LEAFLET NO. 28 : **DRUM-POINTER AND COUNTER/DRUM-POINTER DISPLAY ALTIMETERS**

Note: The material contained in this Leaflet has been issued in accordance with Chapter 10 of Administrative & Guidance Material Section Four: Operations, Part Two: Procedures (JAR-OPS). Following the proposal of the adoption of the ICAO Annex 6 part I standard 6.9.1.c in JAR-OPS 1.652(c), the Operations Sectorial Team realised that in no regulatory document is contained a technical definition of "drum-pointer altimeter" or "counter drum-pointer altimeter". Moreover, a wide variety of such equipment is diffused among operators, and therefore it was deemed necessary to issue this Leaflet in order to guide Operators in assessing the compliance with the proposed JAR-OPS 1 requirement.

1 Background

1.1 Altimeters are amongst the most safety-critical instruments used for the conduct of a flight. The presentation of altitude information is regulated by JTSO/TSOs. Those documents contain the standards and requirements for the general layout of the dial, the rotating sense of the pointers, the length and spacing of the markings, and the basic requirement that the 100 ft pointer must finish a complete clockwise revolution of the dial for each 1000ft of altitude change. There is no existing definitive requirement regarding pointer displays of 1000ft and 10000ft altitude variations.

1.2 In complying with JTSO/TSO's, manufacturers have produced a series of basic altimeter layouts, named after the associated devices. Accident investigations have determined that, in a significant number of cases, the design of altimeter presentation is considered to have contributed to the accident, from a human factors perspective. It is believed to be linked to the particular way in which the human eye focuses on the altimeter dial, especially during approach procedures and manoeuvres.

1.3 Following a number of studies, ICAO identified three basic layouts that are considered to be, from a safety aspect, unacceptable for public transport operations. They are the three-pointer, the drum-pointer and the counter-pointer altimeter displays.

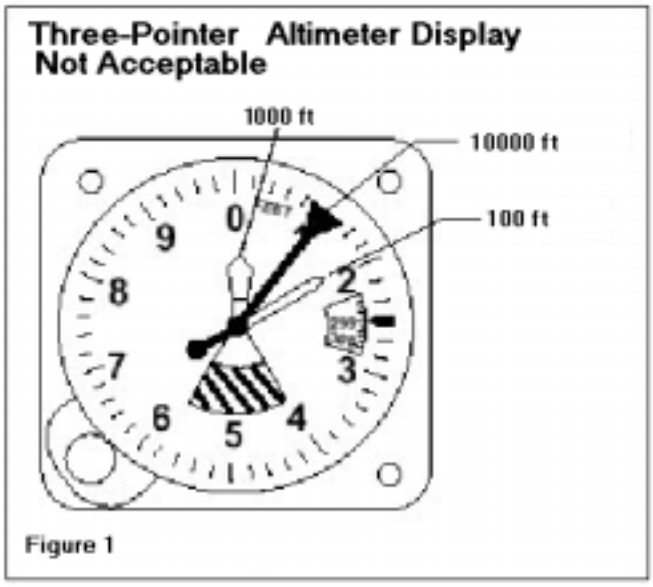


Figure 1

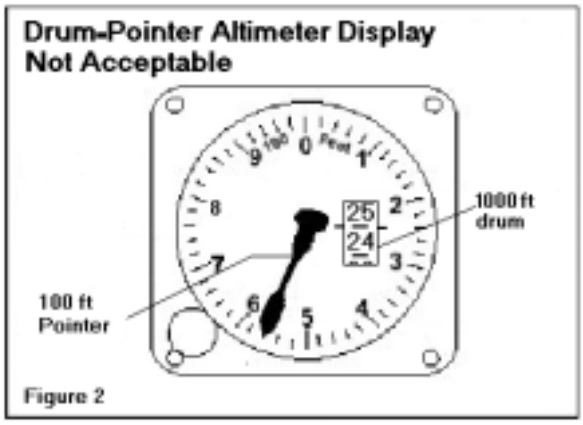
2 Three- pointer Altimeter Display

2.1 Three-pointer altimeters (*see figure 1*) use a third pointer to indicate the ten thousands feet altitude variations. This third (shortest) pointer is generally placed on the same central shaft of the 100 ft and 1000 ft pointers, and is very common on general and private aviation propeller aeroplanes. In modern layouts, to enhance the ten thousands feet indication the pointer is often moved on the outside circumference of the altimeter, and assumes the shape of a triangle.

2.2 This type of layout is considered to be a major reason for a series of accidents (mostly during the execution of Standard Arrival Procedures (STARS) and instrument approach procedures) for which the only plausible explanation lies in a 10000 ft altitude error by the

crew. This error is believed to occur because of the lack of prominence of the third pointer indication.

3 Drum-pointer altimeter



3.1 To overcome the obvious limitations of three-pointer display, in an environment characterised by jet-age rapid altitude variations, a new lay-out was conceived: the drum-pointer display altimeter (*See figure 2*).

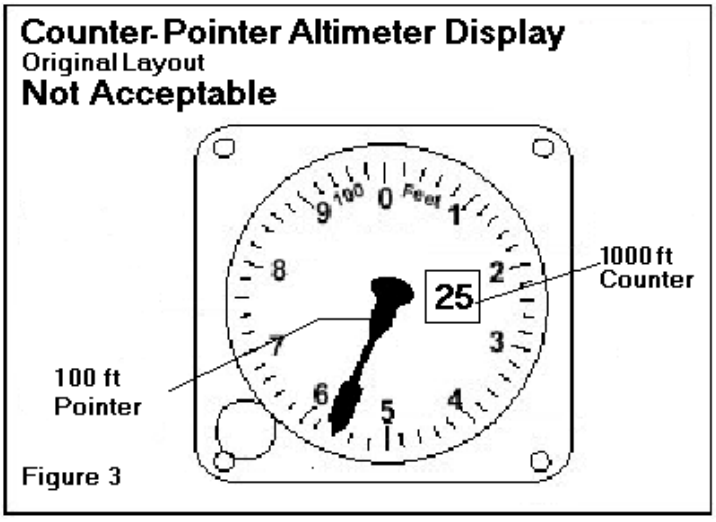
3.2 In this layout, values of 0 - 100 ft are displayed by means of analogue indications - a rotating pointer, whereas the thousands are displayed numerically, by means of a rotating drum.

