SECTION V

INTRODUCTION

This section provides operating limits and restrictions for normal operation of the SR-71A and SR-71B.

MINIMUM CREW

The aircraft may be flown solo.

INSTRUMENT MARKINGS

The instrument markings shown in Figure 5-1 are not necessarily repeated elsewhere in this section.

Airspeed-Mach Meter

The limit hand of the airspeed-mach meter is set to indicate 460 KIAS at sea level.

FUEL

The only approved fuel is JP-7.

EMERGENCY FUELS

Any fuel other than JP-7 (such as JP-4, JP-5, or JP-8) is considered an emergency fuel and may be used only when refueling must be accomplished to avoid loss of the aircraft. Operation with emergency fuels is restricted to speeds below Mach 1.5. Rate of climb is not restricted. If fuels other than JP-7 are used, record it as a discrepancy in AFTO Form 781.

ENGINE OPERATING LIMITS

IN-FLIGHT SHUTDOWN

After any in-flight shutdown, a report must be made if the fuel shut-off valve was operated and/or if windmilling speeds less than 3400 rpm were experienced.

While in-flight, intentional engine shutdown is not permitted during normal operation unless specifically authorized.

EXHAUST GAS TEMPERATURE (EGT)

The nominal operating bands, limits for continuous operation, and emergency operating zones are a function of compressor inlet temperature (CIT) as shown in Figure 5-2.

Ground Operation

The EGT limit for starting and for all ground operations with the RPM at or below idle is 565°C.

Start

Shut down the engine if EGT exceeds 565°C during start. If EGT exceeds 565° but is less than 649°C record in the AFTO Form 781 the number of excursions and peak EGTs. The engine is limited to five excursions between 565°C and 649°C before it must be removed and inspected.

If EGT exceeds 649°C during engine start, do not attempt additional starts; an engine inspection must be made.

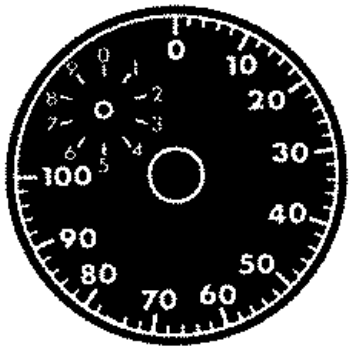
Engine Surge

If an engine surges (compressor stalls) during pretakeoff trimming, downtrim to eliminate the surge, but do not trim lower than 60°C below the desired trim point for the ambient temperature. After takeoff, engines downtrimmed for surge protection should be uptrimmed to 775°C EGT when CIT has reached 0°C if automatic EGT trimming is not employed.

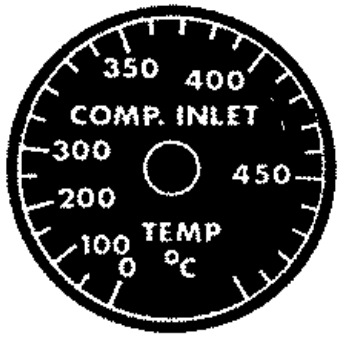
NOTE

When EGT is not above the nominal operating band, Figure 5-2, surging is only a problem during ground operations.

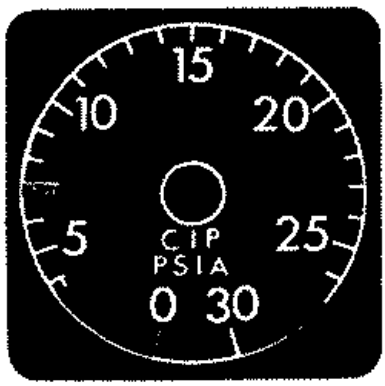
INSTRUMENT MARKINGS



TACHOMETER



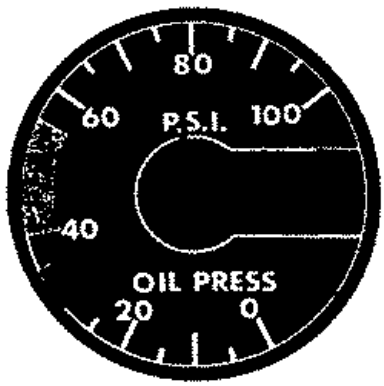
COMPRESSOR INLET TEMPERATURE GAGE



COMPRESSOR INLET PRESSURE GAGE
7 psi-Minimum for airstart

FUEL TANK PRESSURE GAGE

ANGLE OF ATTACK INDICATOR

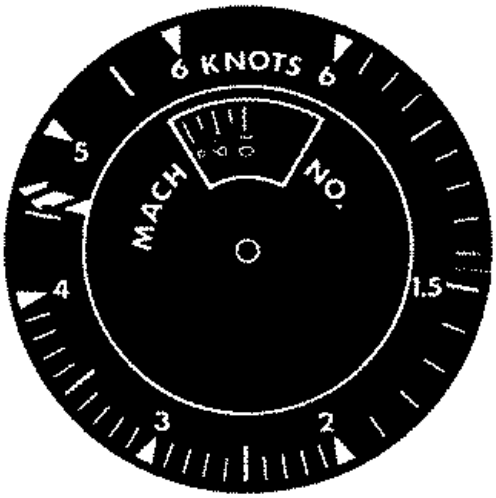


OIL PRESSURE GAGE

NOTE
LIMIT VALUE DENOTED BY EDGE OF RED LINE SO THAT INDICATION WITHIN MARKED RED RANGE EXCEEDS LIMIT VALUE

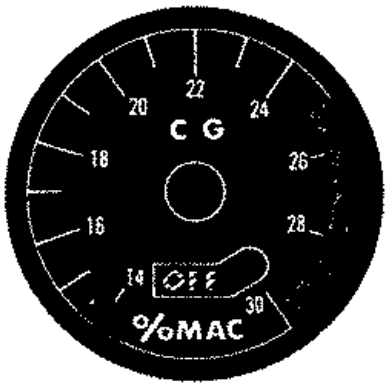
#203-30(3)(i)

Figure 5-1 (Sheet 1 of 2)

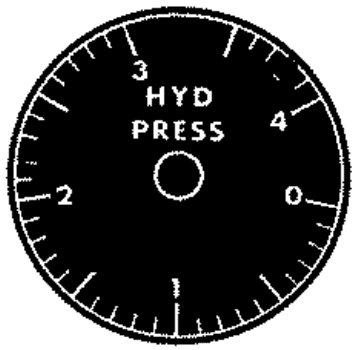


MACH-AIRSPEED INDICATOR

NOTE
LIMIT VALUE DENOTED BY EDGE OF RED LINE SO THAT INDICATION WITHIN MARKED RED RANGE EXCEEDS LIMIT VALUE



C.G. INDICATOR



HYDRAULIC SYSTEM PRESSURE GAGES (A AND B-L AND R)

F203-30(21)(A)

Figure 5-1 (Sheet 2 of 2)

Emergency Operation

Report EGT's experienced and the time involved any time EGT in or above the emergency operating zone is experienced (EGT above 830°C below 40°C CIT; EGT above 805°C above 40°C CIT), as a special post flight inspection is required.

Continuous or accumulated operating time in the emergency EGT operating zone for more than 15 minutes may require engine removal. No more than one hour may be accumulated with EGT in excess of the normal limit schedules.

EGT must be reduced immediately if an emergency limit temperature is exceeded.

WARNING

Shutdown the affected engine for EGT:

- Above emergency EGT limit (845° C above 40°C CIT; 865°C below 40°C CIT) and below 900°C for 2 minutes.
- between 900°C and 950°C for 15 seconds.
- over 950°C for 3 seconds.

CAUTION

At low CIT, EGT above the nominal trim band may cause engine surge (compressor stall).

COMPRESSOR INLET TEMPERATURE (CIT)

With both inlet guide vanes (IGVs) cambered, the maximum allowable compressor inlet temperature is 427°C.

With an IGV in axial (IGV light illuminated), 150°C must not be exceeded, and continued operation with CIT above 125°C is not permitted (approximately Mach 2.0).

ENGINE SPEED (RPM)

Engine speed should not exceed the higher value shown by Figure 5-2 for the nominal operating band. Report engine speeds above 7450 rpm below 300°C CIT, and 7300 rpm above 300°C CIT as an engine overspeed. Include maximum rpm attained, CIT, and accumulated time above the limit.

The allowable rpm fluctuation is ±1%.

