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Joint Eglin Acoustics Week 2013 Data Report

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Abstract

Far-field acoustic measurements were obtained for the AH-64D, HH-60M and CV-22B at the Eglin AFB, Test Area C-72, in July/August 2013. The primary purpose for this flight test was to obtain a benchmark database of detailed acoustic source noise characteristics for the aircraft operating at typical mission gross weights over a range of typical mission operating conditions. Data were acquired for a range of steady-state level and descending flight conditions, hover, and a variety of unsteady maneuver conditions. Between 30 and 37 microphones were deployed during these tests. Vehicle position and state data, as well as weather data, were acquired simultaneously with the acoustic data. This paper describes the test aircraft, onboard instrumentation, ground instrumentation, and the data acquired. Data from this test are available upon request and review.

Introduction

The Chicken Little Joint Project Office of the 46th Test Squadron at Eglin AFB sponsored Acoustics Week 2013 to provide a cost-leveraged test venue to gather developmental system performance, sensor system performance, and signature data for analysis and algorithm development. The US Army Aviation Development Directorate and the NASA Langley Research Center (LaRC) teamed with the US Army's HH-60 and AH-64 Program Management Offices and the Naval Surface Warfare Center (NSWC) to collect acoustic signature data for the AH-64D, HH-60M, and the CV-22B aircraft. The test was conducted at the Eglin AFB, Test Area C-72, in July/August 2013. The primary purpose for this flight test was to obtain a benchmark database of detailed acoustic source noise characteristics for the aircraft operating at typical mission gross weights over a range of mission operating conditions, including both steady-state flight conditions as well as unsteady maneuvers. This database can be used to predict ground noise and aural detection footprints, develop low noise operations, study helicopter source noise mechanisms during maneuvering flight, and validate NASA/Army developed acoustic detection prediction codes. These prediction codes include the Rotorcraft Noise Model (RNM) (References 1 and 2), The Advanced Acoustic Model (AAM), the Acoustic Propagation and Emulation Toolset (APET), and Fundamental Rotorcraft Acoustic Modeling from Experiments (FRAME) (Reference 3). The data acquired are available to authorized organizations with a need to know. This paper will describe the testing of these aircraft and the data available.

Test Aircraft and Onboard Measurements

Test vehicles were the AH-64D and HH-60M helicopters and the CV-22B tiltrotor aircraft. Following is a brief description of each aircraft and the onboard measurements obtained for each aircraft.

The AH-64D (Tail Number 10-05626) was configured to achieve a mission representative gross weight (Figure 1). A 4-place AGM-114 Hellfire missile rack with one dummy missile was installed on each inboard pylon mount point, rocket pods (empty) were installed on each outboard pylon mount point, and an auxiliary fuel tank (Combo Pack) was installed internally, to achieve a takeoff gross weight of approximately 18,200 pounds. The Aircraft Navigation and Tracking System (ANTS), developed by

NASA Langley, was installed to obtain vehicle position and inertial navigation data. The ANTS unit incorporates a VectorNav VN-200 Inertial Navigation System (INS) chip into a self-contained device that receives the GPS signal, processes the GPS data in conjunction with built-in sensors, calculates a Kalman-filtered aircraft state solution, and logs the solution to an SD memory card at a programmable rate of 1 to 50 Hz. The state solution contains information about the location, velocity, acceleration, attitude, and attitude rates. The GPS signal was supplied by a GPS antenna installed on the tail of the aircraft during this test specifically for the ANTS. The ANTS unit was powered by internal batteries. During this test, data were sampled continuously and uninterrupted throughout the flight day at a rate of 20 Hz. Table 1 provides a list of the AH-64D variables that were acquired during this test.

The M-model HH-60 (Tail Number 04-27001), with the new wide-chord blade that is principally characterized by its unique tapered, anhedral tips (Figure 2), was used for this test. The takeoff gross weight was approximately 16,600 pounds during this test. Vehicle position and state data were obtained from the standard onboard Integrated Vehicle Health Management System (IVHMS). Table 2 provides a list of the HH-60M variables that were acquired during this test.

The AH-64D and HH-60M helicopters used during the Acoustics Week 2013 tests were based out of the US Army Aviation Development Directorate's, Aviation Applied Technology Directorate (AATD) located at Ft. Eustis, VA. The research test pilots that flew the aircraft during these tests were also provided by AATD.

The US Air Force 413th Flight Test Squadron based at Hurlburt Field, FL provided the CV-22B tiltrotor aircraft (Tail Number 99-0021) and test pilots. The aircraft used for this test (Figure 3) was a standard vehicle with a takeoff gross weight of approximately 47,000 pounds. Onboard measurements came from a full-bus capture of four of the MIL-STD-1553 Data Bus channels – Avionics A, Avionics B, Flight Controls #1, and Flight Controls #2. A serial data stream from a NovAtel High-Precision Differential GPS Receiver was captured, as well as 4-6 video channels. All data were captured using an IRIG-106 Chapter 10 compliant recorder as the data collection system. The system had an internal time counter that was synched with UTC Time from a GPS receiver and has an accuracy of 100 nanoseconds. Table 3 provides a list of the CV-22B variables that were acquired during this test.

Experimental Setup

The Eglin remote Test Range C-72 was used for this test program. During the experiment, the aircraft were flown over a NASA deployed ground-based microphone array to measure source noise hemispheres for a range of flight conditions, including level flight, approaches, hovers, and maneuvers that are representative of typical mission operating conditions. In addition to the NASA microphones, Wyle Laboratory personnel deployed a set of microphones during the AH-64D testing. Because aircraft source noise is affected by gross weight and drag, it was desirable to ballast the aircraft, when feasible, to a typical mission gross weight and drag configuration. An overview of the test range showing the primary flight track and the locations of the microphones, weather balloon, hover points, descent target point, and the NASA command and instrumentation trailers is shown in Figure 4. Detailed descriptions of the microphone instrumentation, weather system, and flight conditions are discussed in the following sections.

Acoustic Instrumentation

Wireless Acoustic Measurement Systems (WAMS) were deployed to acquire all acoustic data obtained by during this test. With the WAMS, microphone gains are set and acoustic data acquisition is initiated and terminated wirelessly from a central command computer. The acoustic pressure-time history data are recorded on compact flash cards located within each remote unit. Upon termination of each run, sufficient data metrics and system health information are transmitted back to the command computer to assure that good data were acquired at each microphone station during the run. A typical WAMS microphone station deployment is shown in Figure 5. One-half inch prepolarized free-field response condenser microphones (B&K Model 4189) fitted with grid caps and standard 4-inch diameter windscreens were used. The microphones were mounted inverted above a 15-inch diameter round ground board, ¼ radius from the edge of the ground board, as shown in Figure 5. The spacing between the microphone diaphragm and the ground board was nominally ¼ inch. The analog microphone signals were low-pass filtered at 11,670 Hz and digitized at 25,000 Hz, then recorded on compact flash cards. Each remote unit uses a GPS receiver to acquire a common time code for synchronization of the acoustic data with the vehicle tracking and performance data, as well as the weather data. Wyle Laboratories deployed additional microphones during the AH-64D testing only. Wyle microphones were mounted inverted above NASA provided ground boards. Wyle used one-half inch externally polarized free-field response condenser microphones (B&K Model 4190) connected to Type 2669 preamplifiers powered by GRAS 12AA amplifiers. The output signal was transmitted via RG-58 coax cable to a PXI chassis containing National Instruments model 4472 data acquisition cards that digitized the signal with a 24-bit A/D converter at 25,000 Hz. Calibration tones were recorded before and after measurements every day.

The primary NASA microphone array consisted of 22 ground-board-mounted microphones deployed in a linear array aligned perpendicular to the flight path. The precise location of all microphones, as well as the descent target and the NASA and Naval Surface Warfare Center (NSWC) hover points, are provided in Table . The reference microphone (microphone 11) is situated directly on the flight path and forms the origin of the Cartesian coordinate system used in Table 4 and subsequent analysis. The coordinate system is a right-hand Cartesian system with X along the flight track in the direction of flight, Y positive to the left of the flight path, and Z positive up. With the aircraft directly overhead of the reference microphone at an altitude of 100 feet above ground level (AGL), the microphone spacing was designed to provide approximately 10° angular resolution, up to 10° below the horizon. Additional microphones provide observer angles as small as 2.4° below the horizon as shown in Table . A secondary NASA microphone array of 7 microphones was deployed perpendicular to the flight track at 1,400 feet before the primary microphone array (X = -1400) to capture the aft-propagated noise during approaches to the descent target. The Wyle microphone array of 7 microphones was deployed perpendicular to the flight track at a point 1,500 feet beyond the primary microphone array (X = 1500) for the purpose of validating a Wyle developed process called Hotspot that attempts to predict the directionality of the highest noise levels in front of the vehicle. NASA microphone 30 was co-located with Wyle microphone 34 to validate Wyle’s acoustic measurement capability.

Meteorological Instrumentation

A tethered weather balloon system (Figure 6) was used to acquire weather profiles during each day’s flight testing period. The system consists of a winch-controlled tethered balloon, an instrument/telemetry pod, a ground-based receiver/data controller, and a ground-based support computer. Profiles of pressure, temperature, relative humidity, wind speed, and wind direction were acquired at altitudes up to 750 feet AGL. The weather balloon was located near the NASA Command Trailer as shown in Figure 4. In addition to the balloon mounted weather sensors, tripod mounted weather sensors (see Figure 5) measuring wind velocity, pressure, temperature, and humidity were located near the centerline microphone for each of the three microphone arrays at a height of 5 feet AGL, and at the command trailer location at a height of 30 feet AGL.

Test Procedures and Flight Conditions Measured

Acoustic measurements are extremely sensitive to atmospheric conditions, especially wind and temperature profiles. During this test program flights began at dawn (approximately 0600 hours) when the winds are typically the lowest of the day, and were terminated when winds and thermals built to unacceptable levels (typically between 0900 and 1100). Experimental setup began each day with microphone system deployment approximately 3 hours prior to first flight. This allowed time to deploy the equipment, resolve system problems, and acquire all pretest data. The weather balloon was also deployed during this setup period, but kept below 100 feet AGL until approved by range control.

During data acquisition, the aircraft approached the microphone array from a distance great enough to allow the pilot to achieve a steady-state flight condition on the prescribed flight path (Heading 307° True, 310° Magnetic) at the prescribed airspeed prior to beginning acoustic data acquisition. The pilot provided data-on and -off radio calls when the aircraft reached prescribed ranges as defined in the next section. A hard deck of 50 feet AGL was maintained for safety, at all times. Upon completion of data acquisition each day, posttest data were acquired and all data were provided to the data reduction and analysis engineer for processing.

AH-64D Helicopter

AH-64D steady-state flight conditions tested are provided in Table while the maneuver flight conditions are provided in Table . Daily flight cards for the three test days for this vehicle are provided in Table through **Table** .

Steady-State Conditions

Steady-state test conditions measured for the AH-64D are provided in Table . The aircraft was flown in a steady-state condition throughout the duration of acoustic data acquisition, at the prescribed airspeed and glideslope, along the primary flight path shown in Figure 4.

For all level flyovers, the aircraft was flown at an altitude of 100 feet AGL at the reference microphone location. Data-on was called at 5000 feet before the primary microphone array (X = -5000) and data-off was called 6000 feet past the primary microphone array (X = 6000).

Approaches were flown to acquire the prescribed glideslope and airspeed at a sufficient range to be in a steady-state operating condition for one mile from the Descent Target, which was located on the flight path centerline 500 feet before the primary microphone array (X = -500). Approaches were flown on the prescribed glideslope, with the glideslope intersecting a point 50 feet above the descent target as shown in Figure 7. This steady-state condition was held for as long as possible throughout the approach to the point 50 feet above the Descent Target, with the pilot pulling out of the descent at the lowest possible altitude for safe flight operations or at an altitude sufficient to not burst the 50-foot hard deck, whichever came first. Data-on was called at 5000 feet out (X = -5000) and data-off at the point of the pullout from the steady-state condition.

