INTRODUCTION TO TURBOPROP ENGINE TYPES

The turbopropeller engine consists of a gas turbine engine driving a propeller. Most of the energy of the gas flow (air and burned fuel) is used to drive the propeller and compressor. The remaining energy, in the form of differential velocity of the airflow exiting the turbine, provides a small amount of residual thrust (effectively, a small amount of jet propulsion). Additional information on the specifics of the gas turbine cycle is provided elsewhere in this training package.

There are two basic types of turboprop engines:

1. Single shaft
2. Free turbine

The main difference between single shaft and free turbines is in the transmission of the power to the propeller.

In the majority of turboprops, the fuel pump is driven by the engine. This is known as "direct drive." In some older types of engines, the fuel pump is driven by the propeller, which can affect proper response to an engine failure. Refer to type-specific procedures.

Single Shaft. In a single-shaft engine, the propeller is driven by the same shaft (spool) that drives the compressor. Because the propeller needs to rotate at a lower RPM than the turbine, a reduction gearbox reduces the engine shaft rotational speed to accommodate the propeller through the propeller drive shaft.

Free Turbine. In a free-turbine engine, the propeller is driven by a dedicated turbine. A different turbine drives the compressor; this turbine and its compressor run at near-constant RPM regardless of the propeller pitch and speed. Because the propeller needs to rotate at lower RPM than the turbine, a reduction gearbox converts the turbine RPM to an appropriate level for the propeller.

The chief advantage of the free turbine is that it reduces torque loads during engine start, since the start mechanism does not have to rotate the propeller and reduction gear, but only the compressor and its turbine. In a single-shaft engine, the starter must rotate not only the engine basic components, but the reduction gear and a propeller as well. An important requirement of the single-shaft engine is that the propeller must be able to move to a very fine pitch setting (8° to 12°) before startup of the engine, so that the power required to turn the propeller while the engine is idling is kept to a minimum. Propellers may be in a high-pitch or feather condition during the start of free-turbine engines.

SHAFT HORSEPOWER (S.H.P.)

The total work of the turboprop gas turbine engine is taken out as shaft horsepower (S.H.P.) to drive the propeller rather than as the equal-and-opposite kinetic energy of the accelerated air expelled out the exhaust of a turbojet. However, not all the energy of the air in a turboprop engine has been used to drive the compressor and propeller; there remains a small residual amount of energy from the accelerated air. This provides some additional thrust in the form of jet exhaust. The proportion of total thrust between the propeller and the jet force is about 90% propeller to 10% jet.

It is often useful and sometimes necessary for the pilot to know the S.H.P. output of a turboprop engine. Since the torque (that is, the reaction of the complete engine to the power output) is directly proportional to the S.H.P., measurement of the torque gives the desired information. Torque meters can be calibrated to read either torque (ft.-lb.) or S.H.P.

The weight of a turboprop engine is about half that of a comparable piston engine. The propulsive efficiency of the turboprop is at its maximum at speeds below about 450 knots; above this speed, propeller efficiency falls off.

ADVANTAGES OF THE TURBOPROP OVER THE TURBOJET

By using a propeller, the following advantages are gained:

a. The amount of power available for propulsion is largely independent of the forward speed of the aircraft, so that more power is available during the initial stages of the takeoff run.
b. A slipstream is produced behind the propeller that improves elevator and rudder control at low speeds.
c. The engine can be run under more efficient and economical conditions at low and medium altitudes, and retains these two qualities at low aircraft speeds.
d. With the use of interconnected engine and propeller controls, the power response to throttle movement is more rapid than that of a turbojet engine.
e. Operations can be conducted from shorter runways.