FLIGHT ENVELOPE

NO EXTERNAL STORES
GROSS WEIGHT—16,000 LB

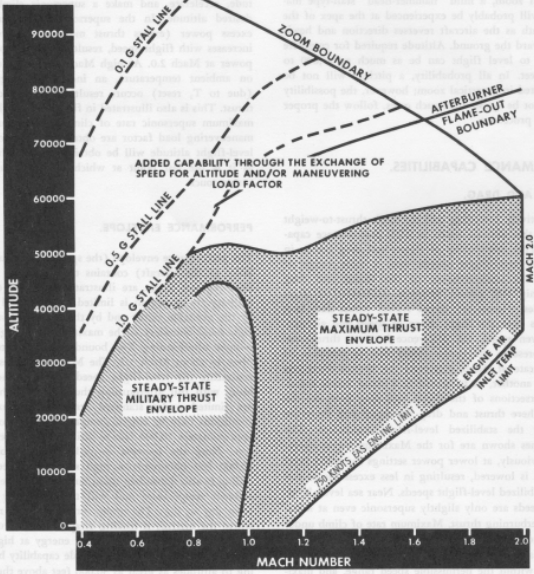

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Figure 6-6

available from the engine and steady speeds cannot be maintained without loss of altitude. Therefore, careful flight planning is necessary for optimum utilization of zoom capabilities.

CLIMB.

At Maximum thrust, the high rate of climb at best climb Mach number results in a steep flight path angle. Care should be exercised following takeoff to anticipate the high forward acceleration of the aircraft as climb speed is approached and to assume the proper climb attitude to ensure maximum performance. Figure 6-7 shows relative angles for the various climb configurations.

ZOOM CLIMBS.

WARNING

The maximum performance zoom climb is a hazardous maneuver which can result in a spin and should be performed only if the operational requirement warrants.

A zoom climb forms an important aspect of the performance capability of the aircraft. It is the quickest way to reach a higher altitude once an adequate level of total energy has been achieved. The high speed capability of the aircraft permits a wide flexibility in changing altitude in zooming flight in relatively short distances and permits zooming to altitudes far in excess of the thrust-limited ceiling. Zoom climbs can be initiated from any point within the thrust envelope of the aircraft. The altitude reached and the final speed are dependent upon the speed and altitude at the start of the zoom. Generally speaking, the higher the initial speed and altitude, the higher will be the airspeed upon reaching a given altitude. In zooms started from 40,000 to 45,000 feet, and a Mach number of 2.0, approximately 4000 feet may be gained with proper pilot technique, for each 0.1 Mach number loss. Zooms made from a lower speed or higher altitude give a smaller ratio of height gained to speed lost. This ratio may decrease to as little as 2000 feet gained for each 0.1 Mach number lost from the thrust-limited ceiling. Maximum altitude is obtained in a zoom initiated from maximum permissible speed in the 40,000 foot altitude range. In this altitude range sufficient excess thrust is available to permit rotation of the flight path to a steep climb angle with a minimum bleed-off in speed. In zooms initiated at or near the thrust-limited ceiling of the aircraft, the speed loss in rotating to steep angles is greater due to the absence of excess thrust to hold speed. Practice is required to perfect pilot technique. Zooms to intercept a target should be preplanned as much as possible since the intercept altitude, desired intercept speed, etc, will dictate the technique required. It is essential to position the aircraft correctly before the zoom is started because further maneuvering after the zoom is initiated will decrease the energy available for the zoom. Therefore, the approximate time and distance required must be known to conserve energy and assure closure on the target. In tactical situations, zoom climbs will probably not be initiated until target detection has been obtained on the radar indicator. A pullup to boresight will be accomplished with a boresighted flight path followed from that point on to firing range. In this case, the technique to be used is automatic since the flight path is dictated by the boresight requirements. In practice zooms from the Mach 2.0 thrust ceiling to a preselected altitude, it is best to make a pullup of approximately 1.5G, attaining a maximum climb angle of approximately 20 degrees. The pushover to the preselected altitude should be