It should be understood that the pilot was flying an approximate (due to instrument resolution and accuracy) descent rate using standard cockpit instrumentation and that there was a certain amount of guesswork required given the typical wind variability with altitude. The emphasis was placed on minimizing control inputs rather than on hitting the precise descent point. Also, emphasis was placed on staying on the flight track centerline over maintaining a precise glideslope.

Hover data were acquired with the aircraft hovering at the prescribed heading and altitude over either the NASA hover point or the NSWC hover point (Figure 4). The pilot called data-on when a steady hover was achieved, and data-off was called by ground control after 60 seconds of acoustic data had been acquired.

Maneuver Conditions

AH-64D maneuver test point conditions are provided in Table . Conditions M1 – M16 were right and left turns at bank angles of 20° to 60°, airspeeds of 70 and 120 knots, and altitudes of 100 to 500 feet AGL. For all turns, the aircraft approached along the primary flight track and initiated the turns 2000 feet before the primary microphone array (X = -2000). The pilot called data-on 1000 feet before initiating the turn (X = -3000). The turn was held until the vehicle heading had changed by 90° (heading change from 307° to 037° or 217° True) at which point the pilot called data-off and terminated the run. M1 – M6 were 20° and 30° bank turns at 100 feet AGL. M7 and M8 were 120 knot right and left turns while descending at a rate of 500 feet per minute (fpm) such that the aircraft reached an altitude of 100 feet AGL when the run was terminated. The desire for the 45° and 60° bank turns (M9 – M16) was to obtain acoustic data when the turns were initiated at 300 feet AGL. However, due to safety concerns that altitude loss during the turns could exceed 250 feet, some of these turns were first flown at an initial altitude of 500 feet AGL. Also, conditions M9 – M16 were only flown after aircraft weight had been reduced by at least 1200 pounds through fuel burn.

M17 and M18 were quick stops performed along the primary flight path. The goal was to stop the aircraft as quickly as possible while not exceeding normal terrain flight maneuver operating conditions. M17 was a quick stop from 90 knots in level flight at 100 feet AGL, while M18 was a quick stop from 90 knots at a 500 fpm descent rate, ending in hover at an altitude between 50 and 100 feet AGL. For both these conditions, the deceleration from steady flight at 90 knots was initiated at X = -2000 feet. Data-on was called 1000 feet prior to initiating the deceleration (X = -3000) and data-off called once the aircraft had achieved a hover condition.

M19 and M20 were pull-up/push-over maneuvers performed along the primary flight path at 100 and 120 knots, respectively. The pull-up was initiated at X = -2000, with data-on called at X = -3000. Data-off was called at the end of the push-over, once the aircraft had established a level flight condition.

M21 was a maximum level flight acceleration maneuver. The aircraft approached along the primary flight path at 100 feet AGL and 40 knots airspeed. A maximum acceleration level flight condition was initiated at X = -2000 and held until the vehicle reached 140 knots airspeed. Data-on was called 5 seconds prior to initiating the acceleration and data-off was called once the vehicle reached 140 knots.

HH-60M Helicopter

The HH-60M steady-state flight conditions tested are provided in Table , and the maneuver flight conditions are provided in Table . Daily flight cards for the three test days for this vehicle are provided in Table through Table .

Steady-State Conditions

The steady-state test conditions measured for the HH-60M are provided in Table . The aircraft was flown in a steady-state condition throughout the duration of acoustic data acquisition, at the prescribed airspeed and glideslope, along the primary flight path shown in Figure 4.

For all level flyovers, the aircraft was flown at an altitude of 100 feet AGL at the reference microphone location. Data-on was called at X = -5000 and data-off was called at X = 6000.

Approaches were flown to acquire the prescribed glideslope and airspeed at a sufficient range to be in a steady-state operating condition one mile from the Descent Target, which was located on the flight path centerline 500 feet before the primary microphone array (X = -500). Approaches were flown on the prescribed glideslope, with the glideslope intersecting a point 50 feet above the descent target as shown in Figure 7. This steady-state condition was held for as long as possible throughout the approach to the point 50 feet above the Descent Target, with the pilot pulling out of the descent at the lowest possible altitude for safe flight operations or at an altitude that would prevent bursting the 50-foot hard deck, whichever came first. Data-on was called at X = -5000 and data-off at the point of the pullout from the steady-state condition.

It should be understood that the pilot was flying an approximate (due to instrument resolution and accuracy) descent rate using standard cockpit instrumentation and that there was a certain amount of guesswork required given the typical wind variability with altitude. The emphasis was placed on minimizing control inputs rather than on hitting the precise descent point. Also, emphasis was placed on staying on the flight track centerline over maintaining a precise glideslope.

Hover data were acquired with the aircraft hovering at the prescribed heading and altitude over either the NASA hover point or the NSWC hover point (Figure 4). The pilot called data-on when a steady hover was achieved and data-off was called by ground control after 60 seconds of acoustic data had been acquired.

Maneuver Conditions

HH-60M maneuver test point conditions are provided in Table . All maneuver test points were conducted at 100.5% RPM. Condition M1 is a variable glideslope, variable airspeed approach terminating in a hover at 50 feet above the Descent Target, as shown in Figure 8. The data-on call occurred at X = -4500 and data-off was called when a hover condition had been achieved.

Maneuver points M2 – M13 are right and left turns conducted at 100 feet AGL. M2 – M4 and M8 – M10 are 20° bank turns while M5 – M7 and M11 – M13 are 30° bank turns. For all turns, the aircraft approached along the normal flight track and initiated the turns at X = -2000. Data-on was called 1000 feet prior to initiating the turn. The turn was held until the vehicle heading had changed by 90° (heading change from 307° to 037° or 307° to 217° True) at which point data-off was called and the test point was terminated.

Maneuver points M14 & M15 are quick stops – the aircraft was stopped as quickly as possible while not exceeding normal terrain flight maneuver operating conditions. M14 was a quick stop from 90 knots in level flight at 100 feet AGL, while M15 was a quick stop from 90 knots on a 3° descending glideslope that terminated at an altitude between 50 and 100 feet AGL. For both these runs, the deceleration from steady flight at 90 knots was initiated 2000 feet before the primary microphone array. Data-on was called 1000 feet prior to initiating the deceleration (X = -3000), and data-off was called once the aircraft had achieved a hover condition.

CV-22B Tiltrotor Aircraft

All test conditions measured for the CV-22B are provided in Table ; while the daily flight cards for the two test days for this vehicle are provided in Table and Table . Note that in Table , every condition code has a unique priority, in case testing was ended abruptly. Due to adequate time on station, all test points were measured multiple times. During testing, for all test conditions except M1 and M2, the aircraft was flown in a steady-state condition throughout the duration of acoustic data acquisition, at the prescribed airspeed and glideslope, along the primary flight path shown in Figure 4. The rotors were operated at 84% Nr while in airplane mode (0° nacelle angle) unless otherwise noted in the flight cards. When the nacelle angle was set to anything other than 0°, the rotors were operated at 100% Nr.

For all level flyovers, the aircraft was flown at an altitude of 150 feet AGL at the reference microphone location. Data-on was called at X = -7000 and data-off was called at X = 6000.

Approaches were flown to acquire the prescribed glideslope and airspeed at a sufficient range to be in a steady-state operating condition for one mile from the Descent Target, which was located on the flight path centerline at X = -500. Approaches were flown on the prescribed glideslope, with the glideslope intersecting a point 50 feet above the descent target as shown in Figure 7. This steady-state condition was held for as long as possible throughout the approach to the point 50 feet above the Descent Target, with the pilot pulling out of the descent at the lowest possible altitude for safe flight operations or at an altitude that would not burst the 50-foot hard deck, whichever came first. Data-on was called at X = -5000 and data-off was called when the pilot initiated his pullout from the descent condition.

Hover data were acquired with the aircraft hovering at the prescribed heading and altitude over the prescribed hover point (Figure 4). The pilot called data-on when a steady hover was achieved and data-off was called by ground control after approximately 60 seconds of acoustic data acquisition.

Maneuver test point conditions for the CV-22B were simply transitions from cruise flight in airplane mode at 200 knots airspeed to hover. The aircraft approached along the normal flight track at 200 knots in airplane mode and one mile back from the target hover point began transitioning such that a hover condition was achieved over the target hover point. The only difference between conditions M1 and M2 is that M1 terminates in a 100-foot hover over the NASA hover point while M2 terminates in a 250-foot hover over the NSWC hover point. Data-on was called 5 seconds prior to initiating the transition from airplane mode and data-off was called once a stable hover condition had been achieved.

Data Reduction and Processing

Time-synchronized, calibrated pressure time history data from all microphones, weather data, vehicle position data and vehicle state data are available throughout the duration of all runs. Acoustic data are also available in the form of narrowband spectra and one-third-octave band spectra computed every 0.5 seconds during a run. Source noise hemispheres are available for all steady-state runs in one-third-octave band and narrowband format upon request and review.

The digital acoustic time domain data were transformed to the frequency domain using 4096-point Fast Fourier Transforms (FFTs) with a Hamming window applied. Averaged narrowband spectra were computed by averaging five 4096-point FFTs with 50% overlap, resulting in 0.4915-second data blocks. These averaged narrowband spectra were computed every 0.5 seconds for each microphone for the duration of each flyover. The averaged narrowband spectra were then integrated to obtain one-third octave band spectra for center band frequencies from 10 Hz to 10 kHz. Source noise hemispheres have been created using the Rotorcraft Noise Model/Acoustic Re-propagation Technique (RNM/ART) methodology (Reference 1) using the measured flight track and acoustic data.

Vehicle position data have been processed for transformation into the local Cartesian coordinate system as described in the Acoustic Instrumentation section of this paper, but are also available in the original latitude, longitude, and altitude GPS data format. Vehicle state and weather data are available in the original text file format as a function of time.

Concluding Remarks

Far-field acoustic measurements were obtained for the AH-64D, HH-60M and CV-22B at the Eglin AFB, Test Area C-72, in July/August 2013. The measurements were obtained as part of the Acoustics Week 2013 test sponsored by the Chicken Little Joint Project Office of the 46 Test Squadron to gather developmental system performance, sensor system performance, and signature data for analysis and algorithm development. The US Army Aviation Development Directorate, the NASA Langley Research Center (LaRC), the US Army's HH-60 and AH-64 Program Management Offices, and the Naval Surface Warfare Center (NSWC) teamed to collect this acoustic signature data for these vehicles during the Acoustics Week 2013 tests. The primary purposes for these measurements were to obtain a benchmark database of detailed acoustic source noise characteristics for these aircraft for the prediction of ground noise footprints, to develop low noise operations, to study helicopter source noise mechanisms during maneuvering flight, and for validation of NASA/Army developed acoustic prediction codes such as RNM, AAM, APET and FRAME.

Data were obtained for the vehicles operating at typical mission gross weights over a range of typical mission operating conditions, including both steady-state flight conditions as well as unsteady maneuver operations. Details of all flight conditions measured during these tests, as well as the experimental setup, vehicle onboard measurements and flight procedures have been provided. Acoustic, weather, vehicle position and vehicle state data were acquired for each run. 37 microphones were deployed during the AH-64D tests while 30 microphones were deployed during the HH-60M and CV-22B tests. Acoustic data are also available in the form of pressure time-histories, narrowband spectra, and one-third-octave band spectra computed every 0.5 seconds during a run, and source noise semispheres in one-third-octave band and narrowband formats. Vehicle state and weather data are available in the original text file format as a function of time. Data from this test are available upon request and review.

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Table 1. Vehicle data acquired during AH-64D testing.

