# SECTION 2

# LIMITATIONS

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# LIMITATIONS

## LIMITATIONS - GENERAL

Certain operating limitations are imposed by the Civil Aeronautics Administration during the process of certification of the aircraft. These are, in effect, a partial statement of the terms upon which the airworthiness certificate for the plane was issued. Compliance with these limitations is therefore required by law.

The company establishes certain operating limitations, more conservative than those specified by the CAA, as operational policy to improve safety margins, or to alleviate maintenance requirements by staying well under warranty limits established by manufacturers of various components of the plane.

In an attempt to present all limitations in one place in this manual where they can be readily found for reference, most of them are grouped together in this section; compliance with them is required.

## AIRSPEED LIMITATIONS

### NEVER EXCEED SPEED - $V_{NE}$

**The maximum glide or dive speed from sea level to 8,000 feet is 364 knots EAS. Never exceed Mach .640 over 8,000 feet.**

### NORMAL OPERATING LIMIT SPEED - $V_{NO}$

**The maximum level flight or climb speed from sea level to 12,000 feet is 324 knots EAS. Normal operating Mach is .615 over 12,000 feet.**

**NOTE: The speed $V_{no}$ should not be deliberately exceeded, even during descents, because of the possibility of excessive gust loads resulting from unexpected gusts. The speed range between $V_{no}$ and $V_{ne}$ is provided for inadvertent speed increases and should not be deliverately used in normal operation.**

### OTHER AIRSPEED LIMITATIONS

Other airspeed limitations, as well as EAL Recommended Operating speeds, $V_1$-$V_2$ speeds, and airspeed instrument calibration curves are presented in Section 3-1 of this manual, immediately following this section.

## WEIGHT LIMITATIONS

There are many limitations placed on take-off weight. In general, these consist of the following: Limitations due to design and structural considerations; limitations due to runway length and gradient, field elevation, temperature and wind conditions as they affect engine-out climb characteristics and ability of the aircraft to clear obstacles adjacent to the runway extension, and enroute; and limitations imposed by the necessity of not being overweight for landing at the airport of intended landing, considering runway length available at destination.

Except for those due to design and structure, take-off weight limitations are determined during the certification of a transport aircraft, and are presented in the CAA Approved Airplane Flight Manual as a series of charts. As these charts are difficult to use; and as information necessary for their use, such as runway gradient and heights and distances of obstacles from the runway end, is seldom available to the pilot, the charts are not included in this manual.

For aid in compliance with these limitations, a "Gross Weights Manual - L188" has been prepared. A copy of the manual will be kept in the flight deck of each Electra operated by EAL. The manual contains data relative to each runway at every airport into which the company will schedule these planes. An example of how they are to be used is shown on page 2 of this section.

The maximum operating weights for field elevation, runway length and gradient, and varying atmospheric conditions must not exceed those specified in the Gross Weights Manual.

# LIMITATIONS

## WEIGHT LIMITS

TAKE-OFF WEIGHT MAXIMUM. . . . . 113,000 Lbs.

LANDING WEIGHT MAXIMUM . . . . . 95,650 Lbs.

ZERO FUEL WEIGHT MAXIMUM
Plane Nos. 501-524 . . . . . 80,910 Lbs.
Plane Nos. 525-541 . . . . . 86,000 Lbs.

NOTE: The maximum take-off and landing weights listed above are for sea level standard atmosphere conditions without runway restrictions. The maximum operating weights for other conditions must not exceed those specified in EAL L188A GROSS WEIGHT MANUAL.

## USE - GROSS WEIGHT MANUAL

### TAKE-OFF WEIGHT LIMITS

A sample page of the Gross Weights Manual is shown below. Permissible take-off and landing weights are tabulated for each runway. Take-off weights are computed at a "Control" or "Base" temperature of 95°, take into account the length and gradient of the runway as well as proper clearance of obstacles in the flight path beyond the runway end, and are tabulated for tail-wind - head-wind increments. Also tabulated by wind increments are weight correction factors which, when multiplied by the difference between the base temperature and observed temperature, will give a weight correction which can be applied to the tabulated take-off weight. The weight correction must be subtracted if the observed temperature is higher than the base temperature, and may be added if observed is less than base. Regardless of the amount of applied correction, the take-off weight can never exceed 113,000 Lbs.

