PART 3 : SECTION 1

▶CHAPTER 3

EFFECT OF VARIATION IN SPECIFIC GRAVITY OF FUELS ON RANGE AND ENDURANCE

Introduction

1. Fuels now being used are permitted to have wide variations in specific gravity. Such variations can have a significant effect on range and endurance.

2. The range or endurance per volumetric gallon depends upon the number of heat units (B.T.Us.) in a gallon of the fuel used. The number of B.T.Us. per pound weight of all approved fuels does not vary more than 3 per cent. and for practical purposes may be considered as a constant. The number of B.T.Us. per gallon may thus be considered as varying with the density of the fuel used, *i.e.* specific gravity. The specific gravity itself depends on:—

(*a*) The basic specific gravity at normal temperature (15°C.) of the fuel used (a considerable range is permitted for certain fuels).

(*b*) The fuel temperature in the aircraft's tanks at the time. This factor applied for all fuels whether for piston or jet engines but in the past it has generally been disregarded.

When the specific gravity of the fuel varies substantially from that of the reference fuel range, corrections are necessary.

Approved Fuels for Jet Engines

3. (*a*) AVTUR—an aviation kerosene having a specific gravity of 0·8 at 15°C.

(*b*) AVTAG—a gasoline fuel which is permitted to have a specific gravity of 0·751 to 0·802 at 15°C. (normal AVTAG has a specific gravity of 0·770 at 15°C.). This wide range has been accepted so that the oil industry may be free to draw upon sources of crude oil in many parts of the world, which have widely varying physical properties.

(*c*) AVGAS—a high-octane gasoline used for piston engines which has a specific gravity of 0·720; its use with jet engines has been approved in emergency only.

Range of Specific Gravity

4. The extreme range of specific gravity fuels at 15°C. may therefore vary from 0·720 to 0·825; variations in temperature between +40°C. and—30°C. have the effect of increasing the extremes to 0·68 and 0·86.

Flight Planning

5. At present every endeavour is being made to maintain the specific gravity of AVTAG at approximately that of "normal" AVTAG and in any event between 0·750 and 0·790—a variation which may be disregarded when making a rough computation of range based on the use of Pilot's Notes. Flight planning charts and data in Pilot's Notes are based on the use of AVTUR unless otherwise stated.

6. When using AVTAG having a specific gravity between 0·750 and 0·780 an approximate correction for safety in temperate conditions is a deduction of 7 per cent. from the range or endurance estimated from such data. A deduction of 5 per cent. is sufficient if it is known that the specific gravity of the fuel in bulk storage is not less than 0·76.

7. When the flight planning data includes a statement that it has been based on the use of AVTAG, no correction is necessary under temperate conditions if AVTAG within the range 0·750 to 0·790 is used. If it is necessary to make a flight using AVGAS (see para. 3(*c*)) a reduction in range of 16 per cent. should be allowed for if the flight planning data is based on AVTUR, or of 10 per cent. if it is based on AVTAG.

Computing the Variation in Range

8. When the specific gravity of the fuel differs considerably from the specific gravity of the reference fuel on which the Pilot's Notes data are based an estimate of the loss or gain in range can be made from the tables now being included in Pilot's Notes; these give the approximate distances in nautical miles by which the range will vary for increments of differences in the specific gravity of the fuel used. When no such table is given in Pilot's Notes a computation of

range loss or gain can be calculated from the formula:—

$$R = \frac{t - r}{r} \times \frac{FD}{C}$$

As found from chart:

- R = Range loss or gain in miles.
- t = Specific gravity of the fuel used.
- r = Specific gravity of reference fuel. (AVTUR = 0·80 or AVTAG = 0·77)
- F = Total fuel available in pounds.
- D = Distance covered on cruise.
- C = Fuel used for cruise in pounds.

Note : If t − r is positive, *i.e.* if t is greater than r then R will be positive indicating a gain in range, and vice versa.

When it is required to determine what quantity of fuel of a different specific gravity will be required to achieve a given range the quantity in pounds shown on the chart should be multiplied by $\frac{r}{t}$.

Effect on Gauge Readings of Specific Gravity of Fuel Used

9. Contents gauges of the paciter type calibrated in gallons are slightly affected by the difference in the specific gravity of fuel used. The variation in indicated contents is roughly proportionate to the specific gravity of the fuel used. It can be assumed unless otherwise stated in Pilot's Notes for the type that gauges are calibrated for AVTUR —specific gravity 0·80. Thus when the specific gravity of the fuel used is less than that of the fuel for which the gauges are calibrated the gauges will give a lower reading and vice versa. For example:—

When using AVTAG (s.g. 0·77) the reading on gauges calibrated for AVTUR (s.g. 0·80) will be $\frac{0{\cdot}77}{0{\cdot}80} \times 100 = 96$ per cent. approx. of the correct figure.

Gallons gone flowmeters are not affected by the specified gravity of the fuel used.

Note: The accuracy of existing type contents gauges in any case should not be relied on too exactly. For flight planning purposes the quantity of fuel available with full tanks should be assumed to be that quoted on the appropriate flight planning chart or table in Pilot's Notes.◀