Variable Name	Description	Units
Time	GPS time of week	sec
Week	GPS week	week
Heading	Heading angle relative to true north	deg
Pitch	Pitch angle relative to horizon	deg
Roll	Roll angle relative to horizon	deg
Latitude	INS solution position in geodetic latitude	deg
Longitude	INS solution position in geodetic longitude	deg
Altitude	Height above ellipsoid (WGS84)	m
NedVelX	INS solution velocity in NED frame (North)	m/sec
NedVelY	INS solution velocity in NED frame (East)	m/sec
NedVelZ	INS solution velocity in NED frame (Down)	m/sec
AttUncertainty	Uncertainty in attitude estimate	deg
PosUncertainty	Uncertainty in position estimate	m
VelUncertainty	Uncertainty in velocity estimate	m/sec

Table 2. Vehicle data acquired during HH-60M testing. Note: Units unavailable at time of publication.

ID	Parameter Name	Ground Station Name	Units
1	ALTITUDE DENSITY	Density Altitude (Hd)	
2	ALTITUDE RATE	Altitude Rate	
3	AVG STATIC PRESSURE	Average Static Pressure	
4	AZIMUTH PLATFORM	Azimuth Platform	
5	BARO CORRECTED ALT	Barometric Corrected Altitude	
6	BARO CORRECTION	Barometric Correction	
7	CAS	Calibrated Airspeed	
8	COLLECTIVE DCU	Collective Position (from DCU)	
9	CORECTED NZ	Corrected Load Factor	
10	CYCLIC LAT CAL	Cyclic Lateral Position Calibrated	
11	CYCLIC LONG DCU	Cyclic Longitudinal Position (from DCU)	
12	GROUND SPEED	Ground Speed	
13	IAS	Indicated Airspeed	
14	INT AUX 1 FUEL QTY	Internal Aux Tank 1 Fuel Quantity	
15	INT AUX 2 FUEL QTY	Internal Aux Tank 2 Fuel Quantity	
16	LAT ACCEL	Lateral Acceleration (Body)	
17	LAT ACCEL (DA)	Lateral Acceleration (Body) (Digital Accelerometer)	
18	LATITUDE	Latitude	
19	LONG ACCEL	Longitudinal Acceleration (Body)	
20	LONG ACCEL (DA)	Longitudinal Acceleration (Body) (Digital Accelerometer)	

Table 2. Continued.

ID	Parameter Name	Ground Station Name	Units
21	LONGITUDE	Longitude	
23	MAIN TANK 1 FUEL QTY	Internal Main Tank 1 Fuel Quantity	
24	MAIN TANK 2 FUEL QTY	Internal Main Tank 2 Fuel Quantity	
25	NR	Main Rotor Speed (from DCU)	
26	OAT	Outside Air Temperature (OAT)	
27	PEDAL CALIBRATED	Pedal Position Calibrated	
28	PITCH	Pitch	
29	PITCH RATE	Pitch Rate (Body)	
30	PRESSURE ALTITUDE	Pressure Altitude	
31	RADALT	Radar Altitude	
32	RADALT RATE FILTERED	Filtered Radar Altitude Rate	
33	ROLL	Roll	
34	ROLL RATE	Roll Rate (Body)	
35	STABILATOR POSITION	Stabilator Position	
36	TAS	True Airspeed	
37	TAT	Total Air Temperature	
38	TORQUE 1	Engine 1 Torque	
39	TORQUE 2	Engine 2 Torque	
40	TOTAL FUEL QTY	Total Fuel Quantity	
41	Total Torque	Total Torque	
42	TRUE HEADING	True Heading	
43	TURN RATE	Turn Rate	
44	UTC DAY OF YEAR	UTC Day of Year	day
45	UTC HOUR	UTC Hour	hr
46	UTC MINUTE	UTC Minute	min
47	UTC SECOND	UTC Second	sec
48	UTC TIME FOM	UTC Time Figure of Merit	
49	UTC YEAR	UTC Year	yr
50	VELOCITY BELLY	Velocity Belly (Zb)	
51	VELOCITY DOWN	Velocity Down (Zn)	
52	VELOCITY EAST	Velocity East (Yn)	
53	VELOCITY NORTH	Velocity North (Xn)	
54	VELOCITY NOSE	Velocity Nose (Xb)	
55	VELOCITY RIGHT WING	Velocity Right Wing (Yb)	
56	VELOCITY XG	Velocity Xg (Geodetic)	
57	VELOCITY YG	Velocity Yg (Geodetic)	
58	VELOCITY ZG	Velocity Zg (Geodetic)	
59	VERT ACCEL	Vertical Acceleration (Body)	

Table 2. Concluded.

ID	Parameter Name	Ground Station Name	Units
60	VERT ACCEL (ADC)	Vertical Acceleration (Body) (ADC)	
61	VERT ACCEL (DA)	Vertical Acceleration (Body) (Digital Accelerometer)	
62	WEIGHT GROSS	Weight Gross	
63	WIND DIRECTION	Wind Direction	
64	WIND VELOCITY	Wind Velocity	
65	YAW RATE	Yaw Rate (Body)	

Table 3. Vehicle data acquired during CV-22B testing.

Number	ID	Description	Units
1	AF1800GA	LWINS1 Acceleration X	ft/sec^2
2	AF1800HA	LWINS1 Acceleration Y	ft/sec^2
3	AF1800JA	LWINS1 Acceleration Z	ft/sec^2
4	A30200EA	DEU Baro Altitude	ft
5	AF1D00UA	LWINS1 Baro Bias	m
6	AP0C00HA	VSLED Calibration Airspeed	kts
7	AT17006A	FCC1 Elevator Position	in
8	AP01004A	VSLED Left Engine Torque	ft-lbs
9	AP03004A	VSLED Right Engine Torque	ft-lbs
10	AL12002C	FMU Left Feed Tank	lbs
11	AL12006C	FMU Left Aft JSAF Tank	lbs
12	AL12005C	FMU Left Fwd JSAF Tank	lbs
13	AL12004C	FMU Left Sponson Tank	lbs
14	AL12003C	FMU Left Wing Aux Tank	lbs
15	BL14002C	FMU Right Feed Tank	lbs
16	BL14006C	FMU Right Aft JSAF Tank	lbs
17	BL14005C	FMU Right Fwd JSAF Tank	lbs
18	VL14004C	FMU Right Sponson Tank	lbs
19	VL14003C	FMU Right Wing Aux Tank	lbs
20	AP0D00LA	VSLED Total Fuel Quantity	lbs
21	AP0D003A	VSLED Gross Weight	klbs
22	AF1T00GA	LWINS1 Ground Speed	kts
23	CF11007A	ADU1 Indicated Airspeed	kts
24	AT17009A	FCC1 Lateral Stick Position	in
25	AT17008A	FCC1 Longtinudinal Stick Position	in
26	AF1H00UA	LWINS1 Latitude	deg
27	AF1H00QA	LWINS1 Longitude	deg
28	AF1H00EA	LWINS1 Magnetic Heading	deg
29	AP0C002A	VSLED Nacelle Angle	deg
30	AP0D002A	VSLED Outside Air Temperature	deg C

Table 3. Continued.

Number	ID	Description	Units
31	AT1700AA	FCC1 Directional Pedal Position	in
32	AF1H00CA	LWINS1 Pitch	deg
33	AF1H00YA	LWINS1 Pitch Rate	deg/sec
34	AF1H00AA	LWINS1 Platform Azimuth	deg
35	AP0C00JA	VSLED Pressure Altitude	ft
36	AP0C00KA	VSLED Radar Altitude	ft
37	AF1H00BA	LWINS1 Roll	deg
38	AF1H00XA	LWINS1 Roll Rate	deg/sec
39	AT15004A	FCC1 Rotor RPM	RPM
40	AP0C004A	VSLED Left Rotor Torque	ft-lbs
41	AP0C005A	VSLED Right Rotor Torque	ft-lbs
42	AP0D001A	VSLED Static Pressure	in Hg
43	AT1700BA	FCC1 Throttle Position	in
44	BA1300PA	ABIU Total Air Temperature	deg C
45	BA03004A	ABIU True Airspeed	kts
46	AF1H00DA	LWINS1 True Heading	deg
47	A30100MA	DEU Turn Rate	deg/sec
48	A91G00XB	MAGR UTC Year	year
49	A91L004A	MAGR UTC Day	day
50	A91L002A	MAGR UTC Hour	hr
51	A91L002B	MAGR UTC Minute	min
52	A91L003A	MAGR UTC Second	sec
53	A91L005A	MAGR UTC Time Figure of Merit	
54	AF1H008A	LWINS1 Velocity Down	ft/sec
55	AF1H006A	LWINS1 Velocity East	ft/sec
56	AF1H004A	LWINS1 Velocity North	ft/sec
57	AF18005A	LWINS1 Velocity X	ft/sec
58	AF18007A	LWINS1 Velocity Y	ft/sec
59	AF18009A	LWINS1 Velocity Z	ft/sec
60	AP0B00AA	VSLED Vertical Velocity	ft/sec
61	A30200FA	DEU Wind Bearing	deg
62	A30200GA	DEU Wind Speed	ft/sec
63	AF1H00ZA	LWINS1 Yaw Rate	deg/sec

Table 4. Microphone location coordinates.

Mic #	Latitude, deg	Longitude, deg	Ellipsoid Height, m	MSL Height, m	Distances Relative to Reference microphone X, ft	Y, ft	Z, ft	Angle below horizon at 100 ft. AGL, deg.
1	30.63281474	-86.32190771	30.470	58.920	-15.19	1446.23	5.74	3.7
2	30.63351281	-86.32133916	32.141	60.591	-4.45	1135.85	11.24	4.5
3	30.63476901	-86.32025808	30.325	58.775	0.36	566.32	5.30	9.5
4	30.63540769	-86.31969859	28.847	57.297	0.33	274.89	0.46	19.9
5	30.63563087	-86.31950184	28.704	57.154	0.01	172.82	-0.01	30.1
6	30.63574974	-86.31939937	28.638	57.088	0.43	118.89	-0.22	40.1
7	30.63582543	-86.31933324	28.587	57.037	0.47	84.39	-0.39	49.9
8	30.63588241	-86.31928391	28.642	57.092	0.61	58.50	-0.21	59.7
9	30.63593121	-86.31924264	28.658	57.108	0.98	36.51	-0.16	70.0
10	30.63596981	-86.31920430	28.644	57.094	-0.15	18.04	-0.20	79.8
11	30.63600960	-86.31917006	28.706	57.156	0.00	0.00	0.00	90.0
12	30.63604929	-86.31913551	28.759	57.209	0.05	-18.07	0.17	-79.7
13	30.63608910	-86.31910097	28.697	57.147	0.14	-36.17	-0.03	-70.1
14	30.63613366	-86.31905606	28.782	57.232	-1.34	-57.62	0.25	-60.0
15	30.63619359	-86.31900954	28.896	57.347	0.16	-83.83	0.62	-49.9
16	30.63627044	-86.31894216	28.967	57.147	0.14	-118.91	0.86	-39.8
17	30.63638872	-86.31883857	29.109	57.559	0.14	-172.87	1.32	-29.7
18	30.63661209	-86.31864293	29.339	57.789	0.15	-274.79	2.07	-19.6
19	30.63725113	-86.31808441	29.284	57.734	0.45	-566.14	1.89	-9.8
20	30.63857946	-86.31690785	28.340	56.790	-2.81	-1174.71	-1.23	-4.9
21	30.63948795	-86.31612418	25.905	54.355	0.23	-1586.94	-9.25	-3.9
22	30.64237175	-86.31449699	35.923	64.373	225.61	-2732.08	23.50	-1.6
23	30.63205939	-86.31704820	33.517	61.967	-1399.51	742.41	15.72	6.5
24	30.63304449	-86.31618557	33.031	61.481	-1399.46	292.96	14.14	16.3
25	30.63348246	-86.31580193	32.945	61.395	-1399.46	93.12	13.86	42.8
26	30.63370071	-86.31561006	32.652	61.102	-1399.64	-6.60	12.90	-85.7
27	30.63392022	-86.31541790	32.417	60.867	-1399.61	-106.74	12.13	-39.5
28	30.63435769	-86.31503455	31.558	60.008	-1399.65	-306.38	9.31	-16.5
29	30.63531242	-86.31420457	30.017	58.467	-1398.06	-740.82	4.24	-7.4
30	30.63848346	-86.32298801	21.499	49.949	1500.51	7.68	-23.70	86.4
31	30.63684201	-86.32442542	29.007	57.457	1500.46	756.58	0.92	7.5
32	30.63738937	-86.32394597	27.638	56.088	1500.44	506.83	-3.56	11.5
33	30.63793654	-86.32346780	23.449	51.899	1500.71	257.37	-17.30	24.5
34	30.63848346	-86.32298801	21.499	49.949	1500.51	7.68	-23.70	86.4
35	30.63903026	-86.32250906	24.984	53.434	1500.51	-241.81	-12.27	-24.9

Table 4. Continued.

