UNDERSTANDING THE PERFORMANCE PLANNING CARD

Sikorsky
UH-60A BLACKHAWK

- by -

CW3 Bill Young

REVISED
March 1998

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Item numbers in parenthesis correlate with respective block numbers on the PPC identified in figure 6-8 in TC 1-212, dated 8 March 1996.

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

The explanations in this manual are the interpretations of the author, and are not necessary the views of the Army and/or related regulations.

INTRODUCTION

This booklet contains information intended as an aid to understanding DA Form 5701-R Performance Planning Card (PPC), and how to apply that information towards safe and efficient utilization of the aircraft for given mission conditions. Instructions for completing the PPC can be found in TC 1-212, the UH-60 Aircrew Training Manual (ATM) and the aircraft operator's manual (-10).

NOTE

Drag considerations will be discussed briefly in this booklet where appropriate. Drag corrections can be made for either a clean configuration aircraft, or for a High Drag configuration aircraft. The clean configuration assumes all doors and windows are closed and includes the following external configuration:

- ☞ Fixed provisions for the External Stores Support System (ESSS).
- ☞ Main rotor deice system.
- ☞ Mounting brackets for IR jammer and chaff dispenser.
- ☞ Hover Infra red Suppressor System (HIRSS) with baffles installed.
- ☞ Includes wire strike protection system (WSPS).

The High Drag configuration charts have the High Drag Symbol and assumes the following configuration:

- ☞ ESSS installed.
- ☞ Two 230-gallon tanks mounted on the outboard pylons.
- ☞ Inboard vertical pylons empty.
- ☞ IR jammer and chaff dispenser installed.
- ☞ HIRSS with baffles installed.
- ☞ Main rotor deice and wire strike protection systems installed.

NOTE

All limitations referenced in this booklet are for the UH-60A.

Of first concern to the aviator is the question of when a PPC must be completed. According to the ATM, the aviator will determine and have available aircraft performance data necessary to complete the mission. The PPC is used as an aid in organizing this information, or to handle emergency procedures that may arise during the mission. In accordance with the ATM, the PPC ***must*** be used during RL progression, annual Aircrew Training Program (ATP) evaluations, and when required during other training and evaluations. For evaluation flights, the evaluator will determine which blocks will be filled out. PPC completion is not mandatory in all other situations.

AR 95-1, paragraph 5-2, requires crews to familiarize themselves with aircraft performance. This does not necessarily mean that a PPC has to be completed, however, it is important to remember that the aircrew still has the responsibility of ensuring that aircraft limitations and capabilities are not exceeded. Failure to complete a PPC would most likely be found as a contributing or non-contributing factor in any incident or accident investigation where a PPC was not completed. Whether mandatory or not, it is wise and considered normal practice to do a PPC in every situation.

Secondly, when are PPC corrections for drag necessary? The data presented in the performance charts in the -10 are for either a "clean" or "High Drag" UH-60. Any changes to these configurations can cause performance planning to be inaccurate unless corrections are made. The ATM states that when the external equipment or configuration differs ***significantly*** from the "clean" or "High Drag" configuration, a drag compensation ***will*** be made. There is no definition of what a "significant change" is, so it's up to the aircrew to determine.

DEPARTURE

The maximum pressure altitude and maximum temperature forecasted during the mission are normally used to determine torque ratios, maximum torque available, maximum gross weight, and go/no-go torque values. Predicted hover torque is computed using takeoff conditions. When the takeoff temperature is more than 10°C below the maximum temperature, record both the maximum and the current takeoff temperatures in the FAT block. All other computations should be determined using current conditions forecast for the time of departure.

PRESSURE ALTITUDE (PA)- Is the height measured above the 29.92 inches of mercury pressure level (standard datum plane). It is used to correlate aerodynamic and engine performance in the non-standard atmosphere. The higher the pressure altitude is above standard, the lower the aircraft performance becomes due to thinner air density. Enter the maximum forecast pressure altitude. Current PA is not required since it would have to be 2000 feet below maximum in order to cause a significant difference.

FREE AIR TEMPERATURE (FAT)- The degree of "hotness" or "coldness" of a substance is known as its temperature. The temperature measuring elements are shielded in a manner that avoids direct sunlight and minimizes other effects that cause inaccuracies in the readings. Enter the maximum FAT. If the FAT at the time of takeoff is more than 10°C below maximum, enter both takeoff and maximum temperatures.

TAKEOFF GWT- The actual weight of the aircraft and its contents, in include fuel, at take-off. Obtain this value from the DD Form 365-4 (Weight and Balance Clearance Form F).

LOAD- This block is not required to be completed. It can be used for the weight of ammunition, cargo, troops, etc.

FUEL- The estimated weight of the fuel required for the mission. This includes the appropriate VFR or IFR reserve. This is the fuel weight the crew should ensure they have, as a minimum, before they depart on their mission.

ENGINE TORQUE FACTOR (ETF)- Defined as the ratio of individual engine torque available as compared to a specification engine at a reference temperature of 35°C. The ETF is allowed to range from .85 to 1.0. A 1.0 value means that the engine(s) will perform to, or exceed, a specified (specification) performance level (power) as defined in the Army's UH-60 development contract with General Electric (developer of T-700 engines). As with any engine, as operating times increase, performance levels will decrease due to wear and tear.

The ETF indicates how far below specification the engine performance will be, and allows the pilot to individualize the performance charts to reflect true capabilities for his aircraft. For example, an ETF of .85 would perform 85 percent as well as a specification engine. A .85 ETF engine would require a minimum of a .95 ETF on the second engine to provided a minimum required .90 aircraft torque factor (ATF). The ATF and ETF values for an individual aircraft are found on each engine Health Indicator Test (HIT) log in the logbook.

AIRCRAFT TORQUE FACTOR (ATF)- Defined as the ratio of aircraft power available as compared to specification (low time) engines at a reference temperature of 35°C. The ATF is the average of the ETFs of both engines and this value is allowed to range from .90 to 1.0. An aircraft with a 1.0 ATF is ideal, as it provides more power than a lower ATF aircraft. Although the ATF is an average of the ETFs, the proper name is Aircraft Torque Factor, not Average Torque Factor.

TORQUE RATIO (TR)- This figure provides an accurate indication of available power by incorporating ambient temperature effects on degraded engine performance. Simply stated, the TR allows the pilot to correct a non-specification engine (less than 1.0 ETF) for less than reference temperature (35°C). For temperatures below 35°C, a non-specification engine will be corrected. The colder the temperature goes below 35°C, the more dense the air becomes and the more efficient the engines become. At temperatures of -15°C and below, all TRs will be 1.0 and the engine will provide specification performance due to a significant increase in air density, and corresponding engine efficiency. The TR will not change for a specification engine since a 1.0 engine already meets required design performance. Intuitively, however, the performance would actually increase on days less than 35°C, even for a 1.0 engine, but performance planning charts do not allow us to determine this value. Additionally, the TR will not change for temperatures of 35°C or above, since the ATF/ETFs are based on this temperature anyway. In these cases, the TR will equal the ETF/ATF.

<u>MAX TORQUE AVAIL</u> (MTA)- This torque value represents the maximum torque available at zero airspeed and 100% RPM R for the operational range of PA and temperature. This torque value may or may not be continuous due to Chapter 5 limitations. The actual maximum torque available figure should be annotated on the PPC, regardless of whether it is above continuous transmission (XMSN) torque limits. If applicable, the aviator is responsible for ensuring that Chapter 5 transient limits are applied when using MTA.