EXAMPLE: Given: Wind NNE 15, Temp. 75°.
Desired: Allowable T.O. weight for runway 3.

T.O. Weight at 95° for
+15 Kts. Wind. . . . . .99,900 Lbs.
Temp. Below Base 95-75 = 20°
#Increase per Degree = 355
Correction to be applied
355 x 20 . . . . . 7,100
Allowable T.O. Weight. . . . . 107,000 Lbs.

On the Weight Charts, when there are a number of blank spaces to the right of a given weight figure, it means the last figure entered before the blanks is to be used.

### LANDING WEIGHT LIMITS

Landing weights take into account obstacle clearance in the approach area before the runway threshold. Landing weights for "Intended Destination" take into account the use of 60% of the available runway; those for "Alternate Destination", the use of 70%.

EASTERN AIR LINES, INC.

GROSS WEIGHTS CHARTS

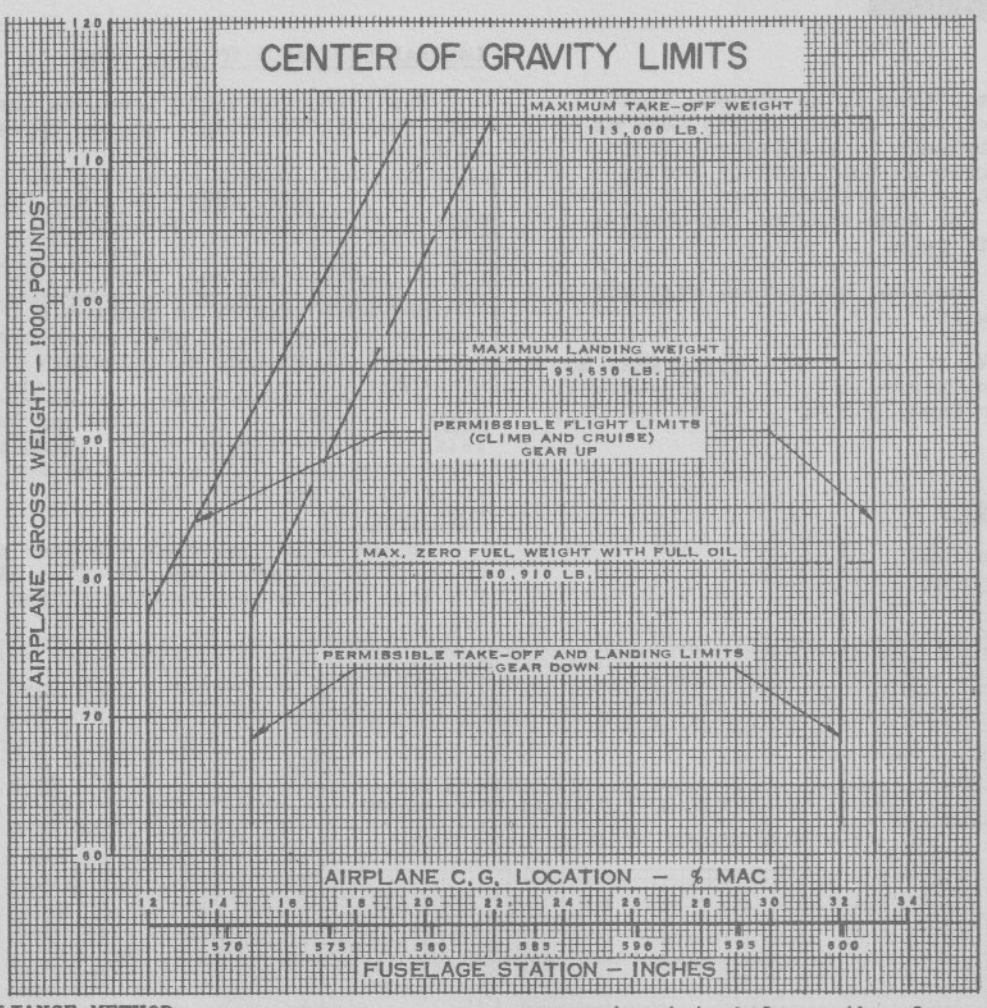
LOCKHEED ELECTRA

ELEVATION 17' ASL

PHOGGY BOTTOM
National Airport

4 AUTOMATIC FEATHERING

| RUNWAY | | WIND COMPONENT KTS. → | -10 | -5 | ZERO | +5 | +10 | +15 | +20 | +30 |
|---|---|---|---|---|---|---|---|---|---|---|
| 3 | TAKE OFF | WEIGHT AT CONTROL TEMP. OF 95°F. | 93200 | 95600 | 98000 | 98600 | 99200 | 99900 | 100600 | 101800 |
| | | LBS. INCREASE PER DEGREE F. ACTUAL TEMP. IS BELOW CONTROL TEMP. | 280 | 330 | 320 | 332 | 345 | 355 | 366 | 344 |
| | | LBS. DECREASE PER DEGREE F. ACTUAL TEMP. EXCEEDS CONTROL TEMP. | 344 | 333 | 311 | 314 | 316 | 314 | 311 | 267 |
| | | * IF ENGINE ANTI-ICING SYSTEM USED WEIGHT MUST NOT EXCEED | 103280 | 107120 | 109520 | 110552 | 111620 | 112680 | 113000 | 113000 |
| | | LANDING INTENDED DESTINATION | 82700 | 87800 | 93000 | 94900 | 95650 | | | |
| | | LANDING ALTERNATE DESTINATION | | | 95650 | | | | | |
