# Performance

## Section V

### Table of Contents

Intentionally Blank

## INTRODUCTION TO PERFORMANCE

The graphs and tables presented in this section identify performance information for aid in flight planning at various parameters of aircraft weight, engine powers, altitudes and temperatures. These charts can be an accurate representation of the way you fly your aircraft and as such a better tool for everyday use than charts representative of a manufacturers best test pilot. The very act of generating the charts will make you a better, more confident pilot.

Do not attempt to start these charts immediately or during your initial "40 hours". Start only when you have a comfortable rapport with the plane. You should be familiar with the feel of the controls throughout the envelope and comfortable with its ground handling and flying qualities. Then record some data, plot it, and when these data are consistent time after time you are ready to begin in earnest. Data should be obtained in the order suggested generally, as each is somewhat dependent on the previous. There is little gained by gathering stall speeds with an unknown static source, your altimeter system.



Data you obtain will be peculiar to your aircraft since its construction and measurements differ from all others. The values (data) you generate and put into the blank charts provided should be conservative and will represent the way you fly your aircraft. In most cases it is suggested that you gather the data, plot it on a copy of the chart and when satisfied plot the final data in your manual.

*NOTE*

**All airspeeds in this section are indicated airspeeds in knots (IAS) and assume zero instrument error. Make sure your system has been correctly calibrated and account for those errors as necessary.**

**Due to the high cruise speed of the Express, the location and quality of the static source can be critical to the systems accuracy. Most importantly indicated altitude is affected. This in turn affects calibrated airspeed, i.e. indicated airspeed corrected for errors due to both the location of the pitot and static port/s on the aircraft.**

## STATIC SOURCE (Altimiter) CORRECTIONS

Static source errors result in **altimeter** errors **and indicated airspeed** errors. An airspeed indicator is essentially a differential pressure gauge (pitot vs static) marked with mph, knot or km/hr indications. Pressure from the aircraft static source is used to transmit encoded altitude and thus must be accurate when used for IFR operations. If the static port is located in an area affected by the positive pressure field of the aircraft it will read a lower altitude than it should and vice versa.

Static source correction data should be obtained first, then the corrected altitudes flown for the airspeed system calibrated tests. Prior to calibration of the system it is best to have your altimeter (the panel gauge) calibrated. This provides a correction curve from indicated to true altitude which should be taken into account when obtaining calibrated values.

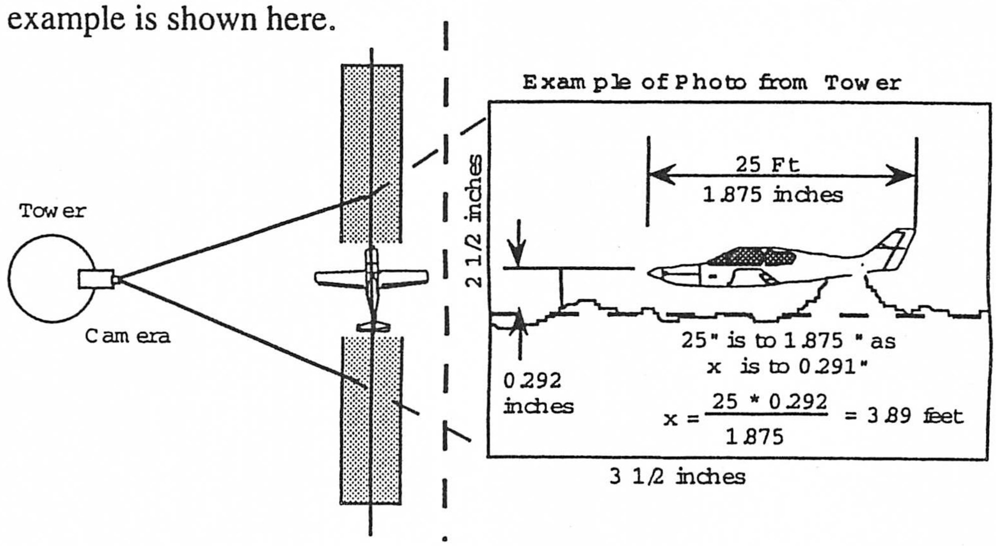
Static system calibrations are typically accomplished utilizing 1) "Tower passes", 2)A known aircraft and the "pacer" method, or 3)A "trailing cone".

### Tower Pass Calibrations

"Tower passes" require numerous fly-bys, each gathering *a* data point at *a* specific flight speed and configuration. The aircraft is flown past a tower (typically an airport control tower) where pressure altitude in the tower, aircraft indicated altitude, aircraft distance to the tower are known and aircraft height above/below the tower are recorded. For example the aircraft must be flown (at least two wing spans above the ground to eliminate ground effects) along a centerline (runway or taxiway) which is a known distance from the tower. The pilots indicated altitude of the aircraft is recorded for each level pass when the aircraft is normal (off the wing tip) to the tower and photographed from the tower using a camera (a polaroid works great, but the aircraft in the photo should be large enough to scale its length to the horizon). The aircraft's height above or below the tower altimeter is later determined for each data point by scaling the length of the aircraft in the picture and its distance above/below the horizon. [Knowing the distance from the tower camera (and altimeter/s) to the centerline, allows a correction of aircraft indicated altitude for data points where the aircraft in the photo is not normal to the tower.

Extreme care should be used when flying such passes particularly the low speed and "dirty" passes. The minimum recommended fly-by speed is 80 kts, and cool smooth early morning air is best for calm air and traffic reasons. The data should be plotted and a smooth curve faired to extrapolate data to the lower speeds. A cooperative tower is required as well as a "helper" in the tower to record data and obtain the photos. An example is shown here.






## Pacer Calibrations

Pacer tests consist of flying side-by-side with another aircraft with a "known" static [generally Part 23 certified aircraft] recording both aircrafts' speeds and altitudes at various test aircraft configurations of gear and flaps settings, and across the speed range. Corrections to the test aircraft's altitude and airspeed can be determined based on the pacers corrected speed and altitude as shown in its Pilots Operating Handbook. Obviously both aircraft should be at the same altitude and speed for each data point and the closer the two are the more accurately any altitude differences can be detected. A minimum of four wingspans of the larger of the two planes should be maintained to eliminate the potential of one aircraft's pressure field effecting the others sensing system. Extreme care is required as formation flying is inherently non-forgiving for inexperienced and/or non practiced pilots.