Based on flight test data, the MTA chart in the operator's manual reflects the maximum torque the engines can produce without exceeding the maximum of any of your three, 30-minute engine operating limitations ← TGT 850°C, ↑ Ng 102%, or → Eng Oil Temp 150°C. MTA is Limited by the HMU through TGT limiting, or Ng limiting. A TGT limiter circuit within the ECU causes the HMU to limit fuel to the engine when TGT reaches 837-849°C. Referring to the MTA chart (Figure 1), TGT limiting would probably occur in the regions where the max torque lines slant up and left as temperature increases. TGT limiting is usually what will limit MTA for the PA and temperature combinations that most Army aviators operate in. When Ng speeds reach approximately 102%, the HMU

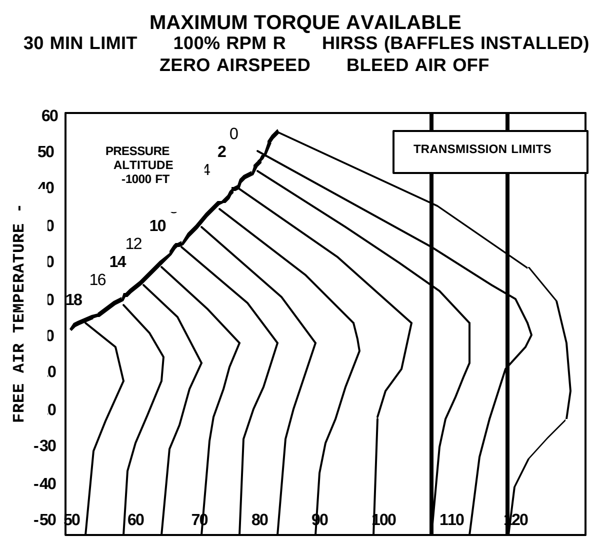

Figure 1

also limits fuel to the Ng section through Ng limiting. This function is adjusted based on compressor inlet temperature (T_2). Do not confuse this function with Ng overspeed protection which ***shuts down*** the engine when Ng speeds of 110 ± 2 % are reached.

Because the speed at which Ng limiting occurs changes based upon the temperature, it would be difficult for the aircrew to determine if Ng limiting has been reached. If MTA is reached and/or rotor droop (decreasing RPM R) ***without*** reaching the TGT limiter range (837-849°C), the aircraft is probably in Ng limiting.

Refer to the MTA chart on the previous page (Figure 1), Ng limiting would likely occur in the regions where the max torque lines slant down and left as temperature decreases. As shown on the MTA chart, even though colder and more dense air improves engine performance, the MTA eventually begins to decrease, rather than increase. Ng speed is limited to prevent airflow through the engine from reaching mach. This is not normally referred to as "compressibility" when discussing engines, since the normal job of the engine is to compress air. Although the axial compressor blades themselves are operating above mach speeds, the airflow through the engine must remain sub-sonic. Mach airflow through the engine would cause engine roughness, engine surge and/or compressor stall.

If MTA is more than 100% torque dual-engine, or 110% single-engine, the aircraft is said to be structurally limited. The engines are capable of producing the power, but components in the XMSN are incapable of sustaining these torque loads continuously without damage. Figure 2 shows the MTA each XMSN component can receive continuously without damage. Concerning dual-engine operation, the input modules could individually accept more than 100% torque continuously (up to 110% actually), but this would generate more than 200% combined torque to the main module if operating dual-engine. The main module cannot accept these torque loads continuously. Therefore, main module capability limits dual-engine MTA. Concerning single-engine operation, the main module can take up to 200% torque continuously, but the smaller gears in each individual input module cannot. Therefore, the input module limits single-engine MTA to 110% continuous.

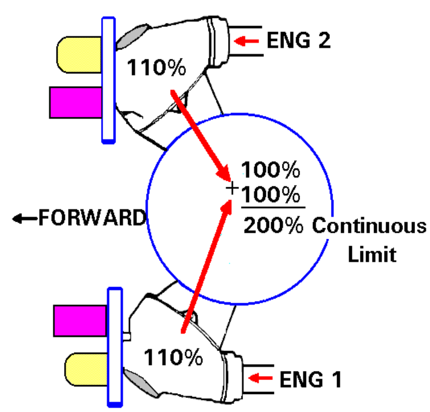

Figure 2

In a structurally limited aircraft (MTA greater than 100% torque dual-engine/110%

torque single-engine), attempting to operate continuously above the allowable torque value in chapter 5 will result in structural damage to the transmission. Refer to chapter 5 of the -10 for current transient limitations.

If MTA is below 100% torque dual-engine, or 110% single-engine, the aircraft is said to be environmentally limited. Due to environmental conditions, the engines are incapable of producing specification power and XMSN torque limits will not be reached. In an environmentally limited aircraft, attempting to demand more torque than MTA, will result in rotor droop. Depending on how far the collective is increased beyond this point, will determine how far the rotor will droop. The pilot will need to limit operation of an environmentally limited aircraft to 30 minutes to prevent the engines from operating longer than the three 30 minute engine limits ← TGT 775-850°C, ↑ Ng 99-102%, and → Eng Oil Temp 135-150°C.

It is important to understand what the aircrew will observe in the cockpit when MTA is needed. One scenario would be an aircraft with identical ETFs, resulting in identical MTA values for both dual and single engine. See PPC values in Figure 3.

UH-60/AH-64 PERFORMANCE PLANNING CARD
For use of this form, see TCs 1-212 and 1-214; the proponent agency is TRADOC

DEPARTURE			
PA / FAT		TAKEOFF GWT	
LOAD	DUAL ENG	SINGLE ENG #1	#2
FUEL			
	ATF ***.95***	ETF ***.95***	ETF ***.95***
	TR ***.952***	TR ***.952***	TR ***.952***
MAX TORQUE AVAIL	***98***	***98***	***98***
MAX ALLOWABLE GWT (OGE/IGE)			
GO/NO-GO TORQUE (OGE/IGE)			
PREDICTED HOVER TORQUE		/	
REMARKS:			

Figure 3

In this situation, when MTA is demanded the aircrew would observe 98% torque on ***both*** the #1 and #2 engine torque gauges, with the respective TGT for each engine at the TGT limiter (837-849°C). Torque from both engines would rise evenly (torque matching) up to MTA. TGT limiting would prevent the pilot from receiving more torque. Attempting to do so would result in rotor droop. See PDU indications in Figure 4.

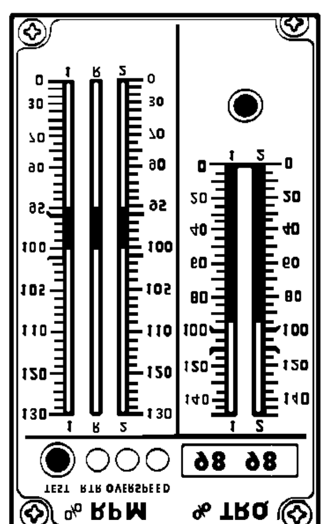

Figure 4

A second, and more common scenario would be an aircraft with ***different*** ETFs, resulting in different MTA values for each engine. See PPC values in Figure 5.

UH-60/AH-64 PERFORMANCE PLANNING CARD For use of this form, see TCs 1-212 and 1-214; the proponent agency is TRADOC				
DEPARTURE				
PA	FAT	TAKEOFF GWT		
LOAD		DUAL ENG	SINGLE ENG	
FUEL			#1	#2
		ATF .95	ETF .90	ETF 1.0
		TR .951	TR .902	TR 1.0
MAX TORQUE AVAIL		98	92	104
MAX ALLOWABLE GWT (OGE/IGE)				
GO/NO-GO TORQUE (OGE/IGE)				
PREDICTED HOVER TORQUE			/	
REMARKS:				

Figure 5

When MTA is demanded in this situation, the aircrew ***would not*** see 98% on the torque gauges, as this is only an averaged number between both engines. As the aviator demands power, torque on ***both*** engines would rise evenly to 92%. At this time, the #1 engine would reach its TGT limiter (837-849°C) and would remain at 92% torque. If the aviator continues to demand more power, the stronger 1.0 engine would produce up to 104% before reaching its TGT limiter (837-849°C). Thus, the aircrew would observe 92% and 104% torque respectively, with TGT on both engines at TGT limiting. See PDU indications in Figure 6.