| 15 | TAKE OFF | WEIGHT AT CONTROL TEMP. OF 95°F. | 95600 | 97700 | 99800 | 100400 | 101000 | 102100 | 103200 | 105400 |
| | | LBS. INCREASE PER DEGREE F. ACTUAL TEMP. IS BELOW CONTROL TEMP. | 317 | 335 | 355 | 360 | 361 | 347 | 333 | 328 |
| | | LBS. DECREASE PER DEGREE F. ACTUAL TEMP. EXCEEDS CONTROL TEMP. | 366 | 322 | 311 | 316 | 322 | 322 | 322 | 283 |
| | | * IF ENGINE ANTI-ICING SYSTEM USED WEIGHT MUST NOT EXCEED | 107012 | 109760 | 112580 | 113000 | 113000 | 113000 | 113000 | 113000 |
| | | LANDING INTENDED DESTINATION | 88000 | 93200 | 95650 | | | | | |
| | | LANDING ALTERNATE DESTINATION | | | 95650 | | | | | |
| 18 | TAKE OFF | WEIGHT AT CONTROL TEMP. OF 95°F. | 108600 | 110500 | 112100 | | | | | |
| | | LBS. INCREASE PER DEGREE F. ACTUAL TEMP. IS BELOW CONTROL TEMP. | 314 | 250 | 225 | | | | | |
| | | LBS. DECREASE PER DEGREE F. ACTUAL TEMP. EXCEEDS CONTROL TEMP. | 344 | 333 | 366 | | | | | |
| | | * IF ENGINE ANTI-ICING SYSTEM USED WEIGHT MUST NOT EXCEED | 113000 | 113000 | 113000 | | | | | |
| | | LANDING INTENDED DESTINATION | 95650 | | | | | | | |
| | | LANDING ALTERNATE DESTINATION | 95650 | | | | | | | |
| | TAKE OFF | WEIGHT AT CONTROL TEMP. OF 95°F. | 93600 | 96100 | 98600 | 99300 | 100000 | 100700 | 101400 | 102800 |
| | | LBS. INCREASE PER DEGREE F. ACTUAL TEMP. IS BELOW CONTROL TEMP. | 310 | 320 | 340 | 337 | 333 | 344 | 355 | 333 |
| | | LBS. DECREASE PER DEGREE F. | | | | | | | | |




EAL C.G. COMPLIANCE METHOD

ENGINEERING COMPUTATIONS

The Engineering Department makes basic computations to determine the C.G. location for each type airplane considering crew, fuel, oil, and all operational equipment to be at their normal stations; i.e., the C.G. with everything aboard except payload.

