OPERATING LIMITATIONS

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INTRODUCTION

This section provides general aircraft restrictions and engine operating limits that must be observed in normal operations. Some specific limits may be changed from time to time. Development flight tests are presently extending operational capabilities, making continued review of the limitations necessary. When necessary, to avoid delay in providing current limits to operating personnel, these specific limits will be supplied by the manufacturer's flight test organization at the operating site.

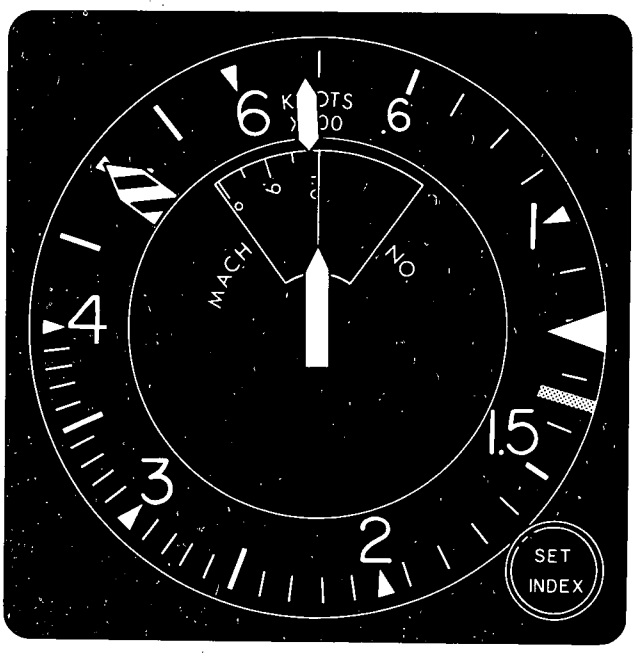
INSTRUMENT MARKINGS

The instrument markings shown in figure 5-1 are self evident and are not necessarily repeated elsewhere in this section.

ENGINE OPERATING LIMITS

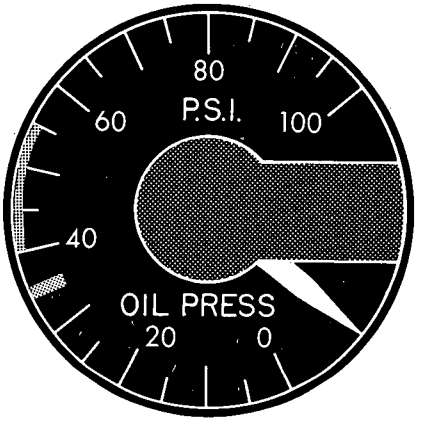
Pilot preflight briefing must include capability and limitations information pertinent to individual engines installed. General engine operating limits are summarized in figure 5-2. Thrust rating definitions are provided in Section I.

INSTRUMENT MARKINGS

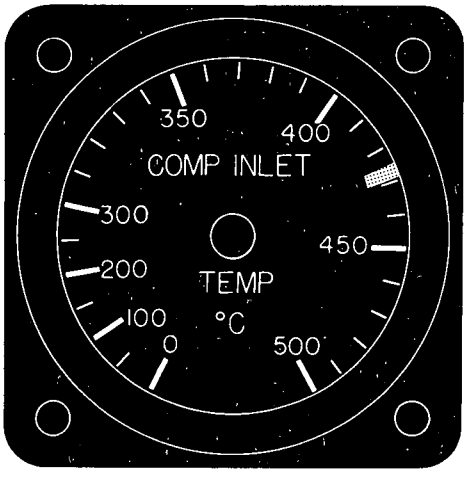


AIRSPEED - MACH METER

TACHOMETER



OIL PRESSURE GAGE



COMPRESSOR INLET TEMPERATURE GAGE

CODE

RED

GREEN

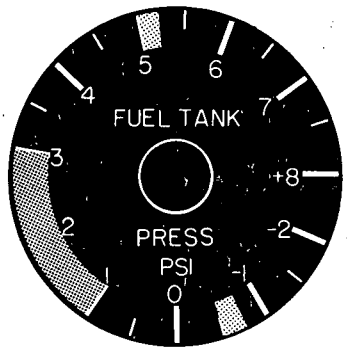
NOTE

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

F200-43(1)(e)

Figure 5-1 (Sheet 1 of 2)

INSTRUMENT MARKINGS



FUEL TANK PRESSURE GAGE

COMPRESSOR INLET STATIC PRESSURE GAGE

CODE

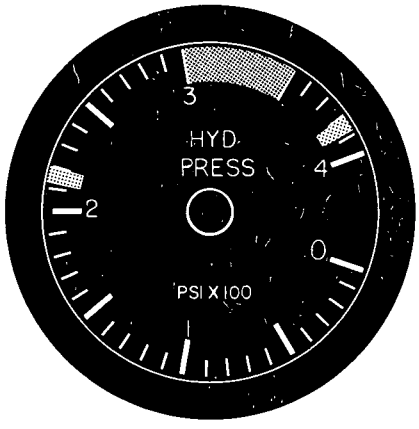
YELLOW

RED

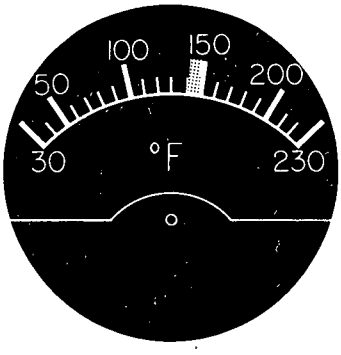
GREEN

NOTE

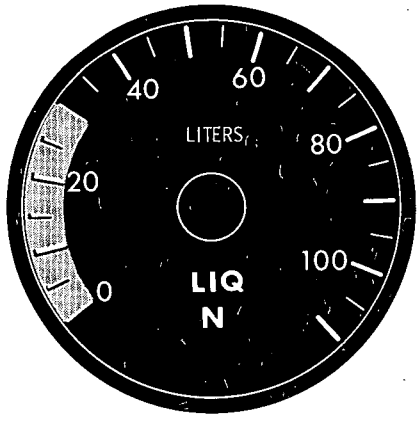
LIMIT VALUE DENOTED BY EDGE OF RED LINE SO THAT INDICATION WITHIN MARKED RED RANGE EXCEEDS LIMIT VALUE