Mic #	Latitude, deg	Longitude, deg	Ellipsoid Height, m	MSL Height, m	X, ft	Y, ft	Z, ft	Angle below horizon at 100 ft. AGL, deg.
36	30.63957755	-86.32202866	26.924	55.374	1500.24	-491.72	-5.91	-12.2
37	30.64012563	-86.32154926	27.170	55.620	1500.41	-741.67	-5.11	-8.1
Descent Target					-500	0		
NASA Hover Point					-100	0		
NSWC Hover Point					4550	0		

Table 5. **AH-64D steady-state test conditions.**

Priority	Condition Code	KCAS	Alt, ft	Glide slope, deg	Descent rate, fpm	Comments
1	L1	140	100	-	-	Best dash speed
1	L2	120	100	-	-	
1	L3	100	100	-	-	
1	L4	80	100	-	-	
1	L5	70	100	-	-	best endurance/lowest pilot stress
1	L6	60	100	-	-	
3	L7	40	100	-	-	
3	L8	20	100	-	-	
3	L9	120	1000	-	-	
3	L10	120	3000	-	-	
1	A1	70	var.	3	371	acquire glide slope 1 mile from Descent Target
1	A2	70	var.	6	741	acquire glide slope 1 mile from Descent Target
1	A3	70	var.	9	1109	acquire glide slope 1 mile from Descent Target
2	A4	50	var.	6	529	flown at 30° (approximate) side slip aimed at Descent Target
2	A5	70	var.	6	741	flown at 30° (approximate) side slip aimed at Descent Target
1	A6	50	var.	3	265	acquire glide slope 1 mile from Descent Target
1	A7	50	var.	6	529	acquire glide slope 1 mile from Descent Target
1	A8	50	var.	9	792	acquire glide slope 1 mile from Descent Target
2	A9	40	var.	6	423	acquire glide slope 1 mile from Descent Target, loudest approach cond. per Bob Wagner
1	H1	0	200	-	-	Heading 310° at NSWC hover point
3	H2	0	50	-	-	Heading 310° at NASA hover point
1	H3	0	var.	-	var.	Heading 310°, pop-up at NASA hover point from 50' hover at max collective to 100' and then drop back to 50'
3	H4	0	50	-	-	Heading 40° at NASA hover point

Table 6. AH-64D maneuver test conditions.

Priority	Condition Code	KCAS	Alt, ft	Descent rate, fpm	Comments
4	M1	120	100	0	20° Right Bank
4	M2	120	100	0	20° Left Bank
3	M3	70	100	0	30° Right Bank
3	M4	70	100	0	30° Left Bank
2	M5	120	100	0	30° Right Bank
2	M6	120	100	0	30° Left Bank
2	M7	120	var.	500	30° Descending (500 fpm) right Bank
2	M8	120	var.	500	30° Descending (500 fpm) left Bank
3	M9	120	500	as req'd	45° Right Bank (after burning > 1200 lbs. fuel)
3	M10	120	300	as req'd	45° Right Bank (after burning > 1200 lbs. fuel)
3	M11	Eliminated this condition code			
3	M12	120	300	as req'd	45° Left Bank (after burning > 1200 lbs. fuel)
1	M13	120	500	as req'd	60° Right Bank (after burning > 1200 lbs. fuel)
1	M14	120	300	as req'd	60° Right Bank (after burning > 1200 lbs. fuel)
2	M15	Eliminated this condition code			
2	M16	120	300	as req'd	60° Left Bank (after burning > 1200 lbs. fuel)
2	M17	90-0	100	0	Quick stop
3	M18	90-0	100	500	Quick stop
1	M19	100	100	0	approach level, pull up, then push over
1	M20	120	100	0	approach level, pull up, then push over
1	M21	40-140	100	0	max level flight acceleration

Table 7. AH-64D flight card for 7/29/13.

Date: 7/29/13		UTC=Local + 5 hours			Steve Paris / Pete Montrond					
Aircraft: AH-64D		Flight Number: 101			CG: 205		GW#: 18,200			
NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
901	N/A	7:55:07	7:56:07	ambient	n/a	n/a	78.7	3.2	166	Possible issues with Ch 21
101	3	8:09:22	8:10:34	L3	100	0	78.5	3.3	117	Data On call at 2 km (Overdrive 16)
102	6	8:16:12	8:17:53	L6	60	0	78.8	1.3	82	
103	7	8:20:41	8:23:02	L7	40	0	79.9	3.4	90	
104	8	8:25:22	8:29:23	L8	20	0	78.5	3.8	96	
105	5	8:32:34	8:34:17	L5	70	0	79.9	0.5	93	
106	4	8:36:55	8:38:27	L4	80	0	80.3	2.0	119	
107	3-1	8:40:46	8:41:59	L3	100	0	79.5	2.2	48	
108	2	8:44:14	8:45:24	L2	120	0	79.5	2.4	109	
109	1	8:47:46	8:48:48	L1	140	0	79.8	4.4	69	130 KTAS actual
110	36	8:52:45	8:53:52	A1	70	3	79.0	2.7	90	
111	37	8:57:36	8:58:41	A2	70	6	80.0	0.4	83	
112	38	9:02:38	9:03:40	A3	70	9	81.0	1.2	77	
113	39	9:07:44	9:09:11	A4	50	6	80.6	3.2	55	70-80' above target, ~30° sideslipped, Mic 30 overdrive late in run
114	40	9:13:01	9:14:13	A5	70	6	80.9	3.2	47	jet noise observed to the north, ~30° sideslipped, 70' above target
115	41	9:17:36	9:18:41	A6	50	3	81.0	0.0	29	
116	42	9:22:15	9:23:31	A7	50	6	81.6	2.4	44	Wyle on radio during run
117	43	9:27:46	9:29:39	A8	50	9	81.8	2.7	25	
118	44	9:33:09	9:34:59	A9	40	6	83.6	0.0	73	
119	39-1	9:38:31	9:38:48	A4	50	6	82.8	1.7	113	RUN ABORTED (Nearby Explosion at C52)
120	39-2	9:41:34	9:42:52	A4	50	6	82.0	2.4	136	70-80' above target, ~30° sideslipped
121	40-1	9:46:39	9:48:02	A5	70	6	83.1	2.4	117	~30° sideslipped
122	42-1	9:51:12	9:52:12	A7	50	6	82.2	1.5	44	
123	37-1	9:55:27	9:56:16	A2	70	6	83.2	1.2	115	
902	N/A	10:02:09	10:03:08	ambient	n/a	n/a	83.6	0.7	150	

Footnote: '-' in KCAS or FPA indicates flight speed or path angle was "as required". See description of test conditions for more information.

Table 8. AH-64D flight card for 7/30/16.

Date: 7/30/13		UTC=Local + 5 hours			Steve Paris / Pete Montrond					Note: UTC time hack agrees with AATD "Watson", cards in UTC-0
Aircraft: AH-64D		Flight Number: 102			CG: 205		GW#: 18,200			
NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
903	N/A	10:49:21	10:50:21	ambient	n/a	n/a				
124	9	11:37:40	11:39:06	L9	120	0	72.0	0.0	220	1000 ft AGL
125	10	11:42:56	11:44:31	L10	120	0	73.2	0.0	262	3000 ft AGL
126	3-2	11:46:57	11:48:35	L3	100	0	72.7	0.3	262	Request target altitude 130 AGL at run start, Mic 5 down, 15 O/D
127	15	11:51:58	11:53:04	M1	120	0	73.4	0.0	262	Right turn 20° bank
128	15-1	11:54:46	11:55:32	M1	120	0	73.8	0.3	262	Right turn 20° bank
129	16	11:57:32	11:58:08	M2	120	0	74.3	0.0	262	Left turn 20° bank, Mic 5 up, poor gains
130	19	12:00:23	12:00:57	M5	120	0	74.7	0.0	262	Right turn 30° bank
131	17	12:03:45	12:04:13	M3	70	0	74.3	0.0	200	Right turn 30° bank
132	19-1	12:06:06	12:06:32	M5	120	0	75.0	0.2	181	Right turn 30° bank
133	18	12:08:37	12:09:04	M4	70	0	73.5	0.0	191	Left turn 30° bank
134	20	12:11:07	12:11:30	M6	120	0	73.9	0.0	191	Left turn 30° bank
135	33	12:15:03	12:15:57	M19	100	0	74.8	0.0	191	Pull-up/push-over (Mic 18 O/D)
136	34	12:18:54	12:19:43	M20	120	0	76.0	0.0	191	Mic 18 O/D
137	35	12:22:52	12:23:58	M21	40-125	0	76.2	1.5	127	Max level flight accel
138	15-2	12:27:04	12:27:34	M1	120	0	76.0	2.2	126	Right turn 20° bank
139	17-1	12:29:35	12:30:03	M3	70	0	76.5	1.0	126	Right turn 30° bank
140	19-2	12:31:57	12:32:23	M5	120	0	76.7	0.0	126	Right turn 30° bank
141	16-1	12:34:16	12:34:43	M2	120	0	76.8	0.0	126	Left turn 20° bank
142	18-1	12:36:49	12:37:15	M4	70	0	77.0	0.5	126	Left turn 30° bank
143	20-1	12:39:13	12:39:37	M6	120	0	77.1	0.2	126	Left turn 30° bank
144	21	12:42:38	12:42:06	M7	120	3	77.3	0.2	126	Right turn 30° bank descending
145	23	12:45:10	12:45:32	M9	120	-	77.6	1.2	126	Right turn 45° bank (rumble in background--jet engine?) (500 AGL)
146	24	12:47:29	12:47:54	M10	120	-	77.7	0.7	126	Right turn 45° bank (300 AGL)
147	24-1	12:49:49	12:50:11	M10	120	-	77.4	1.2	126	Right turn 45° bank (300 AGL)
148	27	12:52:11	12:52:35	M13	120	-	78.9	0.0	126	Right turn 60° bank (500 AGL)
149	28	13:00:12	13:00:37	M14	120	-	78.5	0.5	126	Right turn 60° bank (300 AGL)

Footnote: '-' in KCAS or FPA indicates flight speed or path angle was "as required". See description of test conditions for more information.

Table 8. Continued.

NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
150	28-1	13:02:30	13:02:49	M14	120	-	78.6	0.0	126	Right turn 60° bank (300 AGL)
151	22	13:04:11	13:05:05	M8	120	3	78.0	0.2	126	Left turn 30° bank descending
152	26	13:07:25	13:07:44	M12	120	-	79.0	1.5	126	Left turn 45° bank (300 AGL)
153	26-1	13:09:40	13:10:02	M12	120	-	79.0	0.2	126	Left turn 45° bank (300 AGL)
154	30	13:12:14	13:12:34	M16	120	-	79.1	0.5	126	Left turn 60° bank (300 AGL), Mic 23 and 29 O/D
155	30-1	13:14:24	13:14:46	M16	120	-	79.2	1.0	126	Left turn 60° bank (300 AGL), Mic 23 O/D
156	31	13:16:47	13:17:31	M17	90-0	0	79.8	0.0	126	Quick stop to descent target (poor gains)
157	31-1	13:19:50	13:20:35	M17	90-0	0	79.6	1.0	121	Quick stop to descent target
158	31-2	13:22:27	13:23:04	M17	90-0	0	79.8	0.0	167	Quick stop to descent target
159	32	13:25:43	13:26:23	M18	90-0	-	79.5	0.0	165	Descending quick-stop (500 fpm descent)
160	32-1	13:28:24	13:29:12	M18	90-0	-	80.7	0.5	165	Descending quick-stop (500 fpm descent)
161	11	13:34:07	13:35:41	H1	0	0	80.2	0.0	165	NSWC Hover
162	12	13:40:33	13:41:09	H2	0	0	81.2	0.0	164	NASA Hover
163	13	13:42:09	13:42:58	H3	0	0	81.2	0.0	13	Hover Popup
164	13-1	13:43:42	13:44:24	H3	0	0	81.6	0.0	142	Hover Popup
165	14	13:45:15	13:46:11	H4	0	0	82.3	0.0	112	Hover Heading 217 true
166	1-1	13:49:31	13:50:17	L1	140	0	81.8	2.0	126	130 KTAS actual, Mic 15, 18, 30 O/D
167	1-2	13:53:17	13:54:04	L1	140	0	80.2	0.0	154	
168	2-1	13:56:49	13:57:41	L2	120	0	79.7	2.4	219	overdrove mic 5 (on most points)
169	3-3	14:00:22	14:01:24	L3	100	0	79.5	1.7	215	
170	4-1	14:03:56	14:05:20	L4	80	0	80.5	0.7	191	
171	3-4	14:07:55	14:08:59	L3	100	0	80.0	2.2	200	
904	N/A	14:15:49	14:16:39	ambient	n/a	n/a	80.8	2.2	210	

Footnote: ‘-‘ in KCAS or FPA indicates flight speed or path angle was “as required”. See description of test conditions for more information.

Table 9. AH-64D flight card for 7/31/13.

Date: 7/31/13		UTC=Local + 5 hours			Steve Paris / Pete Montrond					Note: Times in UTC-0
Aircraft: AH-64D		Flight Number: 103			CG: 205		GW#: 18,200			
NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
905	N/A			ambient	n/a	n/a				
906	N/A	11:21:02	11:22:02	ambient	n/a	n/a	69.4	0.0	229	
172	9-1	11:36:53	11:38:04	L9	120	0	69.7	0.0	229	1000' AGL
173	10-1	11:41:54	11:43:07	L10	120	0	70.1	0.0	229	3000' AGL
174	5-1	11:46:29	11:48:10	L5	70	0	70.5	0.0	229	O/D Mic 30
175	4-2	11:50:53	11:52:26	L4	80	0	71.3	0.0	5	
176	3-5	11:55:10	11:56:28	L3	100	0	72.0	2.7	329	
177	2-2	11:59:12	12:00:17	L2	120	0	72.1	0.0	355	
178	1-3	12:03:03	12:04:01	L1	140	0	72.3	0.0	353	130 KTAS actual
179	6-1	12:07:07	12:09:03	L6	60	0	72.5	0.0	353	
180	7-1	12:12:38	12:15:43	L7	40	0	72.8	0.0	69	
181	8-1	12:19:42	12:24:06	L8	20	0	73.0	0.0	314	
182	36-1	12:27:37	12:28:50	A1	70	3	73.4	0.0	2	
183	37-1	12:32:26	12:33:28	A2	70	6	73.3	0.0	2	
184	38-1	12:37:37	12:39:01	A3	70	9	73.6	0.0	2	
185	41-1	12:42:57	12:44:45	A6	50	3	73.2	0.0	2	
186	42-1	12:48:24	12:50:10	A7	50	6	73.2	0.0	2	
187	43-1	12:54:10	12:56:04	A8	50	9	74.4	0.0	99	
188	11-1	13:00:44	13:01:48	H1	0	0	74.9	0.0	99	NSWC Hover Point
189	1-4	13:05:33	13:06:32	L1	140	0	75.6	0.0	99	130 KTAS actual
190	2-3	13:09:41	13:10:44	L2	120	0	75.5	0.0	99	
191	3-6	13:13:40	13:14:53	L3	100	0	75.3	0.0	12	
192	4-3	13:17:43	13:19:06	L4	80	0	75.8	0.0	351	
193	5-2	13:22:04	13:23:42	L5	70	0	76.1	0.0	99	
194	6-2	13:26:48	13:28:43	L6	60	0	76.4	0.0	60	
195	33-1	13:31:54	13:32:48	M19	100	0	76.4	0.0	29	Pull-up/push-over
196	34-1	13:36:13	13:37:11	M20	120	0	76.9	0.7	181	Pull-up/push-over
197	35-1	13:40:16	13:42:09	M21	40-140	0	77.2	1.7	180	Max accel.
198	24-2	13:47:06	13:47:44	M10	120	0	79.1	0.2	224	Right turn 45° bank Mic 24 O/D

Footnote: '-' in KCAS or FPA indicates flight speed or path angle was "as required". See description of test conditions for more information.

Table 9. Continued.

NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
199	28-2	13:49:31	13:50:07	M14	120	-	78.5	4.6	210	Right turn 60° bank many mics overdriven
200	28-3	13:52:10	13:52:53	M14	120	-	78.4	2.7	222	Right turn 60° bank 25, 26 O/D
201	28-4	13:55:32	13:56:10	M14	120	-	79.5	1.0	217	Right turn 60° bank
202	26-2	13:58:08	13:58:45	M12	120	-	78.2	2.0	237	Left turn 45° bank Mic 15 O/D
203	30-2	14:00:45	14:01:55	M16	120	-	78.7	1.2	215	Left turn 60° bank
204	31-3	14:04:53	14:06:08	M17	90-0	0	78.6	2.9	211	Quick stop
205	32-2	14:08:34	14:10:11	M18	90-0	-	79.0	0.2	238	Descending quick stop (500 fpm descent)
206	12-1/ 14-1/ 13-1	14:12:20	14:15:32	H2/ H3/ H4	0	0	79.0	2.4	254	NASA hover, hover turn perpendicular to track (217), popup at perpendicular heading (217)
207	3-7	14:18:44	14:19:59	L3	100	0	78.9	3.4	243	
907	N/A	14:26:00	14:27:00	ambient	n/a	n/a	79.3	3.9	256	Radio chatter during ambient

Footnote: '-' in KCAS or FPA indicates flight speed or path angle was "as required". See description of test conditions for more information.

Table 10. HH-60M steady-state test conditions.

Priority	Condition Code	KCAS	% RPM	Glide slope, deg	Descent rate, fpm	Comments
1	L1	Vh (145)	100.5	-	-	
1	L2	130	100.5	-	-	
1	L3	110	100.5	-	-	
1	L4	90	100.5	-	-	
1	L5	70	100.5	-	-	
1	L6	50	100.5	-	-	
2	L7	Vh (145)	96.5	-	-	
1	L8	130	96.5	-	-	
2	L9	110	96.5	-	-	
2	L10	90	96.5			
1	L11	70	96.5			
2	L12	50	96.5	-	-	
1	A1	80	100.5	6	847	
1	A2	80	100.5	6	847	25° nose left sideslip or 1 ball width sideslip left or right
1	A3	70	100.5	3	371	
1	A4	70	100.5	6	741	
1	A5	70	100.5	9	1109	
2	A6	70	98	3	371	
1	A7	70	98	6	741	
2	A8	70	98	9	1109	
2	A9	70	96.5	3	371	
1	A10	70	96.5	6	741	
2	A11	70	97	9	1109	
1	A12	50	100	3	265	
1	A13	50	100	6	529	
1	A14	50	100	9	792	
2	A15	50	98	3	265	
1	A16	50	98	6	529	
2	A17	50	98	9	792	
2	A18	50	97	3	265	
1	A19	50	97	6	529	
2	A20	50	97	9	792	
1	H1	0	100.5	-	-	Altitude 200 feet, Heading 310°, at NSWC hover point
1	H2	0	100.5	-	-	Altitude 50 feet, Heading 310°, at NASA hover point
2	H3	0	100.5	-	-	Altitude 50 feet, Heading 40°, at NASA hover point

Table 11. HH-60M maneuver test conditions.

Priority	Condition Code	KCAS	Alt, ft	Descent FPA (°)	Comments
1	M1	70 to 50 to hover	var.	9 to 0 to 6	Ingress profile, transition from level flight to descent (see Figure 8)
1	M2	110	100	0	Level flight 90° right turn at a 20° bank angle starting 2000’ before primary array
2	M3	90	100	0	Level flight 90° right turn at a 20° bank angle starting 2000’ before primary array
1	M4	70	100	0	Level flight 90° right turn at a 20° bank angle starting 2000’ before primary array
1	M5	110	100	0	Level flight 90° right turn at a 30° bank angle starting 2000’ before primary array
2	M6	90	100	0	Level flight 90° right turn at a 30° bank angle starting 2000’ before primary array
1	M7	70	100	0	Level flight 90° right turn at a 30° bank angle starting 2000’ before primary array
3	M8	110	100	0	Level flight 90° left turn at a 20° bank angle starting 2000’ before primary array
3	M9	90	100	0	Level flight 90° left turn at a 20° bank angle starting 2000’ before primary array
3	M10	70	100	0	Level flight 90° left turn at a 20° bank angle starting 2000’ before primary array
3	M11	110	100	0	Level flight 90° left turn at a 30° bank angle starting 2000’ before primary array
3	M12	90	100	0	Level flight 90° left turn at a 30° bank angle starting 2000’ before primary array
3	M13	70	100	0	Level flight 90° left turn at a 30° bank angle starting 2000’ before primary array
2	M14	90-0	100	0	Quick stop starting 2000’ before primary array and ending near hover point
1	M15	90-0	var.	3	Quick stop ending at 100 feet AGL, starting 2000’ before primary array and ending near hover point

Table 12. HH-60M flight card for 8/5/13.

Date: 8/5/13		UTC=Local + 5 hours			LTC Evan Brown / CW3 Clark Hall					Note: Times in UTC-0 (a/c time hack agrees)
Aircraft: HH-60M		Flight Number: 104			GW#: 16,600 ± 50		Fuel Start Wt #: 2377			
NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
908	N/A	12:22:25	12:23:28	Ambient	n/a	n/a	72.0	3.2	205	car near NSWC hover point
301	3	13:08:00	13:09:23	L3	110	0	74.4	2.2	354	Aircraft time may be 2 sec behind 100.5% Nr
302	6	13:12:13	13:13:27	L6	50	0	75.6	2.2	346	ABORT: terminated at pilot discretion
303	6-1	13:17:42	13:20:22	L6	50	0	75.0	3.2	340	
304	5	13:23:10	13:24:57	L5	70	0	76.1	1.2	354	
305	4	13:28:05	13:29:26	L4	90	0	76.7	1.7	328	
306	3-1	13:32:58	13:34:07	L3	110	0	76.7	2.0	330	
307	2	13:37:13	13:38:13	L2	130	0	76.9	1.7	13	
308	1	13:41:35	13:42:26	L1	145	0	77.5	3.4	329	152 KTAS actual
309	12	13:46:08	13:48:29	L12	50	0	78.5	0.2	338	reduced NR (96.5)
310	11	13:52:08	13:53:57	L11	70	0	78.4	3.7	38	reduced NR (96.5)
311	10	13:57:17	13:58:45	L10	90	0	78.4	4.2	347	reduced NR (96.5)
312	9	14:01:59	14:03:11	L9	110	0	78.8	1.7	350	reduced NR (96.5)
313	8	14:06:35	14:07:36	L8	130	0	79.6	0.5	1	reduced NR (96.5)
314	7	14:11:09	14:12:04	L7	145	0	79.1	0.0	315	reduced NR (96.5)--150 KTAS actual
315	13	14:16:16	14:17:13	A1	80	6	80.3	1.5	313	headwinds aloft (ABORT: terminated at pilot discretion)
316	13-1	14:20:28	14:21:25	A1	80	6	79.5	3.7	336	headwinds aloft
317	14	14:25:43	14:26:43	A2	80	6	79.7	0.0	342	nose left sideslip (20°-25°)
318	15	14:31:06	14:32:12	A3	70	3	81.1	0.0	20	
319	16	14:36:18	14:37:20	A4	70	6	80.8	0.5	264	
320	17	14:41:48	14:42:48	A5	70	9	81.5	0.0	15	
321	21	14:46:36	14:47:38	A9	70	3	80.9	1.2	6	reduced NR (96.5), pilot was OK skipping 98% runs
322	22	14:51:15	14:52:18	A10	70	6	80.9	2.2	271	reduced NR (96.5)
323	3-2	14:55:52	14:57:05	L3	110	0	81.4	0.7	350	
909	N/A	15:08:31	15:09:30	Ambient	n/a	n/a	82.2	1.7	8	

Footnote: ‘-‘ in KCAS or FPA indicates flight speed or path angle was “as required”. See description of test conditions for more information.