The preceding data are combined with separate computations to determine the affect on C.G. caused by loading varying groups of passengers (0-6 passengers, 7-10 passengers, etc., till the maximum passenger capacity is reached). Two sets of computations are made for each passenger grouping: One assumes all passengers to be seated from the rear forward and a minimum weight is established which, when loaded in the aft cargo compartment, will balance the plane about the rear C.G. limit; the other assumes all passengers to be seated from the front toward the rear to establish a maximum weight which, when loaded in the aft cargo compartment, will balance the plane about the forward C.G. limit. Thus, for a passenger complement of almost any number, whether they be in the rear or the front of the plane, a minimum and a maximum rear cargo compartment load is established which will keep the plane balanced within C.G. limits. Certain rearward groupings of passengers, however, require a given weight in the forward baggage compartment to balance the plane about the aft C.G. limit. This is specified as a "minimum front weight".

WEIGHT CHARTS AND CARGO MANIFEST

The Engineering data derived above are tabulated on WEIGHT CHARTS which are distributed to all EAL stations for use by our Operations Agents. From these charts the agents read off that for a passenger load of any given number; either the rear cargo compartment must contain a weight between a given minimum and maximum figure, or the forward baggage compartment must contain a "minimum front weight" of a given figure. From the Weight Charts, the agent will enter on line 3 of the CARGO AND WEIGHT MANIFEST (form EAL-010), either Min.-Max. rear weight, or the Min. front weight required to keep the plane in balance limits. On the same line of form 010 he also enters the actual weight, whether cargo or ballast, loaded in the cargo bin specified.

COMPLIANCE WITH C.G. LIMITATIONS

For the flight crew to determine that the C.G. of the loaded airplane is within limits, it is only necessary to inspect the form EAL-010 to see that the actual cargo compartment load entered under "TOTAL REAR/FRONT WEIGHT" is either between the min.-max. aft limits, or is equal to or greater than the min. front weight as entered thereon by the operations agent.

# LIMITATIONS

## FUEL LIMITATIONS

During flight, there is no maximum limit on the quantity of fuel in any single tank as long as lateral balance is maintained within the limits set forth in this section and as long as the quantity is greater than the minimum values shown for each tank on the chart at the bottom of this page.

For landing, the fuel quantities must not exceed the following:

Tanks 1 and 4. . . . . 6,700 Lbs. ea.
Total fuel in Tanks 1 & 2. . . . 13,400 Lbs.
Total fuel in Tanks 3 & 4. . . . 13,400 Lbs.

## MINIMUM FUEL GRADE

EMS-64A (Kerosene)
MIL-F-5624C (JP4)

## LATERAL UNBALANCE OF FUEL LOAD

The following table presents the maximum safe fuel differential between opposite pairs of tanks.