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



COCKPIT TEMPERATURE INDICATOR



LIQUID NITROGEN GAGE

4-20-66
F200-43(2)(d)

Figure 5-1 (Sheet 2 of 2)

ENGINE OPERATING LIMITS SUMMARY

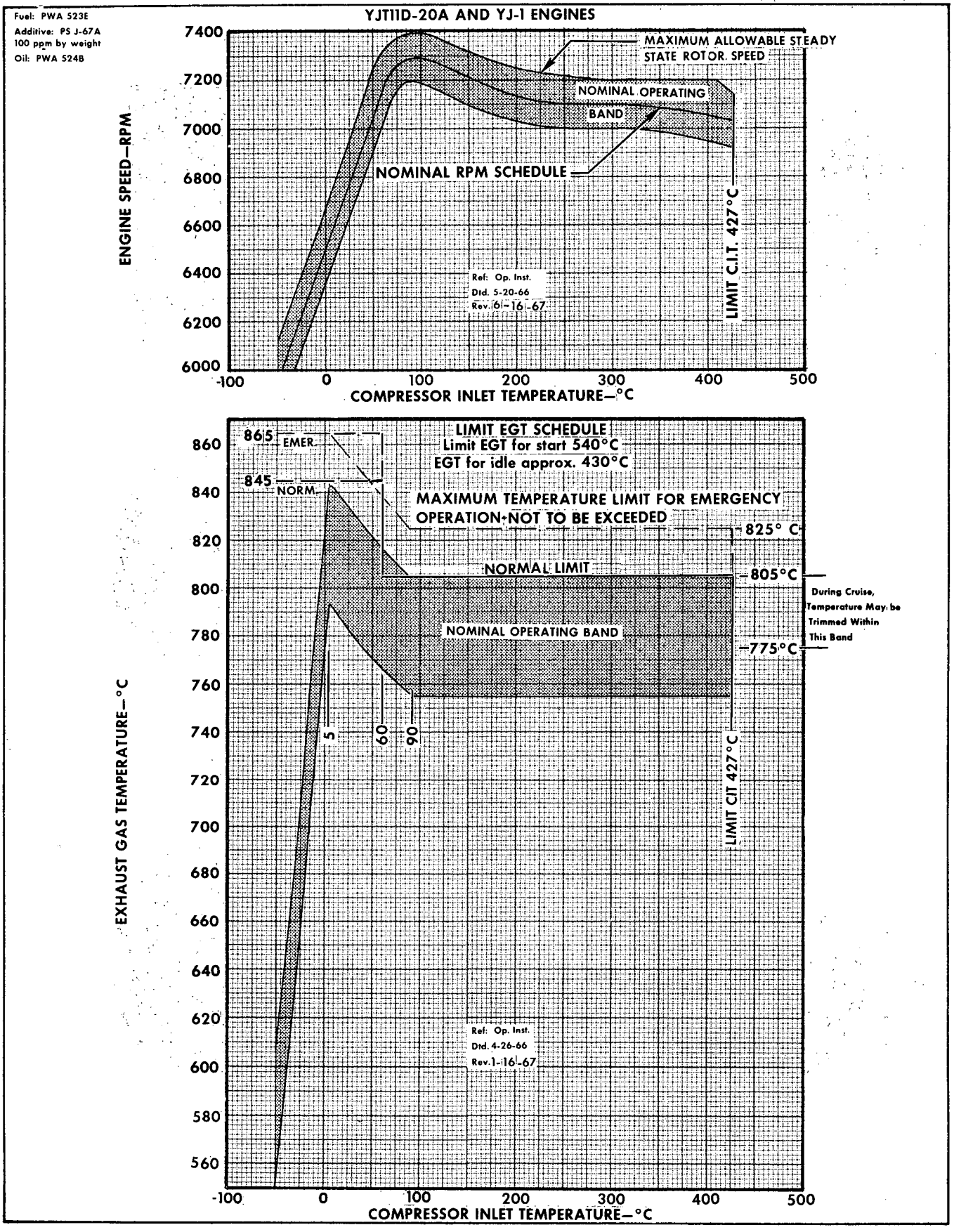


Figure 5-2

TIME LIMITS

YJT11D-20A and YJ-1 engines may be operated continuously at all ratings when within the normal exhaust gas temperature limits; however, no more than one hour may be accumulated with EGT in excess of the normal limit schedule, and EGT must be reduced immediately if an emergency limit temperature is exceeded. (See EGT Limits and figure 5-2.)

CAUTION

Continuous or accumulated operating time in the emergency EGT operating zone for more than 15 minutes may require engine removal.

EXHAUST GAS TEMPERATURE LIMITS

The nominal operating band, normal limits and emergency exhaust gas temperature operating schedules are prescribed as a function of compressor inlet temperature as shown in figure 5-2. Limit EGT's for continuous operation are 805°C when compressor inlet temperature is above 60°C, and 845°C when CIT is below 60°C. The setting at which the red warning light on the EGT gage illuminates and the fuel derichment system operates, if armed, is 860°C, a value which is above the normal operating temperature limit schedule.

Note

At compressor inlet temperatures below 5°C, the possibility of engine stall exists at EGT's between the maximum permissible value and the nominal operating band.

In the event that emergency engine operation is required, EGT may be increased to 825°C when above 60°C CIT, or to 865°C when below 60°C CIT; however, an accurate accounting of operating time in the emergency operating zone must be maintained.

Note

- Any operation in or above the emergency operating zone requires special maintenance action.
- The permissible emergency EGT level at low CIT's is above the derich system actuation point; therefore, the derich system must be disarmed if this level is to be attained.

TIME LIMITS

YJT11D-20A and YJ-1 engines may be operated continuously at all ratings when within the normal exhaust gas temperature limits; however, no more than one hour may be accumulated with EGT in excess of the normal limit schedule, and EGT must be reduced immediately if an emergency limit temperature is exceeded. (See EGT Limits and figure 5-2.)