FLIGHT PATH ANGLE AT BEST CLIMB MACH

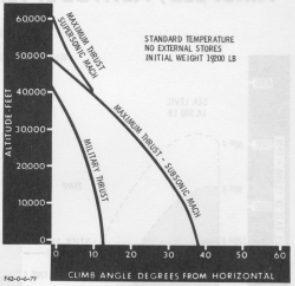

Figure 6-7

CHANGE IN GO-AROUND CAPABILITY WITH AIRSPEED, ALTITUDE, TEMPERATURE AND WEIGHT

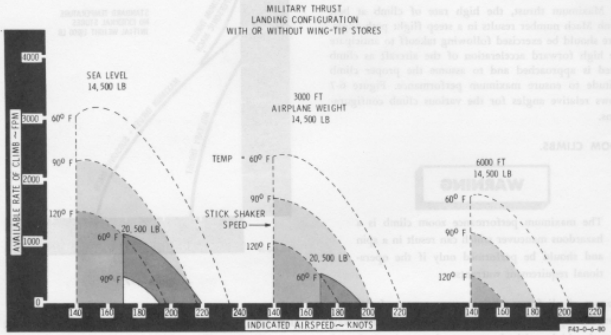

Figure 6-8

started after approximately one half the desired altitude gain. In zooms to above 65,000 feet, afterburner blowout will occur as the minimum operating pressure level of the afterburner is crossed. The speed and altitude combination for this boundary is approximated in figure 6-7. Actually, the boundary is a fairly wide band because the blowout point is affected by individual afterburner performance and is also sensitive to pullup or pushover technique. Also, if the flight path is leveled prior to afterburner blowout, the afterburner will blowout as speed bleeds to the blowout boundary. As the zoom continues above the afterburner blowout boundary, the minimum fuel flow that can be supplied by the fuel control will become greater than required to maintain full rpm. When this happens the nozzle will open and EGT and rpm will increase. To avoid exceeding limit EGT the throttle may have to be retarded to OFF.

CAUTION

Throttle reduction to IDLE or possible engine shutdown may be necessary in order to control EGT. If a shutdown is necessary a restart can be accomplished during the descent following the zoom.

Note

At very high altitudes following high Mach or sustained afterburner operation, cooling airflow is reduced due to low airspeeds, it is possible for the aft section temperature to increase enough to cause illumination of the fire warning lights.

If the throttle is retarded to OFF, the engine will be windmilling. Should the windmill rpm drop below

approximately 65 percent rpm, the under frequency relays will cut the generators off the buses. Under this condition all electrically operated equipment except the number 2 boost pump and the battery bus will be inoperative. Of particular importance is the fact that the APC system will be off and stabilizer trim system will be inoperative. Therefore, airplane buffet (subsonic flight) and possibly attitude will be the only indications of a high angle of attack condition. Zooms accomplished to attain maximum altitude are initiated, as stated previously, from 40,000 feet or wherever in this altitude range maximum Mach number is permissible. An initial pullup of 2.0G to 2.5G should be used to increase climb angle. As the climb progresses, increasing back stick will be required to hold the nose up; however, at no time should the stick shaker stall warning be exceeded. A maximum climb attitude of 45 degrees will be reached at about 50,000 feet. Greater climb attitudes should not be used because indicated airspeed may drop to too low a value at the apogee. Beginning no later than 60,000 feet a small nose down pitch rate must be established to maintain airplane attitude in a safe relation to the ballistic flight path. This is done by maintaining angle of attack well below the shaker boundary. Although indicated airspeed over the top may fall below normal 1G stall speed, the aircraft load factor will be less than 1; and consequently airplane angle of attack will be well below stall attitude. Zoom climbs initiated from 40,000 feet might reach 80,000 feet if unchecked.

Note

The APC system will not be available if the generators have dropped off the line. Therefore, with APC off, airplane buffet (in subsonic flight) and possibly attitude will be the only indication of a high angle of attack.

Because of the pressure lag in the airspeed system, the indicated readings will lag the actual flight path. This becomes obvious when the peak of the zoom has been passed as indicated by the airspeed increasing while the altimeter still shows a climb. Altimeter range limitations are exceeded in maximum altitude zooms, resulting in a maximum reading of 85,000 to 87,000 feet. Prior to making a high altitude zoom, a pressure check on the high altitude suit should be made as well as cinching down the helmet because cockpit pressurization can be expected to decrease, causing suit inflation if engine stall is encountered above the afterburner blowout point. The natural descent angle from the peak altitude of a zoom can be expected to be as steep, or nearly, as the climb angle.

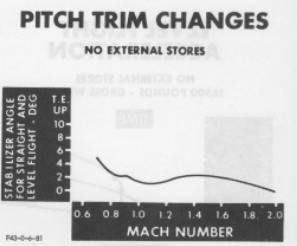

Figure 6-9

GO-AROUND

The excess thrust available for go-around varies with aircraft configuration, airspeed, gross weight, field elevation and ambient temperature. In the landing configuration, Military thrust may be inadequate for go-around (or even approach) as extremes of these variables are approached; afterburning thrust will then be necessary. Figure 6-8 shows the effect of temperature, altitude, and weight on go-around capability in terms of maximum speed and rate of climb available with Military thrust. However, before a rate of climb can be attained, several seconds may be required to make the transition from the down-wind flight path. Altitude lost during this time may exceed 100 feet, depending upon the steepness of the glide slope. Therefore, flat approaches are essential and the pilot should be ready to apply immediate power under marginal conditions. In addition, under marginal conditions, a straight-in approach with TAKEOFF flaps or gear-up configuration is recommended. Change to final landing configuration only after the landing is assured. Determination of marginal conditions can be made readily before flight from the Rate-of-Climb for Go-Around Chart in the Appendix.