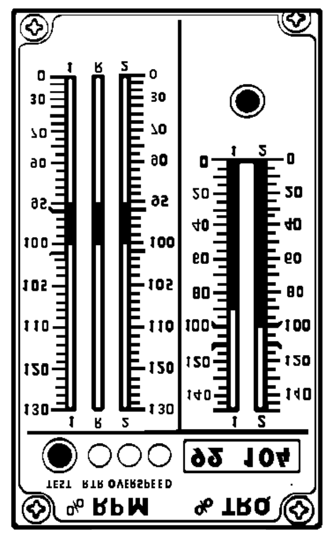

Figure 6

Attempting to demand more power in this case would result in rotor droop. Notice that with unequal ETFs, a torque split will be induced by the aviator when power demanded exceeds that of the weakest engine.

This is considered normal. Although this is a dual-engine situation and the #2 engine is above 100% continuous, as long as the ***average*** torque between both engines is at or below 100% (98% in Figure 5) there would be no transient limitation for this dual-engine power setting (-10 chapter 5). Refer to Figure 7 on transmission components and notice that this scenario does not exceed the continuous combined torque limit, dual-engine, for the main module.

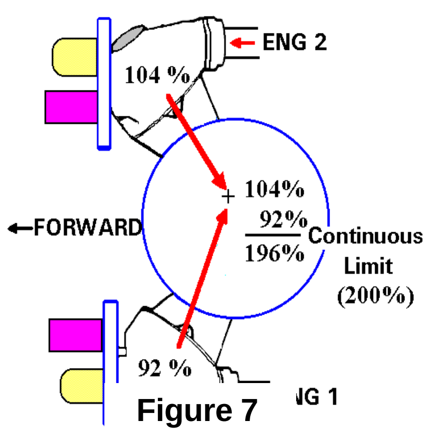

Figure 7

NOTE

With engine bleed air turned on, MTA is adjusted as follows:

a. Engine Anti-Ice On... -16%
b. Cockpit Heater On.. - 4%
c. No IR suppressors, or suppressors w/o baffles...+1%

Note that engine bleed air is used to pressurize the external range fuel system (ERFS), however, the bleed air loss is not significant enough to require MTA adjustments. Note also that cruise and hover power torque remain unaffected when bleed air is utilized. The reduction in torque is lost from MTA.

Understand also that the 16% torque reduction is a maximum value, which would result from the operation of ***both*** engine anti-ice and engine inlet anti-ice. Engine anti-ice uses 5th stage bleed air to heat engine swirl vanes, nose splitters, and inlet guide vanes. However, depending on the ambient air temperature, the engine inlet anti-ice valve may or may not open. If the ambient air sense port on the engine inlet detects a temperature of +4°C or below, the engine inlet anti-ice valve should open and additional bleed air will travel to the engine inlet section to warm the inlet to a minimum of 93°C. At temperatures of +4°C to +13°C, the engine inlet anti-ice valve may or may not open. At a temperatures above +13°C, the valve should not open.

If conditions are such that the engine inlet anti-ice valve remains closed, engine bleed air demand will be less due to engine anti-icing only, and the aircrew will probably not lose a full 16% from MTA. This can be observed during the engine HIT check by watching the difference in TGT rise when engine inlet anti-ice is on, as compared to when it is off. TGT will be higher when the engine inlets are heated, which results in reaching TGT limiting at a lower MTA. Regardless of whether engine inlet anti-icing is in operation or not, a 16% torque reduction will be used for flight planning purposes.

<u>MAX ALLOWABLE GWT</u> (OGE/IGE)- This is the maximum weight the aircraft is capable of, or allowed to operate at a 10 foot hover height for IGE operations, or to a 70 foot hover height for OGE operations. This weight will be limited by either engine capabilities or aircraft structural design. There is no reference in the -10 definitively stating that 70 feet defines an OGE hover, however, OGE hover height is defined in FM 1-203 (Fundamentals of Flight) as 1¼rotor diameters. 70 feet for an OGE hover in a Blackhawk is obtained by multiplying rotor diameter (53 feet 8 inches) by 125% (53.6 x 1.25 = 67 feet) which is then rounded to 70.

The maximum gross weight (MAX GWT) for UH-60A helicopters ***without*** the Engine Output Shaft- STUD BALANCE MWO or without the wedge mounted pitot static probes, is 20,250 pounds. The MAX GWT for UH-60A helicopters ***with*** the MWO provisions and wedge mounted pitot static probes is 22,000 pounds.

If the MAX GWT IGE or OGE is 20,250/22,000 lbs (as applicable), then the aircraft is ***structurally limited***. Although the engines may be capable of lifting more weight, the airframe is not. When the MAX GWT value is 20,250/22,000 lbs (as applicable), attempting to operate at a weight above that value will result in exceeding a structural design limitation and damage is likely.

If your MAX GWT IGE or OGE is less than 20,250/22,000 lbs (as applicable), then the aircraft is ***environmentally limited***. Although the airframe is capable of lifting up to the chapter 5 maximum, the engines cannot lift that much weight for the given environmental conditions. When the MAX GWT value is less then 20,250/22,000 lbs (as applicable), attempting to operate at a weight above that value will result in rotor droop, but no structural damage should occur.

<u>GO/NO-GO TORQUE</u> (OGE/IGE)- This value provides a way for the aircrew to verify that the aircraft weight is at or below maximum limits for the mode of flight intended. At a 10 foot hover height, this is the torque that will determine if the aircraft is at or below the maximum weight that the aircraft is capable of lifting to an IGE or OGE altitude. Hover power checks are normally done at an altitude of 10 feet. If performing slingload operations, plan a GNG value that will place the load at 10 feet AGL. Following are typical examples that aviators may be faced with during typical missions.

UH-60/AH-64 PERFORMANCE PLANNING CARD

For use of this form, see TCs 1-212 and 1-214; the proponent agency is TRADOC

DEPARTURE			
PA / FAT	TAKEOFF GWT		
LOAD	DUAL ENG	SINGLE ENG #1	SINGLE ENG #2
FUEL			
	ATF ***.95***	ETF ***.90***	ETF ***1.0***
	TR ***.951***	TR ***.902***	TR ***1.0***
MAX TORQUE AVAIL	***98***	***93***	***104***
MAX ALLOWABLE GWT (OGE/IGE)	***20,250***		
GO/NO-GO TORQUE (OGE/IGE)	***82***		
PREDICTED HOVER TORQUE		/	

REMARKS:

STRUCTURALLY LIMITED AIRCRAFT
(UNMODIFIED FOR 22,000 LBS MGWT)

Figure 8

Example #1- Refer to Figure 8 and notice that the aircraft MAX GWT OGE is a structural limitation, meaning that the MAX GWT is at the maximum chapter 5 allows (20,250/22,000 lbs). In this scenario, the UH-60A is unmodified and is therefore restricted to 20,250 lbs MAX GWT. With the PA and temperature used in this example, the hover chart indicates that the engines could have produced the power to lift ***20,500*** lbs to OGE, but because the aircraft is unmodified, the airframe could not support the additional weight and 20,250 (Chapter 5 maximum) is placed in the MAX GWT block.

In a case such as this, only one GNG value will be needed and this value will represent both IGE and OGE capability. If the maximum structural weight can be lifted to OGE altitudes, then it can obviously be lifted to IGE altitudes, which requires less power due to ground effect. In this scenario, if the torque required to maintain a stationary hover is at or below the GNG IGE/OGE value (82% torque in the example), the aviator has confirmed aircraft weight to be at or below

MAX GWT and any maneuver requiring OGE power or less may be attempted.