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NOTE

- Any operation in or above the emergency operating zone requires special maintenance action.
- The permissible emergency EGT level at low CIT's is above the derich system actuation point; therefore, the derich system must be disarmed if this level is to be attained.

COMPRESSOR INLET TEMPERATURE

The maximum allowable compressor inlet temperature is 427°C. In addition, deceleration must be monitored so that engine cooling rates will not be excessive. While above an airspeed of Mach 1.8, the aircraft maximum rate of descent should be such that rate of deceleration does not exceed 1.0 Mach in three minutes. There is no limitation on rate of deceleration while below Mach 1.8.

COMPRESSOR INLET PRESSURE

The minimum pressure recommended for airstarts from stabilized windmilling speeds is 7 psi. This pressure is marked by a green radial line.

ENGINE SPEED

Military and afterburning engine speeds are the same and are automatically scheduled by the fuel control as a function of Compressor Inlet Temperature. The normal schedule is shown by figure 5-2. Engine overspeed above 7450 rpm requires a visual inspection of the turbine. Notify the engine manufacturer if 7550 rpm is ever exceeded. Each instance of overspeeding should be reported as an engine discrepancy and should include the maximum rpm attained.

LIMIT FLIGHT SPEED AND ALTITUDE ENVELOPE

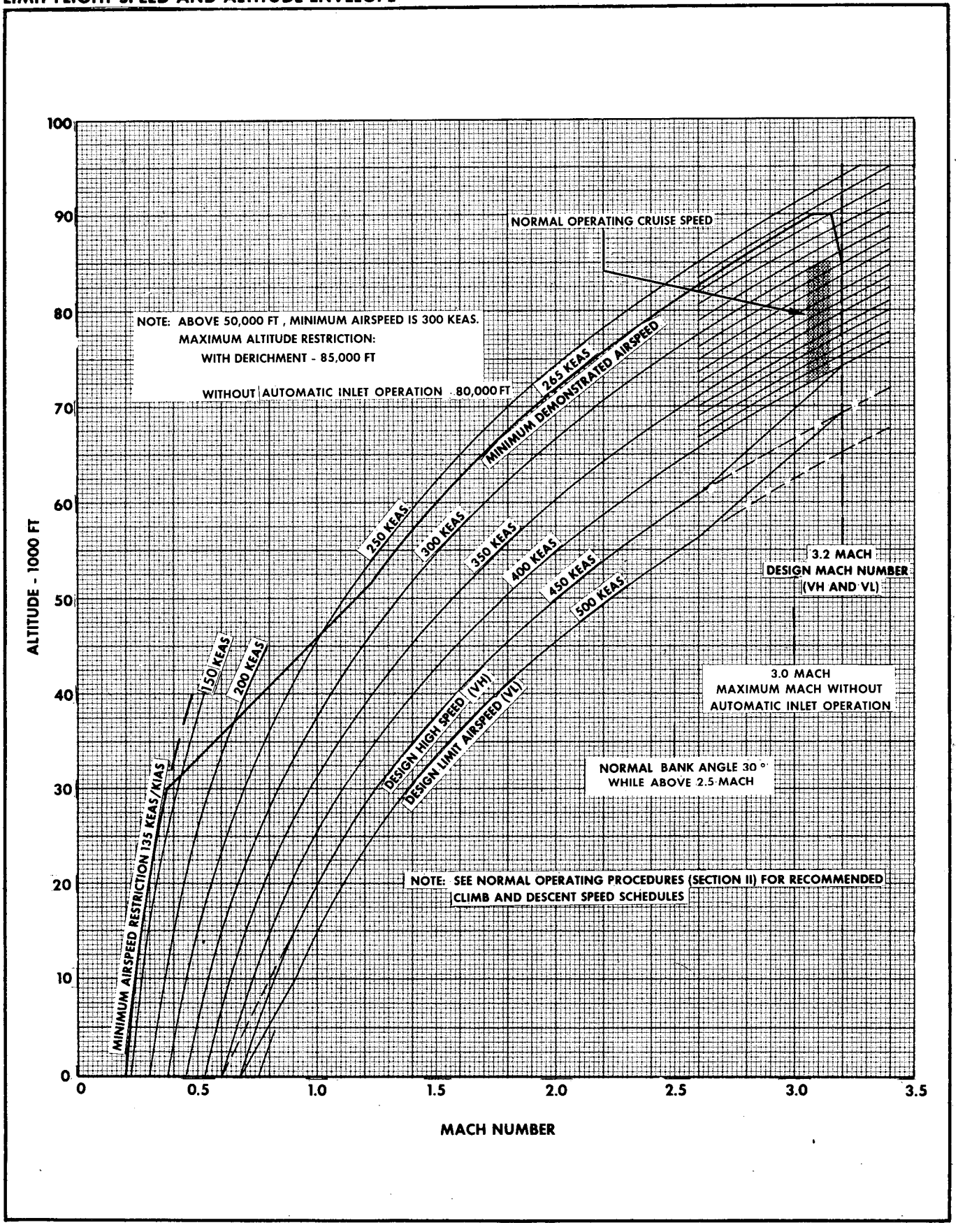

Figure 5-3

FUEL

The approved fuel is PWA 523E. The P&W approved source of lubricity additive, PSJ-67A, must be mixed with the fuel in the ratio of 0.29 gallons per 4000 gallons of fuel. Fuels such as JP-4, JP-5, and JP-6 may be used only for emergency requirements such as air refueling when standard fuel is not available and air refueling must be accomplished or risk loss of the aircraft. Operation with emergency fuels should be restricted to speeds below Mach 1.5.

OIL

The approved oil is PWA 524B. If necessary because of low ambient temperatures, it may be diluted with Trichloroethylene, Federal Specification O-T-634, Type 1, in accordance with Maintenance Manual procedures.

Oil Pressure

Oil pressures below 35 psi are unsafe and require that a landing be made as soon as possible, using minimum thrust required to sustain flight until a landing can be accomplished. Normal oil pressure is from 40 to 55 psi. Except at IDLE throttle settings, oil pressures between 35 psi and 40 psi are undesirable and should be reported after flight. A gradually increasing oil pressure up to 60 psi is acceptable at high Mach numbers provided the indication returns to normal values after aircraft decelerates to subsonic speed.

