MARTIN O'MALLEY
GOVERNOR

ANTHONY G. BROWN
LT GOVERNOR

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COLONEL
TERRENCE B. SHERIDAN
SUPERINTENDENT

April 25, 2011

The Honorable Edward Kasemeyer
Chairman, Senate Budget and Taxation Committee
Miller Senate Office Building, Suite 3W
11 Bladen Street
Annapolis MD 21401

The Honorable Norman Conway
Chairman, House Appropriations Committee
121 Lowe House Office Building
6 Bladen Street
Annapolis MD 21401

Dear Chairman Kasemeyer and Chairman Conway:

The purpose of this correspondence is to request an extension for the Helicopter Maintenance Study required by the 2010 Joint Chairman's Report, Page 166. Although the report was due to the Committees by May 1, 2011, the Maryland Department of State Police respectfully requests an extension until October 1, 2011.

This Maintenance Study Committee has reached consensus on the recommended best practices for the maintenance of the State's new fleet of helicopters. However, due to delays in awarding the FAA Part 135 consultant contract, the study committee is not able to confirm their recommendations comply with Part 135 maintenance requirements. It would be prudent that the study committee's recommendations do not conflict with FAA mandates. The Aviation Command continues to work with DOIT on the final solicitation and award of a FAA Part 135 consultant. This project continues to move forward, an award should be forthcoming in the immediate future.

Thank you for your consideration in this matter. Should you require any additional information, please do not hesitate to contact me directly at 410-653-4219.

Sincerely,

Terrence B. Sheridan
Superintendent

TBS:WFL:meg

cc: Ms. Cathy Kramer, Department of Legislative Services
Ms. Chantelle Green, Department of Legislative Services
Major Mark E. Gibbons, Commander, Aviation Command
Mr. Thomas M. Williams, Director, Planning and Research Division

THE MARYLAND GENERAL ASSEMBLY
ANNAPOLIS, MARYLAND 21401-1991

May 31, 2011

The Honorable Terrence B. Sheridan
Superintendent, Department of State Police
1201 Reisterstown Road
Pikesville, Maryland 21208-3899

Dear Superintendent Sheridan:

In correspondence dated April 25, 2011, the Department of State Police (DSP) requested an additional extension. DSP now requests that its review of helicopter maintenance alternatives be further extended from May 1, 2011 to October 1, 2011. In light of the protracted Medevac procurement, coupled with the delay in awarding the contract for the Part 135 consultant, the budget committees grant the request for an extension and request that the report be submitted by October 1, 2011.

Sincerely,

Edward J. Kasemeyer, Chairman
Senate Budget and Taxation Committee

Norman H. Conway, Chairman
House Appropriations Committee

EJK:NHC/CMG/vin

cc: Senator Nathaniel J. McFadden
Senator James E. DeGrange, Sr.
Delegate James E. Proctor, Jr.
Delegate Galen R. Clagett
Delegate John L. Bohanan, Jr.
Mr. Karl S. Aro
Mr. Warren G. Deschenaux

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Maryland State Police Aviation Command Helicopter Maintenance Study

-- Final Report--

Maryland Department of Transportation

October 28th, 2011

Table of Contents

I. Introduction

For the past fifty (50) years, the Maryland State Police Aviation Command (MSPAC) has served the citizens of the State of Maryland and its neighbors. The MSPAC uses multipurpose aircraft and cross-trained crews to execute five (5) separate mission profiles: Medical Evacuation, Aerial Law Enforcement, Search and Rescue, Homeland Security & Disaster Assessment. These missions are accomplished through the efforts and coordination of flight crews, support services and maintenance personnel.

The Maryland State Legislature requested a Helicopter Maintenance Study be completed by October 1, 2009 to review the MSPAC Maintenance Operations in order to determine the best and most effective maintenance method for the MSPAC and the citizens they serve. The MSPAC requested an extension on the Helicopter Maintenance Study on September 25, 2009 which the Legislature granted because of the MSPAC's engagement in the helicopter procurement process.

On October 20th, 2010, the Maryland Board of Public Works approved a contract with AgustaWestland for the purchase of six (6) AW139 helicopters with an option to purchase up to six (6) more. Five (5) of the additional helicopters have been approved and preauthorized with General Obligation Funds. Estimated delivery of these helicopters is shown in Figure 4. As the new helicopters are delivered and the current fleet is retired, the MSPAC's maintenance requirements will significantly change for two reasons:

i. Transitioning from the Dauphin II fleet to the AW 139 fleet will require maintenance technicians be trained to work on the new aircraft
ii. The fleet of AW 139 helicopters will be significantly younger than the current fleet, and naturally will require less maintenance than helicopters ranging from eleven (11) to twenty-one (21) years old.

As per the legislative request, the purpose of this maintenance study is to collect helicopter maintenance methods and ultimately select the best strategy for maintaining the MSPAC fleet.

II. Current State

A. Current Fleet

The Maryland State Police Aviation Command currently operates eleven (11) Eurocopter AS365 Dauphin II helicopters out of seven (7) bases across Maryland. One (1) helicopter is to be at each of the seven (7) bases while the remaining four (4) helicopters are housed at Martin State either undergoing maintenance or ready to fly as airworthy alternatives. Figure 1 details the current MSPAC fleet.

The MSP also maintains a Fixed Wing Section which includes the following two aircraft:

- Twin Turbine engine, Beechcraft "Super" King Air 350
- Single engine, Cessna Centurion P210

All maintenance personnel are certified to maintain these two aircraft in addition to the helicopter fleet. However, only four (4) technicians have experience working on fixed wing aircraft, and generally only two (2) techs perform fixed wing maintenance.

Figure 1: MSPAC Helicopter Equipment Detail

Helicopter	Purchase Date	Helicopter Age	Configuration	Date Modified
57 MD	4/89	21+ years	N-1	
93 MD	9/89	21+ years	N-1	
94 MD	11/89	21+ years	N-3*	5/03
95 MD	11/89	21+ years	N-3*	10/00
96 MD	11/89	21+ years	N-3*	10/02
97 MD	7/90	20+ years	N-3*	5/01
38 MD	8/90	20+ years	N-3*	11/01
79 MD	7/90	20+ years	N-3*	05/02
61 MD	9/94	16+ years	N-2	
65 MD	11/94	16+ years	N-2	
82MD	4/99	11+ years	N-3	

*Beginning in 1999, the MSPAC began purchasing Dauphin Model N3's and in 2000 began the conversion of the Dauphin Model N1 helicopters to N3's. This conversion process improved the capabilities of the aircraft by increasing the horsepower of each engine and improving the communication systems.

Recent 2011 mission data shows that, the MSPAC operates its fleet an estimated 2,490.8 flight hours per year executing medevac, inter-hospital transport, law enforcement, search and rescue, homeland security and disaster assessment missions[1].

B. Current MSPAC Maintenance Environment

All maintenance is currently performed by the MSPAC Maintenance Operations which is an approved Federal Aviation Administration (FAA) Certified Repair Station (CRS) under the Code of Federal Regulations (CFR) 14, Part 145. The CRS is located at Martin State Airport in Baltimore, Maryland and serves as the MSPAC's repair station for all aircraft inspections. Current maintenance tasks on the Eurocopter fleet that are performed at the repair station

[1] As per a January 1, 2011 to September 29, 2011 mission report from SYSCOM, all missions performed through SYSCOM including medevac, law enforcement, inter-hospital transport, search and rescue, homeland security, disaster assessment, critical infrastructure and training missions totaled 2,713.1 flight hours for the nine month period. Extrapolating these flight hours for a twelve month period equals 3,608.4 flight hours. In order to determine a consistent baseline for this study and missions associated with MSPAC helicopters only, some mission types were excluded from these 2011 flight hours. Excluded missions included those performed by non-MSPAC helicopters such as fixed-wing, Delaware, Commercial and Park Services. These hours equated to 397.3 total flight hours, or an annualized 528.4 flight hours. Also excluded was MSPAC flight training missions. Because of significant changes to the MSPAC future operations (flight training device and proposed maintenance strategy), these were analyzed separately in this report. These missions totaled 443.0 flight hours, or an annualized 589.2 flight hours. Therefore, subtracting flight hours including Other Aircraft and MSPAC helicopter training missions from the total annualized missions [3,608.4 – 528.4 (other aircraft) – 589.2 (MSPAC training/maintenance flight hours) = 2,490.8] equals 2,490.8 flight hours per year.

include 100 hour inspections, "T" Inspections (every 600 hours), "G" Inspections (every 5,400 hours) and unscheduled maintenance. As of January 2011, 25, 50 and 75 hour inspections are being performed at each trooper base. Visual pre- and post-flight aircraft inspections are performed by pilots at each base on a daily basis. Maintenance tools are generally not located at each base; however each base has a three (3) piece tool kit for light preventative maintenance such as light bulb replacement. The processes for the maintenance tasks are detailed in Maryland State Police Aviation Command Maintenance Checklist Document and the Original Equipment Manufacturer (OEM) maintenance checklist as appropriate. *(Per the MSPAC, they stated that due to operational changes in the maintenance processes (more maintenance activities being incorporated at the sections versus Martin State) since January 2011, there has been a 22% drop in flight time, while missions have increased by over 15%. They assess these changes have resulted in a savings of over $400,000 in fuel alone in fiscal year 2011.)*

The MSPAC CRS has authorized positions for thirty-one (31) people. As of December 2010 the Aviation Command Organizational Chart (Appendix A.2) showed five (5) vacancies including one (1) avionics technician position, one (1) inspector position and three (3) maintenance technician positions. Figure 2 shows the number of positions in each of the various occupational groups.

Figure 2: MSPAC Certified Repair Station Positions (2010)*

Positions	Total # of Positions	Total Positions Filled
Management	1	1
Supervisory (Maintenance)	3	3
Inspection	6	5
Technicians(Maintenance)	16	13
Technicians (Avionics)	3	2
Administrator & Expeditor	2	2
Total	**31**	**26**

**As of 12/8/2010*

The maintenance staff levels were increased to the above staffing levels after 2001. An MSP 2001 organizational chart lists eighteen (18) maintenance technicians and total maintenance staff of twenty-five (25) people (Appendix A.3).

(The MSPAC did want to point out that there has been a requirement to increase staff due to the current Eurocopter's fleet incurring a 3:1 unscheduled to scheduled maintenance ratio, as well as a mandated requirement from the Department of Legislative Services audit of 2008 to separate the inspectors from the supervisors, resulting in the creation of three (3) new inspector billets.)

Figure 3: MSPAC Certified Repair Station Positions (2001)

Positions	Total # of Positions	Total Positions Filled
Management	1	1
Supervisory (Combined w/Inspectors)	0	0
Inspection	3	3
Technicians (Maintenance)	18	14
Technicians (Avionics)	2	1
Administrative	1	1
Total	**25**	**20**

It is important to note that the MSPAC maintained twelve (12) helicopters and two (2) fixed-winged aircraft at eight (8) bases while incurring a five-year (1995 – 2000) annual flight hour average of 5,395.3 flight hours per year with a maintenance staff of twenty (20) employees. Currently the MSPAC maintains eleven (11) helicopters and two (2) fixed-winged aircraft at seven (7) bases and utilizes a staff of twenty-six (26) employees and a comparable annual flight hour total of 3608.4 (see footnote 1). This change represents a 30% increase in staffing despite a 33% decrease in annual flight hours incurred. *(MSPAC does point out that the 33% decrease in annual flight hours includes flight hour savings in 2011 alone of 22% due to efficiencies in implementation of new maintenance approaches (more maintenance occurring at the bases versus flying all maintenance requests to Martin State) over the past year.)*

C. MSPAC Maintenance Software and Helicopter Downtime Tracking

The MSPAC Maintenance and Inventory Support Operations currently utilizes MX Manager software, a multifunctional database which tracks aircraft component records, inventory levels, work order details and other logistical functions. It is important to note that this system is no longer supported by the developer. A robust maintenance and inventory solution, AVTRAK was identified by AgustaWestland. MX Manager will continue to function with limited capabilities, as newer Windows operating systems are released MX Manager's functionality will be negatively impacted.

Despite the aging fleet, open positions and software challenges, the MSPAC cites a 93.8% sectional operational readiness rate according to a MSPAC Maintenance Operations Response to Interrogatories (Appendix B). This means that all seven bases have an operational helicopter 93.8% of the time. This sectional operational readiness rate of 93.8% is not to be confused with helicopter readiness or availability. The MSPAC had been working with eleven (11) helicopters for the past 2.5 years to cover the seven (7) sections. The MSP was asked about the current ability to track helicopter availability currently. As shown

below they currently have been tracking this from April of 2009, and because of limitations in the MX Manager Software must calculate the individual helicopter manually.