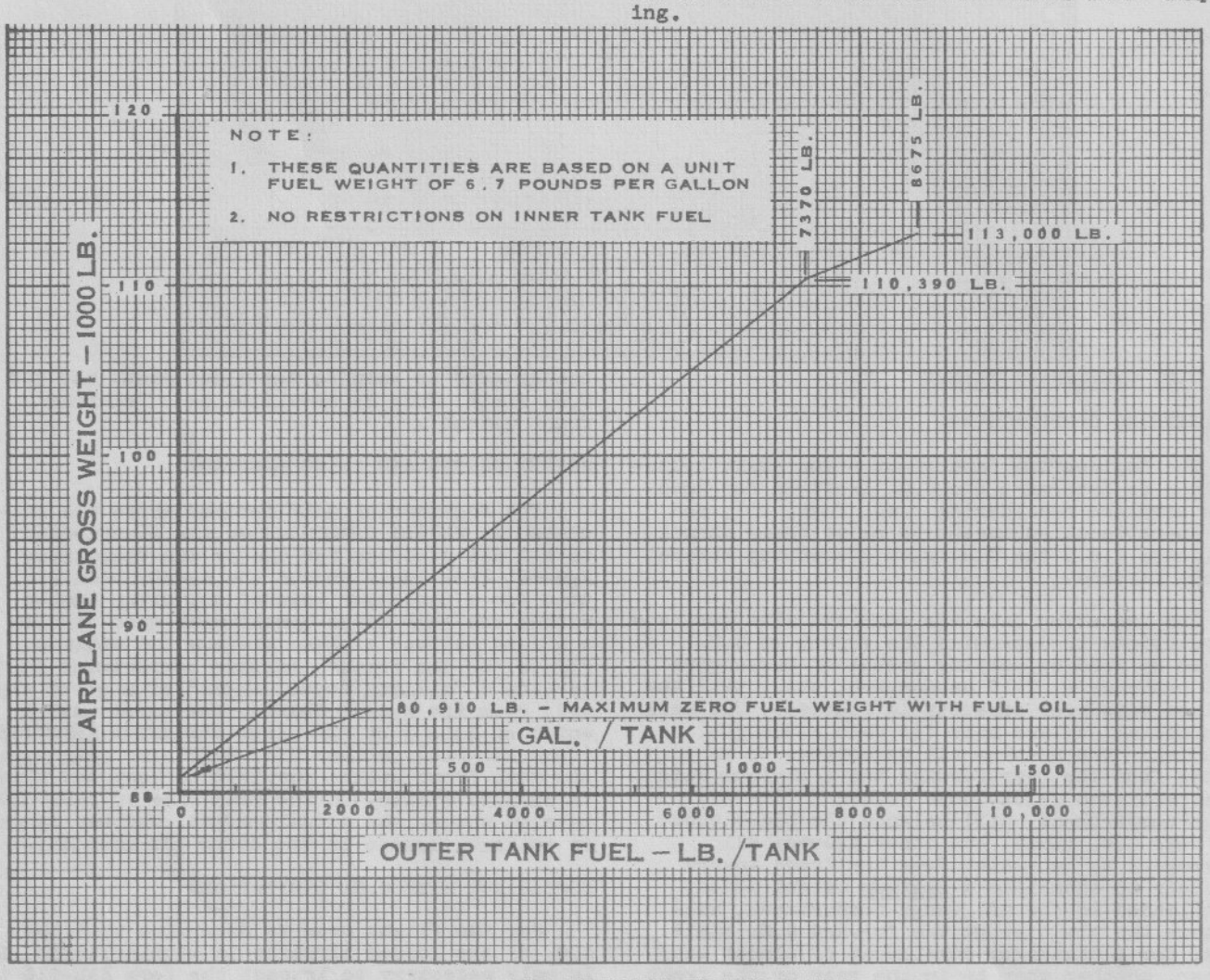
| TANK | MAX. DIFFERENTIAL - POUNDS* | | |
|---|---|---|---|
| | FLIGHT | TAKE-OFF | LANDING |
| 1 & 4 | 4389 | 1400 | 4389 |
| 2 & 3 | No Restriction | 6700 | No Restriction |

*Symmetrical balance in tanks 1 & 4 or 2 & 3 must be maintained if maximum unbalance differential is desired or necessary in either pair of tanks.

NOTE: In addition to restricting lateral unbalance to the values shown, it is necessary to observe minimum fuel quantities for each tank as shown on the chart below.

## FUEL DUMPING

Do not dump fuel with the gear or flaps down, or at speeds above 200 Kts. EAS or below 140 Kts. EAS. Do not release flares while dumping.