Oil Temperature

Oil temperature must be at least 60°F (15°C) prior to starting unless previously diluted with Trichloroethylene (PWA 9003). Engine oil temperatures above 290°C are unsafe and a landing should be made as soon as possible if the temperature cannot be maintained below this value. An engine should not be restarted after windmilling at subsonic speed when CIT is less than 15°C (60°F) for more than 5 minutes. If restarted, operation above IDLE with OIL TEMP warning light illuminated shall be as brief as possible.

MAXIMUM WEIGHT LIMITS

Maximum gross weight is not limited except by takeoff performance capabilities. Base maximum takeoff weights on information provided in Part II of the Appendix.

MAXIMUM ALTITUDE

Maximum altitude with derichment installed and operational is 85,000 feet; maximum altitude without derichment is 75,000 feet.

LIMIT AIRSPEEDS

(Refer to figure 5-3 for the limit flight speed and altitude envelope.)

MINIMUM AIRSPEED RESTRICTION

The stall warning light on the annunciator panel and the master caution light illuminate when angle of attack reaches 14° in flight. A tone is also produced in the pilot's headset. When above 135 KIAS, the speed at which stall warning occurs is the minimum airspeed restriction for the existing vehicle weight, c.g., and load factor unless operation is governed by a higher value of minimum KEAS as displayed by the Triple Display Indicator. Minimum airspeed is 300 KEAS above 50,000 feet.

INDICATED AIRSPEED

The Mach-airspeed indicator limit hand is set to indicate airspeed (KIAS) corresponding to 500 KEAS. However, the 500 KEAS limit applies only at altitudes above 9400 feet, and at airspeed below Mach 2.6. Below 9400 feet, limit airspeed decreases linearly with altitude from 500 KEAS at 9400 feet to 450 KEAS at sea level. Above Mach 2.6, limit airspeed decreases linearly from 500 KEAS at Mach 2.6 to 450 KEAS at Mach 3.2. See figure 5-4 for variation of KIAS with altitude for KEAS.

Note

Maximum recommended operating speeds are at least 50 KEAS less than limit airspeeds. 450 KEAS (Mach 0.9) is not recommended below 14,800 feet.