OIL PRESSURE

35 psi is the minimum oil pressure permitted at idle rpm. Oil pressure below 35 psi is unsafe and requires that a landing be made as soon as possible using the minimum thrust required to sustain flight. The engine may have to be shut down.

In-flight oil pressures between 35 and 40 psi are undesirable but acceptable.

The normal pressure is 40 to 55 psi while rpm is in the nominal operating band. Gradually increasing oil pressure up to 60 psi is acceptable at high Mach provided the indication returns to normal values after deceleration to subsonic speeds.

The allowable oil pressure fluctuation is ±3 psi.

EXHAUST NOZZLE POSITION (ENP)

Random ENP fluctuations of ±4% are acceptable in-flight (if rpm is within limits). Cyclic ENP fluctuations should be reported.

MAXIMUM WEIGHT

The maximum gross weight for takeoff and landing is not limited; however, when feasible, routine full-stop landings should be made with no more than 10,000 pounds of fuel. The maximum fuel load recommended for touch-and-go landings is 25,000 pounds remaining.

SECTION V

ENGINE OPERATING SCHEDULES AND LIMITS

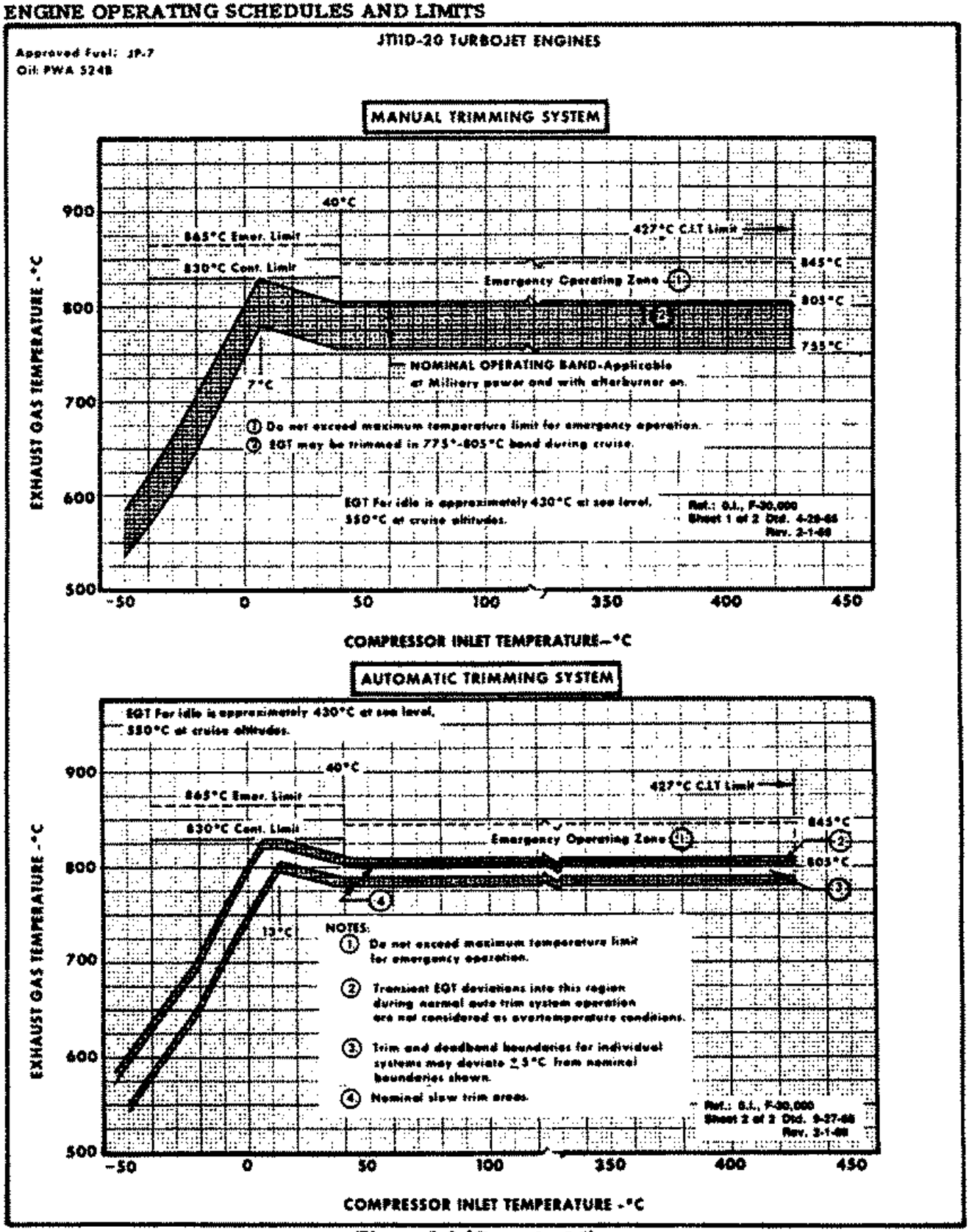


Figure 5-2 (Sheet 1 of 2)

ENGINE OPERATING SCHEDULES AND LIMITS

JT11D-20 TURBOJET ENGINES

Approved fuel : JP-7
Oil: PWA 5248

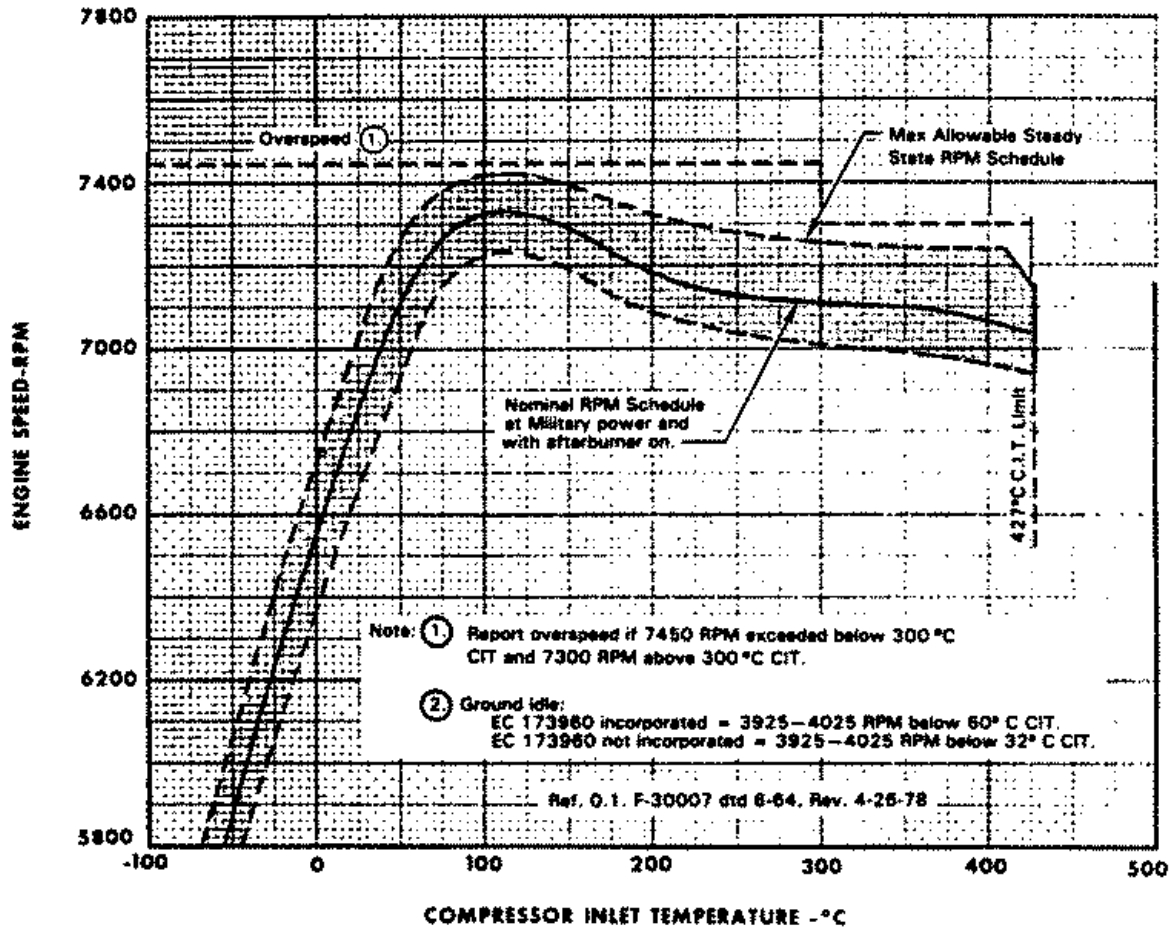


Figure 5-2 (Sheet 2 of 2)

The maximum gross weight capability for single-engine flight is presented in Part II of the Appendix.

