0.024	-0.006	41.2	1.892	0.00223	-1.0	-3.0	0	-	89.3
26	0.001	-0.016	-0.032	-0.035	0.073	-0.011	41.2	1.892	0.00223	-1.0	0.0	0	-	89.3
27	-0.079	-0.015	-0.032	-0.036	0.016	-0.012	41.2	1.895	0.00223	-3.0	0.0	0	-	89.4
28	-0.158	-0.051	-0.029	0.004	-0.084	-0.005	41.5	1.916	0.00223	-3.0	-3.0	0	-	89.4
29	-0.232	-0.049	-0.018	0.002	-0.149	-0.002	41.4	1.913	0.00223	-5.0	-3.0	0	-	89.6
30	-0.158	-0.012	-0.018	-0.037	-0.047	-0.005	41.6	1.922	0.00223	-5.0	0.0	0	-	89.7
31	-0.350	-0.008	0.009	-0.029	-0.210	-0.001	41.2	1.891	0.00223	-10.0	0.0	0	-	89.8
32	-0.430	-0.047	0.016	0.003	-0.299	0.001	41.1	1.884	0.00223	-10.0	-3.0	0	-	89.8
33	0.000	0.000	0.000	0.000	0.000	0.000	2.8	0.008	0.00223	-0.0	0.0	0	-	89.8

Table F.171: Testing conditions and rotor 2 loads in the hub coordinate system for run 154.

Point	Fx2_H [lb]	Fy2_H [lb]	Fz2_H [lb]	Mx2_H [in-lb]	My2_H [in-lb]	Mz2_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_2	Phase_2 [deg]	T. Temp [°F]
3	0.000	0.000	0.000	0.000	0.000	0.000	0.8	0.001	0.00224	0.0	0.0	0	-	87.6
4	-0.111	0.053	-0.008	-0.042	-0.086	-0.034	0.8	0.001	0.00224	0.0	-3.0	0	-	87.6
5	-0.151	0.055	-0.005	-0.043	-0.121	-0.035	0.9	0.001	0.00224	-1.0	-3.0	0	-	87.6
6	-0.051	0.004	0.001	-0.009	-0.049	0.007	1.0	0.001	0.00224	-1.0	0.0	0	-	87.6
7	-0.126	0.003	-0.001	-0.006	-0.121	0.004	1.1	0.001	0.00224	-3.0	0.0	0	-	87.7
8	-0.229	0.051	-0.003	-0.038	-0.189	-0.039	0.8	0.001	0.00224	-3.0	-3.0	0	-	87.6
9	-0.306	0.055	0.010	-0.044	-0.264	-0.037	1.1	0.001	0.00224	-5.0	-3.0	0	-	87.6
10	-0.201	0.004	0.006	-0.006	-0.195	0.006	0.6	0.000	0.00224	-5.0	0.0	0	-	87.6
11	-0.397	0.000	0.031	0.002	-0.372	-0.000	0.0	0.000	0.00224	-10.0	0.0	0	-	87.7
12	-0.496	0.053	0.045	-0.033	-0.446	-0.044	0.5	0.000	0.00224	-10.0	-3.0	0	-	87.7
13	-0.451	0.038	0.042	-0.037	-0.436	-0.053	20.8	0.482	0.00224	-10.0	-3.0	0	-	88.0
14	-0.350	-0.012	0.031	-0.002	-0.369	-0.011	20.8	0.482	0.00224	-10.0	0.0	0	-	88.0
15	-0.147	-0.022	0.000	-0.002	-0.193	-0.014	20.9	0.489	0.00224	-5.0	0.0	0	-	88.0
16	-0.253	0.028	0.008	-0.035	-0.256	-0.059	20.9	0.489	0.00224	-5.0	-3.0	0	-	88.1
17	-0.178	0.031	-0.008	-0.038	-0.185	-0.060	20.9	0.488	0.00224	-3.0	-3.0	0	-	88.1
18	-0.070	-0.016	-0.000	-0.005	-0.120	-0.017	20.9	0.489	0.00224	-3.0	0.0	0	-	88.1
19	0.003	-0.021	-0.001	-0.003	-0.045	-0.019	20.8	0.484	0.00224	-1.0	0.0	0	-	88.2
20	-0.101	0.030	-0.013	-0.036	-0.109	-0.063	20.8	0.481	0.00223	-1.0	-3.0	0	-	88.2
21	-0.058	0.034	-0.022	-0.040	-0.077	-0.061	20.8	0.484	0.00223	-0.0	-3.0	0	-	88.3
22	0.046	-0.014	-0.006	-0.008	-0.013	-0.015	20.8	0.482	0.00223	-0.0	0.0	0	-	88.3
23	0.090	-0.024	-0.001	-0.014	0.046	-0.012	41.2	1.892	0.00223	-0.0	0.0	0	-	89.0
24	-0.019	0.034	0.003	-0.039	-0.002	-0.054	41.4	1.914	0.00223	-0.0	-3.0	0	-	89.1
25	-0.061	0.042	0.006	-0.040	-0.035	-0.047	41.2	1.892	0.00223	-1.0	-3.0	0	-	89.3
26	0.045	-0.005	0.018	-0.009	0.024	-0.002	41.2	1.892	0.00223	-1.0	0.0	0	-	89.3
27	-0.036	-0.007	0.017	-0.003	-0.039	-0.006	41.2	1.895	0.00223	-3.0	0.0	0	-	89.4
28	-0.138	0.043	0.005	-0.039	-0.101	-0.050	41.5	1.916	0.00223	-3.0	-3.0	0	-	89.4
29	-0.218	0.050	0.011	-0.041	-0.168	-0.048	41.4	1.913	0.00223	-5.0	-3.0	0	-	89.6
30	-0.114	-0.005	0.018	-0.004	-0.105	-0.004	41.6	1.922	0.00223	-5.0	0.0	0	-	89.7
31	-0.307	-0.006	0.036	0.007	-0.280	-0.008	41.2	1.891	0.00223	-10.0	0.0	0	-	89.8
32	-0.410	0.045	0.039	-0.031	-0.341	-0.055	41.1	1.884	0.00223	-10.0	-3.0	0	-	89.8
33	0.000	0.000	0.000	0.000	0.000	0.000	2.8	0.008	0.00223	-0.0	0.0	0	-	89.8