MINIMUM FUEL REQUIRED DURING FLIGHT

# LIMITATIONS

## TESTED CROSSWIND

20 Knots was the maximum value available at time of certification tests. This is not a limiting figure.

When determining the effective take-off and landing runway lengths in a crosswind, the full headwind component can be used, providing that the crosswind component does not exceed 20 knots.

## TYPE OF AIRPLANE OPERATION

Transport category. Instrument night flying when the required equipment is installed.

## MINIMUM CREW

The minimum crew with which this airplane can be flown consists of a Pilot, Co-pilot, and Flight Engineer.

## DE-ICING

The wing and empennage de-icing system must not be operated during take-off. Engine and propeller anti-icing should be used if the temperature is 2°C (36°F) or less and visible moisture is present in the atmosphere. In this event, the airplane gross weight for take-off should not exceed the figure shown in the Gross Weight Charts for the particular runway being used with the prevailing headwind component.

EXAMPLE: Determine allowable take-off gross weight, Phoggybottom National Airport, runway 3, wind NNE 15, temp. 32°F, light drizzle.

Refer to the proper Gross Wdight Chart (see illustration on page 2 of this section), refer to runway 3 under the proper wind component; allowable take-off weight if engine anti-icing is used is 112,680 lbs.

NOTE: If the engine anti-icing system is used at OAT higher than 36°F, the max. take-off weight shown would have to be reduced by 400 lbs. for each degree OAT exceeds 36°F.

## CABIN PRESSURIZATION

Maximum cabin differential pressure. . . . . .13.34 (±.2)" Hg.

Maximum emergency relief pressure. . . . . .14.45" Hg.

## PASSENGER LOADING LIMITATIONS

Do not load or unload passengers through forward door on left side with adjacent engines operating.

## BULKHEAD DOORS & CURTAINS

If the passenger cabin is unoccupied, doors and curtains between the flight station and passenger cabin must be secured in the open position.

## AUTOMATIC PILOT

When using the automatic pilot, the Captain or Pilot must be in his seat with his safety belt fastened so that if the automatic pilot should malfunction, he can regain control of the airplane immediately.

The maximum speed for operation with the auto pilot engaged is $V_{no}$.

## FLARES

Do not release flares while dumping fuel, nor while in an area where fuel is being dumped.

Flares have been successfully dropped at speeds up to 157 knots EAS in the clean configuration, and at speeds up to 138 knots EAS with the gear down and flaps in the APPROACH position.

## OPERATIONAL LIMITATIONS

### NTS AND AUTOFEATHER CHECKS

An NTS check will be conducted at the conclusion of each flight and a static autofeather check will be made once daily, as outlined in Section 6-3, pages 3 and 4 respectively.

### TAKE-OFF AND LANDING

- The maximum altitude approved for take-off and landing is 8,000 feet.
- The maximum ambient temperature for which take-off and landing are approved is plus 35°C from standard. Performance is shown to a minimum temperature of minus 30°C for standard. For temperatures of minus 30°C and below, these data should be used.
- The maximum runway slopes for which take-off and landing operations are approved cover gradients from 2% downhill to 3% uphill.
- The maximum tailwind component approved for take-off and landing operation is 10 knots.

### ENROUTE

- The maximum operating altitude for this airplane is 25,000 feet.
- The maximum ambient temperature for which enroute operation is approved is standard plus 35°C.