LIMIT AIRSPEED VS ALTITUDE

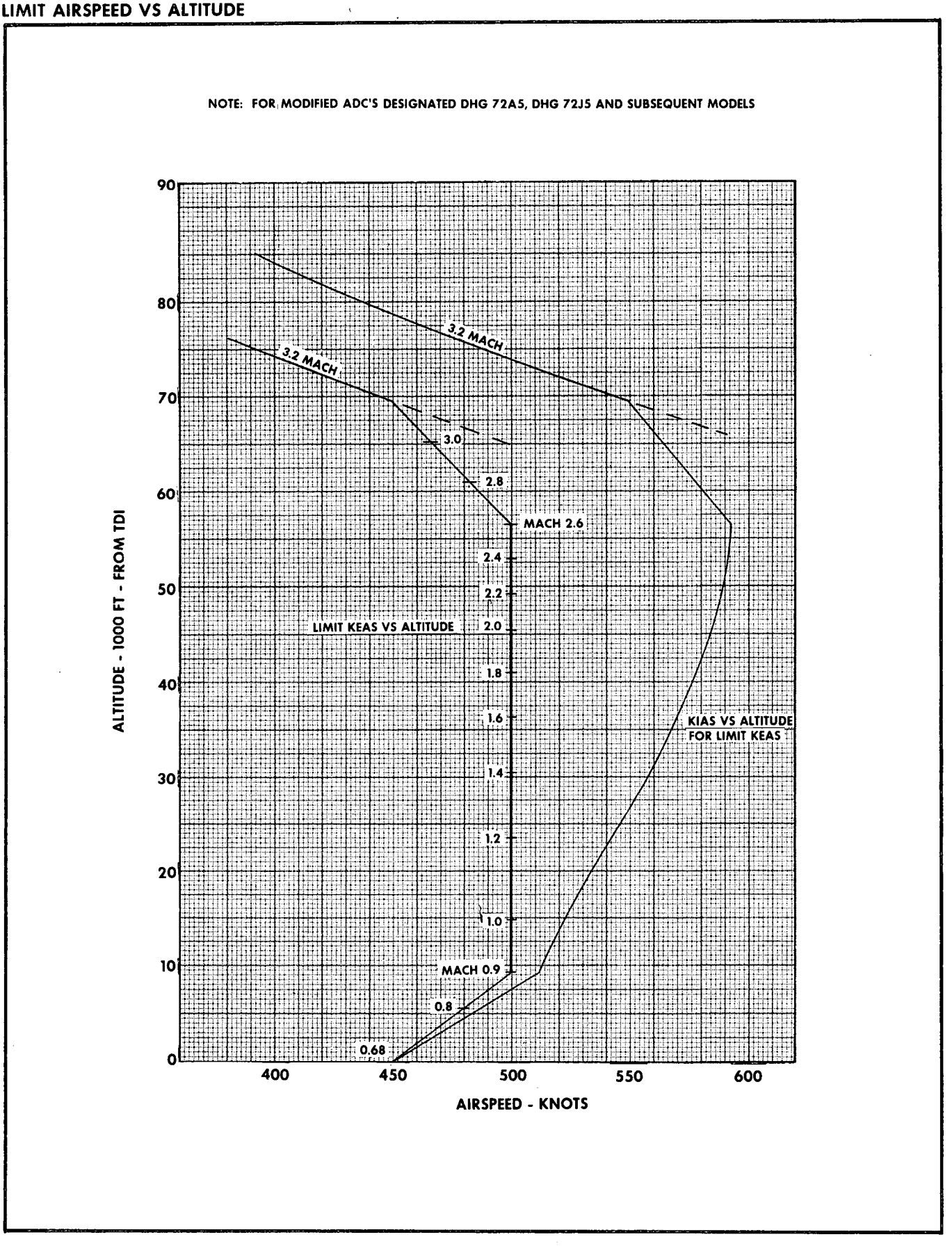

Figure 5-4

MINIMUM AIRSPEED LIMITS FOR 14° ANGLE OF ATTACK

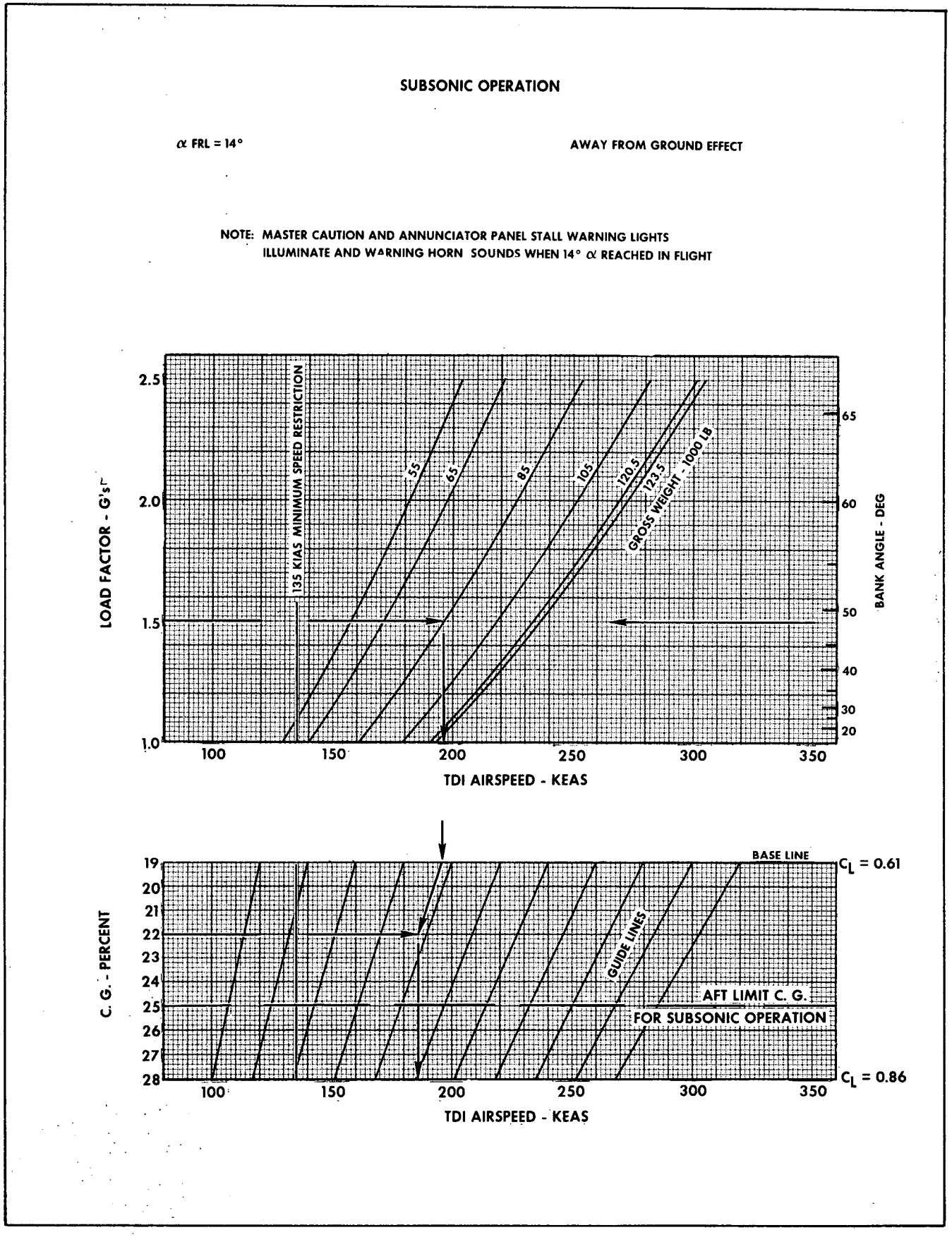

Figure 5-5

LIMIT LOAD FACTOR DIAGRAM

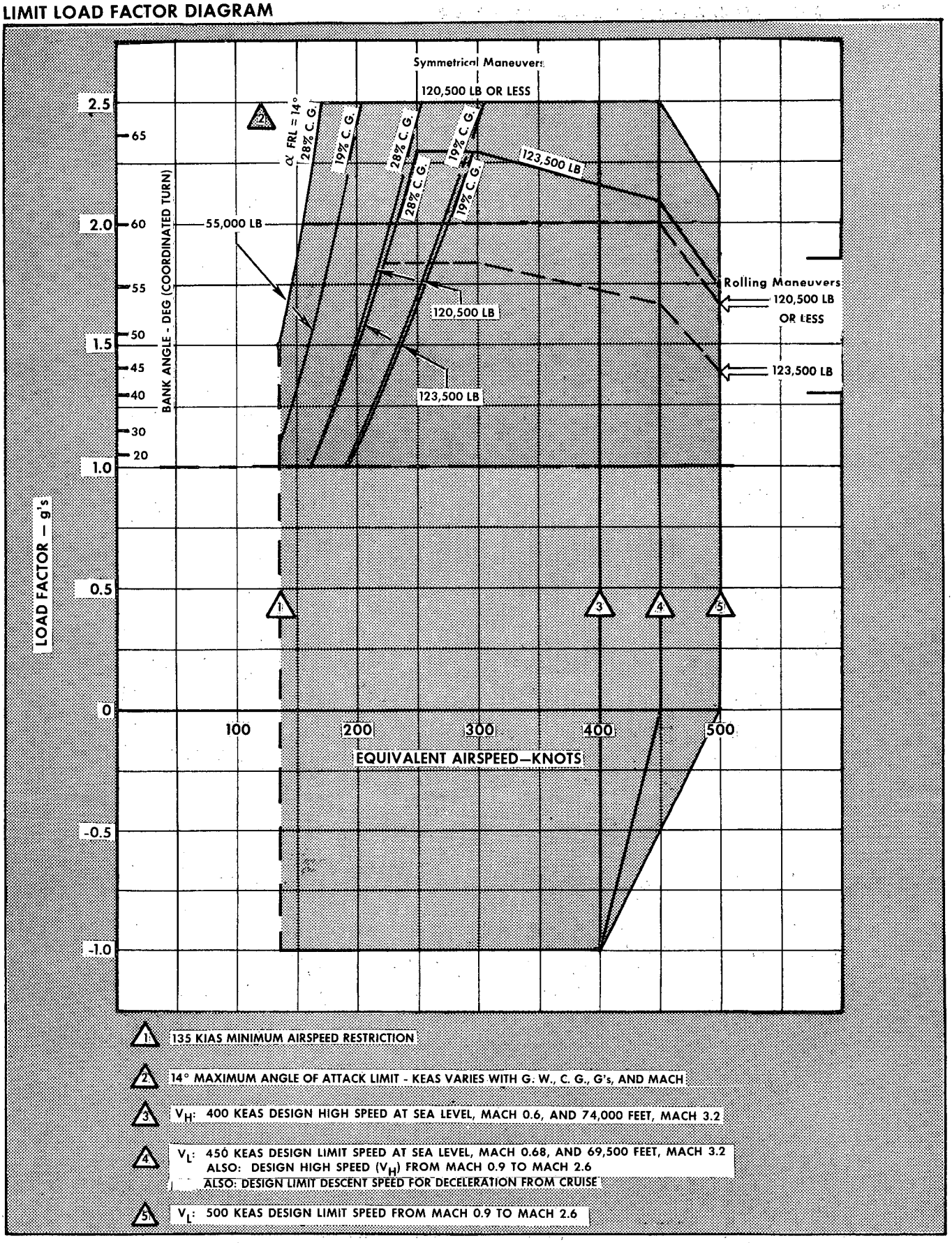

Figure 5-6

A red radial line at 135 KIAS represents the minimum subsonic speed restriction below 30,000 feet when the stall warning light is off.

EQUIVALENT AIRSPEED

The triple display indicator is not marked however, the limit equivalent speeds are as follows unless:

a. The Mach-airspeed instrument indicated airspeed equals either the limit airspeed hand indication or the minimum (135 KIAS) restriction.

b. The stall warning light illuminates or the stall warning tone is heard.

Maximum TDI Airspeed

The limit airspeed is 450 KEAS at sea level, increasing linearly with altitude to 500 KEAS at 9400 feet pressure altitude; then 500 KEAS between 9400 feet and the altitude for Mach 2.6. Limit airspeed then decreases linearly with Mach number to 450 KEAS at Mach 3.2. Normal operation cruise speed is 3.1 Mach.

Minimum TDI Airspeed

The minimum airspeed restriction varies linearly with Mach number from 135 KEAS (Mach 0.38) at 30,000 feet to 300 KEAS (Mach 1.34) at 50,000 feet, and is then a constant 300 KEAS to 85,000 feet (Mach 3.1).

LOAD FACTOR LIMITS

The maximum allowable positive load factor is 2.5 g's in symmetrical maneuvers and 2.0 g's in roll maneuvers as described by figure 5-6. The maximum negative load factor is -1.0 when below 400 KEAS varying from -1.0 to 0 g's at higher airspeed as shown by figure 5-6.