Table F.172: Testing conditions and rotor 3 loads in the hub coordinate system for run 154.

Point	Fx3_H [lb]	Fy3_H [lb]	Fz3_H [lb]	Mx3_H [in-lb]	My3_H [in-lb]	Mz3_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_3	Phase_3 [deg]	T. Temp [°F]
3	0.000	0.000	0.000	0.000	0.000	0.000	0.8	0.001	0.00224	0.0	0.0	0	-	87.6
4	-0.116	-0.002	-0.001	0.011	-0.085	0.003	0.8	0.001	0.00224	0.0	-3.0	0	-	87.6
5	-0.157	-0.001	-0.002	0.010	-0.127	0.003	0.9	0.001	0.00224	-1.0	-3.0	0	-	87.6
6	-0.032	0.003	0.000	-0.004	-0.059	0.004	1.0	0.001	0.00224	-1.0	0.0	0	-	87.6
7	-0.111	-0.002	0.005	0.002	-0.126	0.006	1.1	0.001	0.00224	-3.0	0.0	0	-	87.7
8	-0.228	-0.005	0.008	0.013	-0.201	0.007	0.8	0.001	0.00224	-3.0	-3.0	0	-	87.6
9	-0.307	-0.010	0.017	0.018	-0.278	0.009	1.1	0.001	0.00224	-5.0	-3.0	0	-	87.6
10	-0.187	-0.004	0.013	0.003	-0.203	0.010	0.6	0.000	0.00224	-5.0	0.0	0	-	87.6
11	-0.378	-0.008	0.038	0.016	-0.395	0.017	0.0	0.000	0.00224	-10.0	0.0	0	-	87.7
12	-0.495	-0.008	0.053	0.028	-0.467	0.018	0.5	0.000	0.00224	-10.0	-3.0	0	-	87.7
13	-0.493	-0.006	0.058	0.022	-0.419	0.011	20.8	0.482	0.00224	-10.0	-3.0	0	-	88.0
14	-0.372	-0.005	0.044	0.015	-0.347	0.007	20.8	0.482	0.00224	-10.0	0.0	0	-	88.0
15	-0.178	-0.003	0.020	0.010	-0.159	0.001	20.9	0.489	0.00224	-5.0	0.0	0	-	88.0
16	-0.299	-0.009	0.022	0.026	-0.229	0.002	20.9	0.489	0.00224	-5.0	-3.0	0	-	88.1
17	-0.226	-0.007	0.012	0.019	-0.155	0.000	20.9	0.488	0.00224	-3.0	-3.0	0	-	88.1
18	-0.104	-0.002	0.014	0.007	-0.084	-0.002	20.9	0.489	0.00224	-3.0	0.0	0	-	88.1
19	-0.029	-0.000	0.002	-0.001	-0.008	-0.004	20.8	0.484	0.00224	-1.0	0.0	0	-	88.2
20	-0.149	-0.007	-0.002	0.019	-0.081	-0.002	20.8	0.481	0.00223	-1.0	-3.0	0	-	88.2
21	-0.112	-0.007	-0.002	0.020	-0.044	-0.003	20.8	0.484	0.00223	-0.0	-3.0	0	-	88.3
22	0.014	-0.003	0.006	0.000	0.025	-0.005	20.8	0.482	0.00223	-0.0	0.0	0	-	88.3
23	0.074	-0.006	0.003	0.007	0.104	-0.020	41.2	1.892	0.00223	-0.0	0.0	0	-	89.0
24	-0.046	-0.011	0.002	0.017	0.025	-0.018	41.4	1.914	0.00223	-0.0	-3.0	0	-	89.1
25	-0.082	-0.011	0.011	0.007	-0.011	-0.020	41.2	1.892	0.00223	-1.0	-3.0	0	-	89.3
26	0.042	-0.007	0.007	-0.002	0.058	-0.024	41.2	1.892	0.00223	-1.0	0.0	0	-	89.3
27	-0.029	-0.009	0.019	0.003	-0.014	-0.021	41.2	1.895	0.00223	-3.0	0.0	0	-	89.4
28	-0.152	-0.009	0.024	0.010	-0.080	-0.016	41.5	1.916	0.00223	-3.0	-3.0	0	-	89.4
29	-0.234	-0.012	0.022	0.010	-0.156	-0.013	41.4	1.913	0.00223	-5.0	-3.0	0	-	89.6
30	-0.108	-0.006	0.027	-0.001	-0.083	-0.016	41.6	1.922	0.00223	-5.0	0.0	0	-	89.7
31	-0.306	-0.006	0.042	0.000	-0.263	-0.006	41.2	1.891	0.00223	-10.0	0.0	0	-	89.8
32	-0.421	-0.012	0.051	0.013	-0.337	-0.003	41.1	1.884	0.00223	-10.0	-3.0	0	-	89.8
33	0.000	0.000	0.000	0.000	0.000	0.000	2.8	0.008	0.00223	-0.0	0.0	0	-	89.8