If the torque required to maintain a stationary hover is above the GNG IGE/OGE (greater than 82% torque in the example), then the aviator cannot operate in compliance with the -10 because he is exceeding the maximum structural gross weight of 20,250 lbs. The -10 requires an entry on the 2408-13-1 any time an operational limit is exceeded. The aircrew should verify conditions and computations for accuracy. If the GNG value is correct, the helicopter shall not be flown until corrective maintenance action has been taken. Some aviators may elect to land, burn down fuel or remove cargo to reduce weight, and then recheck their hover torque. If it is at or below the GO/NO-GO on the PPC, the aircraft would be below the maximum weight, but the fact is, the aircraft maximum structural weight was still previously exceeded and damage may have been done. In contrast, if the MAX GWT OGE is an environmental limitation (less than 20,250/22,000 lbs), then damage will not result to the aircraft by exceeding the OGE GNG and the aircrew would be able to reduce weight and try again.

NOTE

In a UH-60A, the aircraft will have to be unmodified (20,250 lbs MAX GWT) in order to have only one GNG representing both IGE and OGE. T700 engines can lift 20,250 lbs to OGE altitudes on cooler days, but a modified UH-60A is not capable of lifting 22,000 lbs to OGE at any PA or temperature combination shown on the hover chart. The stronger T701s of the UH-60L are capable of lifting 22,000 lbs to OGE and you will need only one GNG for IGE and OGE in these situations.

Example #2- With the same PPC conditions, but with a ***modified*** UH-60A, refer to Figure 9 on the following page. Notice that the MAX GWT OGE is an environmental limitation (20,500 lbs), meaning that the MAX GWT is less than what chapter 5 allows (22,000 lbs). The airframe could handle more than 20,500 lbs OGE, but the PA and temperature will not allow the engines to produce the necessary power to achieve OGE altitudes with weights greater than 20,500 lbs. This will require a GNG value for both IGE and OGE.

UH-60/AH-64 PERFORMANCE PLANNING CARD
For use of this form, see TCs 1-212 and 1-214; the proponent agency is TRADOC

DEPARTURE			
PA / FAT	TAKEOFF GWT		
LOAD	DUAL ENG	SINGLE ENG #1	SINGLE ENG #2
FUEL			
	ATF *.95*	ETF *.90*	ETF *1.0*
	TR *.951*	TR *.902*	TR *1.0*
MAX TORQUE AVAIL	*98*	*93*	*104*
MAX ALLOWABLE GWT (OGE/IGE)	*20,250/22,000*		
GO/NO-GO TORQUE (OGE/IGE)	*83 91*		
PREDICTED HOVER TORQUE		/	

REMARKS:

STRUCTURALLY LIMITED AIRCRAFT
(MODIFIED FOR 22,000 LBS MGWT)

Figure 9

In this scenario, if the torque at a 10 foot hover is at 83% (GNG OGE), then the aircraft weighs 20,500 lbs and the crew is at the maximum weight to perform OGE operations. As the aircraft ascends to OGE altitude, the aircrew could expect to see 93% and 104% torque once the aircraft reached approximately 70 feet AGL. 93% and 104% is your MTA from each engine, as indicated on the

PPC. The aircrew would not see 98% torque from both engines, as it is only a mathematical average between both engines. Note that any time your MAX GWT OGE is an environmental limitation (less than 20,250/22,000 lbs) the aircrew can expect to be using MTA upon reaching hover OGE altitudes.

If the torque required to maintain a stationary hover exceeds 83% (GNG OGE), but does not exceed 91% (GNG IGE), then only IGE maneuvers may be attempted. If the aircraft was hovering above GNG OGE at 10 feet and the aircrew attempted a climb to OGE altitudes, MTA values of 93% and 104% would be reached before obtaining out-of-ground effect and rotor droop would result if the climb attempt was continued.

Once again, if the torque at a 10 foot hover exceeds 91%, then the aircraft has been flown above the MAX GWT of 22,000 lbs. The helicopter shall not be flown until corrective maintenance action has been taken.

Example #3- Refer to Figure 10 and you will notice that for an aircraft that is environmentally limited for ***both*** OGE and IGE, (meaning that the MAX GWT is less than the maximum chapter 5 allows), the aircrew should not be able to exceed the GNG IGE. The GNG IGE will equal the MTA (90% in the example).

UH-60/AH-64 PERFORMANCE PLANNING CARD
For use of this form, see TCs 1-212 and 1-214; the proponent agency is TRADOC

DEPARTURE			
PA / FAT		TAKEOFF GWT	
LOAD	DUAL ENG	SINGLE ENG #1	SINGLE ENG #2
FUEL			
	ATF ***.95***	ETF ***.90***	ETF ***1.0***
	TR ***.951***	TR ***.902***	TR ***1.0***
MAX TORQUE AVAIL	***90***	***87***	***93***
MAX ALLOWABLE GWT (OGE/IGE)	***18,900/21,000***		
GO/NO-GO TORQUE (OGE/IGE)	***77 90***		
PREDICTED HOVER TORQUE		/	

REMARKS:

ENVIRONMENTALLY LIMITED AIRCRAFT
(MODIFIED FOR 22,000 LBS MGWT)

Figure 10

As such, if the aircrew tries to hover IGE at a heavier weight, rotor droop will develop when the engines reach their TGT limiters at 837-849°C. No structural damage should result.

In summary, it is very important to ensure accurate computation of MAX GWT and GNG values. Inaccurate calculations and/or a poor understanding can result in not having the necessary power available to successfully complete a maneuver and/or could result in aircraft damage. Extra vigilance must be used when attempting to operate an aircraft that is structurally limited OGE or IGE, meaning that it is capable of lifting chapter 5 maximum weights.

If the GNG OGE/IGE is exceeded for such an aircraft, the aircrew has very likely hovered a helicopter that is over MAX GWT, which requires maintenance action. It is important to be as accurate as possible on the weight and balance and cargo load weights, so as to ensure the aircraft is not above MAX GWT "on paper" before you attempt to weigh the helicopter at a hover.

NOTE

On page 6-4 of the ATM, dated 08 March 1996, all maneuvers requiring OGE power are listed. Other maneuvers in the ATM will indicate by means of a NOTE, that OGE power may be required. This will depend on such factors as barrier height, aircraft speed, winds, pilot technique, etc. The need for OGE power in these situations is left to the determination of the aircrew.

PREDICTED HOVER TORQUE (Dual Engine)- At takeoff GWT, this is the estimated torque required for a stationary 10 foot hover, dual engine, in zero wind conditions. The aircrew compares the actual hover torque against this value in an effort to validate actual takeoff weight. For external load operations, record the predicted torque required to hover at a height that will place the load at 10 feet AGL.

NOTE

If the actual hover torque is not equal to the predicted value, it could be attributed to some of the following conditions:

a. The aircraft weight is not what was predicted. Was the 365-4 reviewed? If the correct weight was used from the 365-4, and the actual hover torque is still different than predicted, the aircrew can work the hover chart backwards to determine the current weight.
b. Environmental conditions have changed since the computation of the PPC. Remember that hover values are based on zero wind conditions. Strong winds can affect hover performance. Hovering over other than level, smooth surfaces can also affect hover torque.
c. An error was made in deriving this value from the chart.

REMARKS- Use this area to note useful data for the particular mission, such as drag factors and computations.

CRUISE DATA

Cruise data is computed at the planned cruise PA and forecast FAT at that altitude. It is left to the aviator's discretion as whether to round values to the nearest 10 degrees and 2,000' PA, or to interpolate between higher and lower charts, or to round all values up (worst case). If forecast temperatures at cruise altitude are not available, use the surface temperature and apply the standard lapse rate of - 2°C for every 1,000' increase in altitude.