LOAD FACTOR LIMITS

Limit load factors are shown by Figure 5-5. The diagrams presented for symmetrical flight are also applicable to entry into turns with normal bank angles. Allowable load factors applicable to rolling flight (abrupt maneuvers as a result of rapid control displacement) are especially identified and have a minimum limit of 1 g. Specific limits are shown for flight at Mach 3.2, 2.6, and at Mach 2.0 or less and for subsonic cruise and transonic penetration at forward c.g. Limit speeds and load factors applicable to operation at intermediate speeds above Mach 2.0 are obtained from sheets 4 and 5 of Figure 5-5.

The following rule of thumb may be used for operational limit load factors for symmetrical flight:

Mn 2.0 or less:

65,000 to 124,000 lb	-.2 to 2.5 g
124,000 to 143,000 lb	-.2 to 2.0 g
80,000 to 90,000 lb	
below 50,000 ft	-.2 to 3.5 g
above 50,000 ft	-.2 to 2.5 g
Mn 2.0 to 2.6	
all weights	-.1 to 2.0 g
Mn 2.6 to 3.2	
all weights	-.1 to 1.5 g

FLIGHT ENVELOPE LIMITS

Refer to Figures 5-3 and 5-4 for summarized Mach, airspeed, angle of attack, altitude and bank angle limits and restrictions. Refer to Center of Gravity Limits, this section, for speed limits with c.g. forward of 17%.

MAXIMUM MACH

Mach 3.2 is the design Mach number. Mach 3.17 is the maximum scheduled cruise speed recommended for normal operations. However, when authorized by the Commander, speeds up to Mach 3.3 may be flown if the limit CIT of 427°C is not exceeded.

WARNING

Mach excursions when using Mach Hold may be severe during turns or while flying through rapid temperature changes at altitude. Use the basic pitch autopilot instead of Mach Hold if speed and altitude excursions are excessive.

Without Inert Tank Atmosphere

Mach 2.6 is the maximum speed without an inert atmosphere in the fuel tanks. To achieve an inert atmosphere in the tanks, LN_2 must be available and fueling to the ground shutoff level must be accomplished prior to flight or aerial refueling must be accomplished to a minimum level of 65,000 lb.

During descent from flight above Mach 2.6 with fuel tank pressurization failure, 250 KEAS minimum airspeed is permissible during subsonic loiter between FL 400 and FL 350.

AIRSPEED

WARNING

Monitor flight instruments during autopilot operation. Assure that speed does not exceed the normal operating envelope.

Refer to Figure 5-3. The minimum airspeed restrictions are 310 KEAS when supersonic, 300 KEAS when subsonic above FL 250, and 145 KIAS below FL 250 unless angle of attack limits would be exceeded.

LIMIT SPEED AND ALTITUDE ENVELOPE

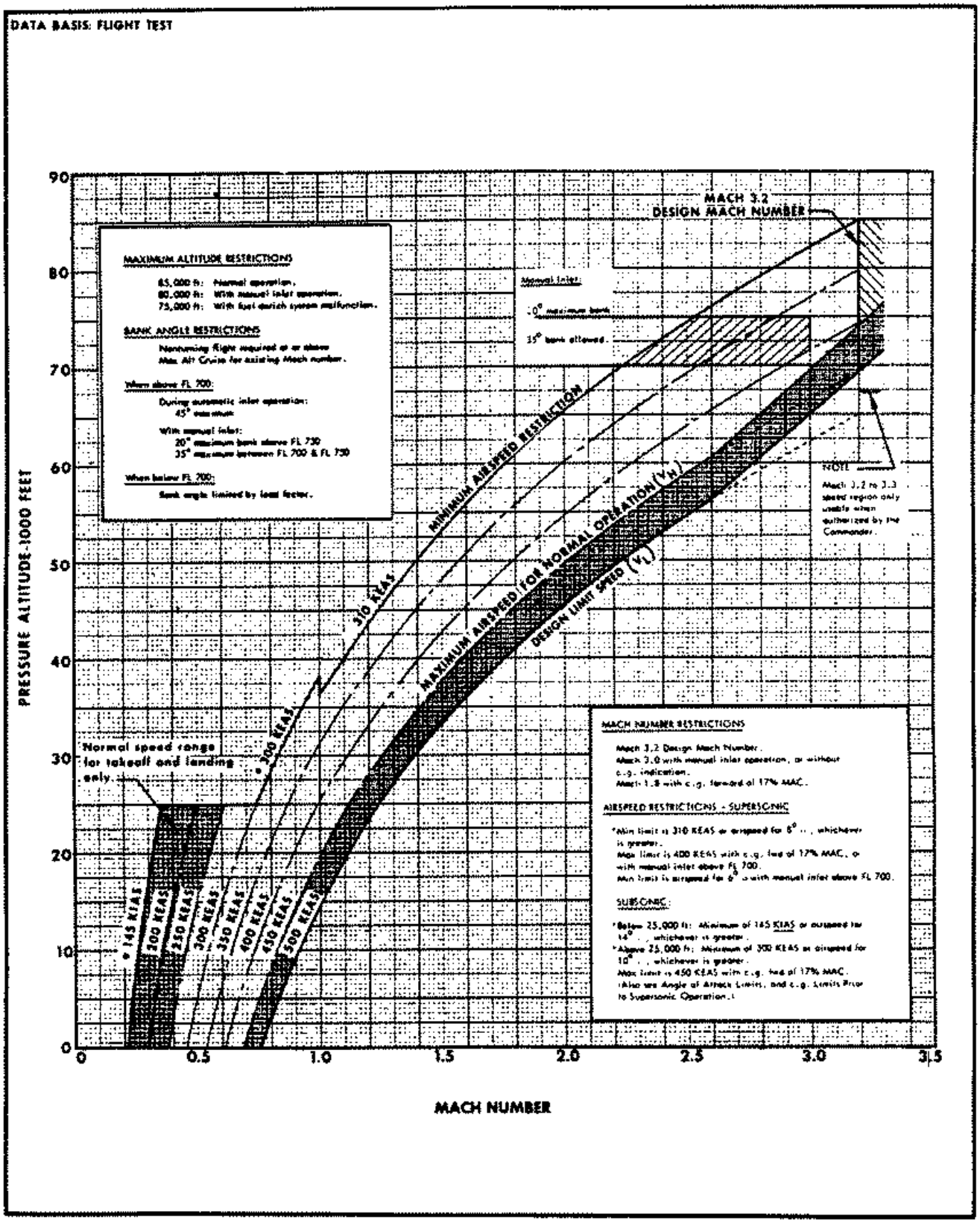


Figure 5-3

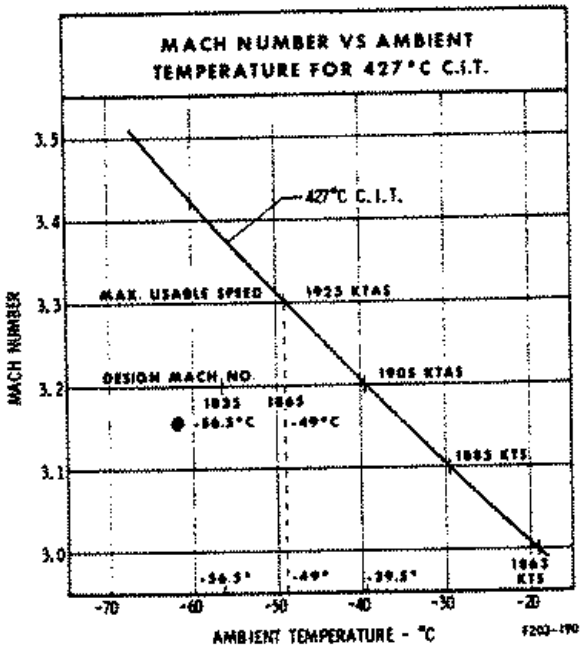


Figure 5-4

ANGLE OF ATTACK

The maximum angle of attack limit is the stick shaker boundary or the following (whichever occurs first):

6° with manual inlet above 70,000 feet.