## Trailing Cone Calibrations

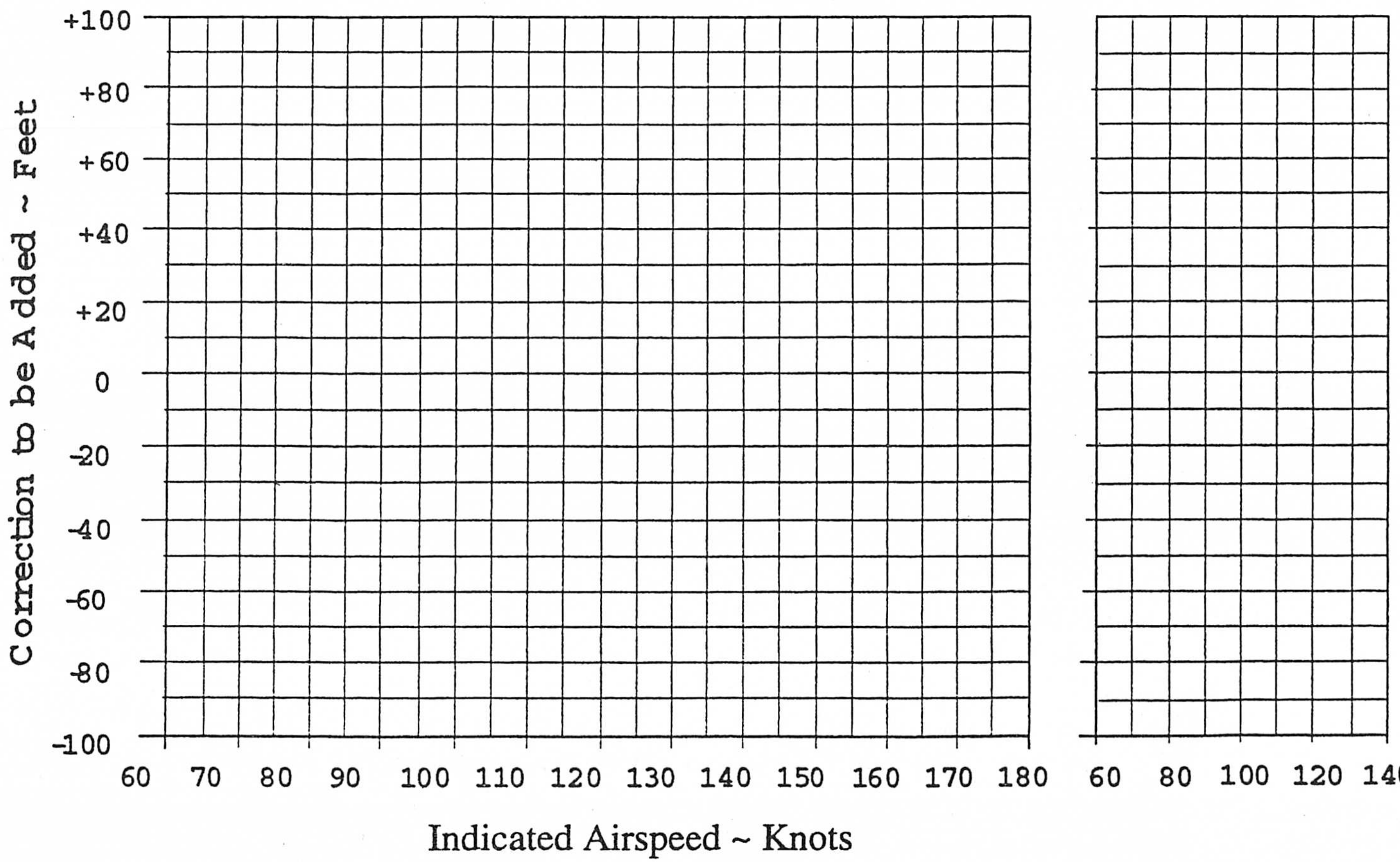
Another method utilizing a "trailing cone" can be utilized for "solo" data gathering which will eliminate the hazards and transfer errors of a pacer calibration and the time consumed by tower passes as well as increase the measurement accuracy. These data can be gathered at several altitudes, across the full speed range, with far greater accuracy, and require no external assistance. This method requires the use of a drag cone which is trailed behind the aircraft (typically from the top of the vertical fin) and at such a length that the pressure field of the aircraft has decayed. (This is on the order of 35 feet for the Express). Static ports are located in a sleeve in the tubing forward of the cone 10 to 12 cone base diameters. Since the "Cone" provides true outside pressure altitude, a differential pressure gauge between the Cone and the aircraft's system will display the error. This eliminates the error associated with the comparison of two absolute measurements but requires the use of tables of pressures versus altitudes in the range of inches of water for the altitudes flown. The result is however an extremely accurate calibration of your static source such that you will know that your corrected 8000 feet in IMC conditions is really 8000 feet, and you'll know the effects of gear and flaps on indicated altitude also. The Trailing Cone is used world wide for static source location development and certification purposes and is an excellent approach for the serious IFR pilot.

Once these data are gathered by whichever means, they can be plotted on the following chart and then represent the calibration for your aircraft specifically. The Trailing Cone is by far the most accurate and quickest method, but requires the availability of an approved Cone system. The Tower Pass method is the next most accurate, but is somewhat time consuming and requires the cooperation of toawer and other personnel and equipment (mulitple altimeters and a camera). Pacer calibrations must only be done with air-to-air communications, and a thorough pre-briefing of both aircraft crews. Corrected altitudes should then be flown for all subsequent airspeed system tests.

Altimeter Correction Chart

# Altimeter Correction ~ (Owners Calibration

**Flaps and Gear UP, Cruise Configuration** **Flaps and Gear DOWN**

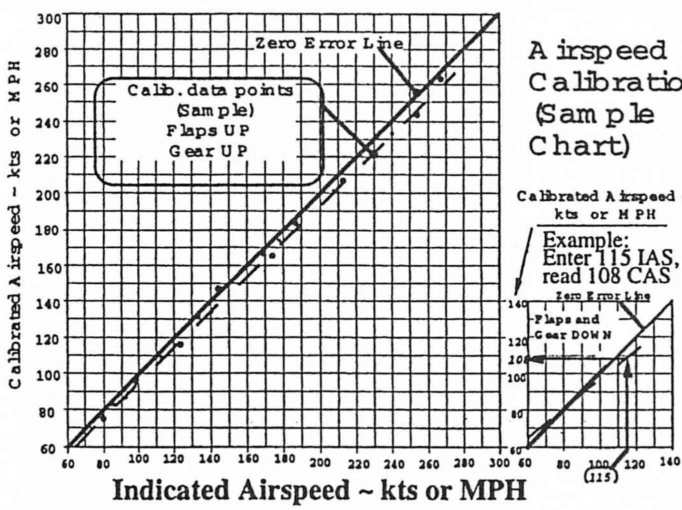



7

# PITOT (Airspeed) SYSTEM CALIBRATION

Airspeed pitot and static system calibrations can be obtained while flying against a pacer aircraft. Pitot systems can also be calibrated by flying between two known locations (fixes), in opposite directions carefully measuring the time and air temperature then working back from true airspeed to a calibrated value. (The altimeter system should be calibrated prior to this test.) Ideally the wind should be calm, along the flight path, and the test run at relatively low altitude to minimize the timing errors due to fix passage factors. GPS, LORAN and/or DME can also be used effectively when the DME station slant range is minimal. A test leg from 50 to 75 miles from the station and return would be acceptable.

These calibration data can be plotted as lines (faired thru the data scatter) on the accompanying charts and tagged as to flap position (up, approach and full, typically) and gear position, or presented in tabular form for each configuration. The data should be taken from the lowest practical speed to maximum in approximately 20 kt increments. If the chart method is used, it would be prudent to plot the data, fair a smooth line thru that data, then plot the faired line data to reduce data acquisition scatter. Thus data obtained at 154 kts for example could be "corrected" and tabulated at 150 or 160 kts.




