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TWIN ENGINE HELICOPTER POWER REQUIREMENTS

1. PURPOSE:

The purpose of this document is to define the power spectrum during normal and emergency operations of a twin engine helicopter and thereby to postulate suitable power plant rating structures.

The document does not address the power requirements for single engine helicopters or those with more than two engines.

2. ENGINE RATINGS:

Rating structures are used to define "time at power" which enables a helicopter to achieve its optimum performance while, at the same time, addressing issues of airworthiness and safety.

The rating structure is the means by which the engine's life consumption in service is related to its output power capability as demonstrated in the manufacturer's qualification program.

Factory engine testing to these specific ratings, which are imposed as mandatory limits on the pilot, forms a practical but approximate method of limiting the rate of engine life consumption in order to achieve acceptable in-service lives.

3. RATING DEFINITION:

A rating is defined as a minimum power level, delivered at specified atmospheric conditions for a maximum specified time duration, without exceeding operating limits over the life of the engine. For example, a "takeoff" rating, at sea level, ISA which can be used only during that phase of flight, and is limited in duration to "x" minutes, will be restricted to the appropriate engine speed, turbine temperature and torque limits. All ratings must be demonstrated during certification and the ratings may, or may not, be demonstrated during the acceptance process.

A rating is recognized by the airworthiness authorities as a restriction for safety consideration but may sometimes be imposed by the engine manufacturer as a commercial consideration.

4. HELICOPTER ROLES:

The rest of this document considers firstly the power requirements for various operations and flight conditions of the twin engine helicopter and secondly how the engine ratings can be structured to accommodate these requirements, while giving due consideration for engine service life.

The use of helicopters is broadly summarized as follows:

OPERATOR	ROLE	CRITICAL CONSIDERATIONS
Military & Civil	Passenger/Internal Freight Transportation	Minimum decision point in takeoff
Military & Civil	Air Sea Rescue	Prolonged Hover
	Carriage of External Load	Engine Failure in Hover
Military	Anti-Submarine Warfare Sonar Dunking	As above plus land back on ship
Military	Battlefield	Engine failure in high power maneuver. Enroute OEI at low altitude requiring maneuvering.

The bulk of helicopter operations is made up by the conventional transport role and, therefore, could form the basis of a generalized rating structure. Other specialized uses should form an addendum or a modification to the rating structure.

4. (Continued):

The power requirements for twin engine and OEI operation in the transportation role can be stated as follows:

MODE	TWIN ENGINE OPERATION	DURATION	OEI	DURATION
Takeoff	Liftoff - accelerate to V1 climb at 90-100% A/C TRX limit. After CDP accelerate V2 climbing.	5 min	Emergency power at CDP for transition. Reduce power for climb or obstacle clearance.	30 s 2 min
Climb/ Cruise	60-80% A/C TRX limit.	Continuous	Power to achieve minimum of 150 ft/min ROC at 1000 ft above site. Cruise to Base	Unlimited when needed
Descent	20-0% A/C TRX limit.	Minutes	--	--
Land	Up to over 95% A/C TRX limit dependent upon technique.	Up to 30 s	Dependent on ability to off-load fuel.	Up to 1 min

<u>Terminology</u>

OEI One Engine Inoperative
TRX Transmission Torque Limit
CDP Critical Decision Point
ROC Rate of Climb
V1 1st Segment Climb Velocity
V2 2nd Segment Climb Velocity

4. (Continued):

The typical power requirement for the twin engine transport role helicopter can be summarized as follows:

a. Twin Engine

1. A short duration power (up to 5 min) is required for takeoff to produce 100% TRX on the aircraft transmission. This power level is required over the full takeoff envelope, hence a high degree of flat-rating can be assumed.

2. Power levels to produce 60-80% TRX are required continuously for the majority of the flight. Ideally the engine should not suffer any significant life consumption during this regime.

3. A short duration power (up to 30 s) is required to produce a high level torque for landing. This level is a little less than the takeoff level due to fuel burn but this may be ignored for short duration flights.

b. OEI

1. A short duration power (up to 30 s) is required to transition to higher forward speed at or around the CDP. It may be necessary to specify this power at a reduced power turbine speed owing to the rotor speed decay on some aircraft.

2. A further short duration power (up to 2 min) is required to produce a power level slightly lower than 1) to restore rotor speed if decayed and climb away clearing obstacles.

3. An extended duration (several hours) is required to produce a power level to sustain cruise speed back to base or to diversion. This requires a power level which will enable the aircraft to climb sufficiently to clear any obstacles encountered.

4. A short duration power level (up to 1 min) is required to produce a power level to allow safe landing (run-on if possible) at base.

In ratio terms with the "takeoff" rating as the base of 1.0, these power levels and durations are likely to be:

TWIN			OEI			
1.	Takeoff and land 1.00	5 min	1.	CDP Transition	1.25	30 s
			2.	Climb Out	1.10	2 min
2.	Cruise 0.60-0.80	Continuous	3.	Cruise	0.95	Continuous

4. (Continued):

Note: The relationship between the base 1.0 ("takeoff") of this table and the aircraft 100% TRX implies the degree of flat-rating the aircraft designer has chosen for the aircraft/engine combination.

Other Roles

There are two main further implications of the other roles described:

1. The need to provide hover power up to 100% of TRX for periods beyond that of the takeoff.

2. The need to provide a high level power for a short duration to cover the single engine failure in the hover. This is generally referred to as the "fly-away" and is similar to the failure at takeoff situation except that it is at a lower height above the ground and there is no obstacle to clear.

A further minor difference is that the battlefield role requires a higher level of power for OEI since the "enroute" is often carried out over hostile conditions and optimum cruise may not necessarily be possible.

A chart, parallel to the basic transportation role can be made:

TWIN			OEI			
1.	Takeoff and Prolonged Hover	0.90-1.00 1 h	1.	Flyaway Transition	1.25	30 s
2.	Cruise 0.60-0.80	0.60-0.80 Continuous	2.	Flyaway Climb Out	1.10	2 min
			3.	Anti-tank	1.08	30 min
			4.	Enroute	1.05	Continuous

Summary

The foregoing gives the power spectrum for the different roles in which twin engined helicopters are used.

The main use is undoubtedly the civil and military transportation role and this model is useful in defining a generalized power rating structure.

Additional power levels/durations should be treated as extensions of the baseline structure with special provisions made in the regulations for the certification of these extensions. Since ratings are heavily dependent on OEI considerations, methods to record engine life consumption can optimize their effectiveness.