8° supersonic

10° subsonic, above FL 250.

14° below FL 250.

Angle of attack limits are valid only if airspeed and c.g. limits specified in this section are observed.

With a normally operating automatic pitch warning system, do not position the APW (pusher/shaker) switch to OFF.

If either the stick shaker or pusher/shaker warning is activated, reduce angle of attack immediately. Operation in flight conditions such that the shaker warning is on continuously is not permitted. The pitch boundary indicator (PBI) should be cross-checked with the angle of attack when operating near the angle of attack limits or PBI shaker boundary.

WARNING

Avoidance of the stick shaker or pusher/shaker warning boundaries does not, by itself, assure that load factor or angle of attack limits will be observed.

ALTITUDE

The maximum altitude limit is 85,000 feet unless higher altitude is specifically authorized.

Do not exceed 80,000 feet with an inlet in manual operation.

Do not exceed 75,000 feet with either fuel derichment system inoperative.

HIGH ALTITUDE TURNS

Flight at or above the Maximum Altitude Cruise profile (for the existing Mach, gross weight, and ambient temperature) is restricted to nonturning flight. A descent of approximately 2000 feet below the Maximum Altitude Cruise profile (i.e. to the Intermediate Altitude Cruise Profile) prior to turn entry is recommended. Refer to Maximum Afterburner Ceiling Profile and Maximum Altitude Cruise Profile, Section VI.

PROHIBITED MANEUVERS

Stalls, spins, inverted flight, and intentional inlet unstarts are prohibited.

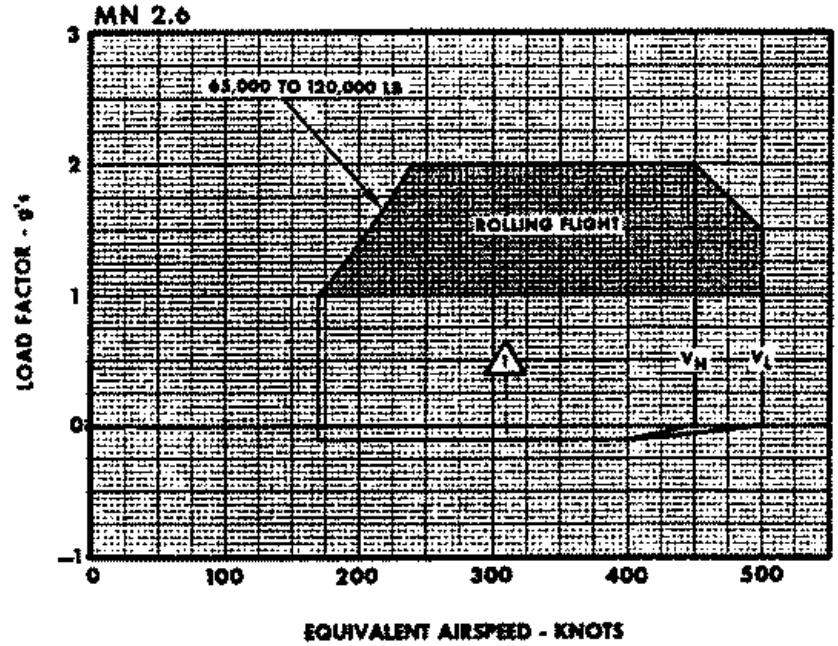
SIMULATED SINGLE-ENGINE FLIGHT

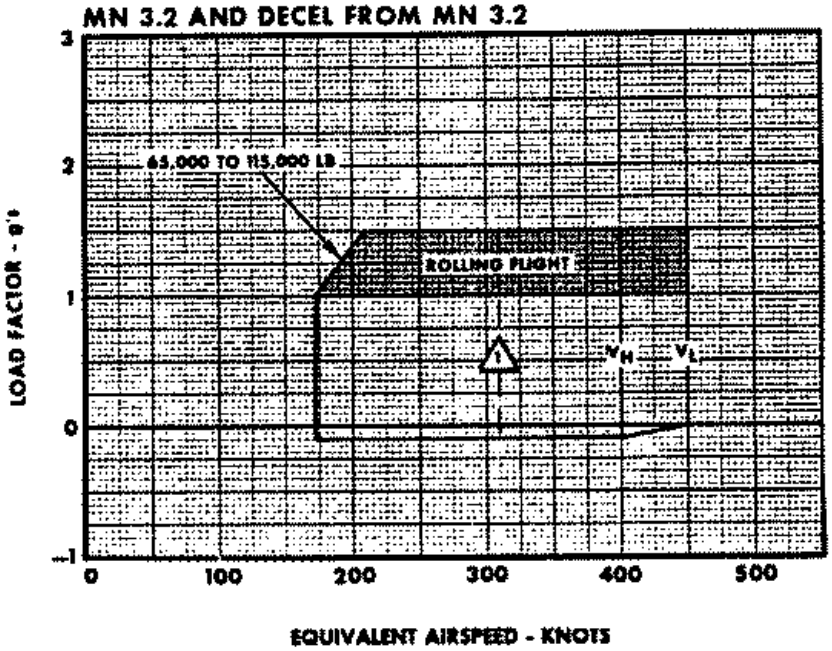
Simulated single-engine approaches at less than 200 KIAS or with more than 25,000 pounds of fuel remaining are prohibited. Planned single-engine missed approaches/go-arounds will be initiated not lower than 300 feet above the ground.

LIMIT LOAD FACTOR DIAGRAM

DATA BASIS: FLIGHT TEST

SYMMETRICAL, TURNING, AND ROLLING FLIGHT





LIMIT SPEEDS AND LOAD FACTORS AT INTERMEDIATE MACH NUMBERS ARE SHOWN ON SHEETS 4 AND 5 OF FIGURE 5-4.

CONDITIONS ALLOWABLE FOR ROLLING FLIGHT. 1 - G MINIMUM.

1 MINIMUM SUPERSONIC AIRSPEED RESTRICTION: 310 KEAS

V_H - MAXIMUM AIRSPEED FOR NORMAL OPERATION

V_L - LIMIT AIRSPEED

Figure 5-5 (Sheet 1 of 5)