VELOCITY NEVER TO EXCEED (V_{ne})- The maximum permitted airspeed as a function of temperature, PA, and aircraft weight. This airspeed cannot be obtained in level flight. The aircraft will have to be in a dive/descent to achieve this speed. Exceeding this airspeed may cause the aircraft to encounter the effects of retreating blade stall, compressibility, and/or aircraft structural damage. Chapter 5 of the -10 states that retreating blade stall has not been encountered in one G flight up to the airspeeds shown on the V_{ne} chart. Note that retreating blade stall may be encountered at airspeeds much less than V_{ne} when maneuvering. Item b of the same paragraph discusses the application of Figure 5-8, which is used to determine airspeed/angle of bank combinations that will likely produce blade stall. As a technique, the aircrew may want to place the maximum angle of bank in the remarks block for reference purposes. While the airspeed/angle of bank chart is not an aircraft limitation, any maneuvering which results in severe blade stall and a significant increase in 4 per revolution vibration, is expressly prohibited by the -10. Compressibility is given consideration by referring to Figure 5-6 in the -10. Note that any airspeed below the dashed lines labeled "mach limits" could result in compressible flow over the advancing blades. Note that this should not be a problem for temperatures above -10°C. Lastly, aircraft structural damage and/or component failure is a possible outcome if the aircraft exceeds V_{ne} during flight.

If V_{ne} minus 15 knots is less than MAX RANGE airspeed, it will be the recommended maximum turbulence penetration airspeed for moderate turbulence (-10 chapter 8). The 15 knot speed subtraction from V_{ne} reduces the likelihood of the pilot exceeding V_{ne} due to airspeed fluctuations associated with turbulence.

<u>MAX TORQUE AVAILABLE</u> (MTA)- This torque can be computed in two ways. One method is to use the same hover charts used previously on the PPC, but with cruise conditions. The alternate method is to use the cruise charts by using the applicable ATF line where it meets the bottom of the chart (zero airspeed). Interpolate if the ATF is between .90 and 1.0. Understand, however, that identical MTA values will not be obtained between the two methods unless the temperature is in an increment of 10 C and the PA is an increment of even thousands (e.g. S.L., 2,000, 4,000). The cruise charts have fixed temperature and PA combinations, unlike the MTA chart, which has unlimited temperature and PA combinations. Unless the aviator can match the temperature and PA on the cruise chart, it is probably best to use the hover chart. This will allow the aviator to match the exact temperature and PA conditions, with no rounding error.

<u>CRUISE SPEED</u> (IAS/TAS)- Cruise speed is dictated by the mission or chosen by the pilot within aircraft limits. Indicated airspeed is the airspeed as shown on the airspeed indicator that has been calibrated for standard atmosphere at sea level and is uncorrected for airspeed system errors.

NOTE

Calibrated airspeed (CAS) is the indicated airspeed corrected for position and instrument error. Calibrated airspeed would be equal to true airspeed at standard atmosphere at sea level. If desired, CAS can be found by referring to the CAS placard located in the aircraft on the left hand side of the lower console. The difference between IAS and CAS is not enough to be considered significant. As such, a note in chapter 7 of the -10 states that conversion data from KIAS to KTAS is provided directly in the cruise charts without regard for other chart information (CAS).

TAS is calibrated airspeed (equivalent airspeed is not applicable in the absence of compressibility effects) corrected for error due to density altitude. Since the airspeed indicator is calibrated for the dynamic pressures corresponding to airspeeds at sea level conditions, variations must be accounted for when air density is other than standard.

When determining what speed to use for the PPC, the aircrew should use the speed that the aircraft will operate at for the majority of the flight profile. This will provide the best estimate of fuel flow (burn rate) per hour. For dual-engine operation, most aviators use 120 KIAS, however this will vary greatly depending on fuel endurance required and aircraft configuration (i.e. ERFS).

In determining single-engine cruise speed, the aviator has the option of choosing any speed that falls within the MIN/MAX SE speed range. The aviator may wish to consider using at least 80 KIAS or higher. 80 KIAS is the recommended airspeed for autorotation. Speeds below 80 KIAS would not ensure that sufficient airspeed was available to arrest the aircraft rate of descent, should the other engine become inoperative (-10 para 9.12). Autorotative decelerations initiated at speeds below 80 KIAS will most likely result in aircraft damage.

Although it is not always possible, a single-engine cruise airspeed should be chosen that will maintain cruise flight ***at or below*** continuous torque available single- engine. Torque settings maintained above the continuous value will limit the aircrew to 30 minutes of operation.

CRUISE TORQUE- This is the torque required to maintain the Cruise Speed (IAS/TAS) that the aircrew selects for the mission. When correcting for drag, the additional torque required to overcome the drag will be added to the clean torque value to ensure that the cruise speed can be maintained. For single-engine drag correction, be sure to first add the torque correction to the dual-engine torque ***before*** doubling the value, not after.

CRUISE FUEL FLOW- This is the predicted fuel flow (burn rate) that the aircraft should have at CRUISE TORQUE. Note that the cruise fuel flow requires a relatively constant torque setting to be accurate. Aircraft flying in the rear of formations typically consume 50 to 100 pph more fuel per hour than predicted. This will vary depending on formation size and aircrew proficiency in maintaining slot positions. Don't get caught short on multi-ship missions!

NOTE

With bleed-air extracted, increase fuel flow as follows during dual-engine operation
(-10 chapter 7):

a. Eng Anti-Ice On...About 60 lbs/hr
b. Heater On.............About 20 lbs/hr
c. Both On................About 80 lbs/hr

For single-engine fuel flow, reduce dual-engine values by one-half (-10 chapter 7).

In addition, when an IR suppressor system is installed and the baffles removed, the dual-engine fuel flow will ***decrease*** about 16 lbs/hr (8 lbs/hr single-engine). The decrease in exhaust back pressure improves engine efficiency.

NOTE

The -10 currently states in chapter 7 that fuel flow should be decreased when "***cruise*** IR suppressors are removed". This is the only place in the -10 that uses this terminology. Disregard the word "cruise", as there are no cruise IR suppressors in the Army inventory and there hasn't been for many years. The cruise system was never very effective at a hover or lower airspeeds and was replaced with the HIRSS.

CONT TORQUE AVAIL- This is the most torque the engines can produce continuously and remain out of the 30 minute engine operating limitations. The aircraft will be at the top of one or more of the continuous range(s) ← TGT 775°C, ↑ Ng 99%, or → Eng Oil Temp 135°C. As the name implies, there is no time limit on maintaining this torque.

As far as pre-mission flight planning is concerned, this torque value alone is limited in its application. The proper way to compute this value is to enter the chart horizontally at the cruise airspeed until you intercept the continuous torque line and then read straight down for the torque. Note however, that if the continuous torque line is to the right of your aircraft GWT line, then you will be in a climb if using CONT TORQUE AVAIL while maintaining a constant airspeed. So how would you apply this torque value?

This continuous torque, as it is currently used, may have value to the aircrew if fuel economy was not a concern and the crew wanted to make an extended climb of several thousand feet, while maintaining a given airspeed and remaining out of any 30 minute limits. Perhaps there is mountainous terrain to clear along the route. By entering the chart at a given airspeed, the groundspeed and estimated times enroute could be computed for flight planning purposes. The rate of climb could be computed by determining the excess power between CRUISE TORQUE and CONT TORQUE AVAIL for the airspeed selected (CONT

TORQUE AVAIL minus CRUISE TORQUE). This excess torque value would allow the aviator to refer to the Climb/Descent charts in the -10 (Fig 7-32/7-33) and compute a rate-of-climb and an approximate time to reach the desired altitude. Keep in mind that as temperature and PA change during the climb, so does CONT TORQUE AVAIL and/or airspeed, depending on what the aircrew is trying to maintain.