Table F.173: Testing conditions and rotor 4 loads in the hub coordinate system for run 154.

Point	Fx4_H [lb]	Fy4_H [lb]	Fz4_H [lb]	Mx4_H [in-lb]	My4_H [in-lb]	Mz4_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_4	Phase_4 [deg]	T. Temp [°F]
3	0.000	0.000	0.000	0.000	0.000	0.000	0.8	0.001	0.00224	0.0	0.0	0	-	87.6
4	-0.098	0.035	0.001	-0.022	-0.110	0.003	0.8	0.001	0.00224	0.0	-3.0	0	-	87.6
5	-0.141	0.042	0.002	-0.025	-0.144	0.002	0.9	0.001	0.00224	-1.0	-3.0	0	-	87.6
6	-0.046	0.007	0.001	-0.001	-0.048	0.003	1.0	0.001	0.00224	-1.0	0.0	0	-	87.6
7	-0.117	0.010	0.008	0.006	-0.123	0.005	1.1	0.001	0.00224	-3.0	0.0	0	-	87.7
8	-0.221	0.039	0.008	-0.015	-0.211	0.002	0.8	0.001	0.00224	-3.0	-3.0	0	-	87.6
9	-0.304	0.042	0.019	-0.010	-0.278	-0.000	1.1	0.001	0.00224	-5.0	-3.0	0	-	87.6
10	-0.197	0.016	0.008	0.007	-0.195	0.004	0.6	0.000	0.00224	-5.0	0.0	0	-	87.6
11	-0.399	0.019	0.040	0.022	-0.365	-0.003	0.0	0.000	0.00224	-10.0	0.0	0	-	87.7
12	-0.500	0.050	0.061	0.000	-0.452	-0.003	0.5	0.000	0.00224	-10.0	-3.0	0	-	87.7
13	-0.493	0.049	0.065	-0.007	-0.416	-0.002	20.8	0.482	0.00224	-10.0	-3.0	0	-	88.0
14	-0.392	0.019	0.053	0.015	-0.334	0.002	20.8	0.482	0.00224	-10.0	0.0	0	-	88.0
15	-0.201	0.012	0.015	-0.003	-0.150	0.006	20.9	0.489	0.00224	-5.0	0.0	0	-	88.0
16	-0.320	0.033	0.024	-0.017	-0.227	-0.002	20.9	0.489	0.00224	-5.0	-3.0	0	-	88.1
17	-0.232	0.039	0.022	-0.029	-0.160	0.003	20.9	0.488	0.00224	-3.0	-3.0	0	-	88.1
18	-0.129	0.010	0.020	-0.011	-0.074	0.007	20.9	0.489	0.00224	-3.0	0.0	0	-	88.1
19	-0.051	0.004	0.014	-0.015	-0.004	0.006	20.8	0.484	0.00224	-1.0	0.0	0	-	88.2
20	-0.155	0.035	0.013	-0.034	-0.093	0.004	20.8	0.481	0.00223	-1.0	-3.0	0	-	88.2
21	-0.129	0.029	0.006	-0.038	-0.048	0.002	20.8	0.484	0.00223	-0.0	-3.0	0	-	88.3
22	-0.010	0.004	0.007	-0.022	0.021	0.008	20.8	0.482	0.00223	-0.0	0.0	0	-	88.3
23	0.045	0.005	0.008	-0.027	0.118	0.018	41.2	1.892	0.00223	-0.0	0.0	0	-	89.0
24	-0.071	0.022	0.013	-0.048	0.034	0.012	41.4	1.914	0.00223	-0.0	-3.0	0	-	89.1
25	-0.098	0.029	0.012	-0.048	-0.011	0.014	41.2	1.892	0.00223	-1.0	-3.0	0	-	89.3
26	0.005	0.002	0.000	-0.018	0.079	0.018	41.2	1.892	0.00223	-1.0	0.0	0	-	89.3
27	-0.071	-0.000	0.011	-0.017	0.009	0.015	41.2	1.895	0.00223	-3.0	0.0	0	-	89.4
28	-0.165	0.038	0.017	-0.035	-0.071	0.018	41.5	1.916	0.00223	-3.0	-3.0	0	-	89.4
29	-0.239	0.033	0.026	-0.038	-0.143	0.018	41.4	1.913	0.00223	-5.0	-3.0	0	-	89.6
30	-0.125	0.012	0.015	-0.013	-0.063	0.021	41.6	1.922	0.00223	-5.0	0.0	0	-	89.7
31	-0.316	0.007	0.047	0.003	-0.238	0.010	41.2	1.891	0.00223	-10.0	0.0	0	-	89.8
32	-0.414	0.039	0.060	-0.019	-0.331	0.009	41.1	1.884	0.00223	-10.0	-3.0	0	-	89.8
33	0.000	0.000	0.000	0.000	0.000	0.000	2.8	0.008	0.00223	-0.0	0.0	0	-	89.8