To avoid exceeding a safe angle of attack positive g's are limited to 1.5 g's when operating above 2.5 Mach. (This is equivalent to approximately a 45° bank level turn.)

PROHIBITED MANEUVERS

The aircraft shall be operated in a manner to avoid full stalls, spins, and inverted flight. Normal bank angle when operating above Mach 2.5 is 30 degrees.

RATE OF DESCENT LIMITATION

Rates of descent must be limited so as to maintain positive fuel tank pressure when sustained cruise speeds have exceeded Mach 2.8.

CENTER OF GRAVITY

The aircraft shall be operated within a c.g. range from 19% to 25% MAC while subsonic. The c.g. must be forward of 25% MAC for takeoff and should be as near to 19% MAC as possible with existing fuel for landing.

The aft c.g. limit is 28% MAC while supersonic. This limit results from stability considerations at high Mach number. Adequate stability exists at farther aft centers of gravity between Mach 1.2 and Mach 2.6 but for simplicity the aft limit is not changed. The purpose of elevon trim limits imposed in this Mach region is to alert the pilot of a major malfunction in the fuel system.

On those aircraft incorporating S/B 1141, if an aft c.g. emergency exists and EMER forward transfer is operated to place more than 4000 lbs in tank 1 and total fuel is less than 30,000 lbs, the aircraft should be limited to maneuvers causing not more than 1.5 g.

As elevon trim can be used as an indication of abnormal c.g. condition, the following pitch trim limits apply:

While subsonic - no more than 1° nose down.