LIMIT LOAD FACTOR DIAGRAM

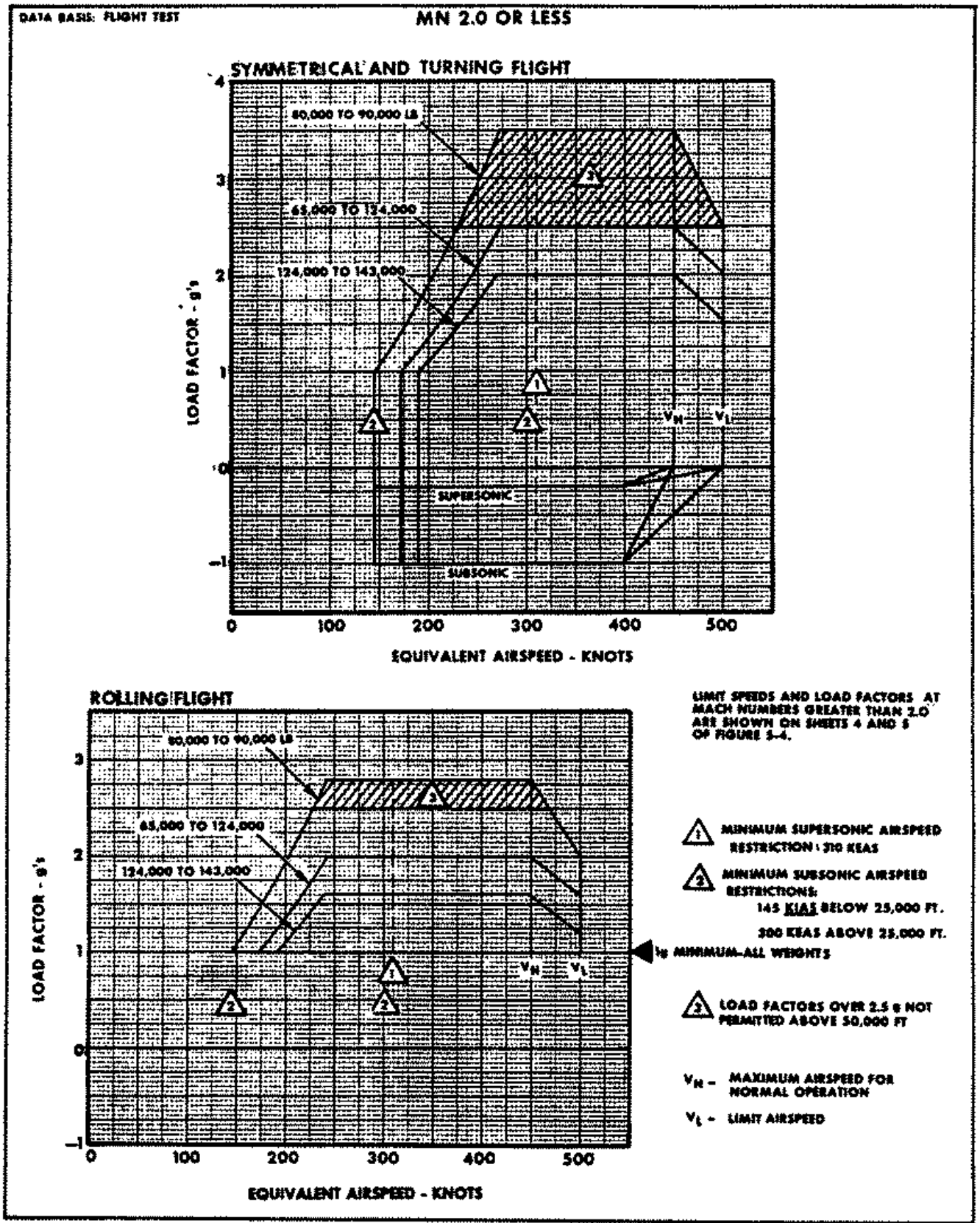


Figure 5-5 (Sheet 2 of 5)

LIMIT LOAD FACTOR DIAGRAM

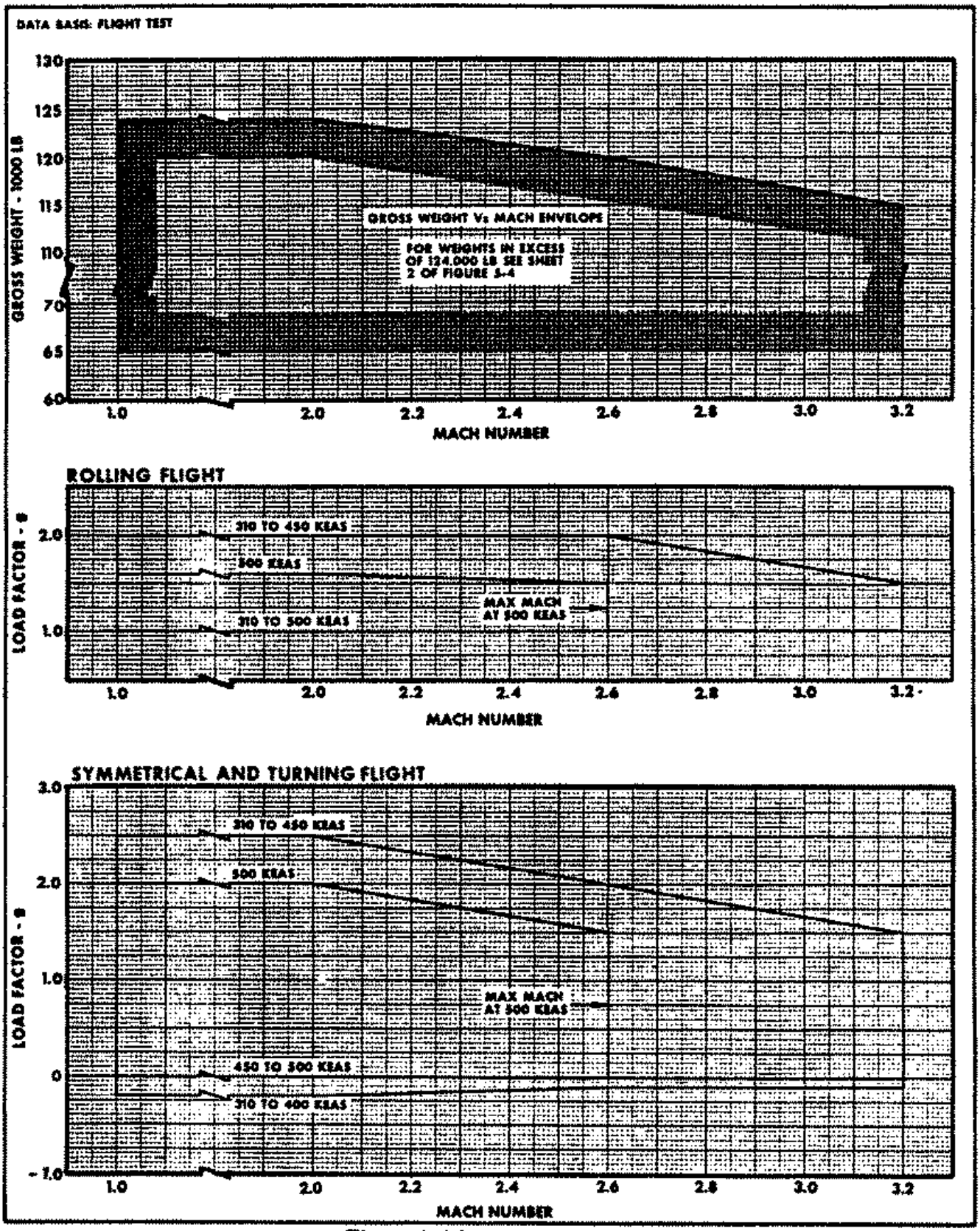


Figure 5-5 (Sheet 4 of 5)