Run 155: Concept Quadrotor, Uncertainty and transient

Table F.174: Run 155 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R4 on R1
number of blades	2
RPM	2000, 2500, 3000
model pitch	0, -1, -3, -5, -10
rotor tilt	0
phase	none

Table F.175: Testing conditions and rotor 1 loads in the hub coordinate system for run 155.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
4	-0.014	0.000	-0.010	0.000	-0.005	0.000	0.2	0.000	0.00233	0.0	0.0	0	-	68.0
5	-0.005	0.174	1.805	-1.175	0.493	-2.235	2.4	0.007	0.00233	-0.0	0.0	1999	-	68.1
6	0.478	-0.007	2.137	-1.841	6.347	-1.869	20.4	0.484	0.00233	0.0	0.0	1999	-	67.5
7	0.632	-0.016	3.262	-2.080	8.786	-2.991	20.2	0.476	0.00233	0.0	0.0	2499	-	67.4
8	0.844	-0.002	4.833	-1.512	11.697	-4.382	20.2	0.474	0.00233	0.0	0.0	3000	-	67.4
9	0.771	-0.002	3.857	-1.374	9.988	-3.162	20.2	0.474	0.00233	0.0	0.0	2639	-	67.4
10	0.649	0.012	3.635	-1.256	9.618	-3.392	20.6	0.494	0.00233	0.0	0.0	2540	-	67.4
11	0.668	-0.006	3.059	-1.499	8.184	-2.555	20.0	0.464	0.00233	0.0	0.0	2359	-	67.3
12	0.682	0.006	3.863	-1.367	9.901	-3.571	20.4	0.483	0.00233	-0.0	0.0	2640	-	67.3
13	0.863	0.018	4.827	-1.051	11.567	-4.343	20.1	0.473	0.00233	-1.0	0.0	3000	-	67.2
14	0.680	0.023	3.331	-1.559	8.947	-2.948	20.2	0.474	0.00233	-1.0	0.0	2500	-	67.3
15	0.509	-0.016	2.156	-1.698	6.260	-1.849	20.2	0.476	0.00233	-1.0	0.0	2000	-	67.3
16	0.673	0.016	3.859	-1.369	9.757	-3.555	20.4	0.487	0.00233	-1.0	0.0	2631	-	67.2
17	0.653	0.016	3.160	-1.530	8.325	-2.631	20.2	0.474	0.00233	-1.0	0.0	2395	-	67.2
18	0.441	0.018	2.099	-1.914	5.996	-1.864	20.3	0.481	0.00233	-3.0	0.0	2000	-	67.3
19	0.595	0.050	3.288	-1.671	8.466	-2.990	20.2	0.475	0.00233	-3.0	0.0	2499	-	67.3
20	0.816	0.043	4.797	-1.182	11.119	-4.417	20.3	0.479	0.00233	-3.0	0.0	3000	-	67.3
21	0.620	0.024	3.127	-1.642	8.032	-2.672	20.4	0.486	0.00233	-3.0	0.0	2399	-	67.3
22	0.627	0.033	3.721	-1.521	9.223	-3.514	20.6	0.496	0.00233	-3.0	0.0	2598	-	67.3
23	0.806	0.049	4.745	-1.068	10.563	-4.518	20.0	0.468	0.00233	-5.0	0.0	2999	-	67.2
24	0.632	0.050	3.245	-1.634	7.954	-3.100	20.0	0.465	0.00233	-5.0	0.0	2500	-	67.2
25	0.473	0.022	2.031	-1.854	5.547	-1.942	19.9	0.463	0.00233	-5.0	0.0	2000	-	67.3
26	0.621	0.046	3.688	-1.404	8.661	-3.639	20.1	0.470	0.00233	-5.0	0.0	2611	-	67.3
27	0.582	0.037	3.071	-1.579	7.510	-2.745	20.1	0.472	0.00233	-5.0	0.0	2388	-	67.3
28	0.359	0.053	1.959	-1.834	4.940	-2.070	20.2	0.477	0.00233	-10.0	0.0	2000	-	67.3
29	0.483	0.078	3.179	-1.670	7.235	-3.258	20.3	0.480	0.00233	-10.0	0.0	2499	-	67.3
30	0.644	0.073	4.676	-1.198	9.690	-4.720	20.4	0.486	0.00233	-10.0	0.0	3000	-	67.3