For another application, perhaps the aircrew is on an IFR flight enroute to a destination and ATC advises the crew to climb to a higher altitude. If there is more than 1,000' to climb, the pilot should climb at an optimum rate consistent with the aircraft capabilities until within 1,000' of the assigned altitude. By utilizing CONT TORQUE AVAIL, the aviator could climb at an optimum rate (not within 30 minute limits) while still maintaining the airspeed filed on the flight plan. From a practical application standpoint however, the CONT TORQUE AVAIL value would not need to be known or computed for this scenario. For large rates of climb, power can be increased until TGT indicates 775°C (Maximum continuous TGT), which will produce CONT TORQUE AVAIL without having to compute the torque value in advance.

As previously mentioned, using CONT TORQUE AVAIL on the PPC for a given airspeed will make the aircraft climb, if the continuous torque line on the chart is to the right of your aircraft GWT line. A constant climb enroute to a destination is not practicable. Although the ATM/-10 does not say to use CONT TORQUE AVAIL in this manner, perhaps a more practical and useful application would be to obtain a ***continuous level airspeed***, (rather than a continuous torque) which could be used in the flight planning stage, and would allow the aircrew to determine times enroute and flight plan speeds. The following method is a technique only and can be used in addition to, rather than in replacement of, a CONT TORQUE AVAIL value!

Rather than determining a torque value for a given airspeed (as is currently done), reverse the process and determine a continuous airspeed for a given torque (CONT TORQUE AVAIL). The aircrew may obtain a continuous ***level*** airspeed by tracing the continuous line upward until reaching the intersection of the aircraft GWT line. Read horizontally to indicated airspeed. This will provide the aircrew with a speed value to fly level as quickly as possible to the destination, while remaining out of any 30-minute limits. This is a more practical pre-mission planning value that is probably more useful to the aviator.

On a different matter, notice that unlike the ATF lines, there is only one CONT TORQUE AVAIL line on the cruise charts. The CONT TORQUE AVAIL line on the cruise chart represents an ATF of .95 or greater. If the aircraft ATF is lower than .95, the CONT TORQUE AVAIL value will be ***less than*** the PPC indicates, but there is no means to compute how much less (-10 chapter 7).

Notice that the continuous line stops at approximately 70-80 KIAS. For torques below these speeds, read straight down from where the continuous line terminates to obtain this value. Do not interpolate below the line.

Both the continuous and ATF lines are slanted to the right as they move upward. This is to show the increase in torque produced by the engines as the aircraft increases speed. With increased airspeed, the inlet of each engine will receive a larger volume of air to work on, which results in greater efficiency and cooler TGTs, hence TGT limiting will occur at a higher torque setting.

Note that the continuous line will not always appear on a cruise chart. As an example, notice the PA and temperature combination of 20°C and 0' PA. The continuous line is missing. When operating in colder temperatures, the improved efficiency of the engines will cause the 100% MTA transmission limit to be reached before the engines enter a 30 minute limit. CONT TORQUE AVAIL will then be the same as MTA.

NOTE

The ATM says that an adjustment should be made, as appropriate, for engine anti-ice or cockpit heater if in use. Use the same values used in MTA adjustments (-16% engine anti-ice, -4% heater).

As mentioned earlier, bleed air reduces torque available from the top end of MTA. Cruise and hover torque remain unaffected. Why then do we adjust CONT TORQUE AVAIL for bleed air operation? When bleed air is taken from the engines, they operate less efficiently and result in higher TGTs to produce the same amount of torque as without bleed air usage. Just as MTA is reduced with bleed air extracted due to reaching TGT limiting (837-849°C) at an earlier value; CONT TORQUE AVAIL is also going to be lower due to reaching the maximum continuous TGT value earlier (775°C).

MAX R/C OR ENDURANCE IAS- The Max R/C and ENDURANCE IAS is the airspeed where total drag is the lowest for a given combination of GWT and environmental conditions. MAX ENDURANCE IAS will allow the aircrew to fly straight and level for the longest period of time (time aloft or loiter time) due to the lowest fuel burn rate.
This airspeed will produce MAX ENDURANCE only when operating at a torque value that provides level flight. This associated torque value can be derived from the cruise chart if desired.

Normally, the ENDURANCE IAS value will work satisfactorily for MAX R/C performance. MAX R/C IAS is the airspeed that allows the aircraft to climb from one altitude to a higher altitude in the least amount of time when using MTA. Also, in the event of a single-engine failure, this airspeed will give the aircrew the best chance of maintaining flight. If continued level flight is not possible, this airspeed will provide the aircrew with the minimum rate of descent.

NOTE

> Although the aircraft may be at the MAX R/C airspeed, it will only produce a maximum rate of climb if MTA is utilized. Any torque setting less than the maximum, will produce the BEST R/C performance for the power applied. Notice then that the MAX R/C airspeed will always be the lowest total drag airspeed, but depending on how much power is used will determine what it is called and what it will provide.

As mentioned earlier, the MAX ENDURANCE IAS normally works satisfactorily for MAX R/C performance. It is left to the aircrew's discretion as to whether an airspeed correction is necessary. Following is a brief explanation of why MAX R/C airspeed may need to be corrected for large rates of climb.

The -10 in chapter 7 describes the errors associated with the airspeed system in this aircraft. Although the airspeed system errors are small in level flight, there can be relatively large system errors associated with climbs and descents.

There are two different pitot static systems on the UH-60A. The first type is the original, and increasingly uncommon, flush mounted pitot tubes. These can only be found on UH-60A model Blackhawks. The second type is the wedge mounted pitot tubes which rotates the tubes 20°outboard and 3° nose down.

All indicated airspeeds shown on the cruise charts are based on level flight of an aircraft with the ***modified*** pitot tubes.

To minimize sensing errors, the pitot tubes are in a location and position that allows minimum disturbance of air caused by aircraft motion. An error results from climbs less than 1400 fpm and will result in a ***lower*** indicated airspeed (-10 Figures 7-35 thru 7-37). Climbs greater than 1400 fpm will result in a ***higher*** indicated airspeed. These pitot tube sensing errors occur as a result of disturbed airflow in and around the pitot tubes. Note on Figures 7-35 thru 7-37 (airspeed system correction) that autorotative airspeeds should also be corrected due to the large sink rates involved.

MAX RANGE IAS- This is the airspeed which will take you the farthest distance for a given amount of fuel. This is the best ‘miles-per-gallon' airspeed under zero wind conditions. This is a good value to use for planning when the mission will not allow large fuel reserves between refueling stops. This airspeed can also be used as the Maximum Turbulence Penetration Airspeed, provided it is less than V_{ne} minus 15 knots (-10 chapter 8). A method of estimating MAX RANGE speed in winds is to increase IAS by 2.5 knots for each 10 knots of effective head wind (which reduces flight time and minimizes loss in range) and decrease IAS by 2.5 knots for each 10 knots of effective tail wind for economy (-10 chapter 7).

SINGLE-ENG CAPABILITY IAS (MIN/MAX)- This is a very important block, but unfortunately, it often receives very little attention by aircrews. Engine failures are uncommon in the Blackhawk, but the consequences can be undesirable and even unavoidable during certain flight modes. Quick application of these values will often make the difference between flying away to a safe landing, or merely extending your glide path to the crash sight. Keeping your airspeed between these two values in a single-engine situation is critical!

MIN SE IAS is the minimum airspeed possible without losing altitude during single-engine operation. At the MIN SE IAS, the aircraft would be operating at maximum torque available 30 minutes and TGT would be at the limiter. Remember that if the derived airspeed is less than 40 KIAS, indicated airspeed will be unreliable (-10 chapter 7) and perhaps unreadable. This is the slowest aircrews should attempt to operate single-engine. There are some modifying variables that will affect operation at or below this value. They will be discussed after a basic explanation of minimum and maximum values.

The MIN SE IAS can be applied not just for cruise flight, but for takeoffs and landings. If an engine failes during takeoff, the aircrew should note their airspeed. If the aircraft has accelerated at or above the MIN SE IAS, the aircraft should be able to continue flight to a suitable landing area. The pilot on the controls will need to act promptly with collective, regardless of whether the aircraft is at or above the MIN SE IAS. If collective pitch is greater than the corresponding TGT limiter of the operating engine (power available), then the resultant rotor drag will result in rotor droop and a resulting aircraft descent, even though the aircraft is above MIN SE IAS! Note also that the aircrew does not have to attempt continued flight, but may elect to land immediately if sufficient runway remains ahead.