LIMIT LOAD FACTOR DIAGRAM

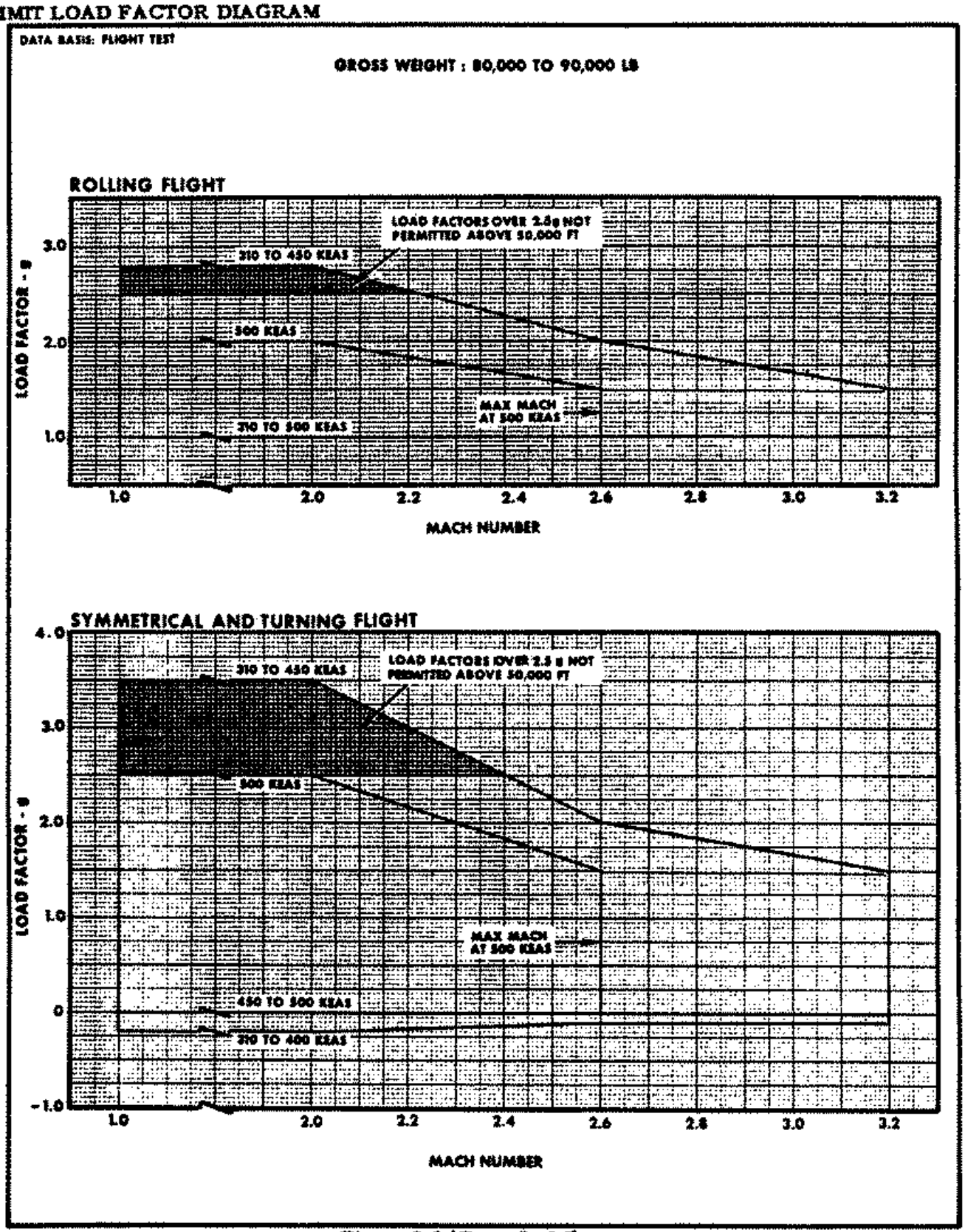


Figure 5-5 (Sheet 5 of 5)

RATE OF DESCENT

Rate of descent must be limited so as to maintain positive fuel tank pressure when sustained speeds have exceeded Mach 2.6.

While above Mach 1.8, the maximum rate of descent should be such that rate of deceleration does not exceed 1.0 Mach number in 3 minutes. There is no limitation on rate of deceleration while below Mach 1.8.

CENTER OF GRAVITY

Use the c.g. indicator and pitch trim to determine center of gravity location. However, both systems are subject to indicator and system tolerance. Computed and indicated c.g. should agree within 0.5% during stabilized cruise conditions and on the ground (after allowing for the effect of the three-point attitude on the computed c.g. value). When supersonic, pitch trim indications should conform with values derived from Figure 6-7 within 1°. If c.g. is suspected to be aft of the prescribed limit, correct the condition with fuel forward transfer.

Subsonic Operation

The c.g. must be forward of 22% for takeoff. The unrestricted c.g. range is from 17% to 22% during sustained subsonic operation within the airspeed and load factor limits provided by sheet 2 of Figure 5-5.

When gross weight is below 100,000 pounds and speed is below Mach 1.8, operation with c.g. from 14.5% to 17% is permitted within reduced airspeed and load factor limits. For the reduced airspeed and load factor limits shown by sheet 3 of Figure 5-5 to be valid, tank 1 must contain no more than half the fuel remaining. Note that limit airspeeds are 450 KEAS while subsonic and 400 KEAS while supersonic, and that the maximum airspeeds recommended are 50 KEAS less than these limit values.

Prior to Supersonic Operation

After takeoff or air refueling, c.g. as far aft as 24% is permitted while subsonic when normal climb and supersonic acceleration procedures have been initated.

Similarly, the subsonic aft c.g. limit is 24% when a short period of subsonic cruise is necessary prior to initiating normal supersonic acceleration procedures if:

a. Speed is at least 0.90 Mach and 325 KEAS.

b. All pitch SAS is operating.

Supersonic Operation

Below Mach 3.2, the supersonic aft c.g. limit is 25%. If speed exceeds Mach 3.2, the c.g. must be positioned forward of 25% by 0.7% per 0.1 Mach number increase in speed; e.g., to 24.3% at Mach 3.30.

C.G. Forward of 17%

When gross weight is below 100,000 pounds, operation with c.g. from 14.5% to 17% is permitted while below Mach 1.8 if tank 1 contains no more than half the fuel remaining and the reduced airspeed and load factor limits shown by sheet 3 of Figure 5-5 are observed. Note that limit airspeeds are 450 KEAS while subsonic and 400 KEAS while supersonic, and that the maximum airspeeds recommended are 50 KEAS less than these limit values.

PITCH TRIM INDICATIONS WHILE SUBSONIC

In trimmed flight (autopilot on or off), no more than 1.5° nose-down trim is permitted when subsonic with c.g. at or forward of 22%, and no more than 2.5° nose-down trim is permitted if operating in accordance with the special conditions when the 24% aft c.g. limit applies.

PITCH TRIM INDICATIONS WHILE SUPERSONIC

Refer to Figure 6-7 for the normal variation of pitch trim indications with Mach. When supersonic, steady-state trim indications should agree within $\pm 1^{\circ}$ of values derived from this figure when trimmed at 1-g load factor.

NOTE

The minimum pitch trim indication to be expected at Mach 2.6 is $+0.5^{\circ}$. At higher Mach, the minimum limit depends on KEAS, aircraft weight, and c.g. Assure trim is at or above 0° except for the specific high Mach, high KEAS conditions at 25% c.g. depicted on Figure 6-7. Check the c.g. if less nose-up trim is indicated.

In trimmed flight (autopilot on or off) at 25% c.g., no more than 1.5° nose-down trim is permitted when supersonic.

While supersonic, trim indication should increase about 1° per 50 KEAS decrease in trimmed speed, and 1° for each 1% forward c.g. shift from 25%.

Excessive nose-down trim indicates a potentially hazardous situation and the possibility of a fuel system or c.g. indicating system malfunction.

AIRCRAFT SYSTEMS LIMITATIONS

SURFACE LIMITER

The control surface limiter shall be engaged whenever speed exceeds either 330 KEAS or 0.7 Mach.

STABILITY AUGMENTATION SYSTEM

The SAS shall be on for all takeoffs. Landings with normally functioning SAS channels intentionally disengaged are not permitted except that the roll SAS may be disengaged prior to simulated and actual single-engine landings.

Normal operation with all pitch and yaw SAS intentionally disengaged is not permitted; however, they may be disengaged for training demonstrations provided Mach 1.0 is not exceeded and gross maneuvers are not attempted.

Operation with both roll channels disengaged is permitted without limitation.

AUTOPILOT

Do not use the pitch autopilot with bank angles exceeding 45°.

FUEL SYSTEM

Use Of Forward Transfer

In-flight, with c.g. between 14.5% and 17%, no more than half of the remaining fuel may be transferred to tank 1; otherwise, the load factor limits shown by sheet 3 of Figure 5-5 are not valid.

Refueling Door

If the air-refueling door is open while supersonic, write up in AFTO 781 the temperature encountered and duration of exposure.

ANTICOLLISION LIGHTS

If the anticollision lights are not retracted before high-temperature flight, write up in AFTO 781 the temperature encountered and duration of exposure.

CANOPY

The canopy shall be opened or closed only when the aircraft is stationary. Maximum taxi speed with a canopy open is 40 knots. Gusts or strong winds should be considered as a portion of the 40-knot speed limit.

LANDING GEAR

Touchdown Sink Rates

The main landing gear is designed for landing sink speeds at touchdown which decrease from 600 feet per minute at 68,000 pounds to 360 feet per minute at 125,000 pounds gross weight. Landing at gross weights above 125,000 lb is not recommended. However, if a landing must be accomplished before weight can be reduced to this value, the sink rate at touchdown should not exceed 300 feet per minute. Side loads during takeoff, landing, and taxiing must be kept to a minimum, as landing gear side-load strength is critical during ground maneuvering.

Maximum Speed

In-flight, gear door strength limits the airspeed with gear down to 300 KEAS or Mach 0.7, whichever is less, with a maximum permissible sideslip angle of 10°. Maximum permissible speeds are 300 KEAS or Mach 0.9, whichever is less, with gear down when sideslip does not exceed 5°.

Crosswind Limits

Because of the loads imposed on the landing gear system, operation with crosswind components above 30 knots is not recommended.

Crosswind components between 25 and 30 knots represent a cautionary area. See Appendix Figure A2-1. A decision to land with winds of this magnitude should consider all related factors, i.e., weather, runway surface condition, airdrome facilities, and availability of a suitable alternate.

The maximum recommended crosswind components are:

25 knots with a grooved runway (wet or dry) or with a dry, nongrooved runway.

20 knots with a nongrooved, wet runway.

Retraction-Extension Cycles

Do not extend the landing gear more than 10 times each flight.