Table 13. UH-60M flight card for 8/6/13.

Date: 8/6/13		UTC=Local + 5 hours			LTC Evan Brown / CW3 Clark Hall					Note: Times in UTC-0
Aircraft: HH-60M		Flight Number: 105			GW#: 16,600 ± 50		Fuel Start Wt #: 2377			
NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
910	N/A	10:15:46	10:16:47	ambient	n/a	n/a	70.5	0.0	350	
324	3-3	11:10:45	11:11:59	L3	110	0	67.9	0.0	27	
325	13-2	11:16:01	11:16:57	A1	80	6	68.3	0.0	27	
326	14-1	11:21:58	11:22:57	A2	80	6	70.5	0.0	27	nose left sideslip (~20°)-- temperature inversion (+8°F over 300')
327	15-1	11:27:09	11:28:34	A3	70	3	68.5	0.0	27	
328	16-1	11:32:32	11:33:34	A4	70	6	68.5	0.0	27	
329	17-1	11:37:35	11:38:42	A5	70	9	68.8	0.0	27	
330	15-2	11:42:37	11:43:42	A3	70	3	69.3	0.0	27	actual 100.5%
331	16-2	11:47:44	11:48:48	A4	70	6	69.6	0.0	27	actual 100.5%
332	23	11:53:47	11:54:54	A11	70	9	69.9	0.0	27	reduced NR (96.5%) a/c at 35,000 ft
333	21-1	11:59:18	12:00:17	A3	70	3	70.0	0.0	27	actual 100.5%
334	22-1	12:04:55	12:06:00	A4	70	6	70.7	0.0	27	actual 100.5%
335	24	12:10:20	12:11:32	A12	50	3	71.2	0.0	27	
336	25	12:15:48	12:17:06	A13	50	6	72.0	0.0	27	
337	26	12:21:38	12:22:58	A14	50	9	72.2	0.0	27	
338	30	12:27:16	12:28:31	A18	50	3	72.7	1.7	24	reduced NR (96.5%)
339	31	12:32:58	12:34:21	A19	50	6	73.2	0.0	6	reduced NR (96.5%)
340	32	12:38:55	12:40:16	A20	50	9	74.0	0.0	4	reduced NR (96.5%)
341	3-4	12:44:50	12:47:52	L3	110	0	74.6	0.7	28	extended path
342	36	12:52:07	12:53:25	M1	70-50-0	-	74.9	0.5	29	compound approach (50' high) jet overflight
343	36-1	12:58:03	12:59:37	M1	70-50-0	-	74.7	0.0	16	compound approach
344	34	13:00:27	13:02:03	H2/H3	0	0	75.3	0.2	19	NASA hover (30 sec then heading change)
345	33	13:03:42	13:04:23	H1	0	0	75.7	0.0	19	NSWC hover

Footnote: '-' in KCAS or FPA indicates flight speed or path angle was "as required". See description of test conditions for more information.

Table 13. Continued.

NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
Refuel										
911	N/A	13:13:20	13:14:21	ambient	n/a	n/a	74.7	0.0	19	
346	3-5	13:52:10	13:54:41	L3	110	0	79.3	0.0	359	extended path (jet noise in area near beginning of run)
347	37	13:58:16	13:59:07	M2	110	0	79.9	0.5	8	20° bank right turn
348	40	14:01:15	14:02:19	M5	110	0	80.0	0.0	2	30° bank right turn
349	6-2	14:05:02	14:07:21	L6	50	0	80.6	0.0	2	
350	5-1	14:10:18	14:11:59	L5	70	0	80.5	1.2	298	
351	4-1	14:14:59	14:16:15	L4	90	0	80.7	2.4	332	pickup idling near NSWC since REFUEL
352	3-6	14:20:14	14:22:43	L3	110	0	81.9	0.7	28	extended path
353	2-1	14:25:55	14:26:55	L2	130	0	81.6	1.7	346	
354	1-1	14:34:19	14:35:08	L1	145	0	81.5	2.0	339	152 KTAS actual
355	7-1	14:38:08	14:39:02	L7	145	0	81.8	1.2	7	150 KTAS actual, reduced NR(96.5%)
356	8-1	14:42:00	14:43:00	L8	130	0	81.7	1.5	347	reduced NR (96.5%)
357	9-1	14:45:37	14:46:51	L9	110	0	81.6	2.4	348	reduced NR (96.5%)
358	10-1	14:49:39	14:51:07	L10	90	0	82.8	0.2	344	reduced NR (96.5%)
359	11-1	14:53:58	14:55:48	L11	70	0	83.3	0.0	300	reduced NR (96.5%)
360	12-1	14:58:33	15:01:02	L12	50	0	83.0	2.9	14	reduced NR (96.5%)
912	N/A	15:10:31	15:11:31	ambient	n/a	n/a	82.6	4.9	31	UH-1 inbound to C7 during ambient

Footnote: ‘-‘ in KCAS or FPA indicates flight speed or path angle was “as required”. See description of test conditions for more information.

Table 14. HH-60M flight card for 8/7/13.

Date: 8/7/13		UTC=Local + 5 hours			LTC Evan Brown / CW3 Clark Hall					Note: Times in UTC-0
Aircraft: HH-60M		Flight Number: 106			GW#: 16,600 ± 50		Fuel Start Wt #: 2377			
NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
913	N/A	10:01:55	10:02:55	ambient	n/a	n/a	67.4	2.0	345	
361	3-7	11:06:28	11:07:53	L3	110	0	67.9	1.2	17	Microphone 14 down
362	36-2	11:10:46	11:13:17	M1	60-50-0	-	67.8	0.0	17	Revised to start descent around 60 KTAS
363	36-3	11:15:04	11:17:24	M1	60-50-0	-	67.7	0.2	17	Significant wind gradients (5 kts / 100', 15 kts @ 43°)
364	36-4	11:18:42	11:21:12	M1	60-50-0	-	67.8	1.7	17	
365	37-1	11:23:20	11:24:16	M2	110	0	68.0	1.2	36	GRAS 47AX O/D 20° right bank
366	37-2	11:26:31	11:27:17	M2	110	0	68.1	1.5	36	20° right bank
367	37-3	11:29:31	11:30:23	M2	110	0	68.3	0.7	39	20° right bank
368	38	11:32:42	11:33:36	M3	90	0	68.4	0.7	40	20° right bank, Mic 22 O/D
369	38-1	11:35:58	11:36:49	M3	90	0	68.4	0.0	41	20° right bank
370	38-2	11:38:58	11:39:51	M3	90	0	68.5	0.5	41	20° right bank
371	39	11:42:05	11:42:57	M4	70	0	68.7	2.4	2	20° right bank
372	39-1	11:45:08	11:46:07	M4	70	0	68.9	0.0	41	20° right bank
373	39-2	11:48:08	11:49:08	M4	70	0	68.8	0.0	41	20° right bank
374	40-1	11:51:11	11:52:00	M5	110	0	70.8	0.0	41	30° right bank
375	40-2	11:53:54	15:54:44	M5	110	0	68.8	0.7	41	30° right bank (O/D 20,21,22)
376	40-3	11:56:33	11:57:21	M5	110	0	68.9	0.0	20	30° right bank
377	41	11:59:17	12:00:12	M6	90	0	68.9	0.0	20	30° right bank
378	41-1	12:02:03	12:02:50	M6	90	0	69.2	0.0	20	30° right bank
379	41-2	12:04:43	12:05:32	M6	90	0	69.3	2.2	24	30° right bank
380	42	12:07:31	12:08:30	M7	70	0	69.2	1.7	24	30° right bank
381	42-1	12:10:24	12:11:19	M7	70	0	69.3	0.0	24	30° right bank
382	42-2	12:13:12	12:14:06	M7	70	0	69.3	0.0	24	30° right bank
383	43	12:17:07	12:18:06	M8	110	0	69.8	0.0	24	20° left bank
384	43-1	12:20:17	12:21:16	M8	110	0	69.8	0.2	20	20° left bank
385	43-2	12:23:19	12:24:19	M8	110	0	69.8	0.0	20	20° left bank
386	44	12:26:25	12:27:26	M9	90	0	69.5	2.7	10	20° left bank

Footnote: ‘-‘ in KCAS or FPA indicates flight speed or path angle was “as required”. See description of test conditions for more information.

Table 14. Continued.

NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
387	44-1	12:29:33	12:30:33	M9	90	0	69.9	0.0	7	20° left bank
388	44-2	12:32:35	12:33:34	M9	90	0	70.1	0.0	7	20° left bank
389	45	12:35:49	12:36:48	M10	70	0	70.1	0.0	7	20° left bank
390	45-1	12:39:05	12:40:05	M10	70	0	70.3	0.0	7	20° left bank
391	45-2	12:42:12	12:43:15	M10	70	0	70.3	0.0	7	20° left bank
392	46	12:45:15	12:46:05	M11	110	0	71.6	0.5	7	30° left bank
393	46-1	12:48:02	12:48:51	M11	110	0	70.5	2.4	18	30° left bank
394	46-2	12:50:48	12:51:37	M11	110	0	70.9	1.0	19	30° left bank
395	47	12:53:37	12:54:28	M12	90	0	70.6	1.7	34	30° left bank
396	47-1	12:56:20	12:57:11	M12	90	0	71.0	0.7	27	30° left bank
397	47-2	12:59:05	12:59:59	M12	90	0	71.4	1.7	27	30° left bank
398	3-8	13:01:53	13:02:57	L3	110	0	72.7	0.2	27	
Refuel										
914	N/A	13:16:26	13:17:31	ambient	n/a	n/a	75.0	2.9	62	
399	3-9	13:43:57	13:45:06	L3	110	0	76.1	0.5	51	
400	48	13:47:40	13:48:34	M13	70	0	75.6	2.0	353	30° left bank
401	48-1	13:50:50	13:51:42	M13	70	0	76.6	0.2	51	30° left bank
402	48-2	13:54:14	13:54:58	M13	70	0	76.0	2.0	53	30° left bank (jet noise near end of run)
403	49	13:57:07	13:58:16	M14	90-0	0	77.2	0.5	53	quick stop
404	49-1	14:00:35	14:01:45	M14	90-0	0	77.1	2.9	92	quick stop (decel increased at end of run)
405	49-2	14:03:58	14:04:34	M14	90-0	0	77.2	1.2	92	quick stop (ABORT)
406	49-3	14:06:59	14:08:33	M14	90-0	0	78.9	0.0	55	quick stop
407	50	14:10:33	14:11:42	M15	90-0	0	78.0	2.4	67	descending quick stop
408	50-1	14:13:53	14:15:02	M15	90-0	0	77.8	2.2	67	descending quick stop
409	50-2	14:17:09	14:18:10	M15	90-0	0	78.1	0.0	65	
410	51	14:20:35	14:21:45	M16	90-0	0	77.8	2.0	123	faster M14, bit unsteady
411	51-1	14:23:56	14:25:05	M16	90-0	0	77.4	1.7	123	faster M14
412	51-2	14:27:21	14:28:24	M16	90-0	0	77.8	2.9	116	faster M14
413	1-2	14:31:56	14:32:47	L1	145	0	78.2	0.0	79	151 KTAS actual

Footnote: '-' in KCAS or FPA indicates flight speed or path angle was "as required". See description of test conditions for more information.

Table 14. Concluded.

NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
414	7-2	14:36:30	14:37:22	L7	145	0	80.3	2.0	126	reduced NR (96.5%)
415	2-2	14:40:50	14:41:46	L2	130	0	80.2	3.2	53	
416	8-2	14:44:43	14:45:41	L8	120	0	80.6	3.4	71	reduced NR (96.5%)
417	9-2	14:48:40	14:49:47	L9	110	0	83.9	2.7	40	reduced NR (96.5%)
418	3-10	14:52:56	14:53:51	L3	110	0	81.3	2.2	109	
419	4-2	14:56:40	14:57:57	L4	90	0	81.4	8.4	54	
420	10-2	15:00:45	15:02:02	L10	90	0	80.7	2.2	54	reduced NR (96.5%)
915	N/A	15:12:43	15:13:43	ambient	n/a	n/a	81.9	4.2	103	

Footnote: ‘-‘ in KCAS or FPA indicates flight speed or path angle was “as required”. See description of test conditions for more information.

Table 15. CV-22B test conditions.

Priority	Condition Code	KCAS	Nacelle Angle, deg.	Glide slope, deg	Descent rate, fpm	Comments
11	L1	VNE	0	0	0	
1	L2	220	0	0	0	
6	L3	190	0	0	0	
7	L4	160	0	0	0	
2	L5	130	60	0	0	
8	L6	110	60	0	0	
3	L7	80	60	0	0	
4	L8	70	87	0	0	
9	L9	50	87	0	0	
17	A1	80	60	4	565	
18	A2	60	87	4	424	
12	A3	80	60	7	987	
13	A4	60	87	7	741	
14	A5	80	60	10	1407	
15	A6	60	87	10	1055	
16	H1	0	87	-	-	Altitude 250 feet, Heading 310°, at NSWC hover point
19	H2	0	87	-	-	Altitude 100 feet, Heading 310°, at NASA hover point
20	H3	0	87	-	-	Altitude 100 feet, Heading 40°, at NASA hover point
10	M1	200 to 0	as req'd	as req'd	as req'd	Transition from cruise to land at approach point compressed to start at 1 mile
5	M2	200 to 0	as req'd	as req'd	as req'd	Transition from cruise to land at NSWC hover point compressed to start at 1 mile

Table 16. CV-22B flight card for 8/13/13.

Date: 8/13/13		UTC=Local + 5 hours			Maj Dirkes / Maj McMullen					Note: Times in UTC-0
Aircraft: CV-22B		Flight Number: 107			GW: ~47,000#		Fuel Start Wt: ~13,000#			
NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
916	N/A	10:26:30	10:27:30	ambient	n/a	n/a				All level flights at 150' altitude
501	3	11:36:43	11:37:45	L3	192	0	69.3	0.0	321	0° nacelle (rear door open), gear up
502	3-1	11:40:24	11:41:19	L3	192	0	69.8	0.0	321	0° nacelle (192 KCAS), gear up
503	1	11:44:44	11:45:28	L1	267	0	70.0	0.0	321	0° nacelle (temp. inversion +10°F over 300') 267 KCAS actual, gear up
504	1-1	11:48:11	11:48:53	L1	265	0	69.4	0.0	321	0° nacelle 265 KCAS actual, gear up
505	2	11:51:30	11:52:17	L2	221	0	69.8	0.0	321	0° nacelle, gear up
506	2-1	11:54:49	11:55:38	L2	220	0	69.8	0.0	321	0° nacelle, gear up
507	4	11:57:59	11:58:59	L4	160	0	70.7	0.0	321	0° nacelle (160 KCAS @ 84% NR), gear up
508	4-1	12:01:14	12:02:16	L4	160	0	71.3	0.0	5	0° nacelle (160 KCAS @ 84% NR), gear up
509	5	12:04:35	12:05:46	L5	130	0	71.7	0.0	318	44° nacelle, 100% NR, Mics O/D, gear up
510	5-1	12:08:28	12:09:42	L5	130	0	72.3	0.0	318	44° nacelle, 100% NR, gear up
511	5-2	12:12:27	12:13:47	L5	130	0	73.1	0.0	318	44° nacelle, 100% NR, gear up
512	6	12:16:40	12:17:49	L6	110	0	73.6	0.0	318	60° nacelle, gear down
513	6-1	12:20:11	12:21:43	L6	110	0	74.2	0.0	318	60° nacelle, gear down
514	7	12:24:46	12:26:45	L7	80	0	74.8	0.0	318	79° nacelle, 100% NR, gear down
515	7-1	12:29:22	12:31:27	L7	80	0	74.6	0.0	322	79° nacelle, 100% NR, gear down
516	8	12:34:27	12:36:37	L8	74 var	0	74.8	0.0	293	81° nacelle, 100% NR, gear down, A/S fluctuated
517	8-1	12:39:03	12:41:19	L8	70	0	75.5	0.0	293	81° nacelle, 100% NR, gear down
518	8-2	12:43:38	12:45:48	L8	70	0	75.7	0.0	293	81° nacelle, 100% NR, gear down
519	9	12:48:29	12:51:38	L9	50	0	76.5	2.2	297	85° nacelle, 104% NR, gear down
520	9-1	12:54:47	12:57:35	L9	50	0	77.6	0.0	300	85° nacelle, 104% NR, gear down, ±3 kts A/S
521	3-2	13:00:00	13:00:53	L3	190	0	78.6	0.5	288	0° nacelle, 84% NR, gear up
522	10	13:04:47	13:06:32	A1	80	4	78.3	3.2	274	80° nacelle, steeper approach near beginning of run (15 kts headwind @ 300')
523	10-1	13:09:35	13:11:39	A1	80±3	4	78.1	4.9	270	80° nacelle, ±3 kts A/S
524	10-2	13:14:42	13:16:46	A1	80±3	4	77.5	2.2	276	80° nacelle, ±3 kts A/S

Footnote: '-' in KCAS or FPA indicates flight speed or path angle was "as required". See description of test conditions for more information.

Table 16. Continued.

NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
525	11	13:19:28	13:21:58	A2	60±3	4	78.0	1.2	274	104% NR for a little bit at beginning, 80° nacelle, ±3 kts A/S
526	11-1	13:25:15	13:27:48	A2	60±3	4	78.3	0.0	267	83° nacelle, ±3 A/S
527	12	13:30:46	13:32:49	A3	80	7	78.5	3.9	319	78° nacelle
528	12-1	13:35:46	13:37:44	A3	80	7	78.7	2.9	295	78° nacelle
529	13	13:40:46	13:43:11	A4	60±3	7	78.9	4.4	269	82° nacelle (bit shallow)
530	13-1	13:45:52	13:48:29	A4	60±3	7	78.8	4.4	261	82° nacelle
531	14	13:52:06	13:54:10	A5	80±5	10	79.1	1.0	281	80° nacelle
532	3-3	13:56:51	13:57:41	L3	190	0	78.4	3.2	250	balloon wind direction stuck since morning
533	17	14:01:18	14:03:06	H2-H3	0	0	78.5	4.6	279	NASA hover
534	16	14:05:52	14:06:43	H1	0	0	78.9	4.9	255	NSWC hover, O/D some mics
535	19	14:09:37	14:11:13	M1	200-0	-	79.5	4.3	253	overshot PMA, slight O/D
536	19-1	14:13:56	14:15:01	M1	170-0	-	79.5	4.9	316	170 KCAS entry
537	19-2	14:18:15	14:19:14	M1	170-0	-	80.4	2.4	298	
538	20	14:23:10	14:23:44	M2	170-0	-	81.6	1.5	287	170 KCAS entry (abort)
539	20-1	14:26:29	14:27:36	M2	170-0	0	80.9	6.6	295	level decel from 170 KCAS (O/D on SMA)
540	20-2	14:30:17	14:31:22	M2	170-0	0	80.8	8.6	302	
541	14-1	14:34:43	14:36:57	A5	80±5	10	80.9	5.1	303	80° nacelle
542	3-4	14:39:13	14:40:12	L3	190	0	80.8	8.3	332	
917	N/A	14:43:46	14:44:57	ambient	n/a	n/a	81.4	6.4	299	range quiet after 10 sec

Footnote: '-' in KCAS or FPA indicates flight speed or path angle was "as required". See description of test conditions for more information.

Table 17. CV-22B flight card for 8/14/13.

Date: 8/14/13		UTC=Local + 5 hours			Maj Dirkes / Maj McMullen					Note: Times in UTC-0
Aircraft: CV-22B		Flight Number: 108			GW: ~47,000#		Fuel Start Wt: ~13,000#			
NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
918	N/A	10:19:24	10:20:24	ambient	n/a	n/a	70.7	0.0	313	thunder during ambient?
544	3-5	11:27:43	11:28:33	L3	190	0	68.5	0.0	314	84% NR
545	10.1	11:31:21	11:33:22	A1.1	80	4	68.5	0.7	314	60° nacelle (deck not level)
546	11-2	11:36:58	11:39:33	A2	60	4	68.9	0.5	315	level deck
547	10-2	11:42:21	11:44:11	A1	80	4	69.6	0.0	315	78° nacelle (level deck)
548	12-2	11:47:03	11:49:07	A3	80	7	69.9	0.0	315	79° nacelle (level deck)
549	12.1	11:52:13	11:54:08	A3.1	80	7	69.7	0.0	315	70° nacelle (deck not level)
550	12.2	11:57:22	11:59:18	A3.2	80	7	69.7	0.2	326	60° nacelle (deck not level)
551	13-2	12:02:18	12:04:45	A4	60	7	70.2	0.0	339	83° nacelle (level deck)
552	14-2	12:07:12	12:09:13	A5	80	10	70.4	0.0	340	80° nacelle (level deck)
553	14.1	12:12:20	12:14:16	A5.1	80	10	70.1	0.0	340	70° nacelle (deck not level)
554	14.2	12:17:18	12:19:35	A5.2	80	10	69.7	2.7	340	62° nacelle (deck not level)
555	15	12:22:27	12:25:07	A6	60	10	69.9	0.0	340	83° nacelle (level deck)
556	19-3	12:28:02	12:29:11	M1	-	-	70.1	0.0	340	
557	19-4	12:33:24	12:35:03	M1	-	-	70.6	0.0	340	
558	20-3	12:37:49	12:38:54	M2	-	-	70.7	0.0	340	Mic O/D on SMA, center PMA
559	20-4	12:41:52	12:43:00	M2	-	-	70.9	0.0	340	Starting at 180 KCAS
560	1-2	12:46:18	12:47:00	L1	VH	0	71.0	1.0	343	265 KCAS actual
561	2-2	12:49:14	12:49:58	L2	220	0	71.6	0.0	343	
562	3-5	12:52:11	12:53:02	L3	190	0	71.5	0.0	343	
563	4.2	12:55:19	12:56:15	L4.2	160	0	71.4	1.2	300	100% NR
564	4-2	12:58:16	12:59:13	L4	160	0	71.4	1.0	209	back to 84% NR for A/C mode
565	4.1	13:01:36	13:02:32	L4.1	150	0	71.4	0.0	323	
566	5-3	13:05:12	13:06:22	L5	130	0	71.6	4.9	237	30° nacelle
567	6-2	13:08:38	13:10:05	L6	110	0	72.0	0.0	308	60° nacelle
568	6.1	13:12:53	13:14:04	L6.1	110	0	72.0	0.0	308	50° nacelle (deck not level)
569	7-2	13:16:42	13:18:23	L7	80	0	72.1	0.0	308	79° nacelle (level deck)
570	8-3	13:21:17	13:23:06	L8	70	0	72.3	0.0	309	
571	9-2	13:26:03	13:28:33	L9	50	0	72.6	0.0	309	85° nacelle, 104% NR

Footnote: '-' in KCAS or FPA indicates flight speed or path angle was "as required". See description of test conditions for more information.

Table 17. Continued.