RATED TIRE SPEED

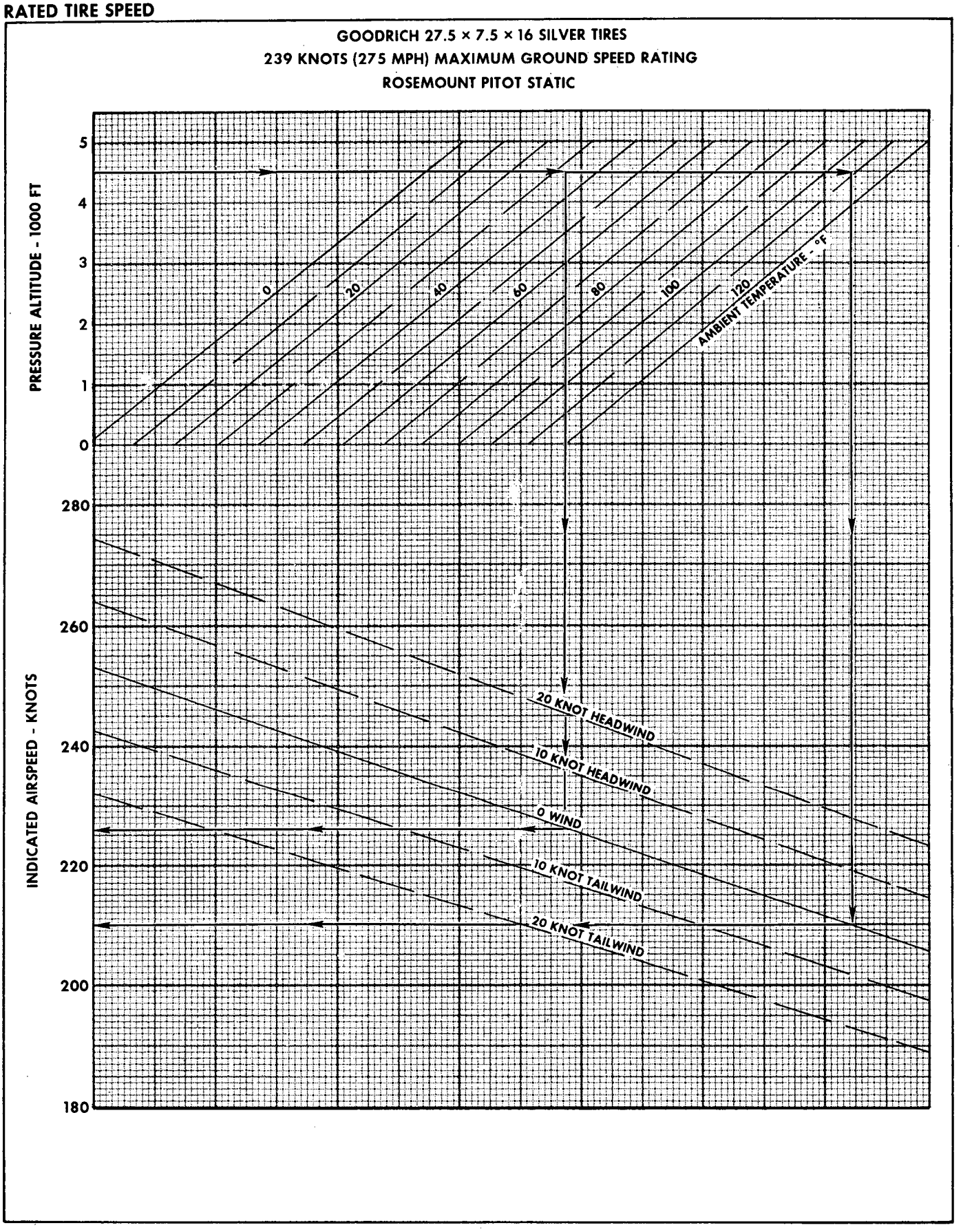

Figure 5-7

SECTION V

Add the following text to CENTER OF GRAVITY

On those aircraft incorporating S/B 1141, if an aft c.g. emergency exists and EMER forward transfer is operated to place more than 4000 lbs in tank 1 and total fuel is less than 30,000 lbs, the aircraft should be limited to maneuvers causing not more than 1.5 g.

Tires

The maximum taxi speed recommended is 40 knots for Goodrich 27.5 x 7.5 x 16 "silver" tires. The rated ground speed limit is 239 knots. At 4500 feet elevation, this corresponds to 210 KIAS at 108°F with ambient temperature on a calm day, and 226 KIAS at 32°F ambient temperature. Limit indicated airspeed on the ground decreases by the amount of tailwind component along the runway and increases by the headwind component. Refer to figure 5-7 for rated speeds at other altitudes and temperatures.

Taxiing Restrictions

A heat check is required for tires, wheels, and brakes:

a. Prior to takeoff when taxiing has exceeded one statute mile.

b. When continuous taxi distance has exceeded 5 statute miles.

c. When clear of the runway after an aborted takeoff or a heavy weight landing.

If required, cooling should be accomplished until ground inspection reveals that the tires and wheels are sufficiently cooled for continued operations (temperatures relatively tolerable to the touch).

Note

Cooling may be accelerated by use of fans.

Abort during takeoff roll requires a tire change.

While climbing - 2-1/2° nose down from Mach 1.4 to Mach 2.6, 3-1/2° nose down above Mach 2.6.

At initial cruise the trim limit is 3-1/2° nose down at 28% c.g. As altitude increases and KEAS decreases, the 28% c.g. trim limit becomes approximately 2° more nose up per 50 KEAS decrease from 450 KEAS. (In addition, expect approximately 1° more nose up trim for each percent that c.g. is forward of 28% MAC).

FUEL LOADING LIMITATIONS

These limits to be supplied at the operating site.

AIRCRAFT SYSTEM LIMITATIONS

STABILITY AUGMENTATION SYSTEM

The SAS shall be on for all takeoffs and landings.

INLET SPIKE AND BYPASS CONTROLS

The spike and forward bypass controls must be operated in the AUTO mode at all times when above 80,000 feet. When inlet controls must be operated manually, maximum allowable speed is Mach 3.0.

CANOPY

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

LANDING GEAR SYSTEM

Landing Gear

Do not exceed 300 KEAS or Mach 0.9 with a maximum of 5° sideslip with gear extended. When sideslip angle exceeds 5°, operation with gear extended is limited to Mach 0.7 or 300 KEAS. Operation at supersonic speed with gear extended is prohibited. The landing gear is designed for landing sink speeds at touchdown which decrease from 9 FPS at 57,000 pounds to 5 FPS at 123,600 pounds. Side loads during takeoff, landing, and taxiing must be kept to a minimum, as landing gear side load strength is critical during ground maneuvering.

Tires

The maximum taxi speed recommended is 40 knots for Goodrich 27.5 x 7.5 x 16 "silver" tires. The rated ground speed limit is 239 knots. At 4500 feet elevation, 239 knots corresponds to 210 KIAS with 108°F ambient temperature on a calm day, and 226 KIAS at 32°F ambient temperature. Limit indicated airspeed on the ground decreases by the amount of tailwind component along the runway and increases by the headwind component. Refer to figure 5-7 for rated speeds at other altitudes and temperatures.

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a. Prior to takeoff when taxiing has exceeded one statute mile.

b. When continuous taxi distance has exceeded 5 statute miles.

c. When clear of the runway after an aborted takeoff or a heavy weight landing.