31	0.499	0.059	3.032	-1.628	6.892	-2.928	20.5	0.489	0.00233	-10.0	0.0	2404	-	67.3
32	0.509	0.069	3.500	-1.497	7.670	-3.726	20.4	0.486	0.00233	-10.0	0.0	2575	-	67.3
33	0.995	-0.046	5.262	-3.928	13.061	-4.702	40.4	1.905	0.00233	-10.0	0.0	3000	-	67.3
34	0.717	-0.057	3.646	-4.575	9.186	-3.307	40.4	1.905	0.00233	-10.0	0.0	2500	-	67.3
35	0.513	-0.054	2.205	-4.560	6.057	-2.168	40.2	1.887	0.00233	-10.0	0.0	2000	-	67.3

Continued on next page

Table F.175: Testing conditions and rotor 1 loads in the hub coordinate system for run 155.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
36	0.737	-0.051	4.012	-4.346	10.230	-3.797	40.5	1.907	0.00233	-10.0	0.0	2589	-	67.3
37	0.725	-0.042	3.386	-4.462	8.757	-2.991	40.6	1.916	0.00233	-10.0	0.0	2397	-	67.3
38	0.518	-0.045	2.607	-4.952	7.102	-2.061	40.4	1.902	0.00233	-5.0	0.0	2000	-	67.4
39	0.713	-0.064	4.051	-4.772	10.574	-3.103	40.4	1.902	0.00233	-5.0	0.0	2499	-	67.4
40	1.118	-0.058	5.710	-3.969	14.991	-4.387	40.4	1.898	0.00233	-5.0	0.0	2999	-	67.4
41	0.832	-0.053	3.912	-4.593	10.319	-2.882	40.3	1.890	0.00233	-5.0	0.0	2431	-	67.4
42	0.843	-0.061	4.382	-4.477	11.578	-3.541	40.5	1.907	0.00233	-5.0	0.0	2576	-	67.4
43	1.184	-0.049	5.874	-3.778	15.789	-4.389	40.3	1.889	0.00233	-3.0	0.0	3000	-	67.4
44	0.829	-0.041	4.225	-4.709	11.115	-3.107	40.3	1.887	0.00233	-3.0	0.0	2500	-	67.5
45	0.566	-0.057	2.787	-5.030	7.297	-2.038	40.4	1.905	0.00233	-3.0	0.0	2000	-	67.5
46	0.874	-0.059	4.659	-4.360	12.414	-3.597	40.5	1.911	0.00233	-3.0	0.0	2606	-	67.5
47	0.809	-0.036	3.899	-4.613	10.320	-2.717	40.3	1.888	0.00233	-3.0	0.0	2373	-	67.5
48	0.556	-0.038	2.955	-4.907	7.485	-1.968	40.3	1.890	0.00233	-1.0	0.0	2000	-	67.5
49	0.770	-0.026	4.463	-4.422	11.661	-3.050	40.4	1.898	0.00233	-1.0	0.0	2499	-	67.5
50	1.179	-0.042	6.165	-3.198	16.494	-4.322	40.6	1.918	0.00233	-1.0	0.0	3000	-	67.4
51	0.846	-0.020	4.197	-4.280	10.921	-2.726	40.3	1.890	0.00233	-1.0	0.0	2400	-	67.5
52	0.883	-0.033	4.833	-3.931	12.757	-3.508	40.3	1.894	0.00233	-1.0	0.0	2593	-	67.5
53	1.247	-0.030	6.270	-3.087	16.770	-4.306	40.4	1.898	0.00233	-0.0	0.0	3000	-	67.6
54	0.854	-0.018	4.604	-4.356	11.749	-3.036	40.4	1.902	0.00233	-0.0	0.0	2500	-	67.6
55	0.601	-0.021	3.072	-4.906	7.469	-1.960	40.3	1.895	0.00233	-0.0	0.0	2000	-	67.5
56	0.898	-0.037	4.974	-3.940	12.969	-3.487	40.4	1.898	0.00233	-0.0	0.0	2586	-	67.5
57	0.941	-0.016	4.812	-3.963	12.459	-3.063	40.3	1.887	0.00233	-0.0	0.0	2550	-	67.6
58	0.412	0.082	2.218	-1.666	6.524	-1.913	20.4	0.484	0.00233	-0.0	0.0	2000	-	67.6
59	0.047	0.161	1.840	-0.582	1.873	-2.212	3.6	0.015	0.00233	-0.0	0.0	2000	-	67.6
60	0.000	0.000	-0.000	0.000	0.000	0.000	2.7	0.008	0.00233	-0.0	0.0	0	-	67.6