NASA Run #	Eglin Run #	Data On Time	Data Off Time	Flight Condition	KCAS	FPA (°)	Temp (°F)	WS (kts)	WD (deg)	Comments
572	10-3	13:31:31	13:33:17	A1	80	4	73.7	0.7	345	80° nacelle (level deck)
573	11-3	13:36:37	13:39:01	A2	60	4	74.4	0.0	345	83° nacelle (level deck)
574	12-3	13:41:49	13:43:35	A3	80	7	75.1	1.5	347	78° nacelle (level deck)
575	13-3	13:46:15	13:48:40	A4	60	7	74.8	2.0	2	jet noise in area, 83° nacelle
576	13-4	13:51:30	13:53:46	A4	60	7	75.4	0.0	334	82° nacelle (level deck), still jet noise
577	14-3	14:00:29	14:02:30	A5	80	10	77.3	0.5	351	80° nacelle (deck level), jet noise
578	14-4	14:06:05	14:08:02	A5	80	10	78.4	2.2	19	79° nacelle (level deck)
579	15-1	14:10:52	14:13:21	A6	60	10	77.2	1.0	281	83° nacelle (level deck, shift to 104% NR after recovery)
580	14.1-1	14:16:18	14:18:08	A5.1	80	10	76.8	1.7	261	70° nacelle (deck not level)
581	14.2-1	14:21:00	14:23:01	A5.2	80	10	76.8	1.7	306	63° nacelle (deck not level)
582	6-3	14:26:39	14:29:09	L6	110	0	76.9	4.4	321	60° nacelle, extended run-in, some jet noise
583	1-3	14:32:11	14:32:54	L1	VH	0	77.6	1.0	262	270 KCAS actual (rear door closed)
584	3-6	14:35:59	14:36:56	L3	190	0	78.7	2.2	267	
919	N/A	14:46:58	14:47:57	ambient	n/a	n/a	77.8	3.7	287	

Footnote: ‘-‘ in KCAS or FPA indicates flight speed or path angle was “as required”. See description of test conditions for more information.

Figure 1. AH-64D Apache Helicopter.

Figure 2. HH-60M Blackhawk Helicopter.

Figure 3. CV-22B Tiltrotor Aircraft.

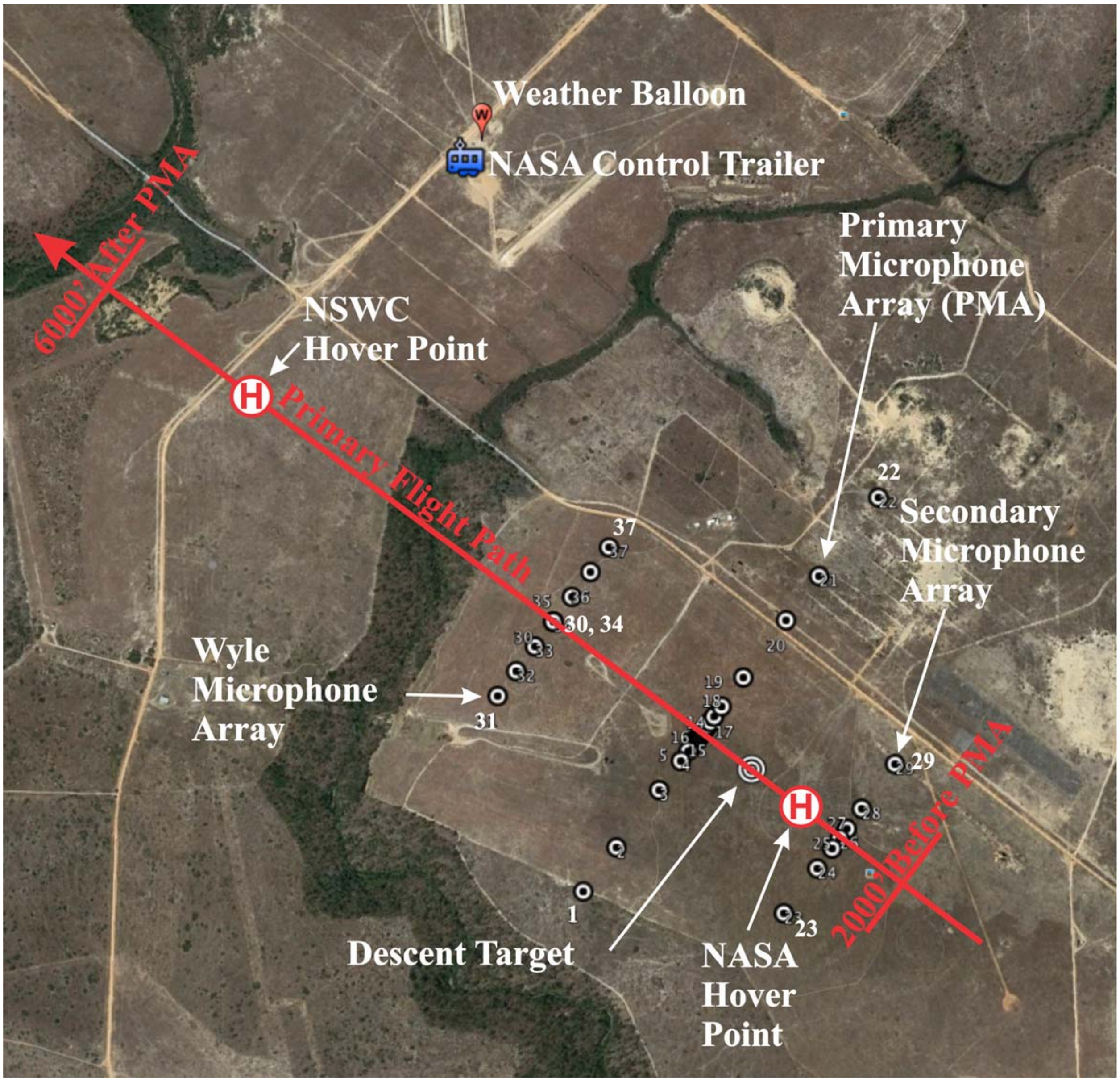
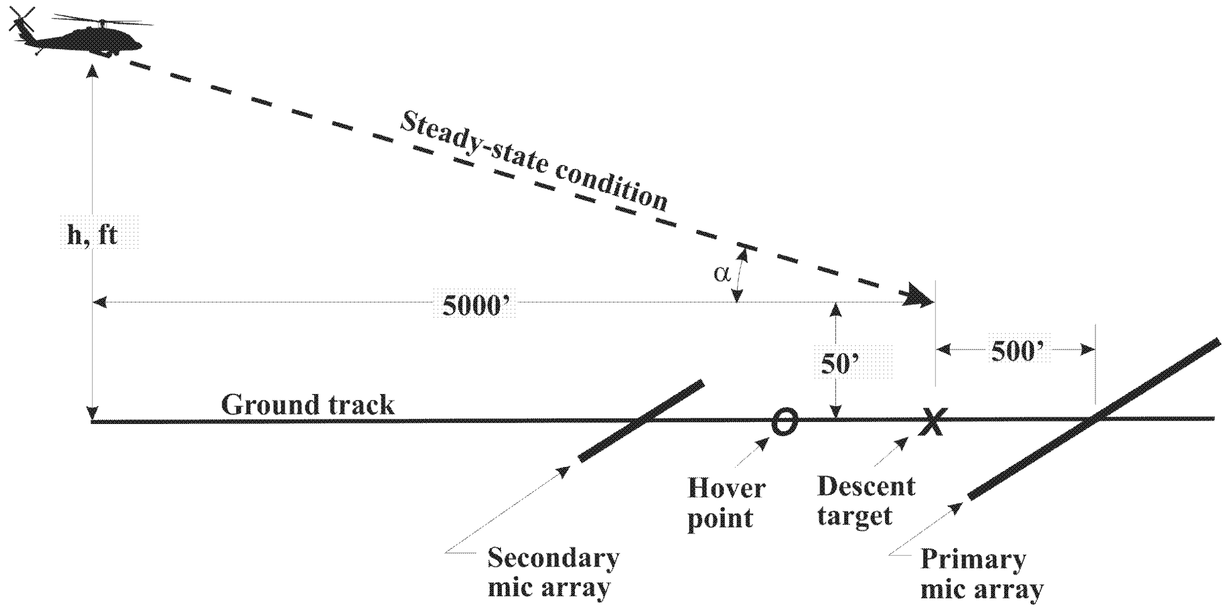


Figure 4. Test range overview.

Figure 5. Typical WAMS microphone station deployment.


Figure 6. Tethered weather balloon system.



Descent Angle, deg	h @ 5000' out	h at 6000' out	h at 7000' out
3	312	364	417
4	400	470	539
6	576	681	786
7	664	787	910
9	842	1000	1159
10	932	1108	1284

Figure 7. Approach profile graphic with glideslope intercept altitudes.

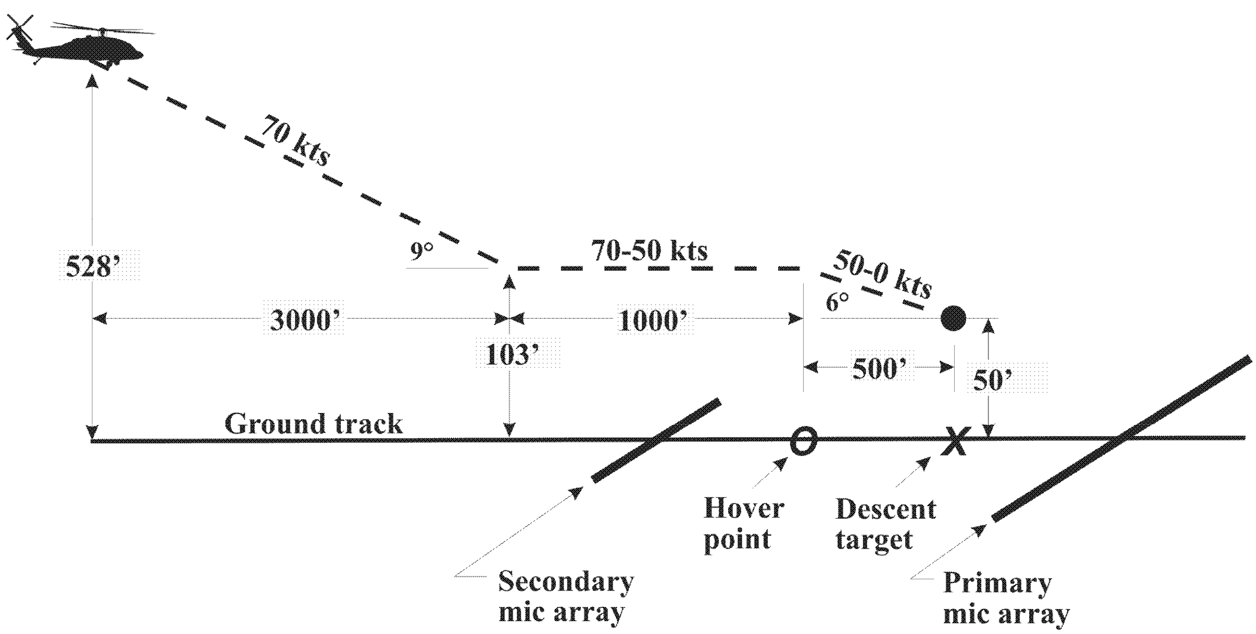


Figure 8. HH-60M descent maneuver M1 graphic.

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14. ABSTRACT
Far-field acoustic measurements were obtained for the AH-64D, HH-60M and CV-22B at the Eglin AFB, Test Area C-72, in July/August 2013. The primary purpose for this flight test was to obtain a benchmark database of detailed acoustic source noise characteristics for the aircraft operating at typical mission gross weights over a range of typical mission operating conditions. Data were acquired for a range of steady-state level and descending flight conditions, hover, and a variety of unsteady maneuver conditions. Between 30 and 37 microphones were deployed during these tests. Vehicle position and state data, as well as weather data were acquired simultaneously with the acoustic data. This paper describes the test aircraft, onboard instrumentation, ground instrumentation, and the data acquired. Data from this test are available upon request and review.

15. SUBJECT TERMS
AH-64; Acoustics; Apache; Blackhawk; CV-22; Flight Test; Osprey; UH-60

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