> Legislative Question: *"Has the MSPAC started tracking downtime by helicopter to more accurately determine the impact of maintenance on individual helicopter availability? (Page 41). If so, please provide results from when this was started to current date.*
>
> MSPAC Response: *"Aircraft downtime is entered into the Work Order module of MxManager; the downtime timeframe begins when the work starts and when the aircraft has been released to service (This process was implemented in April 2009)."*

MxManager does not have the capability to accurately provide the downtime data summary reports. In order to accurately determine the individual aircraft availability, downtime data range must be extracted from the Microsoft Access tables and manually compiled.

In a review of the detailed data MSP provided, the total helicopter availability was shown to be 71.5%, with three (3) of the helicopters having downtime exceeding 42% (42.3%, 48.5, and one with 53.4%).

D. Current Maintenance Costs

The MSPAC maintenance costs can be broken into three categories: direct maintenance personnel costs (technicians and inspectors), administrative maintenance personnel (supervisors and management) and associated maintenance costs (parts, overhauls, etc). Figure 3 shows the 2010 cost per flight hour for the three categories of maintenance costs.

Figure 4: Maintenance Costs per Flight Hour*

Costs Category	Cost per Flight Hour	Total Cost
Maintenance Technicians	$269	$980,000
Inspectors	$84	$306,250
Admin & Supervisory Maintenance Personnel	$69	$252,144
Total Maintenance Personnel	**$423**	**$1,538,394**
Maintenance Costs (parts, overhauls, etc.)	$1,150	$4,185,000
Total	**$1,573**	**$5,723,394**

*Assumes current level of 3,638 flight hours per year (includes training and mission flight time – see Figure 6)

In 2010, the MSPAC budgeted $1.85 million for maintenance staffing and $5.02 million for aircraft parts, overhauls and inspection costs.

III. Future State / End State

A. Fleet Transition

As mentioned above, the Maryland Board of Public Works approved the order of six (6) AgustaWestland AW139 helicopters with a contractual option to order up to six (6) more.

Currently there are discussions within the Maryland Department of Legislative Services that the MSPAC may only purchase ten (10) total helicopters, but this has not been finalized at the time of this report. The assumption at this point is that the MSPAC will purchase eleven (11) helicopters. Figure 5 shows the expected delivery schedule of the AW139 helicopters.

Figure 5: Assumed Delivery Schedule of AW139 Fleet

Order #	# of Helicopters	Assumed Order Dates	Assumed Delivery Dates	Operational Fleet Makeup
Order 1	2	11/1/2010	5/1/2012	9 dauphins, 2 AW139s
Order 1	2	11/1/2010	8/1/2012	7 dauphins, 4 AW139s
Order 1	2	11/1/2010	11/1/2012	5 dauphins, 6 AW139s
Order 2	2	8/1/2011	2/1/2013	3 dauphins, 8 AW139s
Order 2	1	8/1/2011	5/1/2013	2 dauphins, 9AW139s
Order 3	1	8/1/2012	2/1/2014	1 dauphin, 10 AW139s
Order 4	1	8/1/2013	2/1/2015	11 AW139s

As the AgustaWestland helicopters are delivered, the Dauphin II helicopters will be methodically retired. It is anticipated the fleet will be in a transitional period for approximately 33 months. However, the transitional period may change for a variety of reasons ranging from legislative actions to a change in the MSPAC's request.

B. Future Fleet/End State

The future fleet will consist of eleven (11) AW139 helicopters. In addition to the fleet change, there may be several other changes to the fleet that would impact the maintenance environment.

- In 2011 the MSPAC will incur an annualized projection of 2,490.8 hours per year executing missions. This number reflects a 15% increase in flight hours flown in comparison to 2010. This study is based on the MSPAC operating the helicopter fleet 2,490 flight hours per year. This level will provide a baseline to determine maintenance man-power requirements for the MSPAC. There is uncertainty regarding future projections of MSPAC annual flight hours. How long the annual 15% increase will continue is a large question mark in this analysis. Due to the implementation of "no fly zones" and the change in triage protocols between 2006 and 2008, flight hour volumes are not expected to return to the levels prior to 2006. The approach of this analysis will use the base of 2,490.8 flight hours that are currently being flown and determine a man-power level that can handle the maintenance requirements in relation to this flight hour level. Utilizing this relationship, this report will calculate the maximum flights hours per year that the projected maintenance organization will be able to support. The difference between this calculated value and the 2011 flight hour volume (2,490.8) will represent the growth the proposed maintenance organization can absorb.

- The MSPAC is seeking Part 135 certification which has advanced training and maintenance requirements.
- The MSPAC is purchasing a Flight Training Device (FTD) to preserve the fleet by reducing flight-required pilot training.

With the use of a Flight Training Device (FTD), operating helicopters with a single pilot the MSPAC will require 558.8 hours of flight-required training per year, as shown below in future flight-required training hours per base. The training assumptions for this calculation are shown in Appendix C.

Figure 6 shows the impact of the new training environment on the annual flight hours executed by the MSPAC.

Figure 6: Trooper Base Annual Flight Hours (Comparison w/wo Flight Training Device)

Trooper Base	Future Flight-Required Training Hrs. Per Base (with FTD)*	Current Flight-Required Training Hrs. (w/o FTD)**	Avg. Annual Mission Flight Hrs	Future Total Flight Hours (with FTD)	Current Total Flight Hours (w/o FTD)
T-1	79.8	163.93	461.41	541.24	625.34
T-2	79.8	163.93	407.28	487.11	571.21
T-3	79.8	163.93	496.79	576.62	660.72
T-4	79.8	163.93	231.32	311.15	395.25
T-5	79.8	163.93	150.72	230.55	314.65
T-6	79.8	163.93	387.33	467.16	551.26
T-7	79.8	163.93	355.94	435.77	519.87
Total	558.80	1,147.50	2,490.80	3,049.60	3,638.30
# of Dauphin Helicopters:				11.00	11.00
# of AW139 Helicopters:				11.00	11.00
Flight Hours per Dauphin Helo:				**277.2**	**330.8**
Flight Hours per AW139 Helo:				**277.2**	**330.8**

*See Appendix C.1 for the training requirements for a full staff of 54 pilots utilizing a Flight Training Device

**See Appendix C.2 for the training requirements for an assumed full staff of 54 pilots. Note that the training flight hours from footnote 1 (589.2 actual training flight hours for 2011). The variance can be explained because the above chart assumes a fully staffed environment of 54 pilots for both the future and current state.

Between flight-required training, executing missions and responding to cancelled missions, the MSPAC will operate the fleet for approximately 3,049.6 hours per year. This is a decrease of 588.7 flight hours per year or 16.2% reduction.

C. Scheduled Inspections for AW139 Aircraft

In order to operate an AW139 helicopter as safely as possible, scheduled maintenance must be performed periodically. Figure 7 catalogues the AW139 required inspections and the associated maintenance man-hours required for each.

Figure 7: AW139 Scheduled Preventive Maintenance Detail*

Inspection	Downtime (hrs)	Operators Req.	MMH	Line/Base	Inspections per Year	Avg. MMH/Year Conserv.***
Daily Check**	0.50	0	-	L	365	-
Bi-Weekly	0.80	1	0.80	L	26.00	72.80
Year Based						
1 Year	13.73	3	41.20	L	1.00	43.20
2 Year	17.10	1	17.10	B	0.50	9.55
4 Year	91.50	1	91.50	B	0.25	23.38
Hourly Based						
300 Hour	75.00	2	150.00	L	0.92	140.47
600 Hour	6.50	2	13.00	B	0.46	6.93
1200 Hour	27.40	2	54.80	B	0.23	13.12
					TOTAL**	**309.44**

*Assumes 270.3 flight hours per helicopter per year

**Can be performed by a pilot

***Includes an additional two (2) hours to the required maintenance time provided by AW

****Per helicopter

IV. Manufacturer and Other Estimated Maintenance Requirements

A. AgustaWestland Estimated Maintenance Man-Hours for AW139

AgustaWestland reports a maintenance man-hour per flight hour ratio of 1.44 for the AW139. This means that for every hour the AW139 helicopter is flown, 1.44 hours of maintenance labor will be required to maintain the aircraft (scheduled maintenance 1.02 + unscheduled maintenance .42). Therefore, in a perfectly efficient environment, the client above estimates a required 399.2 hours of maintenance per helicopter per year (1.44 x 277.2 future flight hours). This means that 4,391 total maintenance man-hours would be required for an eleven (11) helicopter fleet.

This information isn't directly applicable to a 24/7 operation spread over seven (7) locations because this number focuses solely on labor needs and neglects 24/7 staffing requirements. (**This metric is applicable only to actual physical time that can be expected to be spent servicing and repairing the AW139. This metric does not take into account maintenance personnel downtime, vacation, sick leave or any other duties for which on-site full-time maintenance personnel would incur**).

B. Conklin & de Decker Estimated Maintenance Man-Hours for AW139

Conklin & de Decker is the leader in the aviation information industry. Their mission is to provide objective and impartial information that enable customers to make more informed decisions when dealing with the purchase and operation of aircraft. Conklin & de Decker reports a maintenance man-hour per flight hour ratio of 4.95 (includes scheduled and unscheduled maintenance) with an assumption of a twenty (20) year lifecycle for the AW139. Usually their data from this ratio is derived from a mix of original equipment manufacturer (OEM) information and operator experience. Conklin & de Decker updates it maintenance man-hour per flight hour ratios for each aircraft every six (6) months as more data is received. The AW139 model is only a few years old, and there is currently a very small sample size of data available for this model of helicopter. Because this aircraft is so new, predictions about unscheduled maintenance ten (10) to twenty (20) years into the future are difficult to estimate. Currently Conklin & de Decker's maintenance man-hour per flight hour ratio is more than three (3) times the ratio reported from AgustaWestland. This will require 1,372.1 maintenance man-hours per helicopter (4.95 x 277.2 future flight hours), or 15,094 MMH for the fleet.

C. Los Angeles Fire Department

The Los Angeles Fire Department (LAFD) operates a mixed fleet comprised of six (6) helicopters. The LAFD operates four (4) AW139 helicopters, which are utilized to execute search and rescue, medical evacuation and fire fighting missions. The maintenance is performed in-house with LAFD personnel performing the maintenance. The LAFD use their AW139 helicopters in a multi-mission environment which provides a prime example of what the MSPAC might anticipate from a maintenance perspective. The LAFD helicopter maintenance team reports a 6.4 maintenance man-hour per flight hour ratio. It is important to note that this is more than (4) times the maintenance man-hour per flight hour ratio that AgustaWestland reports. This will require 1,774 maintenance man-hours per helicopter (6.4 x 277.2 future flight hours), or 19,515 MMH for the fleet.

D. MSPAC Self -Proposed AW139 Maintenance Personnel Estimate

The MSPAC proposed a potential scenario for maintenance operations which would comply with the FAA requirements for Part 135 designation. Appendix B, 12/23/2010 response, identified two other scenarios which MSPAC is no longer considering.

The MSPAC is currently reviewing how to be as efficient as possible while weighing the Part 135 certifications requirements affects on the maintenance and inspection requirements.

Pursuant to the Part 135 consultants' recommendations, the potential maintenance model for the future would be:

- *Existing Maintenance personnel will facilitate the section stand up by providing the following field support:*

- *The following positions would be assigned to and responsible for each region (Western, Southern and Eastern) to perform unscheduled and scheduled maintenance in accordance with the approved maintenance program:*
    - *2 - Maintenance Technicians (per region)*
    - *1 - Avionics Technician (per region)*
    - *1 - Inspector (per region)*
- *Aviation Command Repair Station personnel will maintain aircraft at Aviation Headquarters and augment regional maintenance crews in the following areas:*
    - *Field repairs*
    - *Required servicing*
    - *Field staff vacancies*

If we assume the makeup for this scenario is made up of:

- Western Region
    - 1 Working Supervisor / Technician
    - 2 Maintenance Technicians
    - 1 Avionics Technician
    - 1 Inspector
- Southern Region
    - 1 Working Supervisor
    - 2 Maintenance Technicians
    - 1 Avionics Technician
    - 1 Inspector
- Eastern Region
    - 1 Working Supervisor / Technician
    - 2 Maintenance Technicians
    - 1 Avionics Technician
    - 1 Inspector

Then the key driver is what the makeup of Aviation Repair Station. This could look like:

- Aviation Repair Station
    - 1 Maintenance Director
    - 1 Training Manager
    - 1 Production Control Supervisor
    - 4 Maintenance Technicians
    - 1 Avionics Technician
    - 1 Chief Inspector
    - 1 Expeditor
    - 1 Administrator

The Totals therefore are shown in Figure 11:

Figure 11: MSPAC Self-Proposed Repair Station Positions

Positions	# of Positions
Management	2
Supervisory*	4
Inspection	4
Technicians (Maintenance)	10
Technicians (Avionics)	4
Administrator & Expeditor	2
Total	**26**

*Includes three (3) supervisors of the regional teams who also serve as general technicians

The reason for the range of supervisory and technician positions exist because each regional team will have a working supervisor with both supervisory and technical responsibilities. As before, details for the maintenance man-hour per flight ratio are shown below in Figure 12:

Figure 12: MSPAC Maintenance Man-Hours per Flight Hour Ratio Calculations

MSPAC Maintenance Scenarios		Current Personnel (Not incl. Dir. & Admin.)	MSPAC Proposed Personnel (Not incl. Dir & Admin)
Maintenance & Inspection Positions*		28	22
Man Hours per Year**	x	1,684	1,684
Annual Employed Man Hours		47,152	37,048
Flight Hours per Year***	÷	3,050	3,050
Man Hour per Flight Hour Ratio		**15.46**	**12.15**

*Only maintenance technician & inspection Positions are considered in this analysis because they are directly responsible for maintenance activities

** Man-hours per year reflect average leave and vacation schedules for MSP maintenance personnel

*** Flight Hours per Year does not include Fixed-wing hours

E. Maintenance Estimation Disparities & Implications

As described above, a wide-range of disparity exist between the maintenance man-hours per flight hour ratios for the AW139 as reported by AgustaWestland, the Los Angeles Fire Department and the MSPAC proposed maintenance scenario. The implications of these disparities are manifested in the number of employees needed to ensure the fleet experiences minimal maintenance downtime. Figure 13 illustrates the number of maintenance and inspection personnel required based upon all the above listed maintenance man-hour per flight hour ratios.