Airspeed Calibration (Sample Chart)

A sample chart is shown. It is suggested that you initially plot your data on a copy, and when satisfied with that, transfer it to your own blank.

| Cruise Configuration | | |
|---|---|---|
| For actual Kts / mph | Add | Indicated Kts / mph |
| 80 | +5 | 85 |
| 90 | +5 | 95 |
| 100 | +4 | 104 |
| 110 | +2 | 112 |
| 120 | 0 | 120 |
| 130 | -1 | 129 |
| etc. | | etc |

| Landing Configuration | | |
|---|---|---|
| For actual Kts / mph | Add | Indicated Kts / mph |
| 70 | -5 | 60 |
| 80 | -5 | 75 |
| 90 | -4 | 86 |
| 100 | -2 | 98 |
| 110 | 0 | 110 |
| 120 | +3 | 123 |
| etc. | | etc |

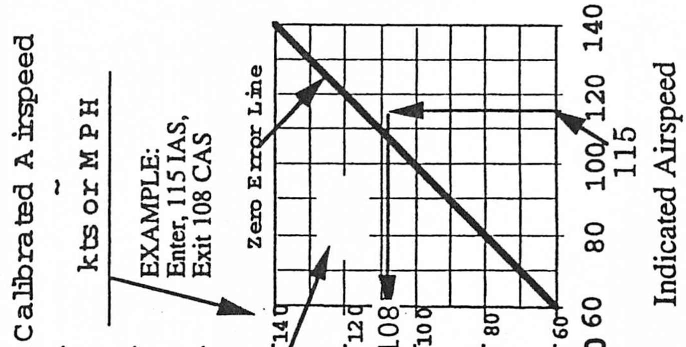
(Sample Calibration Chart and Data)