Run 156: Concept Quadrotor, Rotor in airplane mode

Table F.176: Run 156 operational settings for MTB 2.

Feature	Value
number of rotors	1
rotors used	R1
number of blades	2
RPM	500 - 3000
model pitch	-11.3°
rotor tilt	-78.7°
phase	-

Table F.177: Testing conditions and rotor 1 loads in the hub coordinate system for run 156.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
3	0.254	0.000	-0.310	0.000	0.000	0.000	0.3	0.000	0.00233	-11.3	-90.0	0	-	68.3
4	0.183	0.128	-0.825	-0.091	0.073	-0.035	0.0	0.000	0.00233	-11.3	-90.0	500	-	68.3
5	0.181	0.132	-1.307	-0.064	0.214	-0.581	1.9	0.004	0.00233	-11.3	-90.0	999	-	68.3
6	0.168	0.124	-2.076	-0.124	0.257	-1.375	2.3	0.006	0.00233	-11.3	-90.0	1500	-	68.3
7	0.156	0.125	-3.128	-0.113	0.310	-2.451	2.7	0.008	0.00233	-11.3	-90.0	1999	-	68.3
8	0.146	0.107	-4.448	-0.282	0.276	-3.841	2.0	0.005	0.00233	-11.3	-90.0	2499	-	68.4
9	0.116	0.045	-6.007	-0.385	0.282	-5.551	2.8	0.009	0.00233	-11.3	-90.0	2999	-	68.4
10	-0.002	-0.041	-10.606	-1.290	-1.266	-4.486	40.3	1.890	0.00232	-11.3	-90.0	3000	-	69.0
11	0.043	0.006	-9.150	-0.182	0.090	-2.735	40.6	1.910	0.00232	-11.3	-90.0	2500	-	69.1
12	0.091	0.062	-7.101	0.158	0.170	-2.008	40.4	1.899	0.00232	-11.3	-90.0	2000	-	69.2
13	0.102	0.092	-5.106	0.260	0.298	-2.198	40.3	1.889	0.00232	-11.3	-90.0	1500	-	69.4
14	0.126	0.113	-3.423	0.298	0.403	-1.880	40.7	1.917	0.00232	-11.3	-90.0	1000	-	69.5
15	0.143	0.141	-2.056	0.173	0.368	-0.881	40.4	1.896	0.00232	-11.3	-90.0	500	-	69.6
17	0.114	0.138	-3.453	0.319	0.404	-1.905	40.5	1.899	0.00232	-11.3	-90.0	999	-	69.7
18	0.087	0.113	-5.160	0.263	0.316	-2.244	40.5	1.899	0.00232	-11.3	-90.0	1499	-	69.8
19	0.066	0.109	-7.208	0.108	0.213	-2.112	40.5	1.905	0.00232	-11.3	-90.0	1999	-	70.0
20	0.023	0.051	-9.256	-0.226	0.076	-2.852	40.5	1.901	0.00232	-11.3	-90.0	2499	-	70.1
21	-0.033	-0.012	-10.771	-1.368	-1.413	-4.607	40.4	1.896	0.00232	-11.3	-90.0	2999	-	70.1
22	0.082	0.061	-5.460	-0.055	0.035	-1.915	41.6	2.006	0.00232	-11.3	-90.0	1481	-	70.4
23	0.044	0.089	-6.893	-0.431	-0.318	-3.042	40.1	1.858	0.00231	-11.3	-90.0	1931	-	70.9
24	0.122	0.015	-5.820	-1.480	-0.383	-5.284	20.4	0.482	0.00231	-11.3	-90.0	2999	-	71.2
25	0.121	0.017	-4.936	-0.969	-0.435	-3.668	20.8	0.501	0.00231	-11.3	-90.0	2500	-	71.2
26	0.138	0.054	-3.942	-0.833	-0.375	-2.163	20.3	0.479	0.00231	-11.3	-90.0	1999	-	71.2
27	0.138	0.080	-3.187	-0.281	-0.194	-0.871	20.5	0.487	0.00231	-11.3	-90.0	1500	-	71.2
28	0.172	0.099	-2.240	0.048	0.210	-0.461	20.3	0.477	0.00231	-11.3	-90.0	1000	-	71.4
29	0.168	0.102	-1.379	0.067	0.275	-0.260	20.4	0.481	0.00231	-11.3	-90.0	500	-	71.3
30	0.155	0.125	-2.269	0.018	0.214	-0.518	20.6	0.492	0.00231	-11.3	-90.0	999	-	71.3
31	0.123	0.142	-3.166	-0.319	-0.204	-0.917	20.2	0.474	0.00231	-11.3	-90.0	1500	-	71.4
32	0.108	0.104	-4.013	-1.035	-0.299	-2.207	20.5	0.487	0.00231	-11.3	-90.0	1999	-	71.4
33	0.097	0.088	-4.859	-1.259	-0.466	-3.730	20.2	0.472	0.00231	-11.3	-90.0	2500	-	71.5
34	0.085	0.081	-5.793	-1.399	-0.561	-5.352	20.5	0.486	0.00231	-11.3	-90.0	2999	-	71.5
35	0.141	0.095	-3.119	-0.438	-0.073	-1.620	20.4	0.483	0.00231	-11.3	-90.0	1506	-	71.6