Figure 13: Required Maintenance Personnel Calculations

Information Source		Agusta	Conklin & de Decker	LAFD	Current Personnel (Not incl. Dir. & Admin.)	MSPAC Proposed Personnel (Not incl. Dir & Admin)
Maintenance & Inspection Positions		1.44	4.95	6.40	15.46	12.15
Man Hours per Year	x	3,050	3,050	3,050	3,050	3,050
Annual Employed Man Hours		4,391	15,096	19,517	47,152	37,048
Flight Hours per Year*	÷	1,684	1,684	1,684	1,684	1,684
Man Hour per Flight Hour Ratio		**3****	**9**	**12**	**28**	**22**

*1,684 man-hours derived from MSPAC Response to Maintenance Assumptions found in Appendix E

**Per the previous comment: ***This metric is applicable only to actual physical time that can be expected to be spent servicing and repairing the AW139. This metric does not take into account maintenance personnel downtime, vacation, sick leave or any other duties for which the maintenance personnel are responsible*.

The total annual employed man-hours figure of 1684 represents the total man-hours available from MSPAC maintenance personnel even when they are not working maintenance issues on the aircraft. This number takes into account vacation, holidays, allowable sick leave, and military leave (applicable to a number of MSPAC personnel who are in the Maryland Air National Guard). (This number of 1684 hours is specifically an MSPAC number and could vary with changes in negotiated leave policies or maintenance approaches).

Total MMH from AgustaWestland represents the actual time that an aircraft is repaired (i.e. technician is turning a wrench on the aircraft). This number could be used as an estimate of a vendor provided centralized repair outsourced option. Though there would be other inefficiencies that would be added to this number including transportation of the aircraft to the outsourced facility by MSP pilots, and transportation costs for these pilots back and forth from Maryland to Philadelphia/New Jersey repair center, this could represent the minimum required maintenance expenditure. In preliminary discussions with AgustaWestland, the published rate for maintenance is $130/hour. This rate is not a negotiated rate and the MSPAC could likely obtain a reduced rate in a contractual arrangement to $100 or possibly less.

Employing the average MSPAC maintenance and inspection employee costs $61,250 per year. Figure 14 shows the annual maintenance and inspection personnel costs for different maintenance man-hour per flight hour ratios.

Figure 14: Annual Maintenance and Inspection Personnel Costs

	Agusta	Conklin & de Decker	LAFD	MSPAC Current Personnel (Not incl. Dir. & Admin.)	MSPAC Proposed Personnel (Not incl. Dir. & Admin.)
# of Personnel	3	9	12	28	22
Maintenance & Inspection Personnel Costs	$183,750	$551,250	$735,000	$1,715,000	$1,347,500

Based upon the number of maintenance and inspection personnel for each scenario, there is a $1.53 million range between the AgustaWestland and MSPAC current scenarios. The $1.53 million range refers only to the maintenance and inspection personnel costs and ignores management and support personnel.

V. Potential In-sourced Maintenance Strategy Information

A. Capacity Review

As mentioned previously in the analysis, the proposed personnel requirement in each of the various MMH per flight hour estimates as well as MSPAC proposed organization provides indicators of how efficient these personnel would be in comparison to the actual time estimated to inspect or repair the eleven AW139 helicopters.

As the MMH component is broken down into the scheduled and unscheduled maintenance needs for the AW139, personnel requirements can more clearly be determined. Granted the unscheduled maintenance requirements on the AW139 have limited history. One indicator available at this juncture is 1.44 MMH estimate previously mentioned on page 11. The 1.44 maintenance man-hours estimate 1.02 hours for scheduled maintenance and .42 hours for unscheduled maintenance. Per Figure 7 shown again below, it can be estimated that 309.4 hour of scheduled maintenance will be required per aircraft (3,404 for the fleet).

Figure 7: AW139 Scheduled Preventive Maintenance Detail*

Inspection	Downtime (hrs)	Operators Req.	MMH	Line/Base	Inspections per Year	Avg. MMH/Year Conserv.***
Daily Check**	0.50	0	-	L	365	-
Bi-Weekly	0.80	1	0.80	L	26.00	72.80
Year Based						
1 Year	13.73	3	41.20	L	1.00	43.20
2 Year	17.10	1	17.10	B	0.50	9.55
4 Year	91.50	1	91.50	B	0.25	23.38

Hourly Based						
300 Hour	75.00	2	150.00	L	0.92	140.47
600 Hour	6.50	2	13.00	B	0.46	6.93
1200 Hour	27.40	2	54.80	B	0.23	13.12
					TOTAL**	**309.44**

*Assumes 272.5 flight hours per helicopter per year

**Can be performed by a pilot

***Includes an additional two (2) hours to the required maintenance time provided by AW

****Per helicopter

If unscheduled maintenance is estimated using this relationship (1.02 scheduled maintenance and .42 unscheduled maintenance – 10 year estimate), an estimated 127.4 hours of unscheduled maintenance will be required per helicopter. Therefore, the total estimated maintenance man-hours per aircraft would be 436.8 hours (309.4 scheduled + 127.4 unscheduled) or a total of 4,805 MMH per year for the eleven (11) helicopter fleet.

As illustrated in the chart below, the manpower required per MMH is not a driving factor in the models being proposed to manage the MSPAC maintenance requirement. Figure 15 estimates the maintenance man-hours available taking into account the analysis above:

Figure 15: MMH Estimates/Manpower Requirements (AgustaWestland)

Info Source	Agusta	Conklin & de Decker	LAPD	MSPAC Current	MSPAC Proposed
Estimated Personnel Required	3	9	12	28	22
Man-Hours per Person per Year	1,684	1,684	1,684	1,684	1,684
Total Employed Man-Hours	5,052	15,156	20,208	47,152	37,048
Total MMH Required for AW139	4,805	4,805	4,805	4,805	4,805
Percentage of Direct Maintenance Hours	95.12%	31.71%	23.78%	10.19%	12.97%

The issue with the above analysis is that vendors such as AgustaWestland and Conklin & de Decker do not have enough information from the users to detail maintenance man-hour estimates because of the recent deployment of this helicopter.

Figure 16: MMH Estimates/Manpower Requirements (Conklin)

Info Source	Agusta	Conklin & de Decker	LAPD	MSPAC Current	MSPAC Proposed
Estimated Personnel Required	3	9	12	28	22
Man-Hours per Person per Year	1,684	1,684	1,684	1,684	1,684
Total Employed Man-Hours	5,052	15,156	20,208	47,152	37,048
Total MMH Required for AW139	15,096	15,096	15,096	15,096	15,096
Percentage of Direct Maintenance Hours	298.80%	99.60%	74.70%	32.01%	40.75%

Figure 16 presents the staff utilizations with the most conservative Conklin & de Decker MMH ratio. Regardless, as detailed in the following suggested scenarios, there are sufficient personnel to cover even worse case estimates.

Therefore, based on the above chart, it is clear that developing the appropriate structure for a distributed base alignment with seven (7) bases throughout the State, and being responsive to maintenance requirements for a 24/7, seven day a week operation will not be driven by total maintenance man-hours required for scheduled and unscheduled maintenance activities. As the chart shows, there will be some overcapacity in the maintenance manpower available.

B. In-sourced Maintenance Strategies Introduced

The changes in the environment, aircraft, and support equipment being integrated into the MSPAC operations will result in:

- A decrease in the inspections required per the suggested manufacturer's maintenance schedule when the new AgustaWestland is compared with the current Eurocopter fleet
- A new helicopter fleet replacing aircraft that approaching/or over 20 years old
- Reduction in in-flight training hours due to the use of a Flight Training Device
- An investment in a HUMS system in each aircraft ($273,987 per aircraft) to support/enhance maintenance management. According to the MSPAC Maintenance Operations Director, the investment in the HUMS systems will reduce maintenance trouble shooting requirements by 20-25%. The HUMS system capabilities can be found in Appendix D.

Consequently, the expectation is that there would be a reduction in the required amount of maintenance personnel needed. The following maintenance alignment review identifies three (3) in-sourced maintenance strategies the MSPAC Maintenance Operations may

consider implementing after transitioning to the new fleet of AW139 helicopters. These options are summarized in Figure 17 and detailed in Figure 18.

Figure 17: In-sourced Maintenance Strategies

Option #	Maintenance Details
Option 1	• Centralized maintenance and inspection team at Martin State • **Staffing Requirements: 16 employees – 8 technicians (5 general techs, 3 avionics techs) & 3 inspectors**
Option 2	• Three (3) regional on-call teams across the state consisting of three (3) maintenance technicians (2 general, 1 avionics) • Four (4) technicians (3 general, 1 avionics) at Martin State • Three (3) inspectors on-call across the state to perform inspections as needed; one (1) chief inspector at Martin State • **Staffing Requirements: 22 employees – 13 technicians & 4 inspectors**
Option 3	• One (1) maintenance technician at each base (8 hours per day) to perform daily inspections and routine scheduled and unscheduled maintenance • Three (3) regional avionics technicians across the state to perform routine scheduled and unscheduled maintenance when needed • Three (3) maintenance technicians at Martin State(2 general, 1 avionics) • Three (3) inspectors on-call across the state; one (1) chief inspector at Martin State • **Staffing Requirements: 22 employees – 13 technicians & 4 inspectors**

Two of these options would apply the concept of on-call staffing to the MSPAC maintenance environment as a means of ensuring coverage during a 24/7 operation. The use of on-call maintenance staffing is widely practiced in the industry.

VI. In-sourced Maintenance Strategy Detailed

A. Matrix

Figure 17 designates the responsibilities of all scheduled and unscheduled maintenance events and illustrates the subsequent personnel requirements for the three (3) in-sourced maintenance options from Figure 15.

Figure 18: In-sourced Maintenance Strategy Matrix

	Option 1	Option 2	Option 3
Dauphin II Scheduled Inspections			
25 Hour Inspection	Martin State/Techs	On-call/Techs	On-base or On-call/Techs
50 Hour Inspection	Martin State/Techs	On-call/Techs	On-base or On-call/Techs
75 Hour Inspection	Martin State/Techs	On-call/Techs	On-base or On-call/Techs
100 Hour Inspection	Martin State/Techs	On-call/Techs	On-base or On-call/Techs
600 Hour "T" Inspection	Martin State/Techs	Martin State/Techs	Martin State/Techs
5400 Hour "G" Inspection	Martin State/Techs	Martin State/Techs	Martin State/Techs
Unscheduled Maintenance	Martin State/Techs	Martin State/Techs	Martin State/Techs

AW 139 Scheduled Inspections			
Bi-Weekly Inspection	Martin State/Techs	On-call/Techs	On-base or On-call/Techs
300 Hour Inspection	Martin State/Techs	On-call/Techs	On-base or On-call/Techs
1 Year Inspection	Martin State/Techs	Martin State/Techs	On-base or On-call/Techs
600 Hour Inspection	Martin State/Techs	Martin State/Techs	Martin State/Techs
1200 Hour Inspection	Martin State/Techs	Martin State/Techs	Martin State/Techs
2 Year Inspection	Martin State/Techs	Martin State/Techs	Martin State/Techs
4 Year Inspection	Martin State/Techs	Martin State/Techs	Martin State/Techs
Unscheduled Maintenance	Martin State/Techs	On-call/Techs	On-call/Techs
Personnel Detail			
Management	Maintenance Director	Maintenance Director	Maintenance Director
# of Management Personnel	1	1	1
Supervisory	Training Supervisor, PC Supervisor	Training Supervisor, PC Supervisor	Training Supervisor, PC Supervisor
# of Supervisory Personnel	2	2	2
Inspection Personnel	On-call across the state (3) Chief Inspector (1) – Martin State	On-call across the state (3) Chief Inspector (1) – Martin State	On-call across the state (3) Chief Inspector (1) – Martin State
# of Inspection Personnel	3	4	4
Maintenance Personnel	(5) General Maintenance Techs at Martin State (3) Regional Avionics Pilots Conduct Daily	3 On-call teams of 3 across the state (2 general, 1 avionics); 4 techs at Martin State (3 general, 1 avionics)	1 General tech at each base (1 – 40hr/wk); (3) Regional Avionics; 3 techs at Martin State (2 general, 1 avionics)
# of Maintenance Personnel (general/avionics)	8 (5/3)	13 (9/4)	13 (9/4)
Administrative Personnel	Expeditor (1), Administrator (1) at Martin State	Expeditor (1), Administrator (1) at Martin State	Expeditor (1), Administrator (1) at Martin State
# of Other Personnel	2	2	2
Total Personnel	16	22	22
Minimum Maint. Hours Required	15,096	15,096	15,096
Total Annual Maintenance Hours	18,524	28,628	28,628
Maint. Hours Above Min.	3,428	13,532	13,532
Avg. Cost per employee	$61,250	$61,250	$61,250
Projected Employee Costs	$980,000	$1,347,500	$1,347,500