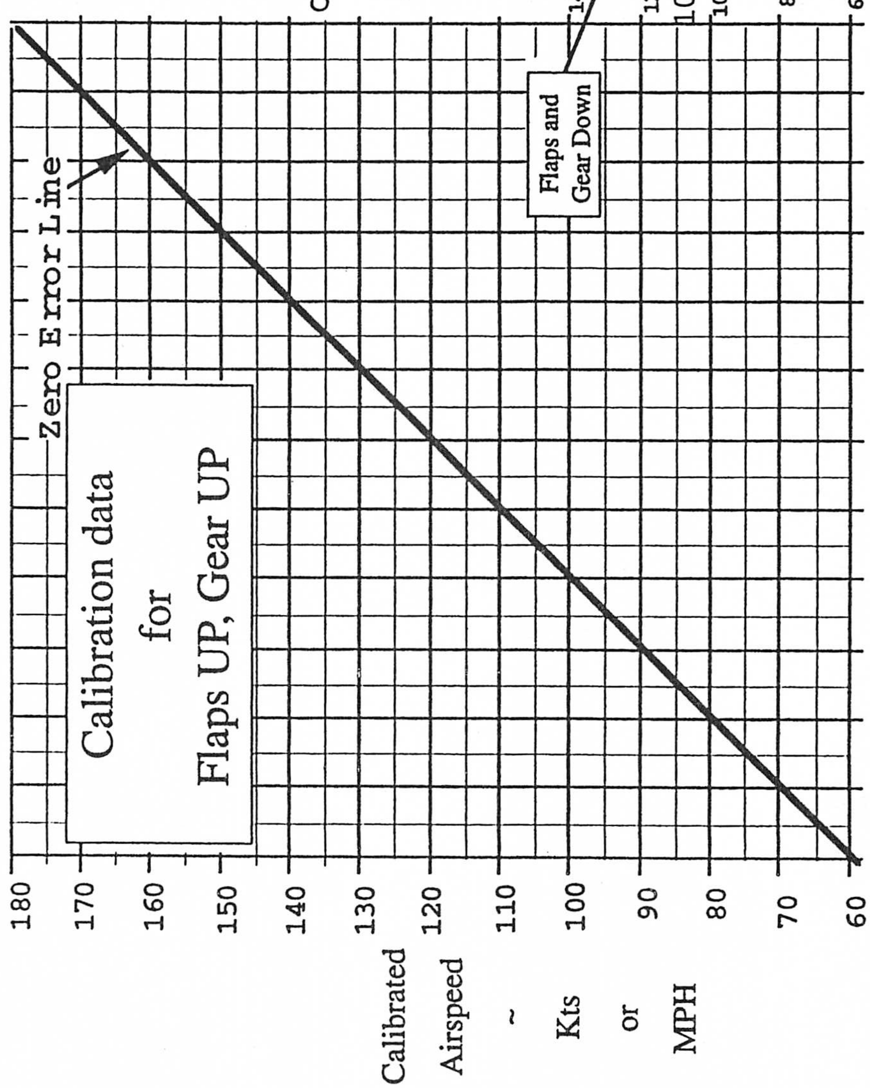
**AIRSPEED CALIBRATION for**

My *Express*

s/n 930-HK

N 832GK




9

**Airspeed Calibration for** ____________

*(U.S. Example, N 9869R)*

**Performance**

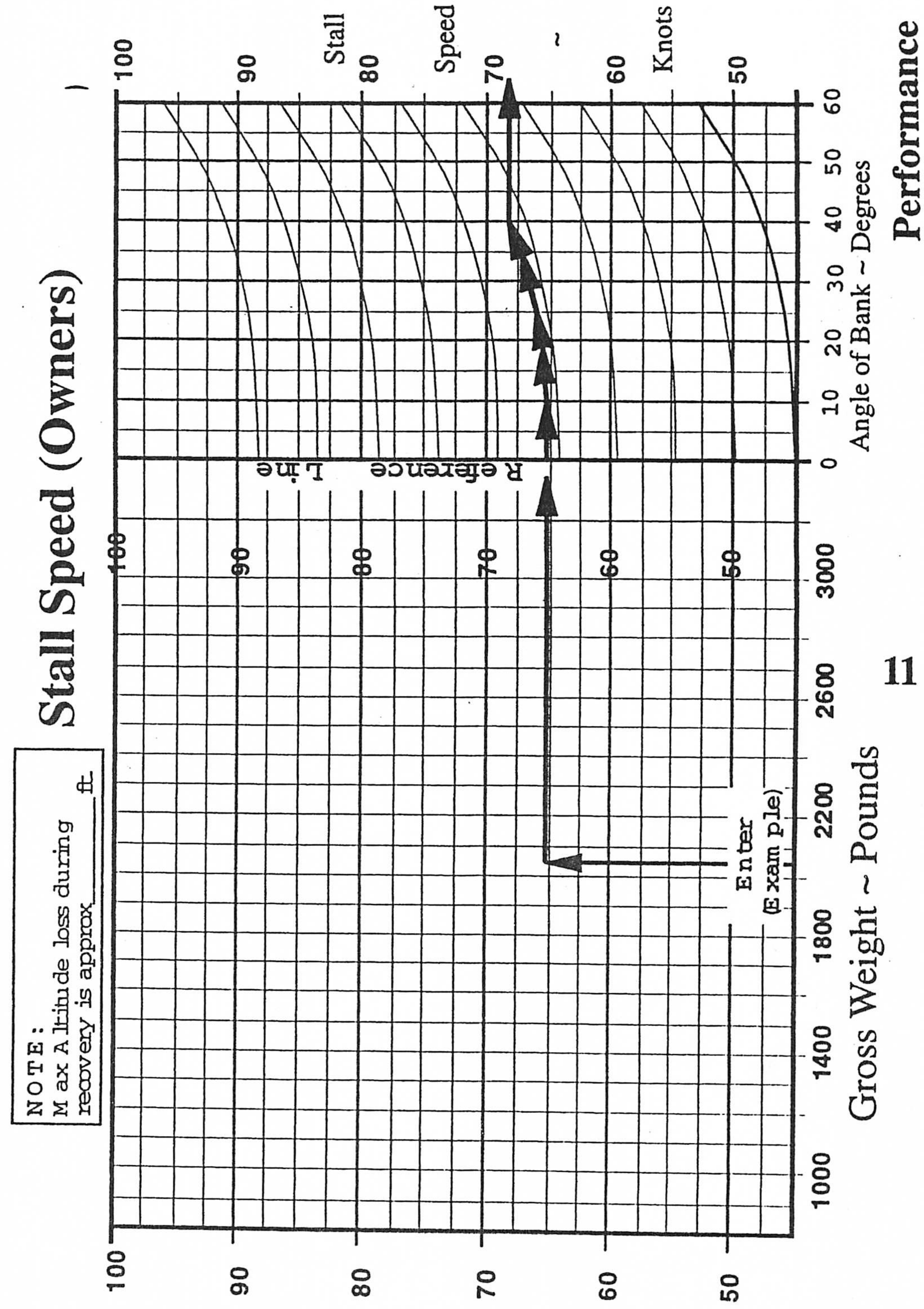
## STALL SPEEDS

Aircraft stall speeds are a function of gross weight, flap position, and engine power setting for unaccelerated stalls. Turning flight adds effective weight as a function of bank angle (i.e. 60° bank equals twice the effective gross weight). Stalls should be conducted from minimum to maximum weights, three flap positions, and appropriate power settings (idle and T.O.).

These tests should be conducted at altitudes such that should a spin inadvertently occur there is sufficient altitude for recovery. Three thousand feet AGL is recommended. As the aircraft is decelerated slowly, altitude should be maintained and notes made as to what speed the stall warnings are initially felt and when the aircraft fully stalls. Sufficient stalls should be conducted to define the repeatability at any one condition, and at three or four weights such that a line can be drawn thru the speed points to form a line for cruise and landing configuration.

Stalls should cover both the cruise configuration and the landing configuration with the gear and flaps in the full down position. Intermediate flaps would be the final data to obtain. Be sure to **note the altitude lost on each stall** so that the Note can be filled in on your "Stall Speeds (Owners)" chart. It is again recommended that you record several sets of data, and when these data plot consistently, plot the data on your stall speed chart as a line (curve thru the points), extrapolating that curve on both the low and high ends as appropriate.

Once your stall speed lines are defined, the values can be corrected for bank angle by using the chart for bank angle effects. The chart is used by entering at the gross weight, moving vertically up the chart until intersecting the appropriate line, then horizontally right to the reference line, then following the curved line until reaching the degree of bank desired then horizontally again to the right scale.




Stall Speed Chart for ____________

## TAKEOFFand LANDING DISTANCES

Takeoff distances are a function of pressure altitude, gross weight, wind component and outside air temperature. Runway slope and surface type (grass, slush, etc.) can lengthen your required takeoff distance significantly, takeoff flaps reduce the number slightly. Takeoff distance is broken into two segments, ground roll and distance to clear a 50 foot obstacle. Significant differences can result from both aircraft and pilot technique so it is recommended that you fly your aircraft and determine these "numbers" specifically. If your test runway has any significant slope, obtain some data in both directions to determine the effect of that factor. The latter is best checked at heavy weights.

These data can be obtained as described below. They should be obtained after the static source, the airspeed and the stall speed tests have been accomplished. **Be sure to make any corrections to your indicated**
2 **speeds when you define your "Vr" and "Vx" for these tests (typically 1.15 and 1.2 times Vs respectively).**

Pick a time when airport traffic is minimal the wind is calm and a "brakes release" point. Coordinate with the "tower" personnel and obtain the necessary support personnel. Station them down the runway (with distance markers on it) such that one can pick off the lift-off point along the runway and the other estimate your distance at the 50 foot altitude. (This will take some practice to judge, and a copilot calling "Mark" based on your indicated altitude can help the ground spotter pick your "50ft" distance. Estimate your gross weight for each takeoff and make multiple runs to define the scatter. It is suggested that you plot each point on a chart to show the data scatter, then enter the data on the chart shown as a conservative line for your take-off distances. Landing distances are obtained in a similar manner, i.e. calling "Mark" at the 50 foot point, noting the touchdown and stopping distance on the runway. Use no more than normal braking for these tests allowing moderate and hard braking for your safety "pad".

**Associated Conditions**
Takeoff pwr- Set prior to brakes release
Flaps- UP (Takeoff)
Gear- Retracted after liftoff
Runway- Paved

**Notes:**
° Decrease distance 4 % for each 5 kts headwind
° Increase distance by 6 % for each 2.5 kts tailwind

| Weight LBS | Takeoff Speed Knots - CIAS Lift off | over 50' | Pressure Altitude Feet | 0° C (32° F) Ground Roll | Clear 50 Ft. |
|---|---|---|---|---|---|
| 2000 | 65 | 75 | msl<br>2000<br>4000<br>6000 | | |
| 2500 | 65 | 75 | msl<br>2000<br>4000<br>6000 | | |
| 3000 | 65 | 75 | msl<br>2000<br>4000<br>6000 | | |

| Weight LBS | Takeoff Speed Knots - CIAS Lift off | over 50' | Pressure Altitude Feet | 20° C (88° F) Ground Roll | Clear 50 Ft. |
|---|---|---|---|---|---|
| 2000 | 65 | 75 | msl<br>2000<br>4000<br>6000 | | |
| 2500 | 65 | 75 | msl<br>2000<br>4000<br>6000 | | |
| 3000 | 65 | 75 | msl<br>2000<br>4000<br>6000 | | |

| Weight LBS | Takeoff Speed Knots - CIAS Lift off | over 50' | Pressure Altitude Feet | 40° C (104° F) Ground Roll | Clear 50 Ft. |
|---|---|---|---|---|---|
| 2000 | 65 | 75 | msl<br>2000<br>4000<br>6000 | | |
| 2500 | 65 | 75 | msl<br>2000<br>4000<br>6000 | | |
| 3000 | 65 | 75 | msl<br>2000<br>4000<br>6000 | | |