# LIMITATIONS

## POWER PLANT LIMITS

1. Engine Manufacturer. . . . . .Allison Division of General Motors Corporation
2. Model. . . . . 501-D13
3. Propeller Drive Ratio. . . . . 13.54 to 1
4. Fuel Minimum Grade . . . . . EMS-64A (Kerosene)
   MIL-F-5624C (JP4)
5. Oil Grade. . . . . EMS-35E

## ENGINE OPERATION LIMITS

| ENGINE OPERATION LIMITS (501-D13) | | | | | | |
|---|---|---|---|---|---|---|
| CONDITION | TURBINE INLET TEMPERATURE °C. | RPM | OIL PRESSURE PSI | | OIL TEMPERATURE °C | INDICATED HORSEPOWER |
| | | | RED. GEAR | POWER UNIT | | |
| START | **max. 965 (1) | | | | Before start -32 | |
| LOW-SPEED TAXI | | 9900-10,300 | 50 Min. | 50-75 | 60-100 | 1000 Max. between oil temperature of 0°C and 60°C. |
| HIGH-SPEED TAXI | | | 130-225* | | | |
| FLIGHT IDLE (GROUND) | | | | | | |
| MAXIMUM REVERSE | | | | | | |
| TAKE-OFF 100% MRT (ANY TEMP. BETWEEN 932 AND 977°C IS LIMITED TO 5 MINUTES. | 971 (1) | 13,820±140 Shut down engine and record if speed reaches 16,000, or exceeds 14,900 for a sustained period, or decays to 13,400. | 150-225* | | 60-85 100 for 5 Minutes. | 4000 for 5 Min. for any T.I.T. between 932 and 977°C. |
| MAXIMUM CLIMB 94% MRT | **895 | | 130-225 | | | 3400 for any T.I.T. below 932°C. |
| MAXIMUM CRUISE 90% MRT | **847 | | | | | |
| MAXIMUM CONTINUOUS 96.9% MRT | 932 | | | | | |

* Momentary pressure to 250 PSI permitted.

** This is not a C.A.A. limitation; it is the engine manufacturer's recommended operating temperature.

Note (1)

During start, any temperature between 877 and 965°C is limited to 5 seconds.

During take-off, any temperature between 932 and 977°C is limited to 5 minutes.

During power increases, any temperature between 1050 and 1116°C is limited to 2 seconds; between 977 and 1050°C is limited to 5 seconds.

Refer to Section 6-3 for Overtemperature Operation.

The wing and empennage de-icing system must not be operated during take-off.

ENGINE OPERATING LIMITS (Continued)

Shut down engine if RPM reaches 16,000, or exceeds 14,900 for a sustained period, or if it decays to 13,400 with synchronizer control OFF.

Air starts are not to be made above 25,000 feet, nor with T.I.T. above 200°C.

As a guide to operation, temperature and RPM ranges will normally be as follows at the indicated throttle position and when the aircraft is parked. THESE ARE NOT LIMITS.

| CONDITION | THROTTLE POSITION | TURBINE INLET TEMPERATURE °C | RPM |
|---|---|---|---|
| LOW-SPEED TAXI | Min. Torque | 380-700 | |
| HIGH-SPEED TAXI | Min. Torque | 395-625 | 13,150-13,750 |
| FLIGHT IDLE (GROUND) | 34° | 460-685 | 13,050-13,600 |
| MAXIMUM REVERSE | 0° | 580-755 | 13,350-14,500 |

POWER PLANT INSTRUMENT MARKINGS

Maximum and minimum limits -- red radial line.

Take-off and precautionary ranges -- yellow arc.

Normal operating ranges -- green arc.

Prohibited operating ranges -- red arc.

Power transitory limit -- red radial dots (T.I.T. indicator only)

PROPELLER

Manufacturer. . . . . Aeroproducts, Allison Division

Hub. . . . . A6441FN-606

Blades. . . . . 6503688

Diameter . . . . . 13' 6"

Negative setting . . . . . -4° at the 42" station

Ground Idle setting . . . . . +1.5° at the 42" station

Start setting . . . . . +7° at the 42" station

Flight Idle setting . . . . . +20° at the 42" station

Feathered setting . . . . . 94.4° ±.2° at the 42" station

Governor setting. . . . . 13,820±140 (Eng. rpm)

PROPELLER LIMITATIONS

Continuous operation of propellers on the ground below 9,900 engine rpm for low rpm idle and above 14,500 engine rpm for overspeed fuel governor checks is not permitted.