The personnel detail shows the maintenance and inspection staffing requirements necessary to execute each option. It also shows the total annual maintenance hours associated with each option as well as the projected staffing costs. Based upon the maintenance man-hour per flight hour ratio from Conklin & de Decker of 4.95 (includes unscheduled and scheduled maintenance) and the estimation of 277.2 annual flight hours per AW139 helicopter from Figure 1, each maintenance strategy must exceed the more

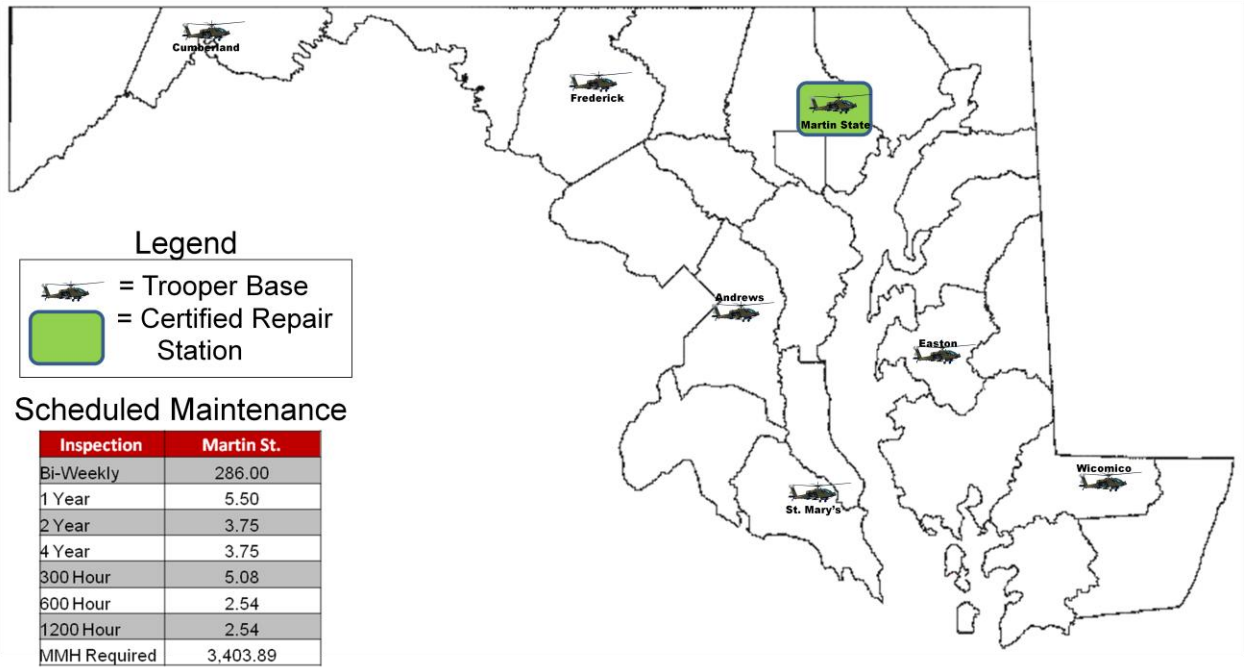
conservative estimate of 15,096 total annual maintenance hours. Because these options exceed 15,096 maintenance man-hours, all of the above maintenance strategies are considered viable.

It is important to note that the positions of Maintenance Director and Maintenance Administrator remain constant in each of these strategies. The only variables in these strategies are the number of maintenance technicians and inspectors required for each option.

B. Option 1

Option 1 is a centralized maintenance strategy in which all maintenance tasks, scheduled and unscheduled, are performed at the Martin State Trooper Base. Figure 19 maps the distribution of maintenance resources across the state for this option.

Figure 19: Option 1 Maintenance Resources Map



Scheduled Maintenance

Inspection	Martin St.
Bi-Weekly	286.00
1 Year	5.50
2 Year	3.75
4 Year	3.75
300 Hour	5.08
600 Hour	2.54
1200 Hour	2.54
MMH Required	3,403.89

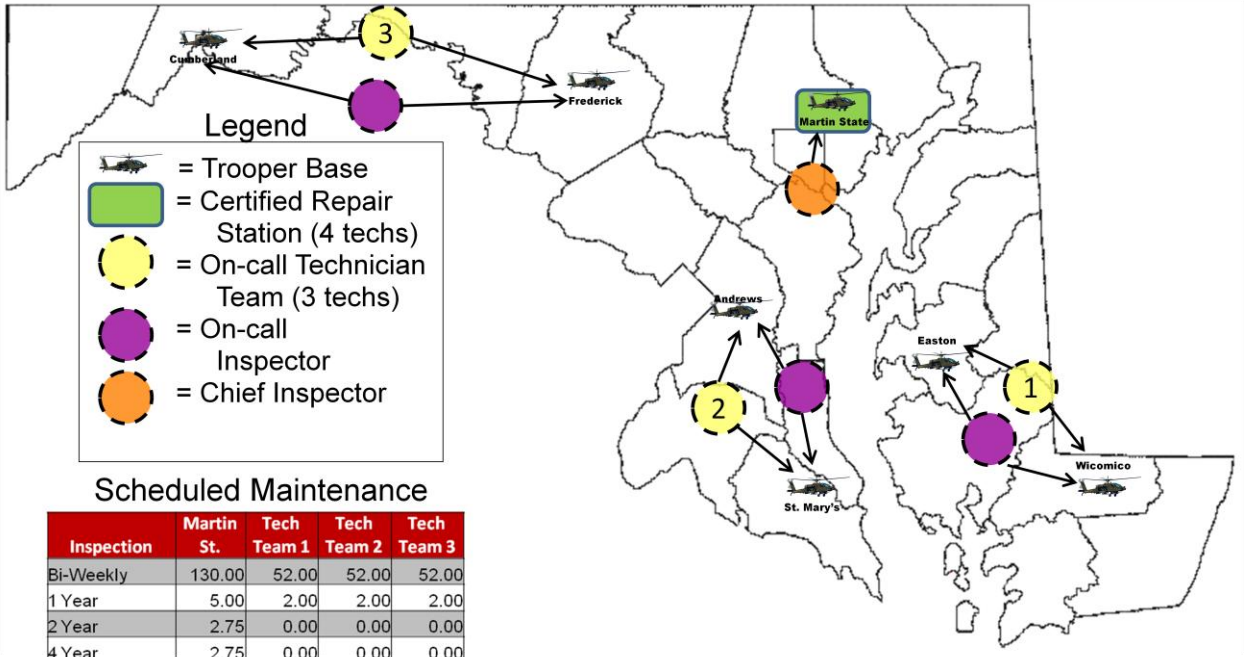
In this option, five (5) maintenance technicians are utilized to perform biweekly or 50 hour inspections. This option also utilizes three (3) on-call inspectors which provide adequate staffing such that an inspector can report to the Martin State Trooper Base whenever needed.

This option requires a total of sixteen (16) employees and has projected salary cost of $980,000 dollars per year. Option 1 has the lowest personnel requirement of the three (3) strategies described in this study and consequently is the least expensive from a staffing perspective. However, there are additional costs related to this option that are explained in the summary area on pages 25 and 26 that offset these personnel salaries.

C. Option 2

Option 2 is decentralized maintenance strategy which employs the use of three (3) mobile on-call teams located across the state and the repair station at Martin State. Figure 20 maps the distribution of maintenance resources across the state for this option.

Figure 20: Option 2 Maintenance Resources Map



Scheduled Maintenance

Inspection	Martin St.	Tech Team 1	Tech Team 2	Tech Team 3
Bi-Weekly	130.00	52.00	52.00	52.00
1 Year	5.00	2.00	2.00	2.00
2 Year	2.75	0.00	0.00	0.00
4 Year	2.75	0.00	0.00	0.00
300 Hour	4.94	1.56	1.93	1.74
600 Hour	2.54	0.00	0.00	0.00
1200 Hour	2.54	0.00	0.00	0.00
MMH Required	1913.84	468.80	524.91	496.35

In this option, three (3) on-call regional maintenance teams comprised of three (3) maintenance technicians (2 general, 1 avionics) and one (1) inspector are located across the state and provide support when needed. Routine scheduled and unscheduled maintenance is performed by the on-base and on-call technicians while heavy scheduled maintenance is performed by four (4) technicians (3 general, 1 avionics) at Martin State. Maintenance on backup helicopters will also be performed at Martin State. In addition to the repair station team, a chief inspector is staffed in the area to handle all inspections at Martin State.

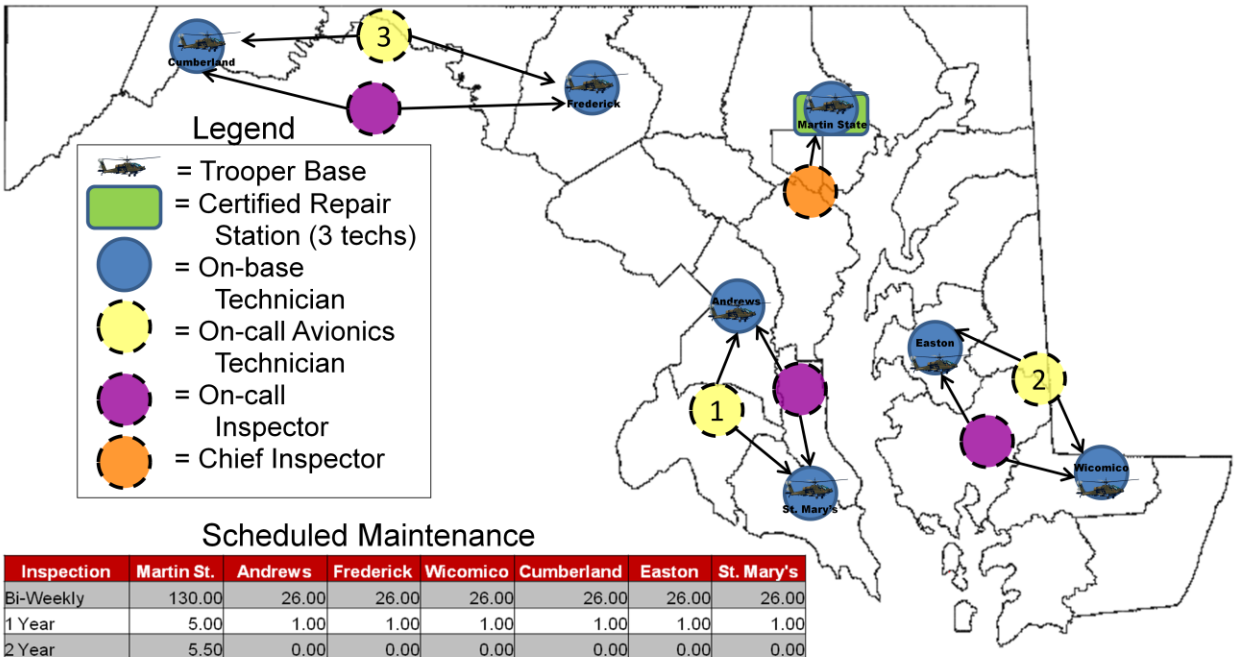
As shown above, an on-call team is responsible for the Frederick and Cumberland trooper bases, the Andrews and St. Mary's trooper bases and the Easton and Salisbury trooper bases. Three (3) on-call inspectors will be responsible for two (2) bases each. The use of regional maintenance teams requires three (3) sets of maintenance tools and means of traveling from base to base.

Option 2 requires a total of twenty-two (22) employees and has projected salary costs of $1.35 million per year. Utilizing this maintenance strategy is projected to have staffing costs of $367,500 per year more than Option 1.

D. Option 3

Option 3 is a decentralized maintenance strategy which employs the use of a maintenance technician located at each base. Figure 21 maps the distribution of maintenance resources across the state for this option.