TIRES

The maximum ground speed rating of the tires is 239 knots. The conversion from 239 knots to KIAS with various combinations of temperature and altitude is shown by Figure 5-6.

A cooling period between the end of taxi and start of takeoff may be required. Figure 5-7 provides recommended cooling time vs taxi distance.

If a tire and/or brake cooling period is necessary, it should be continued until each individual tire and wheel is relatively tolerable to touch.

A check of tires, wheels and brakes is required when clear of the runway after an aborted takeoff or a heavy weight landing.

Takeoff after an abort is not permitted until maintenance has inspected the tires.

WARNING

Extreme caution should be exercised when making the tire and wheel check after a heavy weight landing, an aborted takeoff, or after any heavy braking. Overheated tires may explode and cause injury or loss of life. The check should be delayed until reasonable cooling has been accomplished if there is evidence of an overheated condition.

CAUTION

After an abort, brakes must be cooled to approximately ambient temperature before attempting another takeoff.

RATED TIRE SPEED

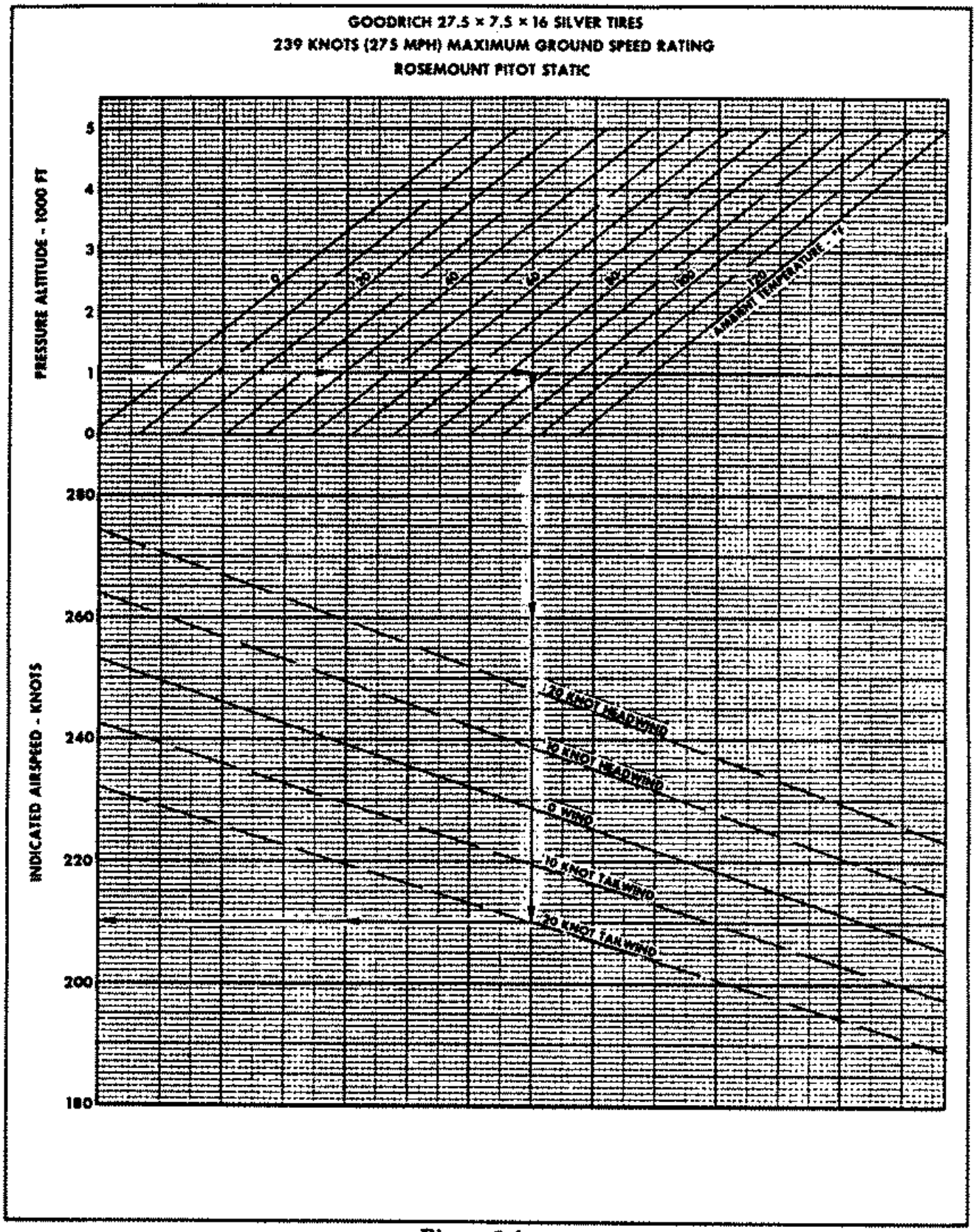
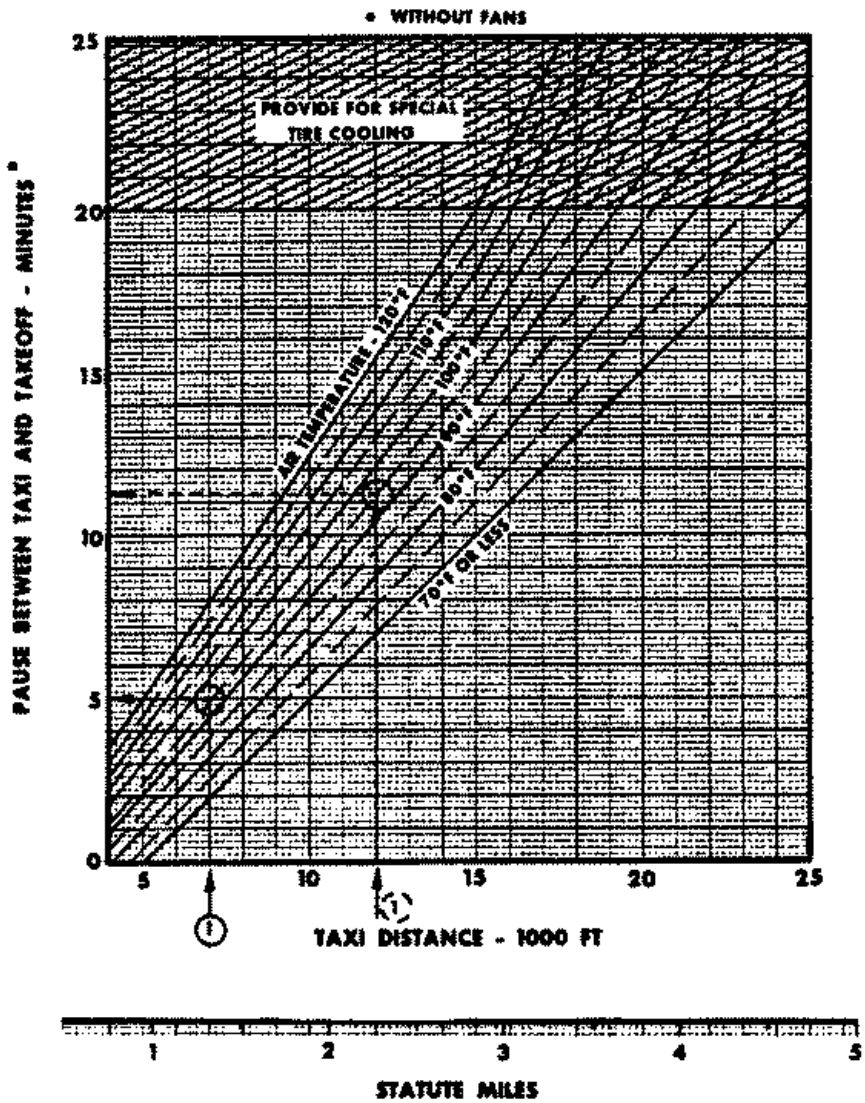


Figure 5-6

ESTIMATED TIRE COOLING PERIOD FOR FULL RTO CAPABILITY

Data Basis: REPORT NO. SP 1331

31% TIRE DEFLECTION
(140,000 LB AND 400 PSI PRESSURE)
(120,000 LB AND 310 PSI PRESSURE)



Conditions:
60 MPH - Maximum Taxi Speed.
(40 MPH - Maximum Speed Recommended)

Examples:
7000 ft Taxi-out, 95°F, 31% Deflection.