If an engine fails below this value, the aircrew must make a quick decision, based on altitude attained, runway remaining, and aircrew reaction time. If there is sufficient altitude available, the pilot on the controls can attempt to lower the nose and adjust collective to minimize rotor bleed-off while attempting to trade altitude for airspeed that will allow the aircraft to attain single-engine “fly away” airspeed (MIN SE IAS). The aircraft can then accelerate and climb to a safe cruise airspeed and altitude and complete a roll-on landing as soon as practicable.

If there is insufficient altitude available to trade for airspeed, then the aircrew must maintain controlled flight to the ground, as a forced landing will be unpreventable. Rotor bleed-off may occur quickly and the pilot on the controls will need to reduce collective to help minimize rotor bleed-off, without developing a high rate of decent. Aircraft damage may be unavoidable.

Concerning single-engine roll-on landings, the ATM requires that the aircraft touch down below 60 knots ground speed, but above ETL. However, if the aircrew thinks that keeping the aircraft above ETL (16-24 knots) will ensure the aircraft keeps flying, there could be an unpleasant surprise coming. As the ATM states, the aircraft should not be decelerated below MIN SE IAS until obstacles in the flight path have been cleared. It would be even more conservative not to decelerate below MIN SE IAS until the landing area is assured (within reach).

The MIN SE IAS on aircraft can be well above ETL. If the aviator needed to arrest a sink rate during a roll-on approach, he would likely droop RPM R if below MIN SE IAS, ***even though he is still above ETL***. If flying a shallow approach angle, as is typically done for roll-on landings, altitude may not be available to recover.

MAX SE IAS is the maximum airspeed possible without losing altitude with a single engine operating. If the derived maximum airspeed exceeds 130 KIAS, use 130 KIAS (max chapter 5 airspeed for one engine operative). If at the MAX SE IAS, the aircraft would be operating at maximum power available 30 minutes and TGT would be at the limiter. If the aircraft is operating above the MAX SE IAS value when an engine failes, rotor-droop will occur quickly. Delayed pilot reaction in slowing the aircraft down will cause rotor bleed-off and altitude loss. It is a good technique not to operate low-level above the MAX SE IAS, due to minimal altitude available to recover in the event of slow engine failure recognition and/or reaction time by the aircrew! Remember, rotor RPM has already begun by the time the low-rotor audio activates (RPM < 95%), and even the sharpest aircrew may not be able to respond in time.

It's important to note two significant areas with respect to this block. First, remember that the accuracy of these values depends on which engine becomes inoperative. These figures are based on the lowest ETF engine operating and at takeoff GWT. If the lowest ETF engine is the one that fails, then the figures will be conservative. The stronger engine will power the aircraft through a larger speed range. This speed range will also widen as fuel is consumed during the mission and the aircraft becomes lighter.

Secondly, both the minimum and maximum airspeeds are based on cruise PA and temperature. As such, the airspeeds are for OGE altitudes. Don't assume that flight is not possible below the minimum single-engine airspeed. If operating IGE, airspeeds below the minimum single-engine airspeed, and/or hovering flight may be possible.

After completing a few drag corrections for MIN/MAX SE IAS, an interesting problem may occur. Referring to Figure 11, notice that after correcting for drag, the CRUISE TORQUE section indicates that the sling load can be flown single-engine at 80 KIAS. The sling load requires an additional 8% torque to overcome the drag (82 + 8= 90%). This is less than the 98% MTA that is available for the weakest engine (No. 1).

Notice also that the actual Takeoff GWT (17,000 lbs) is less than the MAX ALLOWABLE GWT- SE after a correction for drag (19,200 lbs). This also indicates that the aviator should be able to fly single-engine with the sling load.

GO/NO-GO TORQUE (OGE/IGE)			
PREDICTED HOVER TORQUE			
REMARKS: ***3000 POUND SLING LOAD*** ***16 σ F*** ***1.6 DMF***		***TAKE-OFF GWT-17,000 POUNDS***	
CRUISE DATA			
PA ***2000*** / FAT ***15***	Vne ***193***	***Vh***	
	DUAL ENG	SINGLE ENG	
	TR ***.965***	TR ***.932***	TR ***1.0***
MAX TORQUE AVAILABLE	***101***	***98***	***105***
CRUISE SPEED	IAS /TAS	IAS ***80*** /TAS	
CRUISE TORQUE		***82 σ 90***	
CRUISE FUEL FLOW			
CONT TORQUE AVAILABLE			
MAX R/C OR ENDURANCE IAS			
MAX RANGE IAS	/	@ ***49%***	
SINGLE-ENG CAPABILITY IAS (MIN/MAX)		***34*** / ***105 σ 69***	
MAX ALLOWABLE GWT - SINCLE-ENG		***20,000 σ 19,200***	
SINGE-ENG MAX R/C IAS (MAX GWT)			

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The inconsistency is found in the MAX SE IAS value. Notice in the example that after the drag correction is made, a value of 69 KIAS was obtained for MAX SE IAS. This "maximum" value is ***less than*** the 80 KIAS cruise that we earlier determined to be achievable with the sling load. Why is the MAX SE IAS less than the cruise IAS? This does not always occur, bu **Figure 11** on conditions. In some situations, a MAX SE IAS is no[illegible] for drag, even though a CRUISE IAS was.

The problem arises due to the different methods by which drag is determined between the CRUISE TORQUE and MAX SE IAS values. Remember the important principle that total drag increases as airspeed increases above MAX ENDURANCE IAS. There is a direct correlation between the two. Therefore, if the cruise chart is entered at a higher airspeed value, the resulting total drag will be larger. This is key to understanding the problem. The drag correction for the CRUISE SE airspeed of 80 KIAS was accurate because the 80 KIAS that the drag was derived from, was from an airspeed that could be obtained with the sling load. There was enough torque available to overcome the drag and obtain 80 KIAS. Therefore, the drag used correlated to the correct airspeed.
Contrast the above method with MAX SE IAS. The bottom of the chart is entered at half of the lowest MTA single-engine (49% in the example). Trace 49% torque vertically on the chart to the second intersection of the GWT line (17,000 lbs) and trace horizontally to read MAX IAS clean and the torque adjustment for drag.

The problem is that the torque adjustment for drag was determined from a MAX SE IAS ***for clean configuration***, which is not attainable with a sling load. The MAX SE IAS for clean configuration was already using ***all available torque***, and there was no extra torque available to overcome the drag necessary to achieve this speed with a sling load. Therefore, the drag correlating to the clean airspeed value obtained earlier is going to be too high, since that speed will never be reached. This causes the pilot to reduce too much torque from the halved MTA single-engine value, resulting in a MAX IAS for drag that is too low when the chart is reentered.

The way to correct for this problem with MAX SE IAS is by trial and error. Begin by choosing an airspeed that might be obtainable, then start "bracketing down" if the airspeed is too high (requires more power than MTA to achieve), or "bracketing up" if the airspeed is too low (requires less power than MTA to achieve). Eventually, a maximum airspeed can be found that works. If the torque required is equal to or less than the MTA, the airspeed value can be obtained with drag. Refer once again to Figure 12 on the following page for an example of the bracketing method.

- 1st Try -

100 KIAS

™ Cruise TRQ- 46 x 2= 92% SE Clean
™ 4% σ TRQ x 1.6 DMF = 6.4% to overcome drag. Rounded to 7.0
™ 46 + 7= 53% Double to 106% SE Only have 98% available. **TOO FAST**.