Figure 21: Option 3 Maintenance Resources Map



Scheduled Maintenance

Inspection	Martin St.	Andrews	Frederick	Wicomico	Cumberland	Easton	St. Mary's
Bi-Weekly	130.00	26.00	26.00	26.00	26.00	26.00	26.00
1 Year	5.00	1.00	1.00	1.00	1.00	1.00	1.00
2 Year	5.50	0.00	0.00	0.00	0.00	0.00	0.00
4 Year	2.75	0.00	0.00	0.00	0.00	0.00	0.00
300 Hour	4.94	1.17	1.28	0.56	0.46	1.00	0.76
600 Hour	5.08	0.00	0.00	0.00	0.00	0.00	0.00
1200 Hour	2.54	0.00	0.00	0.00	0.00	0.00	0.00
MMH Required	1,913.84	293.43	310.79	200.75	185.56	268.04	231.48

In this option, each base is staffed with a maintenance technician forty (40) hours per week. Three (3) regional avionics technicians will be on-call across the state. Routine scheduled and unscheduled maintenance is performed by the on-base technicians. Heavy maintenance and all maintenance on backup helicopters will be performed Martin State. The chief inspector stationed at Martin State will be responsible for all of these inspections. Three (3) inspectors will also be on-call across the state at all times. Each inspector will be responsible for two (2) bases each.

The use of decentralized maintenance strategy requires seven (7) sets of tools, one for each trooper base. (Seven (7) sets of standard tools currently exist, and the mechanics have their own tools. Money is allotted in the procurement of the new aircraft for the purchase of specialized tools for the AW139.)

Option 3 requires a total of twenty-two (22) employees and has projected salary costs of $1.35 million per year. Utilizing this maintenance strategy is projected to have staffing costs of $367,500 per year more than Option 1 and the same staffing cost as Option 2.

E. Maintenance Options Summary

There has been some variation in options presented by MSPAC concerning how they wanted to move forward with their maintenance personnel model. Though still higher in comparison to the three (3) options presented in this study, the MSPAC model most recently presented a proposed twenty-six (26) person maintenance organization which is more in-line with the finding of this study, that a twenty-two (22) person staff would be more than sufficient to handle the MSPAC maintenance needs. Figure 22 compares the personnel requirements and subsequent costs of the current MSPAC maintenance strategy and the strategies examined in this study.

Figure 22: Option 3 Maintenance Resources Map

	Current State- All Personnel		MSP Proposed Strategy- All Personnel	In-sourced Strategies- All Personnel		
	# of Positions	Filled		Option #1	Option #2	Option #3
Personnel Detail						
Management	1	1	2	1	1	1
Supervisory	3	3	4*	2	2	2
Inspection	6	5	4	4	4	4
Technicians	19	15	14	7	13	13
Expeditor	1	1	1	1	1	1
Administrator	1	1	1	1	1	1
Total Personnel	**31**	**26**	**26**	**16**	**22**	**22**
Avg. Cost/Personnel	$61,250	$61,250	$61,250	$61,250	$61,250	$61,250
Total Personnel Cost	**$1,898,750**	**$1,592,500**	**$1,592,500**	**$980,000**	**$1,347,500**	**$1,347,500**

*Includes three (3) supervisors of the regional teams who also serve as general technicians

It is recommended that the MSPAC implement in-sourced strategy Option #2 or Option #3. (The current MSPAC maintenance management team has experience and also success in implementing this model). Options #2 and #3 provide sufficient staffing levels to provide coverage to their section and a neighboring section during vacations, illness, or training. As shown above, the budget for this option is $1,347,500. The personnel costs associated with these options are anywhere between $61,250 and $612,500 less than the MSPAC's current personnel costs. Options 2 and 3 are initially shown as $367,500 more expensive than Option 1. However, in looking closer at utilizing maintenance strategy that operates at the section level reduces helicopter fuel costs and saves blade time required to fly the helicopters to and from Martin State for inspections. The centralized maintenance strategy requires that a helicopter be flown to and from Martin State to be serviced. It also requires

that a backup helicopter be flown to and from the base to cover for the helicopter receiving maintenance. In order to provide full coverage with a centralized strategy, four (4) flights are required every time a helicopter must be inspected. Besides the obvious effect of increasing the section "Out-of-Service Time" with these trips to Martin State, the specific variables that impact the fuel costs associated with flying to and from Martin State for inspections include:

- Trooper base distance to Martin State
- Fuel price per gallon
- Average speed of 149.6 miles/hour
- Fuel burn rate
- Average Inspections per year on helicopters not located at Martin State (167.2 scheduled; 68.86 unscheduled*)
- Blade time from each trooper base to Martin State

Figure 23: Blade Time to Martin State by Trooper Base

Trooper Base	Miles to Martin St.	Avg. Speed	Flight hours to Martin St.	Start Up / Shut Down**	Total Blade Time	Inspections per Year	Fuel Price	Fuel Costs to Martin St.
Trooper 1	-	-	-	-	-	-		-
Trooper 2	45	149.6	0.30	0.50	0.80	39.77	$4.50	$18,485.66
Trooper 3	55	149.6	0.37	0.50	0.87	39.93	$4.50	$20,109.92
Trooper 4	95	149.6	0.64	0.50	1.14	38.90	$4.50	$25,633.73
Trooper 5	120	149.6	0.80	0.50	1.30	38.76	$4.50	$29,301.16
Trooper 6	50	149.6	0.33	0.50	0.83	39.53	$4.50	$19,143.00
Trooper 7	70	149.6	0.47	0.50	0.97	39.19	$4.50	$22,019.95
TOTAL	-	-	-	-	-	236.08	-	$134,693.43

*Based upon the AgustaWestland MMH ratio 1.44 (1.02 scheduled maintenance, .42 unscheduled)

**Time required preparing helicopter for flight and performing the necessary safety checks

The annual fuel cost of $134,693 only accounts for the cost of flying helicopters to Martin State. The estimated annual fuel cost of flying a helicopter to and from Martin State is doubled to $269,387. In order to fly each helicopter to Martin State for maintenance activities, replace it with a backup helicopter and return the serviced helicopter to the field is again doubled to cost $538,774.

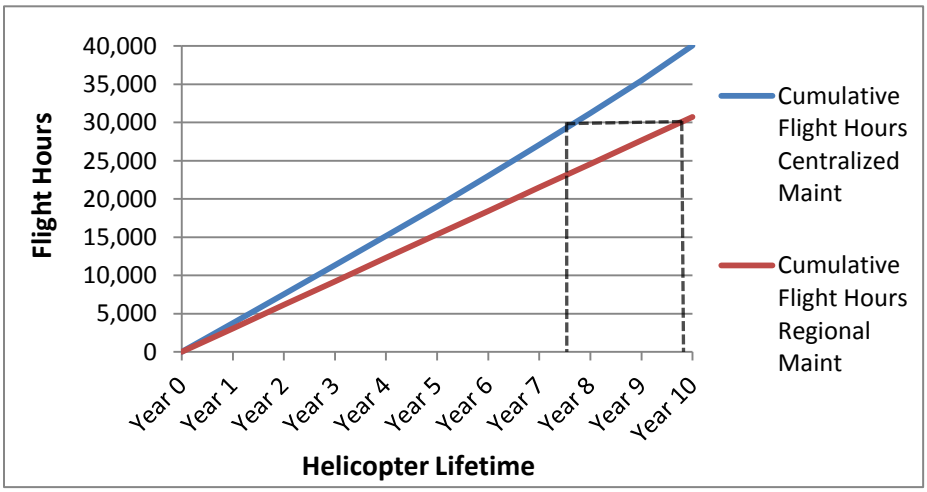
The flight hours required to fly helicopters to and from Martin State for maintenance must also be measured when considering a centralized maintenance strategy. The average scheduled maintenance inspections will require an estimated 164.34 flight hours per year to fly the helicopters to Martin State. The estimated annual flight hour requirement to fly a helicopter to and from Martin State for scheduled maintenance is 328.68 hours. In order to fly each helicopter to Martin State for maintenance activities, replace it with a backup helicopter and return the serviced helicopter to the field is estimated to require 657.35 flight hours per year.

Additional flight hours will result in the need for increases in both scheduled and unscheduled maintenance. Based upon the information derived from the AgustaWestland inspection information in Figure 6, an average of 309.4 scheduled maintenance man hours are required annually for each helicopter. Using the AgustaWestland 10-year MMH ratio (1.02 scheduled + .42 unscheduled), an estimate for maintenance man-hours was determined for unscheduled maintenance on each helicopter. Using an average inspection time, the number of annual inspections from unscheduled maintenance is estimated at an average of 68.86 unscheduled inspections per year. It is assumed that unscheduled maintenance man-hours will start out at a small number and increase at a more rapid rate as the aircraft reach a 10-year maturity. Figure 24 and 25 show the estimated flight hours per year required by a centralized and regional maintenance strategy.

Figure 24: Estimated Flight Hours per Year Centralized vs. Regional Maintenance

Helicopter Lifetime	Centralized Maintenance					Regional Maintenance			
	Flight Hrs - Missions	Sched. Maint. Flight Hrs	Unsched. Maint. Flight Hrs	Total	Cumulative Total	Flight Hrs - Missions	Sched. Maint. Flight Hrs	Total	Cumulative Total
Year 0	0.0	0.0	0.0	0.0	**0.0**	0.0	0.0	0.0	**0.0**
Year 1	3,049.6	657.4	53.6	3,760.5	**3,760.5**	3,049.6	23.63	3,073.2	**3,073.2**
Year 2	3,049.6	657.4	53.6	3,760.5	**7,521.0**	3,049.6	23.63	3,073.2	**6,146.5**
Year 3	3,049.6	657.4	107.1	3,814.1	**11,335.1**	3,049.6	23.63	3,073.2	**9,219.7**
Year 4	3,049.6	657.4	107.1	3,814.1	**15,149.2**	3,049.6	23.63	3,073.2	**12,292.9**
Year 5	3,049.6	657.4	171.4	3,878.3	**19,027.5**	3,049.6	23.63	3,073.2	**15,366.1**
Year 6	3,049.6	657.4	299.9	4,006.9	**23,034.4**	3,049.6	23.63	3,073.2	**18,439.4**
Year 7	3,049.6	657.4	364.2	4,071.2	**27,105.6**	3,049.6	23.63	3,073.2	**21,512.6**
Year 8	3,049.6	657.4	428.5	4,135.4	**31,241.0**	3,049.6	23.63	3,073.2	**24,585.8**
Year 9	3,049.6	657.4	535.6	4,242.5	**35,483.5**	3,049.6	23.63	3,073.2	**27,659.1**
Year 10	3,049.6	657.4	856.9	4,563.9	**40,047.4**	3,049.6	23.63	3,073.2	**30,732.3**

Figure 25: Flight Hours by Maintenance Strategy



These figures show that utilizing a regional maintenance strategy will save the fleet an average of 931.5 flight hours per year over the first ten (10) years. This equates to 30.55% of the annual flight hours spent completing missions and training. As shown in Figure 23, using a regional maintenance strategy will lengthen the usable life of the helicopter by reducing blade time not associated with mission activities. Over the first ten (10) years of helicopter life, using a regional maintenance strategy postpones the 30,000 flight hour level for the fleet of eleven (11) helicopters by more than two (2) years.

The additional staffing requirement ($367,500 per year) of a regional maintenance strategy clearly outweighs the additional fuel costs ($538,774 per year) and extra blade time [up to 9,315.1 flight hours over 10 years (see Figure 24: 40,047.4 – 30,732.3 = 9,315.1)] associated with a centralized maintenance strategy.

VII. Role of Future MSPAC Maintenance Organization

An important consideration is that history has shown that the MSP maintenance organization expansion from 2000 to 2010 of twenty (20) to thirty (30) personnel occurred during the requirement of heavy maintenance for the aging fleet of AS365 Dauphins. This is important to consider because if the current missions and flight hours remain constant, heavy maintenance activities for both scheduled and unscheduled maintenance will rise dramatically in years 13 and 14 for the new helicopter. This heavy maintenance should be incorporated into an outsourced plan with AgustaWestland or one of their certified repair vendors. Therefore, once the maintenance personnel level is determined it should not increase over the lifetime of the aircraft.

There are several other reasons why the proposed level should be held constant. These include:

- As shown in Appendix A.5 mission levels are 60% less than back in 2000. Therefore reducing the total amount of inspections required.
- In the new environment a Flight Training Device will also lower the net hours flown by close to 20% by eliminating training flight hours for annual and new pilot training.
- The new vendor's (AgustaWestland) repair facility is a two (2) hour drive from the MSP headquarters; hence issues of determining maintenance solutions, receiving necessary parts and delays in receiving feedback should be reduced significantly from the current state.
- Each helicopter will also be equipped with a $273,987 HUMS system to support the maintenance operation in exactly what issue is occurring in the helicopter and help to allow the personnel to be more focused on problem resolution.
- If capacity of the maintenance organization is maximized due to unscheduled maintenance far exceeding expectations, work orders over 70 hours should be

outsourced. This would also allow 300 hour scheduled inspections to be integrated into an outsourced negotiation for heavy maintenance only.