(1) 5 Minute pause before Takeoff required for full RTO capability (Cooling time after 12,000 ft RTO = 11.5 minutes if no heavy braking).

[2] (Refer to Figure 5-6)(for 140,000 lb, and BWO Takeoff Run = 6000 ft, Tire limit capability reached before Takeoff if pause time is less than 1.0 minutes.

Figure 5-7

TIRE LIMIT CAPABILITY

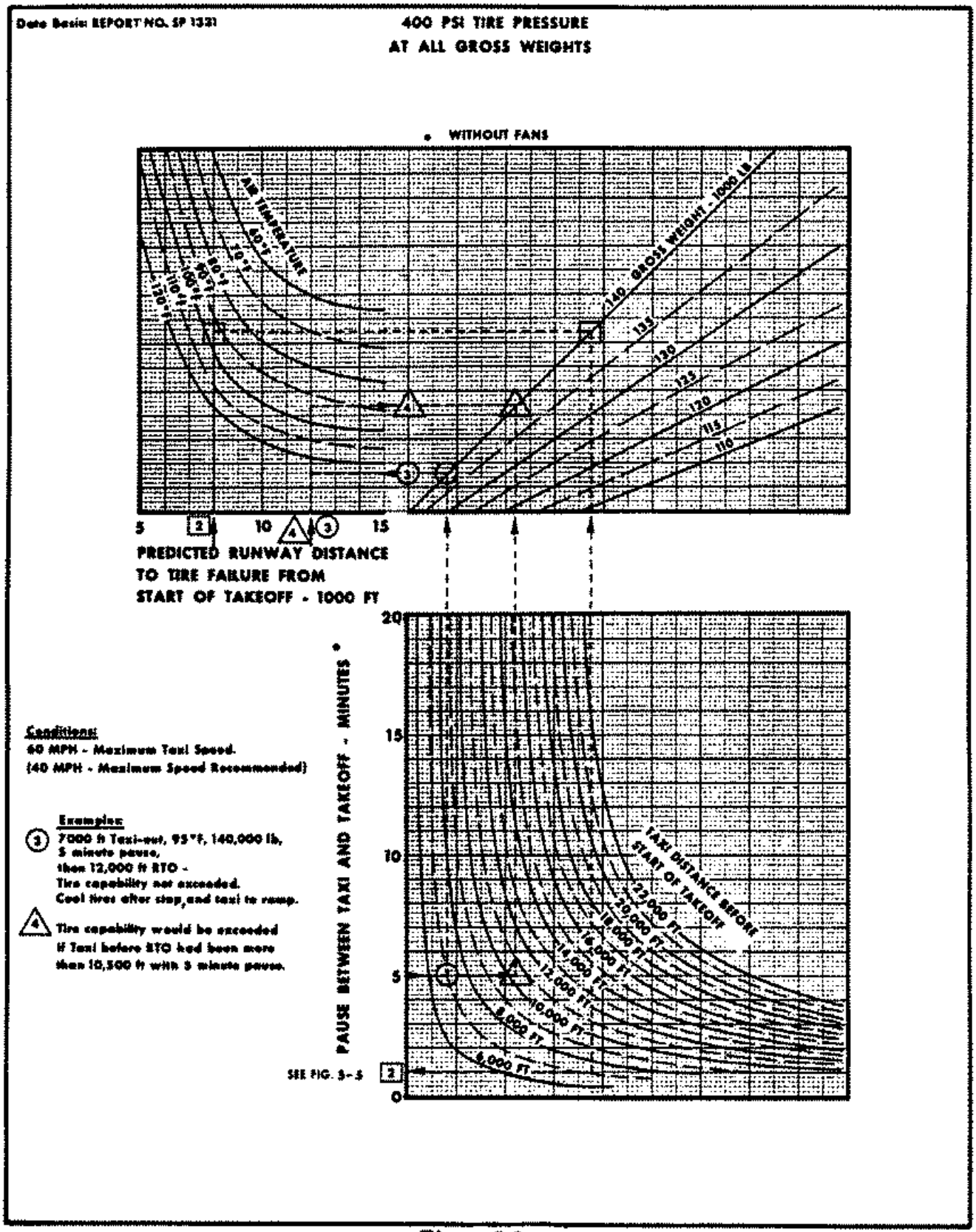


Figure 5-8

MAXIMUM INITIAL BRAKING SPEED FOR STOP USING RATED BRAKE CAPACITY

ONE STOP CAPABILITY

(4×7) + (2×5) ROTOR BRAKES
198,700,000 FOOT - POUND CAPACITY
ROSEMOUNT PITOT STATIC

WITHOUT DRAG CHUTE
NOSE DOWN
DRY AND HARD RUNWAY
ZERO WIND, ZERO SLOPE

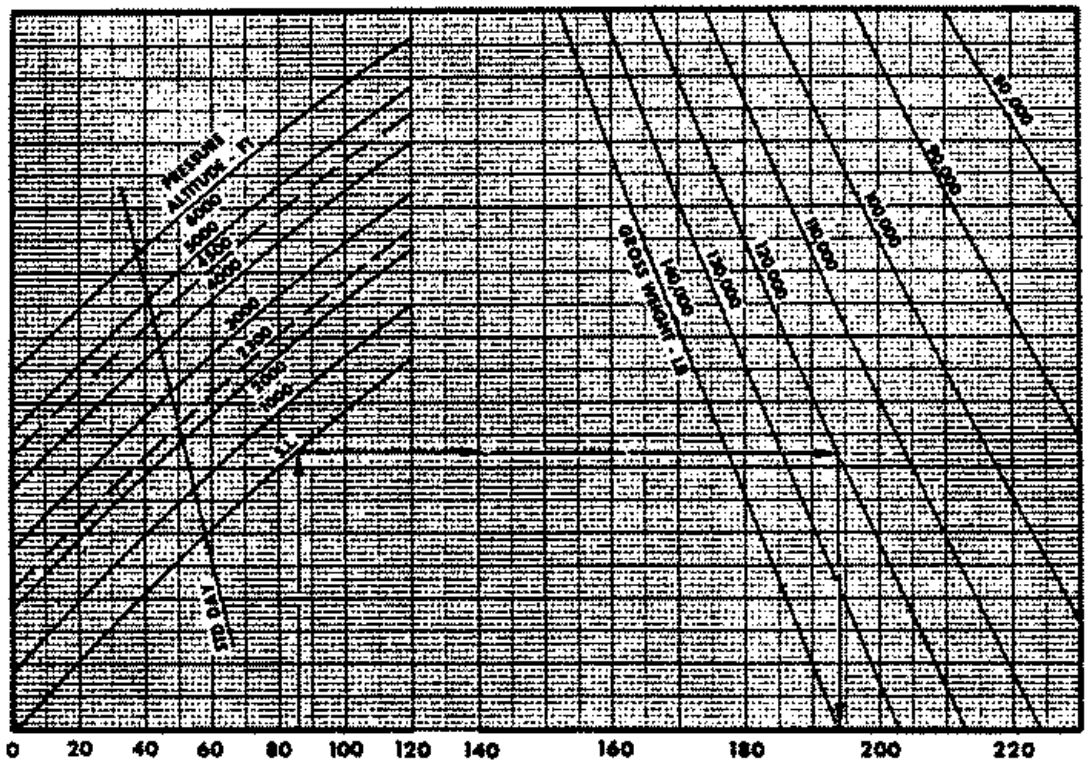


Figure 5-9

Taxiing or landing across exposed arresting gear cables (e.g. BAK-9, BAK-12 systems) is not recommended. Such action could damage the tires and/or wheels.

BRAKES

Maximum initial KIAS for a one-time stop using the maximum brake energy is shown in Figure 5-9. Headwind components may be added to values shown, and tailwind components must be subtracted. Refer to Part II of the Appendix for information on maximum refusal speeds and heavy-weight landings.

DRAG CHUTE

The maximum airspeed for drag chute deployment is 210 KIAS. The drag chute shall not be deployed in-flight except for a drag chute unsafe indication.

The maximum crosswind component for jettisoning the drag chute is 12 knots. The minimum airspeed for jettisoning the drag chute is 55 KIAS.

FLIGHT WITHOUT PRESSURE SUIT

Flight without pressure suits is restricted to below 50,000 feet.