INITIAL BRAKING SPEED FOR STOP USING RATED BRAKE CAPACITY

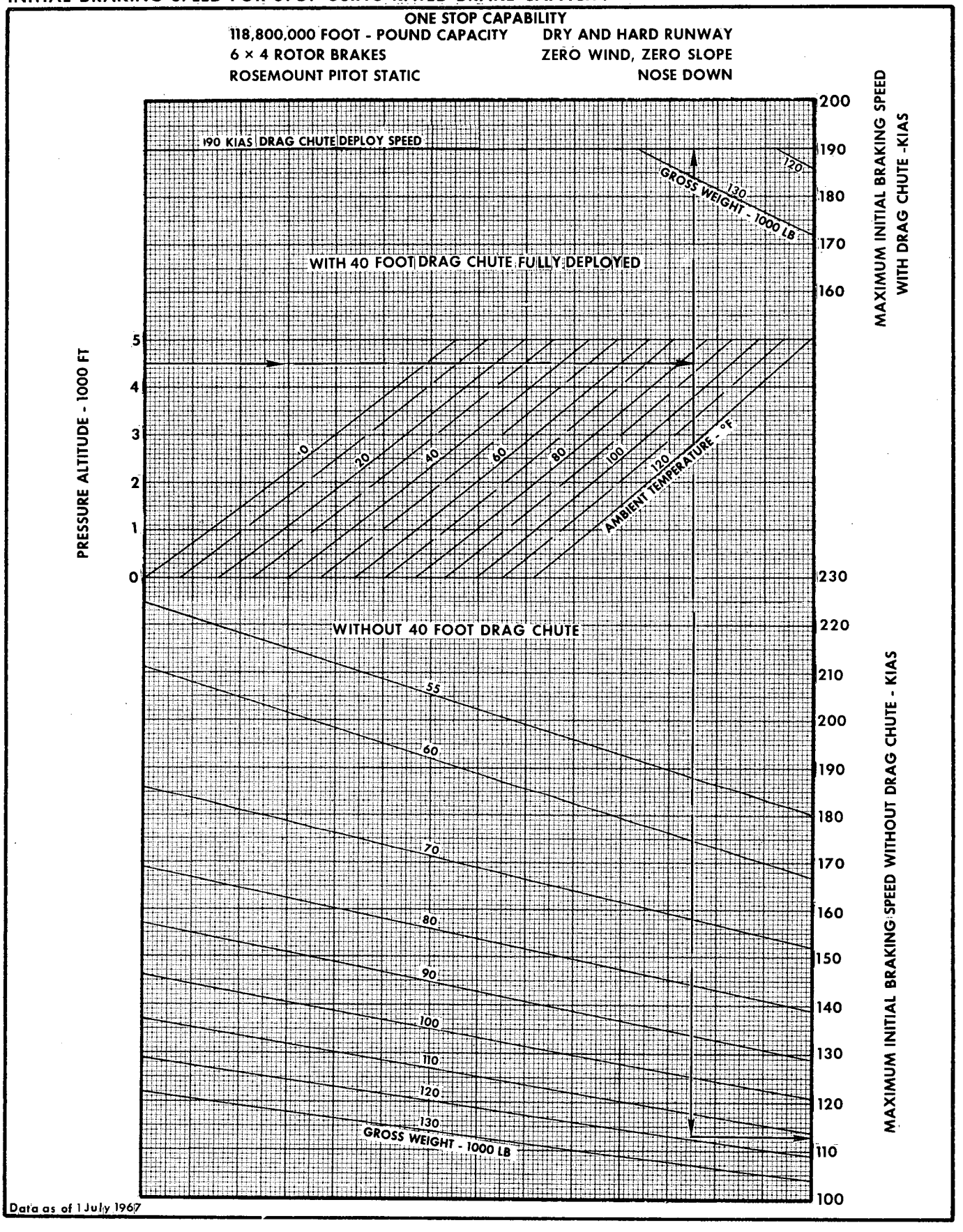

Figure 5-8

DRAG CHUTE LIMITATIONS

The maximum speed for drag chute deployment is 210 KIAS. The maximum crosswind component for jettisoning the drag chute is 12 knots. The minimum airspeed for jettisoning the drag chute is 55 KIAS. Taxiing with the chute attached is permitted if the elevons are not moved.

If required, cooling should be accomplished until ground inspection reveals that the tires and wheels are sufficiently cooled for continued operations (temperatures relatively tolerable to the touch).

NOTE

Cooling may be accelerated by use of fans.

Abort during takeoff roll requires a tire change.

Brakes

The one-stop energy rating of the brakes is 118,800,000 foot-pounds. Speeds corresponding to these energy ratings from which stops can be made vary with gross weight, ambient temperature, altitude, wind, and whether or not the drag chute is deployed. Corresponding indicated airspeed, altitude, temperature, and weight conditions are shown by figure 5-8 for the above rating for stops on dry runways with zero wind component. Headwind components may be added to values shown, and tailwind components must be subtracted from values illustrated. There is no limiation on airspeed for brake application at normal landing weights when the drag chute is used. Refer to Part II of the appendix for detailed information related to maximum refusal speeds and heavyweight landings with various operating conditions.

Brakes in a new condition have a capacity for one hard stop from rated speed. If applied sooner, they will burn out prior to stop. In normal operations, delaying brake application until below 75% of limit speeds reduces wear and conserves brake capacity for high energy stops.

If brakes chatter at slow speeds during taxi, turns, and at the end of the landing roll, light braking only must be used to avoid "walking the gear" and cyclic loads on the airframe structure.

DRAG CHUTE LIMITATIONS

The maximum speed for drag chute deployment is 210 KIAS.

LN_2 Quantity Indicator

The LN_2 quantity indicator is marked with a yellow caution arc between 0 and 30 liters remaining. Approximately 60 liters of liquid nitrogen are required for a normal descent from cruise altitude to landing. Descents initiated with less than 30 liters per system or 60 liters total may deplete the LN_2 system and require use of emergency procedures for fuel tank pressurization failure as lower altitudes are reached.

AUTOPILOT SYSTEM

Updated autopilots now have no limitations when operating within the normal flight operating envelope.

WARNING

An autopilot hardover failure at speeds in excess of 450 KEAS below 10,000 feet or speeds in excess of 465 KEAS between 20,000 and 30,000 feet will cause excessive load factor if immediate pilot corrective action is not accomplished.

OXYGEN SYSTEM

Flights without a pressure suit, using the oxygen mask and regulator, are restricted to altitudes below FL 500 and speeds below 420 KEAS.