## Take-off Distance Data for ____________

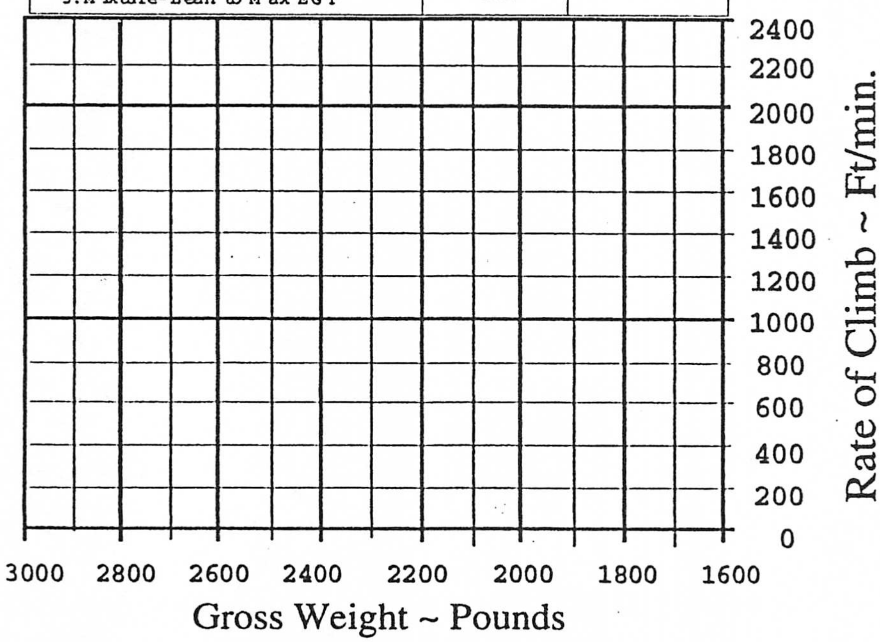
*N9869R*

## RATE OF CLIMB

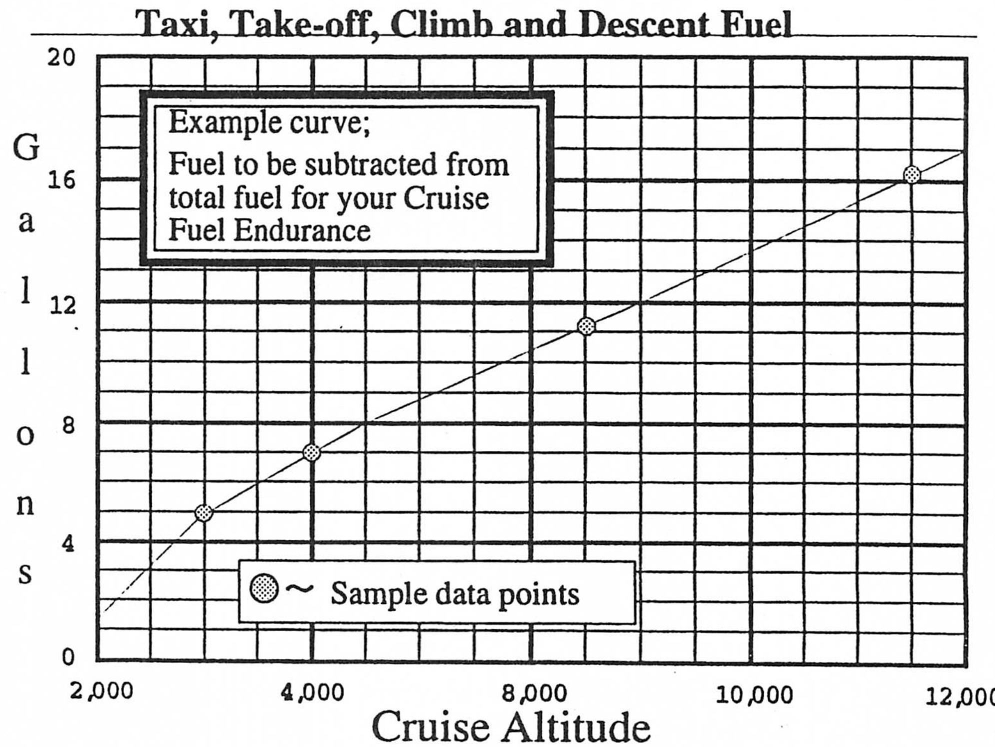
Your rate of climb is a function of gross weight, pressure alltitude and outside air temperature. It assumes full power, (leaned at the higher altitudes), climb at 120 kts IAS, with flaps and gear up. These data can be obtained during normal cross country flights with a little preplanning to record the data. It is suggested that data of OAT, rate of climb, and gross weight be recorded wherever possible, then when sufficient data has been generated over a temperature and weight range, the data can be added to the chart below. At the same time it is prudent to measure the fuel used to climb. This will allow you to calculate the range of your aircraft in terms of time for the fuel quantity you have available. These data are gathered from engine start to level off at cruise speed and should also include the fuel used for descent and landing.

# Rate of Climb

| ASSOCIATED CONDITIONS: | Gross Weight | Cruise Climb Airspeed |
|---|---|---|
| 1. Power-Maximum throttle<br>2. Flaps & Gear-UP<br>3. Mixture-Lean to Max EGT | All | 125 KTS |