A. Proposed Growth Capacity

Per Figure 25, the maintenance labor from the proposed strategy will be able to perform the necessary maintenance the AW139 fleet up to 4,627 flight hours per year.

Figure 25: Maximum Flight Hour Capacity for the Recommended Strategy

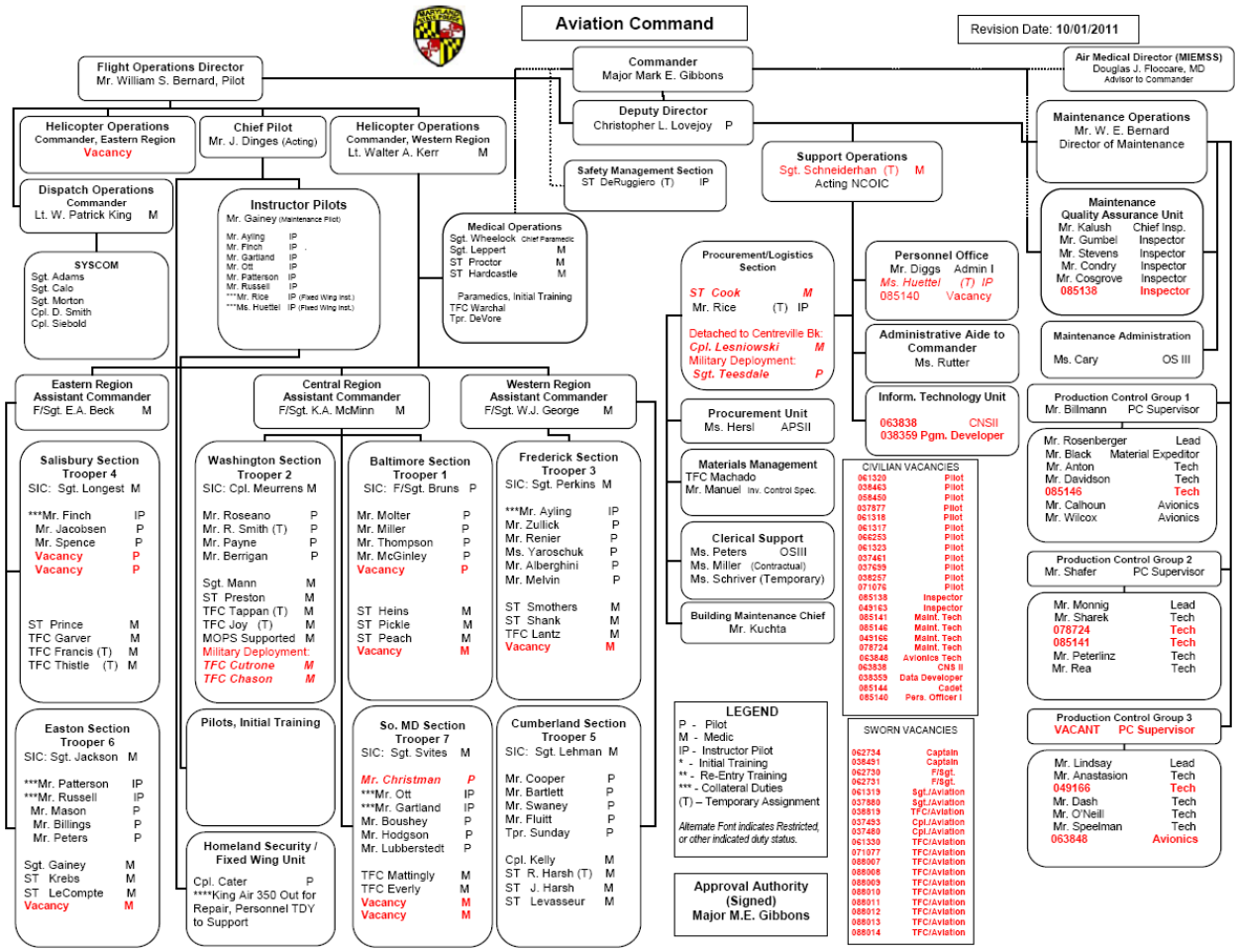
Maximum Flight Hours for the Recommended Strategy		Equation	Calculation
Annual Available Maintenance Man-Hours	28,628 MMH	Maintenance & Inspection Personnel x Maintenance Man-Hours per Year	17 people x 1,684 MMH = **28,628 MMH**
Total MMH Required for AW139 (Conklin & de Decker)	15,096 MMH	(Mission FH + Training FH) x Conklin & de Decker MMH:FH Ratio	(2,490.8 FH + 558.8 FH) x 4.95 MMH/FH = **15,096 MMH**
Efficiency Factor of MSPAC MMH	22,902 MMH	Annual Available MMH x Efficiency	28,628 MMH x 80% (% of time doing maintenance) = **22,902 MMH**
Maintenance Staff Flight Hour Capacity	4,627 FH	(Efficiency Factor of MSPAC MMH - Total MMH Required for AW139) / (Conklin & de Decker MMH/FH Ratio) - Annual Flight Hours	(22,902 MMH - 15,096 MMH) / (4.95MMH/FH) - 3,050 FH = **4,627 FH**

This would assume that the 15% increase in flight hours from missions per year would continue through 2015 (four years). This would represent a 51.7% increase in all non-training missions. This level provides adequate room for growth and there should not be an instance where the estimated MSP maintenance and inspection personnel exceed the necessary estimated twenty-two (22) personnel in the new operation. Choosing between Options #2 and #3 ensures an appropriate staffing level, lengthens the usable life of the fleet and allows the MSPAC the flexibility to implement the appropriate organizational structure.

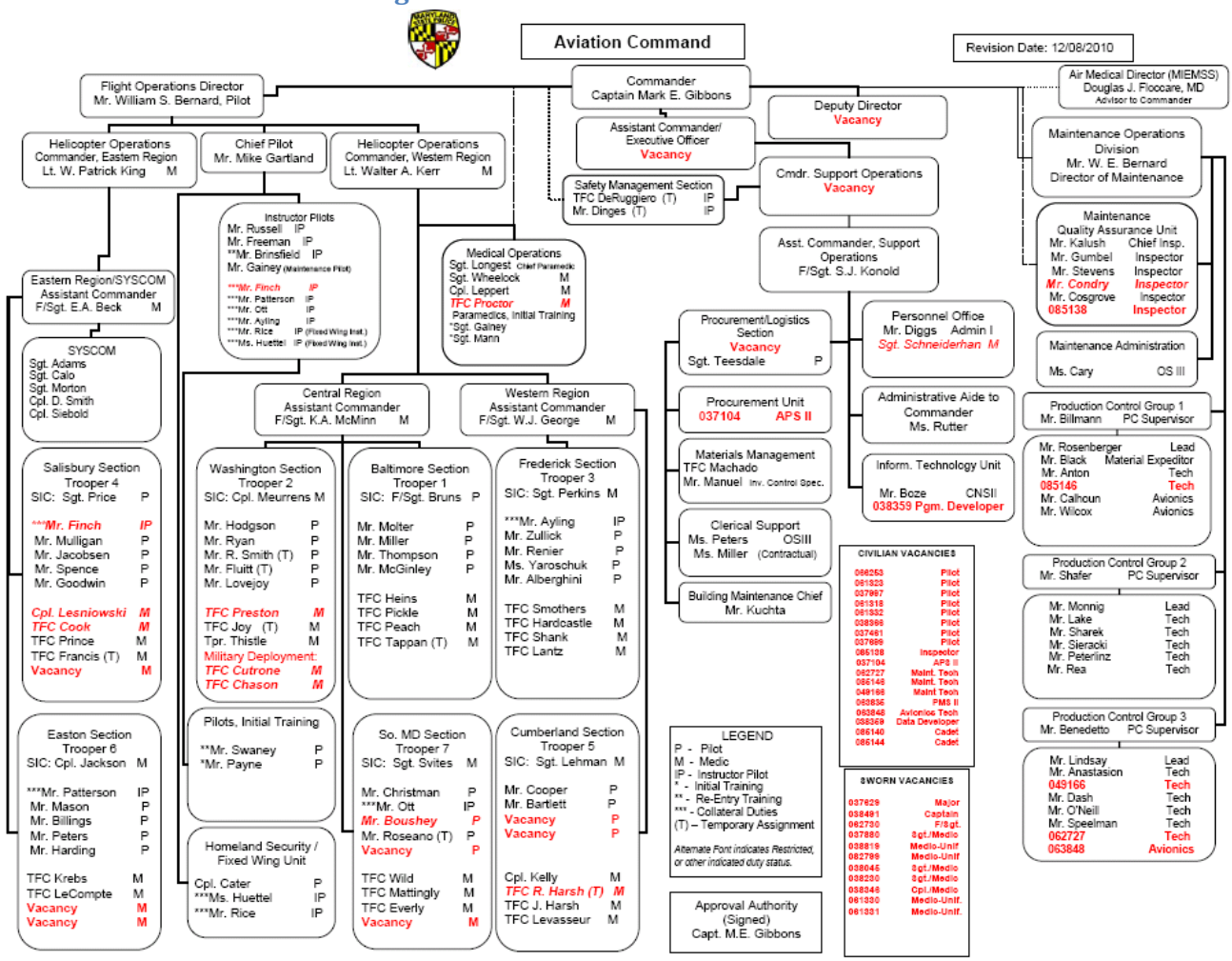
Appendixes

A. MSPAC Organizational Information

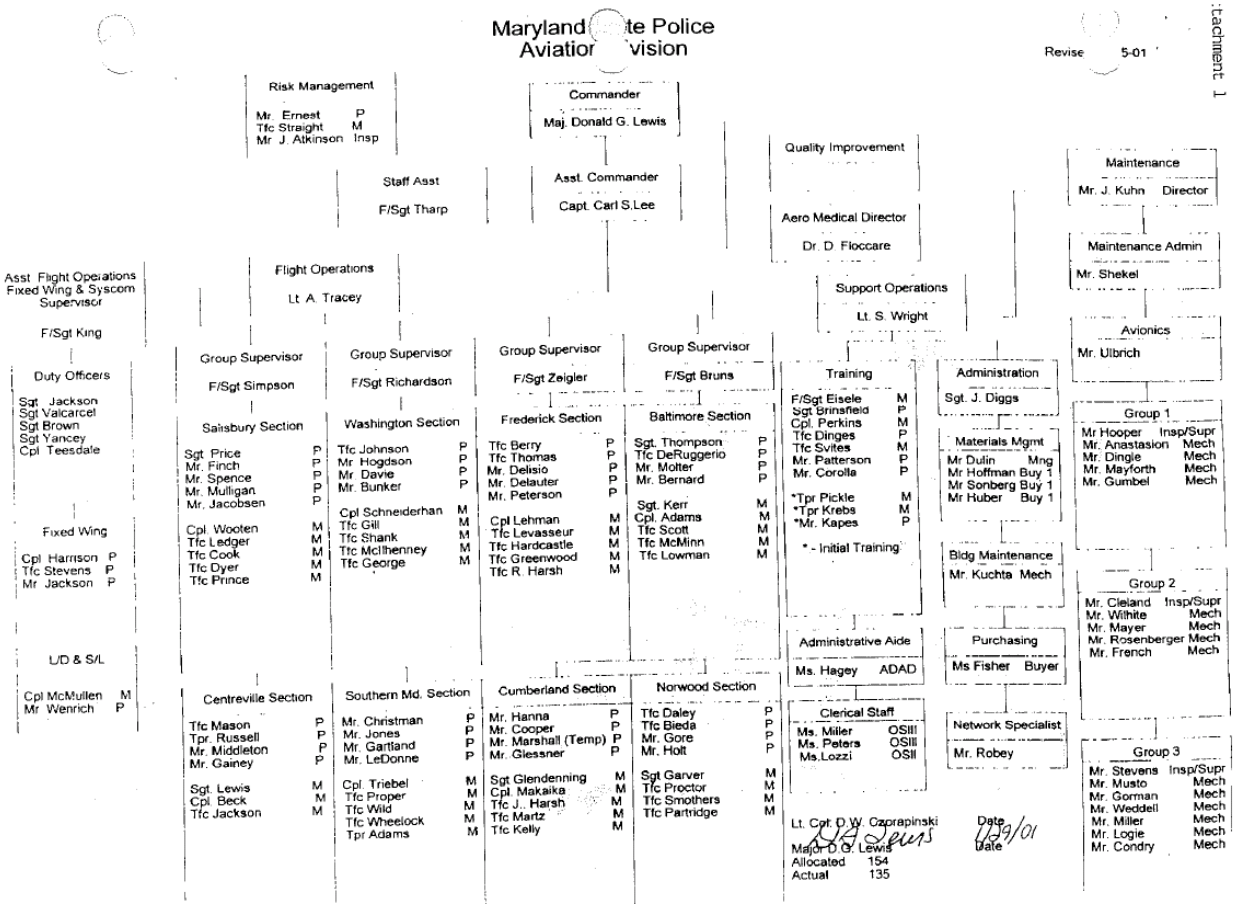
1. MSPAC Org. Chart 2011



2. MSPAC Org. Chart 2010



3. MSPAC Org. Chart 2001



4. MSPAC Maintenance Operation's Table of Organization 2001

Maryland State Police Aviation Command – Maintenance Operation's Table of Organization

NOTES:

* In 2000 this position came under Risk Management

Classification	Number of Positions in 2000	Number of Positions in 2011
Director of Maintenance	1	1
Aviation Mechanic Chief Inspector	*	1
Aviation Maintenance Quality Assurance Inspector	**	4
Aviation Technician Inspector Supervisors	3	3
Maryland State Police Avionics Technician	2	3
Aviation Maintenance Technician Helicopter Lead	***	4
Aviation Maintenance Technician Helicopter	18	13
Computer Network Specialist II	1	****
Office Secretary	*****	1
TOTAL PERSONNEL	25	30

** This position was not created until 2009

*** This position was not created until 2008 (The Lead Technician has no supervisory responsibility. The position is a lead worker that performs all of the duties and responsibilities of an Aviation Maintenance Technician Helicopter.)