- 2nd Try -

GO/NO-GO TORQUE (OGE/IGE)				
PREDICTED HOVER TORQUE			/	
REMARKS: ***3000 POUND SLING LOAD*** ***16 σF*** ***1.6 DMF***		***TAKE-OFF GWT-17,000 POUNDS***		
CRUISE DATA				
PA ***2000***	FAT ***15***	Vne ***193***	***Vh***	
		DUAL ENG	SINGLE ENG	
MAX TORQUE AVAILABLE		TR ***.965*** ***101***	TR ***.932*** ***98***	TR ***1.0*** ***105***
CRUISE SPEED		IAS /TAS	IAS ***80*** /TAS	
CRUISE TORQUE			***82 σ 90***	
CRUISE FUEL FLOW				
CONT TORQUE AVAILABLE				
MAX R/C OR ENDURANCE IAS				
MAX RANGE IAS		/	***@ 49%***	
SINGLE-ENG CAPABILITY IAS (MIN/MAX)			***34 / 105 σ 90***	
MAX ALLOWABLE GWT - SINCLE-ENG			***20,300 σ 19,200***	
SINGE-ENG MAX R/C IAS (MAX GWT)				

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Figure 12

In summary, single-engine cruise speed of 80 KIAS was obtainable with a sling load. The 90% torque required to fly 80 KIAS was less than the MTA single-engine (No. 1) of 98%. Since there was 8% more torque available than was necessary, the "bracketing down" method was used, by beginning with a higher IAS of 100 KIAS. After computation, 100 KIAS required too much torque (106%). 95 KIAS required too much torque (104%), but was closer to the 98% MTA that would power the aircraft in level flight. Finally, 90 KIAS required 96% torque, just below the lowest MTA single-engine and would therefore be the actual MAX IAS SE. A speed of 90 KIAS should be entered on the PPC in place of the 69 KIAS previously recorded.

MAX ALLOWABLE GWT-SINGLE ENG- This is the maximum weight that one engine is capable of powering in level flight. As mentioned before, this weight is based on the weakest of the two engines available. Pay particular attention to whether you will be operating DE at weights above this value. If flying at a weight above MAX ALLOWABLE GWT- SE, an engine failure will force a controlled decent and landing with power, if RPM R is to be maintained in the normal range. Flying above MAX ALLOWABLE GWT- SE should be identified in the risk management process. If the flight is over water or heavily wooded and/or mountainous terrain, such conditions increase the risk involved with a forced landing. If it isn't an operational necessity, avoid this situation. Consider adding another aircraft to the mission to distribute the load.

ERFS operations will commonly cause the aircraft to operate above the MAX ALLOWABLE GWT-SINGLE ENG value for high drag configuration (external tanks attached). This cannot be avoided and increases the risk during single-engine situations. Aircrews may have little choice but to jettison the external tanks (or any external loads for that matter) in order to maintain single-engine flight. As a technique, if the aircraft has to operate above the MAX ALLOWABLE GWT-SINGLE ENG value for high drag configuration, the crew can determine the necessary amount of fuel which needs to be consumed in order to lower the aircraft GWT below the MAX ALLOWABLE GWT-SINGLE ENG value. As a technique, this indicated fuel value and the approximate time it will be reached during the flight profile (hours and minutes after takeoff) can be noted and recorded in the remarks section of the PPC. This will heighten aircrew awareness of aircraft capabilities and hopefully reduce reaction time based on the flight profile.

FUEL MANAGEMENT

This section of the PPC is used to record the in-flight fuel consumption check, to include fuel burnout and appropriate reserve entry time.

ARRIVAL

This section is not required if the arrival conditions do not change significantly from the take-off conditions. Significant change means a change (increase) of over 10°C; 2,000' PA; and/or 1,000 pounds gross weight. If the arrival section is used, record the forecast PA and FAT at your destination at ETA.

It is important to remember that when flying to a higher altitude or higher temperature destination, the aircrew will have to check the GNG torque at the departure point before leaving. This will ensure that the aircraft is not above the MAX GWT for the ***arrival destination***. ***Do not use the GNG value in the departure section of the PPC to determine if hover capability exists at your destination.***

Failure to use the correct values in this situation could result in the pilot running out of power, ideas, and altitude all at the same time because the aircraft is above MGWT! Refer to Figure 12 on the following page for an example of this situation.

If the aircrew were going to fly to a pinnacle (which is 6,000 feet MSL), and the departure point elevation is 2,000' MSL, the MAX GWT that the aircraft can lift will be significantly less at the higher altitude (750 lbs less).

The GNG block on the PPC reflects ***departure data***, which will not be correct for the destination. If the aircrew used departure data to determine the GNG (normal method), then the wrong MAX GWT (19,500 lbs) would be verified, rather than the MAX GWT for the destination (18,750 lbs).

What's the solution? Use the MAX GWT for the arrival and add any fuel that will be consumed on the way to the destination.

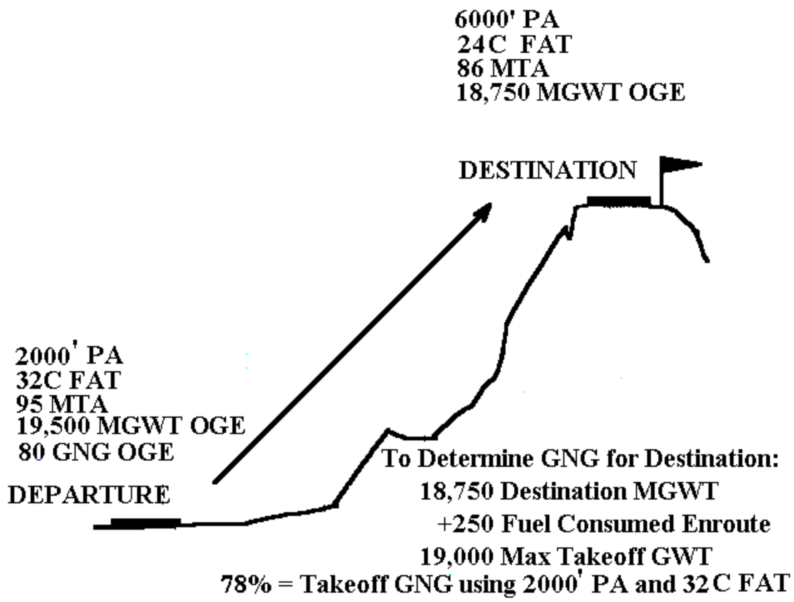

Figure 13

Compute a GNG for the departure airfield using this GWT (19,000 lbs) **at departure conditions** (2000' PA and 32°C FAT).

The aircrew must ensure that they are at or below this GNG (78%) before leaving for the destination. Refer again to Figure 12 to see the computation process.

Keep in mind also that an approach to an OGE hover at the pinnacle would require all power available if performed at MAX GWT. There would be no excess power available to compensate for downdrafts or less than perfect approaches.

It is always wise to ensure you have a few percent more torque available than will be required to hover OGE. This will give you an added safety margin for less than ideal situations that may be encountered during the approach.

RECOMPUTATION OF PPC DATA

The PPC will be recomputed whenever conditions change significantly. Page 6-20 of the ATM defines a significant change as an ***increase*** of 1,000 pounds GWT, 10°C, or 2,000' PA. Note that GNG ***must also*** be adjusted by decreasing this value by 1% for each 10 C decrease in temperature. Although a decrease in temperature would make all other values on the PPC more conservative, the GNG will get the aviator in trouble. The colder temperatures would allow the same 20,250/22,000 aircraft to hover with ***less*** torque. Therefore, operating at the higher (original) GNG torque value would mean the aviator is are actually hovering an aircraft weighing ***more*** than the chapter 5 maximum.

Accurate PPC completion and interpretation is critical to safe and successful mission accomplishment. Regular use of this information will enable the aircrew to receive maximum safe utilization of the helicopter and provide a basis for a sound foundation in performance planning ■