Continued on next page

Table F.177: Testing conditions and rotor 1 loads in the hub coordinate system for run 156.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
36	0.088	0.146	-3.988	-0.735	-0.142	-3.043	20.5	0.487	0.00231	-11.3	-90.0	1990	-	71.9
37	0.110	0.126	-3.170	-0.427	-0.102	-1.778	20.5	0.487	0.00231	-11.3	-90.0	1540	-	71.9
38	0.107	0.140	-3.997	-0.776	-0.208	-3.162	20.5	0.484	0.00231	-11.3	-90.0	2035	-	72.0
39	0.078	0.094	-5.406	-0.068	-0.017	-1.854	40.3	1.873	0.00231	-11.3	-90.0	1524	-	72.6
40	0.063	0.092	-6.579	-0.541	-0.405	-3.054	38.9	1.749	0.00231	-11.3	-90.0	1969	-	72.7
41	0.035	0.098	-7.193	-0.301	-0.324	-3.060	40.8	1.923	0.00231	-11.3	-90.0	2011	-	73.0
42	0.076	0.108	-5.349	-0.057	0.054	-1.904	41.6	1.997	0.00230	-11.3	-90.0	1471	-	73.3
43	0.042	0.097	-6.939	-0.567	-0.466	-3.149	39.8	1.826	0.00230	-11.3	-90.0	2028	-	73.4
44	-0.038	0.010	-10.701	-1.314	-1.430	-4.530	40.8	1.914	0.00230	-11.3	-90.0	2999	-	73.6
45	-0.001	0.056	-10.076	-0.548	-0.775	-3.765	40.5	1.887	0.00230	-11.3	-90.0	2800	-	73.7
46	0.032	0.057	-9.486	-0.277	0.015	-3.099	40.6	1.896	0.00230	-11.3	-90.0	2600	-	73.7
47	0.039	0.069	-8.747	-0.124	0.105	-2.550	40.8	1.914	0.00230	-11.3	-90.0	2400	-	73.8
49	0.065	0.099	-7.964	0.099	0.194	-2.225	40.8	1.911	0.00230	-11.3	-90.0	2200	-	74.0
50	0.072	0.113	-7.072	0.172	0.179	-2.121	40.6	1.900	0.00230	-11.3	-90.0	1999	-	74.1
51	0.090	0.126	-6.282	0.150	0.254	-2.245	40.7	1.902	0.00230	-11.3	-90.0	1800	-	74.2
52	0.097	0.137	-5.461	0.290	0.286	-2.278	40.8	1.909	0.00230	-11.3	-90.0	1600	-	74.3
53	0.105	0.159	-4.751	0.272	0.354	-2.323	40.7	1.903	0.00230	-11.3	-90.0	1400	-	74.5
54	0.113	0.168	-4.023	0.272	0.346	-2.202	40.7	1.906	0.00230	-11.3	-90.0	1200	-	74.5
55	0.127	0.188	-3.408	0.275	0.433	-1.889	40.5	1.883	0.00230	-11.3	-90.0	1000	-	74.6
56	0.140	0.194	-2.829	0.185	0.413	-1.515	40.8	1.916	0.00230	-11.3	-90.0	800	-	74.7
57	0.144	0.203	-2.322	0.166	0.374	-1.105	40.8	1.911	0.00230	-11.3	-90.0	599	-	74.7
58	0.124	0.205	-1.924	0.074	0.378	-0.703	40.6	1.897	0.00230	-11.3	-90.0	400	-	74.8
59	0.105	0.235	-1.692	-0.073	0.450	-0.401	40.6	1.897	0.00230	-11.3	-90.0	200	-	74.9