**** In 2011 this position comes under Support Operations

***** In 2000 this position came under Support Operations

The above chart offers a comparison of Aviation Command's Maintenance Operations positions obtained from historical Organizational Charts.
The chart and Highlighted Notes indicate the number of personnel in each classification, when certain classifications were created and the total number of positions in Maintenance Operations. The chart reveals there are five more positions in the Maintenance Operation's 2011 Organizational Chart than there were in 2000. Here is a synopsis.

---

1. In 2011 the Aviation Maintenance Chief Inspector was moved from Support Operations and added to Maintenance Operations (Net gain 1)
2. In 2011 the Office Secretary was moved from Support Operations and added to Maintenance Operations (Net Gain 1)
3. Four Aviation Maintenance Quality Assurance Inspectors Positions were created (Net loss 1. All promotions filled from existing PINs which resulted in one less Aviation Maintenance Technician Helicopter)
4. Four Aviation Maintenance Technician Helicopter Lead positions were created. (Net loss 0 due to item #7. All promotions filled from existing PINs)
5. The Computer Network Specialist II was moved from Maintenance Operations to Support Operations prior to 2011 (Net Loss 1)
6. One cadet PIN was restructured to the Maryland State Police Avionics Technician classification (Net gain 1)
7. Four cadet PINs were restructured to the Aviation Maintenance Technician Helicopter classification. (Net gain 4)

Net gain 5 positions

5. MSPAC Mission Analysis 1970 to 2000

MARYLAND STATE POLICE AVIATION DIVISION
ACCUMULATIVE MISSION STATISTICS

YEAR	MISSIONS FLOWN	PATIENTS FLOWN	POLICE/SUPPORT MISSIONS	TOTAL FLIGHT HOURS
1970	2,537	197	2,340	1,954.4
1971	6,800	391	6,409	3,582.6
1972	8,882	716	8,166	4,488.1
1973	8,060	840	7,220	3,458.1
1974	7,999	1,050	6,948	3,794.6
1975	7,590	1,098	6,492	3,542.6
1976	9,385	1,369	8,016	3,941.7
1977	7,445	1,294	6,151	3,955.0
1978	9,482	1,518	7,964	4,898.0
1979	9,868	1,802	8,067	4,806.4
1980	10,409	2,278	8,131	4,915.4
1981	10,148	2,456	7,692	4,952.6
1982	9,987	2,535	7,452	5,074.4
1983	11,228	2,857	8,371	5,900.3
1984	11,201	2,958	8,243	7,214.8
1985	12,273	3,352	8,921	6,022.2
1986*	7,387	3,025	4,362	6,797.9
1987	7,577	2,983	4,594	8,540.8
1988	7,460	3,489	4,052	8,806.2
1989**	9,220	3,251	5,095	8,343.1
1990	8,659	4,130	4,304	8,116.7
1991	8,566	4,799	3,193	6,866.9
1992	7,790	4,255	2,726	6,363.8
1993	8,516	4,303	3,375	6,253.9
1994	9,647	4,174	4,246	6,682.0
1995	9,621	4,105	4,208	6,410.4
1996	8,401	3,995	3,486	5,622.9
1997	8,328	4,461	2,758	5,862.4
1998	7,870	4,772	2,305	5,391.2
1999	7,214	4,884	2,345	5,114.5
2000	8,160	4,971	2,102	4,985.5
TOTALS	267,710	88,335	169,624	172,373.2

B. MSPAC Maintenance Operation Response to Interrogatories

MARYLAND STATE POLICE

TO: Captain Mark E. Gibbons, Commander Aviation Command DATE December 23, 2010

FROM: Warren E. Bernard, Director Maintenance Operations

X	For your information	____	Take charge of
X	As requested	____	For additional information
____	Approve and return	____	For comment/recommendation
____	Note and return	____	Give me facts so I can answer
____	See me	____	Prepare reply for my signature

Re: Response to Interrogatories – Maintenance Operations

On December 7, 2010 a list of interrogatories was received regarding the maintenance study mandated by the legislature. Below and enclosed are detailed responses with supporting documents to the listed questions, should you require clarification, please contact me.

Overview: The Maryland State Police Aviation Command (MSPAC) provides five (5) separate mission profiles using multipurpose aircraft and cross-trained crews which are: Medevac, Aerial Law Enforcement, Search and Rescue, Homeland Security, and Disaster Assessment for the State of Maryland and its bordering states. These different missions are accomplished through the hard work and coordination of Flight Crews, Support Services, and Maintenance Personnel.

- The MSPAC Maintenance Operations is an approved Federal Aviation Administration (FAA) Certified Repair Station (CRS) under the code of Federal Regulations (CFR) 14, Part 145.
    - Periodic inspections of the maintenance facility are performed by Aviation Safety Inspectors from the local FAA Flight Standards District Office (FSDO) to ensure all regulatory requirements, including adherence to the MSPAC Repair Station Manual (RSM) (Ref: Addendum A) which contains the CRS policies, processes, and procedures.
- The MSPAC CRS employs 26 members comprised of four groups: Management, Supervisory, Inspection, and Maintenance Technicians.
    - Currently the CRS has 4 vacancies (1 Avionics personnel and 3 Maintenance Technicians).
    - All aspects of scheduled and unscheduled maintenance are currently performed by the MSPAC CRS Staff.
    - This workforce level of Maintenance Operation is essential for continued airworthiness and the safety of the current fleet of aircraft which includes 11 AEC365 Dauphins, one Beechcraft King Air 350, and one Cessna P210 as of 12/31/10.
- The three Production Control groups are comprised of a Production Control Supervisor, a Lead Technician and 5-8 Maintenance Technicians.

- Leads and Technicians are assigned to tasks, depending upon required scheduled and unscheduled maintenance events. The workforce structure is illustrated on the MSPAC Organizational Chart. (Ref: Addendum B – Note: Numbered pins denote vacant positions.)

- Maintenance performed at the repair station level includes unscheduled maintenance, preventative tasks (25, 50, 75, and 100 hour inspections), "T" Inspections (every 600 flight hours) and "G" Inspections (every 5,400 flight hours).

- A 93.8% maintenance operational readiness rate has been achieved despite aging fleet issues with the helicopters (This is in comparison to an 81.5% readiness rate of a private EMS operator with a similar aircraft type and a comparable fleet size.)

- Section (Trooper Bases) level maintenance includes, but is not limited to, unscheduled events. On some occasions, a scheduled maintenance event will be conducted when the tasks do not involve the removal of major components, or maintenance that involves measurement of play, tactile checks, visual inspections, etc.

    - Maintenance tools generally are not located at each section.

        - Each section has a 3-piece tool kit for preventive maintenance only such as light bulb replacement. Maintenance stands are available at each section so flight crews can perform their pre and post flight inspections as outlined in their flight manuals.

- The recent approval from the Legislature to purchase the new fleet of helicopters gives the MSPAC the ability to procure up to 12 aircraft to replace its aging fleet. Six of the possible twelve aircraft will be delivered in approximately 18 months.

- Upon final approval to operate Maintenance Operations under the FAA CFR14 Part 135 designation, two possible scenarios exist which could affect current Maintenance Operations staffing levels.

    - Scenario #1: Daily inspections performed by flight crews – staffing levels would remain unchanged and all unscheduled maintenance events would be performed by FAA Part 145 maintenance and inspection personnel.

        - Current salary requirements – 30 personnel = $1.85M/Yr.

    - Scenario #2: Daily inspections performed by maintenance personnel at the section level – an increase of 8 personnel (2 technicians per region), if daily inspections are required to be performed under the Part 135 General Operations Manual (GOM):

        - Projected salary requirements – 38 personnel = $2.34M/Yr.

- Additionally, to support the personnel in the field, 3 vehicles outfitted with standard tool sets and common consumable materials will be required to satisfy the logistics of the operation.

- The AW-139 Maintenance Program is currently under review to identify the definitive necessary requirements and planning to continually maintain airworthiness standards. The scope of work will include frequency, time to complete tasks, and the complexity of the maintenance. On 12/21/10, Maintenance Operations took receipt of the Augusta AW-139 Air Vehicle Maintenance Planning Information (AMPI).

  - Upon consultation with an AW139 operator (Los Angeles City Fire Department), their indications reflect 6.4 labor hours per flight hour.

- Currently no maintenance services are being outsourced, and Keystone Helicopter Corporation is not under contract with the State of Maryland.

  - Keystone Helicopter Corporation was utilized 12 times from August, 2004 –March, 2009 to perform basic "T" inspections. Selected aircraft which did not require extensive work beyond the basic "T" inspection items were outsourced,

  - If contractual maintenance is considered, MSPAC would be required to provide continual oversight of the maintenance process performed at other locations due to the vendors' lack of service experience. This reduces the workforce at MSPAC by removing maintenance and inspection personnel, thus impacting production.

  - It has been MSPAC's experience with vendors that findings such as indicated above, was one factor in the decision of Maintenance Operations no longer using outsourcing.

- The current software utilized by the Maintenance and Inventory Support Operations (MX Manager) was acquired in 2002. MX Manager is a multifunctional database currently utilized to track aircraft component records, inventory levels, work order details and other logistical functions.

  - Note: This system is no longer supported by its developer, Conklin and de Decker (See Addendum C). Although MX Manager will continue to function, but as newer Windows (operating systems) OS versions are released, MX Manager's functionality will be negatively affected. A robust maintenance and inventory solution is being identified by Agusta Westland Corp., as required in the proposal.

Maintenance Operations is a complex and intricate component for the fulfillment of the MSPAC's mission. The multifunctional mission is performed efficiently, professionally and when time is a factor. Full maintenance staffing, parts / resources, and the adaptation to accept new airworthiness standards, are vital in the success of the transition from the Eurocopter to Agusta product. The Maintenance Operations staff is excited, prepared and ready to carry the MSPAC safely into the future.

C. Flight-Required Training Assumptions

1. AW 139 Training Requirement

FFS* (Initial/Recurrent) AW139 (w/FTD**) used for this analysis.