**Rate of Climb for N ____________**





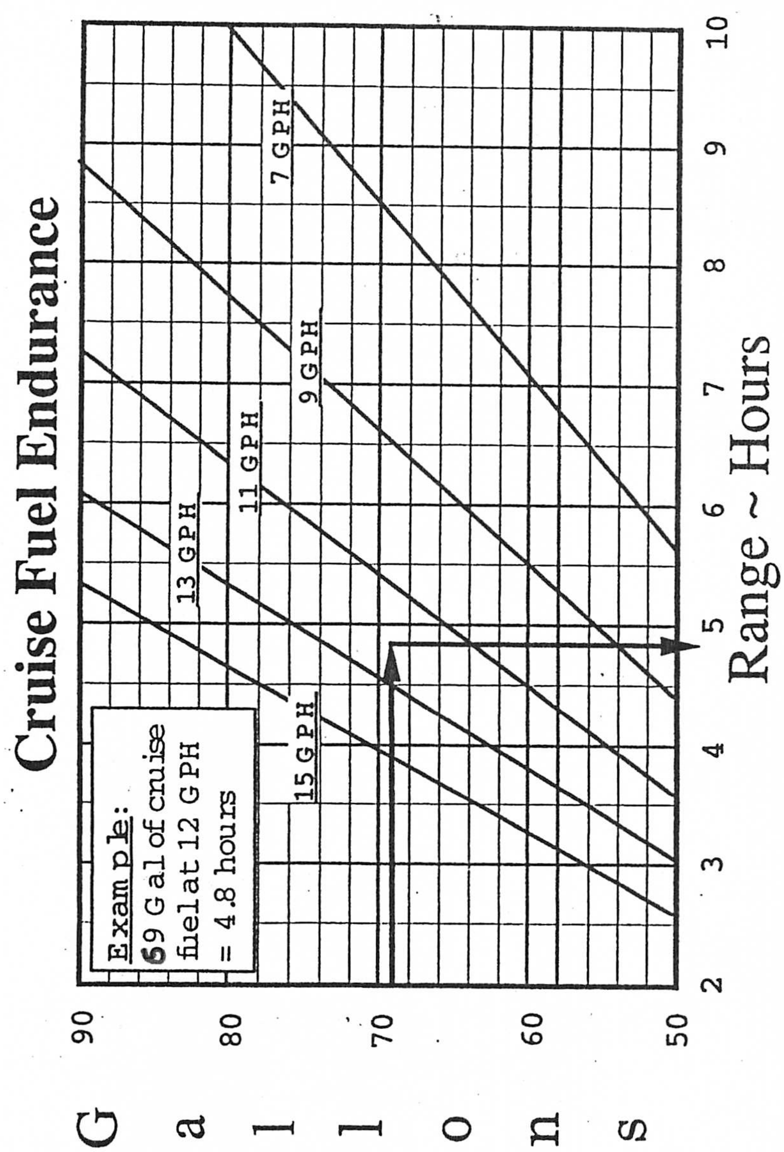

## CRUISE SPEEDS

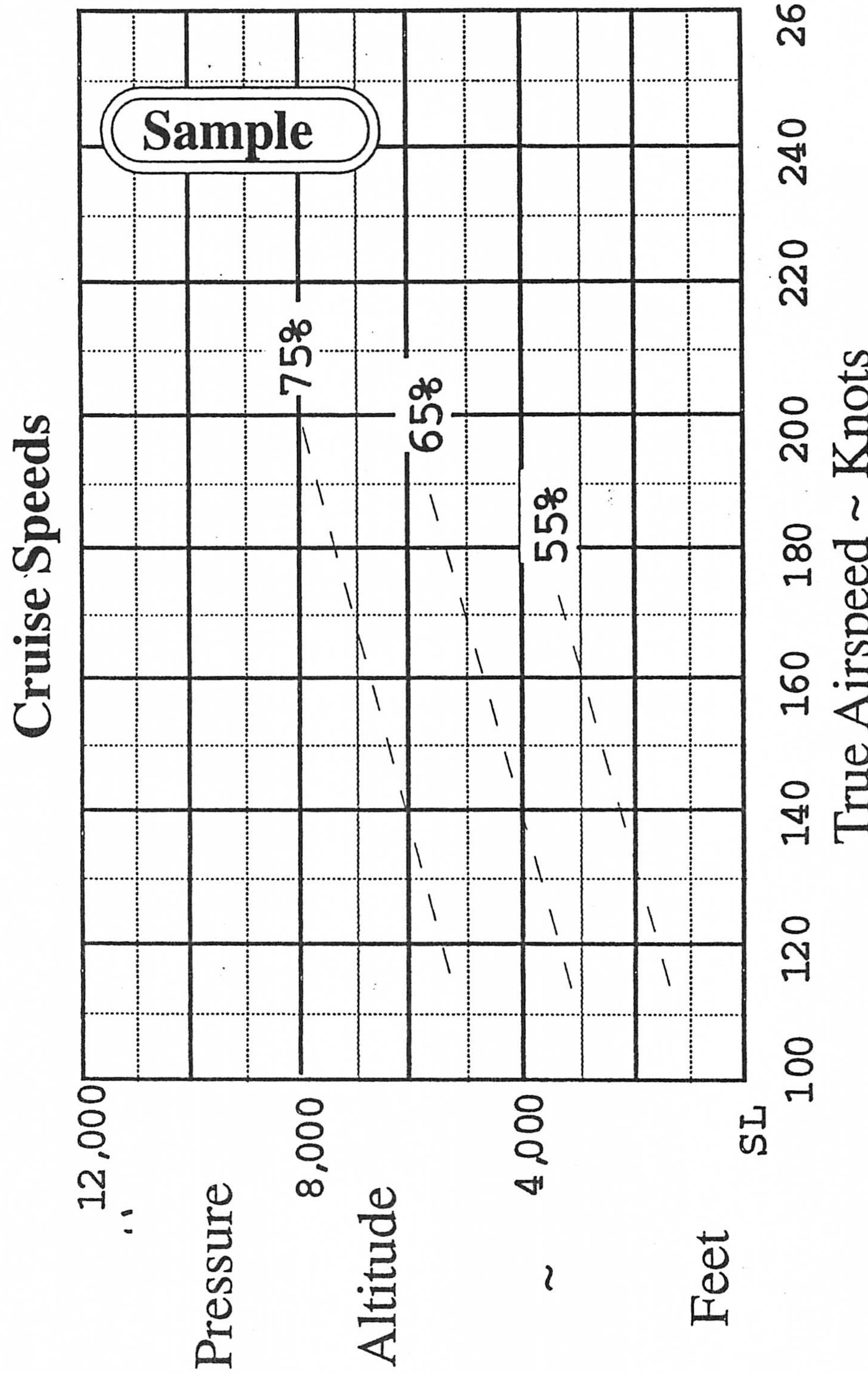
As with the climb chart data, your actual cruise speed data can be recorded during normal cross country flights. Your engines' power setting, (RPM, altitude, and manifold pressure) for the flight must be converted to HP. The engine manual for your engine model will contain such horsepower available data. You should also find a chart such as the "Part Throttle Fuel Consumption" chart from which you can establish your fuel burn rate. The faint dotted lines (as shown on the sample, next page) may be added, faired thru your data. As with the climb data, cruise fuel used data should be obtained by measurement of the fuel used for cruise segments. These data when added to the climb data will allow you to define your range capability quite accurately. Plan at least one (1) hour of fuel for safety reserve for each flight - two hours for winter operations where IMC conditions may exist over wider areas.