3.3 The drum is geared to the pointer and rotates proportionally. At intermediate altitudes, the digitally displayed thousands of feet may become difficult to read, especially at times of high workload.

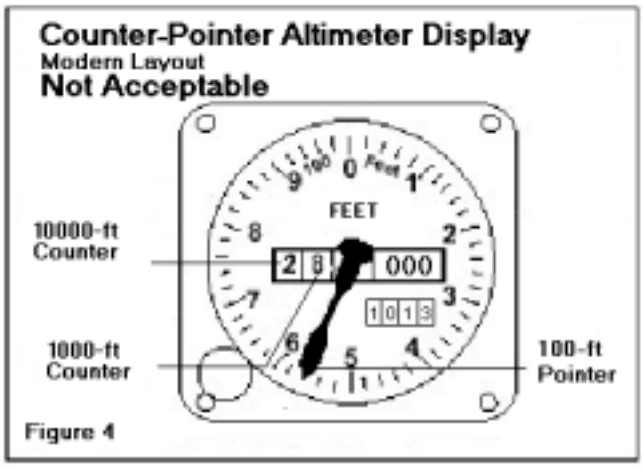
3.4 Furthermore, to interpret altitude information with this instrument layout, reference needs to be made to both digital and analogue displays. Studies have revealed that, during this process, the human eye/brain tends to "lose" the thousand feet display. This phenomenon is exemplified in accidents occurring during the approach, where the aircraft flew either 1000ft above or beneath the correct profile.

3.5 Further confusion regarding the correct interpretation of altitude is apparent when the pointer is in the proximity of the top of the dial. In this situation the digital indication is changing and is temporarily ambiguous, thus giving rise to the potential of misreading by the pilot. This was partially overcome by the use of a smaller window to restrict the view to just one digit, but this in turn led to further difficulties in the readability of the numbers.

4 The counter–pointer display altimeter



4.1 In order to eliminate the shortcomings of drum-pointer display altimeters, a new presentation was designed, in which the drum was replaced by a counter (*see figure 3)*. In this display, the counter changes its display every complete revolution of the pointer, thus minimising the period of transit from one number to the next.



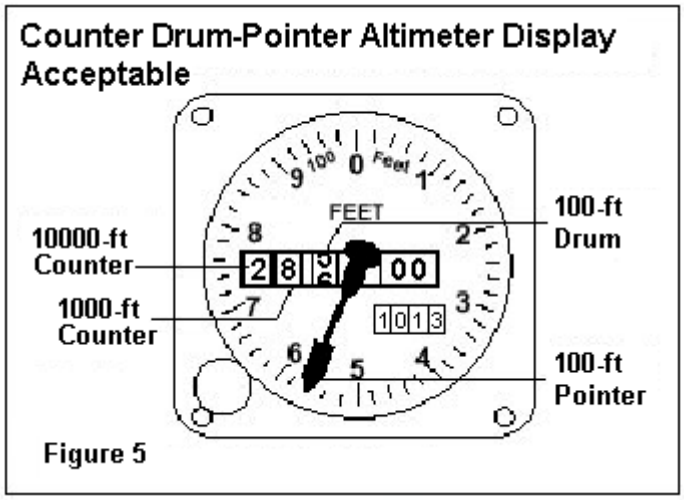
4.2 Modern layouts have even better clarity (*see figure 4)* of the ten-thousand and thousand feet indications, and a fixed row of three zeroes is added to complete the digital display.

5 The counter drum-pointer Display

5.1.1 The counter drum-pointer display altimeters overcome the shortcomings of the previous presentations by introducing a moving drum for the 100 ft digit and shifting the 1000 ft digit on a counter. The fixed "zeros" are, in this case, limited to two (*see figure 5)*.

5.1.2 Modern precision altimeters, driven by air data computers via electronic/electrical signals, have complete altitude presentations (in 10 or 20 ft graduations) on rotating devices. Conventional barometric altimeters, operated by air pressure derived directly from static pressure sources, are only able to drive the 100 ft drum.

5.1.3 The counter drum-pointer display altimeters comply with ICAO and equivalent JAR-OPS 1 standards which require the presentation of altitude information, readable to 100 ft, to be available from a single reference - the counter and the drum.



5.1.4 Presentations developed for EFIS altimeters (e.g. tapes, bars, etc) are equivalent to counter drum-pointer displays, provided they do not replicate the unacceptable layouts described earlier.

6 Standby Altimeters

6.1.1 JAR-OPS 1.652(c) addresses altimeters used in normal operations and since standby altimeters, installed as a result of the Type or Supplemental Type Certification processes, are not routinely used in normal operations they are thus outside the scope of JAR-OPS 1.652(c).

6.1.2 Significant numbers of existing standby altimeter installations utilise the drum-pointer or counter-pointer layout.

6.1.3 It is recommended that Operators should use the counter drum-pointer layout for their standby altimeters, where installed.

7 Altimeters with different displays on the same aeroplane

7.1 System design/considerations can give rise to differing altimeter displays at either pilot's station. This configuration should be avoided.