Training/Evaluation Requirements	Pilots (PIC)	Pilots (SIC)	Flightcrew Member (Medics)	Min. Flight Time Required CFR 135	Min. Flight Time Required MSPAC	FFS* (Initial/Recurrent) AW139 (wo/FTD**)	FFS* (Initial Only) AW139 (wo/FTD**)	FFS* (Initial/Recurrent) AW139 (w/FTD**)	FFS* (Initial Only) AW139 (w/FTD**)	AW139 (w/FTD**)	AW139 Only
Required Flight Checks: CFR 135											
Annual PIC "Competency" Check 135.293(b)	54	0	N/A	1.0	1.5	0.0	0.0	0.0	0.0	13.5	81.0
Instrument Proficiency Check (IPC) 135.297	54	0	N/A	1.0	3.0	81.0	81.0	40.5	40.5	40.5	162.0
Annual PIC Line Check 135.299	54	N/A	N/A	1.0	1.5	81.0	81.0	81.0	81.0	81.0	81.0
Check Airman Check 135.339(2)	2	N/A	N/A	0.1	1.5	3.0	3.0	0.8	0.8	0.8	3.0
Flight Instructor Check 135.340(2)	6	N/A	N/A	0.1	1.5	9.0	9.0	2.3	2.3	6.8	9.0
Total CFR 135 "Checking" Flight Hours:				3.2	9.0	174.0	174.0	124.5	124.5	142.5	336.0
Required Flight Training: CFR 135											
"PIC" Training : 135.347(a)											
Initial	54		N/A	10.0	20.0	0.0	0.0	0.0	0.0	270.0	1080.0
Transition	0		N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Upgrade	0		N/A	1.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
(Annual) Recurrent	54		N/A	4.0	8.0	216.0	432.0	54.0	108.0	108.0	432.0
Requalification	0		N/A	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0
"Co-Pilot" Training : 135.347(a)											
Initial	N/A	0	N/A	10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0
Transition	N/A	0	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Upgrade	N/A	0	N/A	1.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0
(Annual) Recurrent	N/A	0	N/A	4.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0
Requalification	N/A	0	N/A	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0
Required "Crewmember" Training: 135.329(b) & 135.351©											
Initial	N/A	N/A	54	1.0	1.0	54.0	54.0	54.0	54.0	54.0	54.0
Transition	N/A	N/A	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Upgrade	N/A	N/A	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(Annual) Recurrent	N/A	N/A	54	0.0	1.0	54.0	54.0	13.5	13.5	13.5	54.0
Requalification	N/A	N/A	0	1.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0
"Night Vision Goggle" (NVG) Training: 61.31(k)(1)											
Initial	54	0	54	0.1	5.0	540.0	540.0	135.0	135.0	135.0	540.0
Recurrent	0	0	0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
"Check Airman" Training: 135.339(1)											
Initial	2		N/A	0.1	1.5	3.0	3.0	0.8	0.8	0.8	3.0
"Flight Instructor" Training: 135.340(1)											
Initial	6		N/A	0.1	10.0	60.0	60.0	15.0	15.0	15.0	60.0
Recurrent	0		N/A	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
"CRM" Training: 133.330 (effective 3/22/2011)											
Initial	50	0	54	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Recurrent	0		0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total CFR 135 "Training" Flight Hours:				32.3	132.5	927.0	1143.0	272.3	326.3	596.3	2223.0
Required Flight Training: MSPAC											
"Pilot": Public Aircraft Training: SAR (Hoisting), Law Enforcement, etc.											
Initial	54		N/A	0.0	10.0	540	540	135	135	135	54
Recurrent	0		N/A	0.0	1.0	0	0	0	0	0	0
"Crewmember": "Public Aircraft" Training: SAR (Hoisting), Law Enforcement, etc.											
Initial			54	0.0	1.0	54	54	13.5	13.5	13.5	54
Recurrent			54	0.0	1.0	54	54	13.5	13.5	13.5	54
"Pinch Hitter" Training:											
Initial			0	0.0	1.0	0	0	0	0	0	0
Recurrent			0	0.0	1.0	0	0	0	0	0	0
Total Flight Hours - "MSPAC Training":				0.0	15.0	648.0	648.0	162.0	162.0	162.0	162.0
Total Flight Hours - "CFR 135 Training/Checking":				35.5	156.5	1101.0	1317.0	396.8	450.8	738.8	2559.0
Total Flight Hours - "Training":				35.5	171.5	1749.0	1965.0	558.8	612.8	900.8	2721.0
***Total Cost of AW139 "Level D FFS":						$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
****Total Cost per "AW139" Flight Hour:						$10,163.00	$10,163.00	$10,163.00	$10,163.00	$10,163.00	$10,163.00
Total Cost of AW139 "Flight Training" :						$17,775,087.00	$19,970,295.00	$5,678,576.25	$6,227,378.25	$9,154,322.25	$27,653,523.00

*AW-139 FAA Certified Level D Full Flight (Motion) Simulator

**AW-139 FAA Certified Level 7 Flight Training Device leased by MSPAC; the estimated purchase price of the Level 7 FTD will be approximately $5,000,000 w/ $10,000 per year in consumables.

***At the end of the contract w/AAC, the estimated "initial" pilot training cost in the FFS will be $75,000 per pilot and one "recurrent" training session will cost $15,000 per pilot.

****Total cost per "AW-139" flight hour obtained from Integrity Consulting's 2017 Projected Cost per Flight Hour utilizing the 1.44 Maintenance to Flight Ratio projection.

2. MSPAC Current Training Requirement Assumptions

Training Assumptions	
Training Hours per pilot	17.5
% Positions Filled	90.00%
Annual Pilot Turnover	10.00%
New Pilot Additional Training	55
# of Pilots	54
Training Hours Required	1147.50

D. HUMS System Capabilities

1. MSPAC Technical RFP Document 8/22/2009

AW139 MSPAC Mandatory Options

HUMS

The HUMS kit provides an enhancement of the basic maintenance capabilities already provided with the Central Maintenance Computer in the Modular Avionics Unit (MAU) of the Honeywell Primus Epic system. Additionally, it allows rotor tracking and balancing for the main and the tail rotor. Data from helicopters equipped with HUMS can be used to enhance monitoring of health of the aircraft's major components and systems, increasing the safety of the fleet.

The HUMS system consists of an On-Board System (OBS) and a HUMS Ground Station (HGS). The tasks performed are:

Transmission Vibration Monitoring (TVM).

Proposal Number - 09N002AAC 57

Usage Monitoring (UM) encompassing Transmission Usage Monitoring (TUM) relevant to the drive system usage, and Structural Usage Monitoring (SUM) relevant to the airframe and dynamic components.

Rotor Track and Balance (RTB).

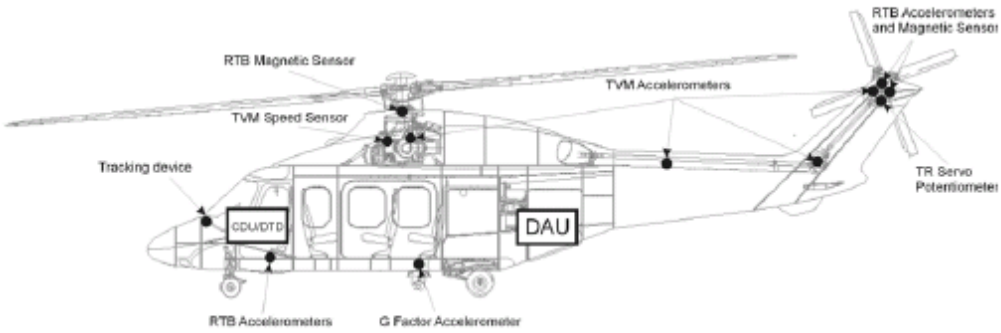
Engine Power Assurance (EPA).

The On-Board System is implemented through two major Line Replaceable Units installed on the helicopter:

Control Display Unit (CDU), integrating a Data Transfer Device (DTD).

Data Acquisition Unit (DAU).

Both the CDU and DAU interface with the Primus Epic System. Moreover, the DAU interfaces directly with TVM, SUM and RTB sensors, thus collecting further data needed for HUMS tasks. Collected data are transferred to the Ground Station (HGS) through the DTD, via a PCMCIA Memory Card. The Ground Station (HGS) allows theanalysis of transferred data using purposely developed software running under Windows 2000.



Cockpit Display Unit/
Data Transfer Unit

RTB sensor

2. AW Response to MSP HUMS Questions

HUMS

1. What health and usage recording devices are available absent the HUMS?

   The Primus Epic Systems, Vehicle Monitoring System (VMS) monitors helicopter systems and functions for normal operations and for any fault or failure that might occur. The system operates continuously from engine start to shut down, alerting the pilot to the condition of monitored systems. The Central Maintenance Computer (CMC) records all exceedance data, fault data and associated Crew Alert System (CAS) messages that occur during flight operations.

2. What is the base capability for aircraft monitoring and diagnostics without the HUMS?

   The base capability built into the Primus Epic System enables the events listed in the attached document to be monitored and recorded.

   a. Please detail the specific capabilities included without the HUMS. A list of key known HUMS capabilities include:

      i. Vibration-Based Methods
      ii. Time Series Signal Acquistion Techniques
      iii. Complex Signal Separation
      iv. Time Sychronous Averaging
      v. Feature Detection and Extraction
      vi. Planet Carrier Monitoring
      vii. Transmission Bearing Health Monitoring
      viii. Gearbox Vibration Database
      ix. Metrics Evaluation Tool
      x. Environmental Effects on Vibration Methods
      xi. Condition Indicators in Certified HUMS
      xii. Acoustic Emissions
      xiii. Data Fusion
      xiv. Auto Rotor Imbalance Detection and Rotor Smoothing

E. Response to Maintenance Assumptions

Response to Maintenance Assumptions

Revised March 31, 2011

Below are responses to the operational assumptions requested for the maintenance study. These responses were provided by members of the Maintenance and Operational leadership based on information provided by AgustaWestland. The transition to the new airframe will be dynamic requiring adjustment to the manner and methods maintenance is performed.

- Operating 7 bases
  - Correct, based on the basing study.
- Buying 11 helicopters
  - Currently only 6 helicopters have been approved, but we may know more at the end of this legislative session.
- Buying Flight Training Device
  - Yet to be determined if funds have been allocated.
- Operate single-pilot
  - Yes
- Pilots will be certified to perform daily inspections (as described and accepted per the approved Manufacturer's Maintenance Program or the Approved Aircraft Inspection Program)
  - Incorrect, Pilots will be "trained" to perform pre-flight checks.
- Maintenance technicians will be certified to perform daily inspections (as described and accepted per the approved Manufacturer's Maintenance Program or the Approved Aircraft Inspection Program)
  - Correct - to clarify, all MSPAC maintenance personnel are certificated per Title 14 of the CFR Part 65, this regulation outlines guidelines and privileges respective to the holder of the license.
- Inspectors are responsible for inspecting all scheduled (50hr, 300hr, yearly) and unscheduled maintenance activities (as described and accepted per the approved Manufacturer's Maintenance Program or the Approved Aircraft Inspection Program)
  - Correct, personnel that are listed on the Repair Station personnel roster (with inspection privileges) will be responsible for inspecting all work performed.
- All maintenance technicians have 1880 available work hours per year. There are 2080 hours in a calendar work year and maintenance technicians receive 10 holidays, 10 vacation days & 5 sick days per year (200 hours off per year).
  - Dependent upon the employees' tenure, the following leave allowances apply:
  - • 1 - 5 years -11 holiday, 10 annual, 6 personal, and 15 sick – Total 336 hours off per year resulting in1744 available work hours

- 6 - 10 years - 11 holiday, 15 annual, 6 personal, and 15 sick – Total 376 hours off per year resulting in1704 available work hours
- 11 – 20 years - 11 holiday, 20 annual, 6 personal, and 15 sick – Total 416 hours off per year resulting in1664 available work hours
- 21 – thereafter - 11 holidays, 25 annual, 6 personal and 15 sick – Total 456 hours off per year resulting in1624 available work hours.
- Note: Military Leave should be considered, this leave is granted to an employee who is a member of a reserve unit of the armed forces, or in the organized militia for military training or active military duty. A maximum of 15 days annually is granted without loss of pay or charge against any other leave.
- Currently 2 employees are members of the Armed Forces.

- Approximately 3000 flight hours per year
  - Future flight hours will depend on mission trends as well as the acquisition of an FTD. With current mission levels it is anticipated that we will incur 3000 flight hours with an FTD, 3700 hours per year without an FTD.
- Approximately 230 flight required training hours with single-pilot and use of Flight Training Device
  - Initial transition of the aircraft would be 22 hours per pilot in the full motion simulator by AgustaWestland. Training in MSP aircraft would be 20 hours for missions in MSPAC aircraft. For fully trained line pilots, annual training in MSP aircraft would be a total of 12 hours with 75% being conducted in a FTD if one is provided. Each pilot fully trained requires a minimum of 12 hours annual training times 50 pilots is 600 hours. Multiply that by 75% which can be conducted in a FTD and that equates to 150 hours a year that would be blade time in an aircraft.
- 17.5 flight-required training hours per pilot per year
  - A minimum of 12 hours for each line pilot with 75% of this time conducted in a FTD.
- 55 flight required training hours per new pilot per year
  - New pilots will go to factory school by contract and receive the type rating. The new pilots would then return to the MSPAC and receive 20 hours of mission specific training in the aircraft. The contract allows for all pilots to receive annual recurrent training by AgustaWestland for the first year after initial type rating.
- 90% annual pilot retention rate
  - The rate is somewhat higher than indicated. See the following:

	Hired	Ave/yr	Lost	Ave/yr
Since 1993	69	3.63	-72	-3.79
Since 2000	51	4.25	-47	-4.67
Since 2005	32	4.75	-39	-5.57

- 10% annual turnover
  - See above

- 74% reduction in flight-required training with the use of the flight training device
    - Dependant on approval of the FAA, it is anticipated the rule of thumb is that an FTD will reduce actual training blade time by 75%.
- Supervisors of the maintenance personnel will perform maintenance tasks along with their management duties.
    - Correct, however the percentage of time spent performing maintenance will be less than that of the maintenance technician because that is not their primary duty.
- Supervisors of the inspectors will provide inspection duties along with their management duties.
    - Correct, however the percentage of time spent performing inspection duties will be less than that of the inspection unit personnel because that is not their primary duty.

Note: It is our plan to perform as much maintenance as possible in the field in order to maximize the time the individual sections remain in service at their primary response areas. Additionally, this will save a significant amount of money in terms of unnecessary blade time since the aircraft will not be flying to Martin State Airport for this maintenance. We believe this is the most fiscally responsible approach to maintaining the Maryland State Police Aviation Command's fleet of AW-139 helicopters.