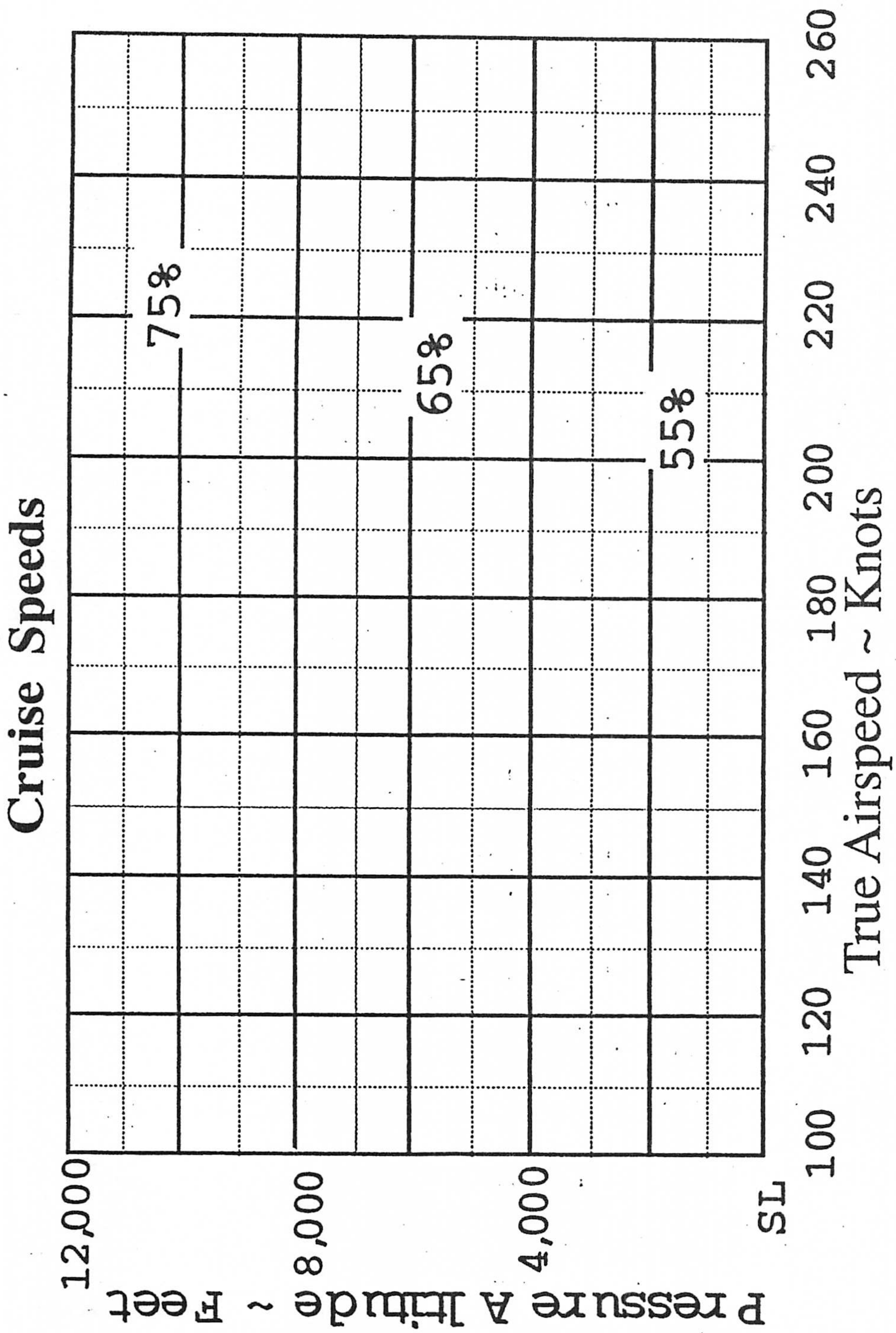
## OTHER CHARTS

Several other charts of a general nature have been included for your use. The aforementioned "Part Throttle Fuel Consumption" chart for one common engine is shown. If this is not your engine, your engine's manual will have a similar chart, and it is recommended that you include such a chart (photo reduced to fit) in your POH.

A chart of the International Standard Atmosphere as well as a Fahrenheit to Celsius conversion chart are included for your reference and convenience.

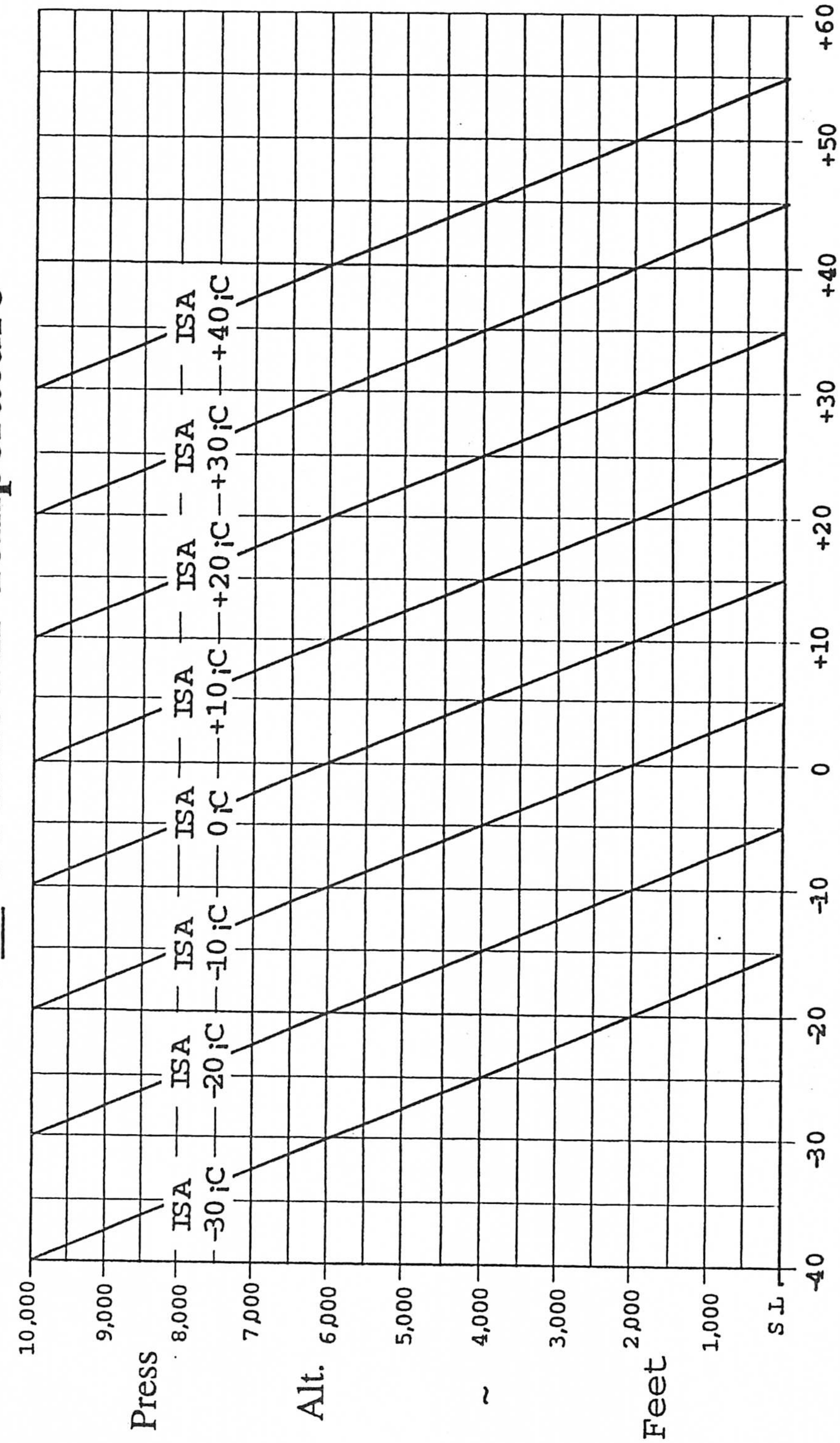



Cruise Speeds
Sample
75%
65%
55%
12,000
8,000
4,000
SL
Pressure Altitude ~ Feet
100
120
140
160
180
200
220
240
260
True Airspeed ~ Knots