60	0.122	0.215	-1.947	0.073	0.382	-0.712	40.6	1.893	0.00230	-11.3	-90.0	400	-	74.9
61	0.132	0.200	-2.327	0.129	0.347	-1.131	40.8	1.912	0.00230	-11.3	-90.0	599	-	75.1
62	0.131	0.202	-2.848	0.181	0.423	-1.528	40.7	1.900	0.00230	-11.3	-90.0	800	-	75.1
63	0.118	0.202	-3.451	0.182	0.383	-1.931	40.5	1.887	0.00230	-11.3	-90.0	999	-	75.1
64	0.102	0.179	-4.059	0.212	0.319	-2.241	40.7	1.903	0.00230	-11.3	-90.0	1199	-	75.2
65	0.107	0.170	-4.805	0.271	0.340	-2.362	40.7	1.905	0.00230	-11.3	-90.0	1399	-	75.3
66	0.099	0.165	-5.529	0.235	0.254	-2.301	40.8	1.907	0.00229	-11.3	-90.0	1599	-	75.4
67	0.089	0.149	-6.382	0.224	0.250	-2.320	40.9	1.916	0.00229	-11.3	-90.0	1799	-	75.5
68	0.072	0.129	-7.149	0.190	0.193	-2.177	40.6	1.895	0.00229	-11.3	-90.0	1999	-	75.5
69	0.070	0.120	-8.020	0.135	0.253	-2.317	40.8	1.909	0.00229	-11.3	-90.0	2199	-	75.6

Continued on next page

Table F.177: Testing conditions and rotor 1 loads in the hub coordinate system for run 156.

Point	Fx1_H [lb]	Fy1_H [lb]	Fz1_H [lb]	Mx1_H [in-lb]	My1_H [in-lb]	Mz1_H [in-lb]	VFPS [ft/sec]	Q [psf]	RHO [slug/ft^3]	Pitch [deg]	Tilt [deg]	RPM_1	Phase_1 [deg]	T. Temp [°F]
70	0.047	0.091	-8.793	-0.097	0.122	-2.642	40.8	1.904	0.00229	-11.3	-90.0	2399	-	75.6
71	0.040	0.092	-9.536	-0.363	0.009	-3.194	40.5	1.882	0.00229	-11.3	-90.0	2599	-	75.7
72	0.014	0.076	-10.191	-0.678	-0.635	-3.826	40.8	1.908	0.00229	-11.3	-90.0	2800	-	75.7
73	-0.044	0.044	-10.777	-1.092	-1.416	-4.598	40.9	1.916	0.00229	-11.3	-90.0	2999	-	75.7
74	0.118	0.124	-5.934	-0.547	0.001	-5.490	3.0	0.010	0.00229	-11.3	-90.0	2999	-	75.8
75	0.150	0.152	-4.361	-0.467	0.219	-3.822	1.2	0.002	0.00229	-11.3	-90.0	2499	-	75.7
76	0.165	0.158	-3.059	-0.265	0.081	-2.451	1.1	0.001	0.00230	-11.3	-90.0	2000	-	75.7
77	0.177	0.162	-2.037	-0.196	0.133	-1.373	0.6	0.000	0.00230	-11.3	-90.0	1500	-	75.6
78	0.189	0.160	-1.290	-0.176	0.157	-0.574	0.0	0.000	0.00230	-11.3	-90.0	1000	-	75.6
79	0.198	0.160	-0.828	-0.141	0.150	-0.012	0.0	0.000	0.00230	-11.3	-90.0	500	-	75.6
80	0.254	0.000	-0.310	0.000	0.000	0.000	0.0	0.000	0.00230	-11.3	-90.0	0	-	75.6