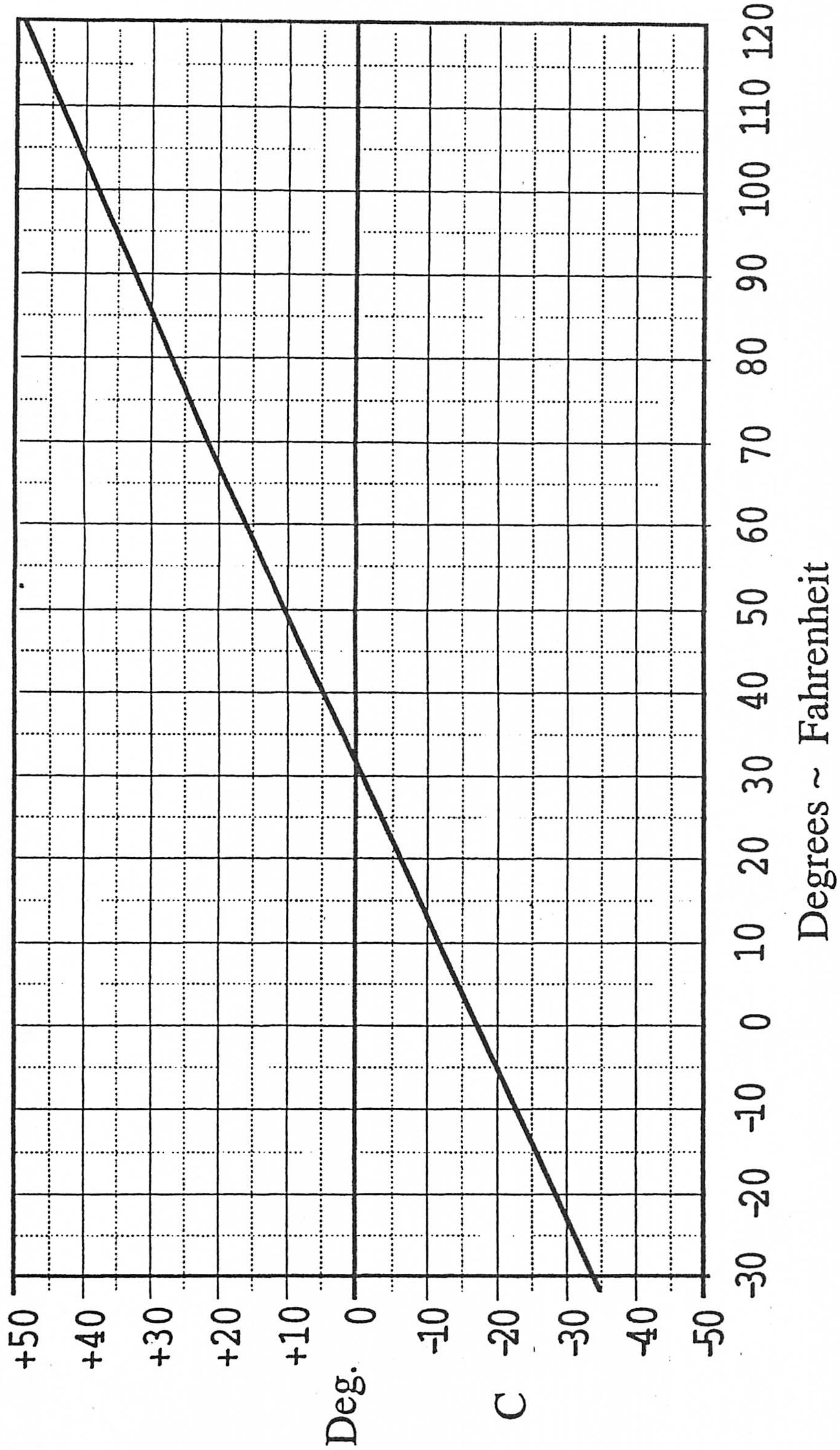

**Cruise Speed Data for_N____________**

# Pressure Altitude vs Outside Air Temperature

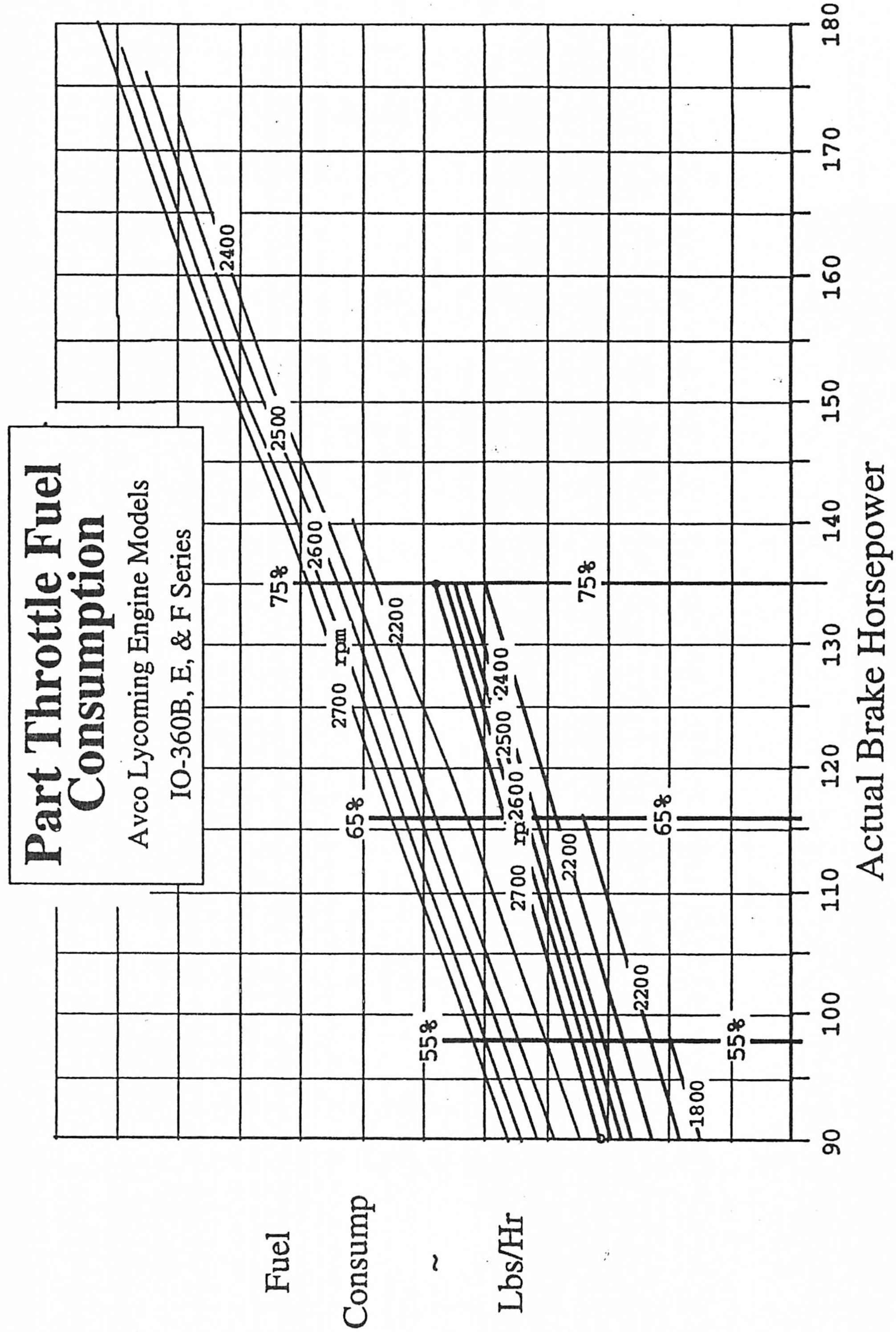



International Standard Atmosphere (ISA)

# Fahrenheit to Celcius Conversion




Temperature Conversion






A Typical Engine Chart

# SUMMARY

While all this performance data may at first seem to be excessive, when completed as outlined, you can take pride in having truly explored the capabilities of your particular machine as well as your piloting technique.

When completed you will have a truly professional document to match your outstanding aircraft with your piloting skill. The combination will prove to be not only to be rewarding to you as the pilot, but will provide a significant **margin of safety** as you operate your aircraft, a fact that all your loved ones, your fellow pilots, and your mother especially will appreciate.

## SAFE

## &

## HAPPY TESTING !

EDI

Express Design, Inc.

NOTES:

NOTES: