NOTICE OF CHANGE

METRIC

MIL-HDBK-759B
NOTICE 2
10 January 1993

MILITARY HANDBOOK

HUMAN FACTORS ENGINEERING
DESIGN FOR ARMY MATERIEL

TO ALL HOLDERS OF MIL-HDBK-759B:

1. THE FOLLOWING PAGES OF MIL-HDBK-759B HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
123	30 June 1992	123	10 JANUARY 1993
124	1 November 1992	124	REPRINTED WITHOUT CHANGE
127	30 June 1992	127	10 JANUARY 1993
128	1 November 1992	128	REPRINTED WITHOUT CHANGE

2. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

3. Holders of MIL-HDBK-759B will verify that page changes and additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the military handbook is completely revised or canceled.

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TABLE 20. Application of various types of mechanical displays

USE	SCALAR INDICATORS		MECHANICAL COUNTERS	PICTORIAL INSTRUMENTS	PRINTERS	FLAGS
	MOVING-POINTER	MOVING-SCALE				
QUANTITATIVE INFORMATION	GOOD Difficult to read while pointer is in motion.	FAIR Difficult to read while scale is in motion.	GOOD Minimum time and error for exact numerical value, but difficult to read when moving.	FAIR Direction of motion/scale relations sometimes conflict, causing ambiguity in interpretation.	GOOD Minimum time and error for exact numerical value.	N/A
QUALITATIVE INFORMATION	GOOD Location of pointer easy. Numbers and scale need not be read. Position change easily detected.	POOR Difficult to judge direction and magnitude of deviation without reading numbers and scale.	POOR Numbers must be read. Position changes not easily detected.	GOOD Real world situation more quickly assimilated.	POOR Numbers must be read. Position changes not easily detected.	GOOD Easily detected. Economical of space.
SETTING	GOOD Simple and direct relation of motion of pointer to motion of setting knob. Position change aids monitoring.	FAIR Relation to motion of setting knob may be ambiguous. No pointer position change to aid monitoring. Not readable during rapid setting.	GOOD Most accurate monitoring of numerical setting. Relation to motion of setting knob less direct than for moving-pointer. Not readable during rapid setting.	GOOD General direct control-display relationship easy to observe.	N/A	N/A
TRACKING	GOOD Pointer position readily controlled and monitored. Simplest relation to manual control motion.	FAIR No position changes to aid monitoring. Relation to control motion somewhat ambiguous.	POOR No gross position changes to aid monitoring.	GOOD Same as above.	N/A	N/A
DIFFERENCE ESTIMATION	GOOD Easy to calculate positively or negatively by scanning scale.	FAIR Subject to reversal errors.	POOR Requires mental calculation.	GOOD Easy to calculate either quantitatively or qualitatively by visual inspection.	FAIR Can predict possible future pattern of pen trace.	N/A
PERMANENT RECORD	N/A	N/A	N/A	N/A	GOOD Provides hard copy.	N/A
GENERAL	Requires largest exposed and illuminated area on panel. Scale length limited unless multiple pointers used.	Some panel space. Only small section of scale need be exposed and illuminated. Use of tape allows long scale.	Most economical of space and illumination. Scale length limited only by numbers of counter drums.			

5.2.2.3.1.3 Scale linearity. Scales should be graduated linearly even if the function being controlled is non-linear. If the non-linearity of the function causes too much scale compression making readout or adjustment difficult, another type of device such as a moving-tape indicator would be preferred over use of a non-linear scale.

5.2.2.3.1.4 Scale marking and numbering.

5.2.2.3.1.4.1 Graduation markings. Scale graduations should be in increments of 1, 2, or 5 units or decimal multiples thereof (except as noted in 5.2.2.3.1.4.2). No more than three sizes of marks should be used on any scale. The scales which require three sizes of marks include those which have numbered values in multiples of 10 but are graduated in 5° and 10° intervals. The number of graduation marks between numbered marks (not to exceed nine) are presented in Table 21, and illustrations of scales graduated in various ways are provided in Figure 27.

5.2.2.3.1.4.2 Scale numerals. Except for measurements that are normally expressed in decimal fractions, whole numbers should be used for major graduation marks. Intermediate marks should ordinarily not be numbered. On fixed scales, numerals should be vertically oriented, and on rotating scales numerals should be radially oriented and positioned so as to be upright when read against the pointer. Bearing dials should have numerals (and major graduation marks) at either 10° or 30° as shown in Figure 28.

5.2.2.3.1.4.3 Scale length. Scales should start and end on a major graduation mark even if this puts either or both ends beyond the usable range of the scale. For example, if the maximum voltage which can be read on an instrument is 23 volts, the scale should go at least to 25 volts where there could be a major graduation mark.

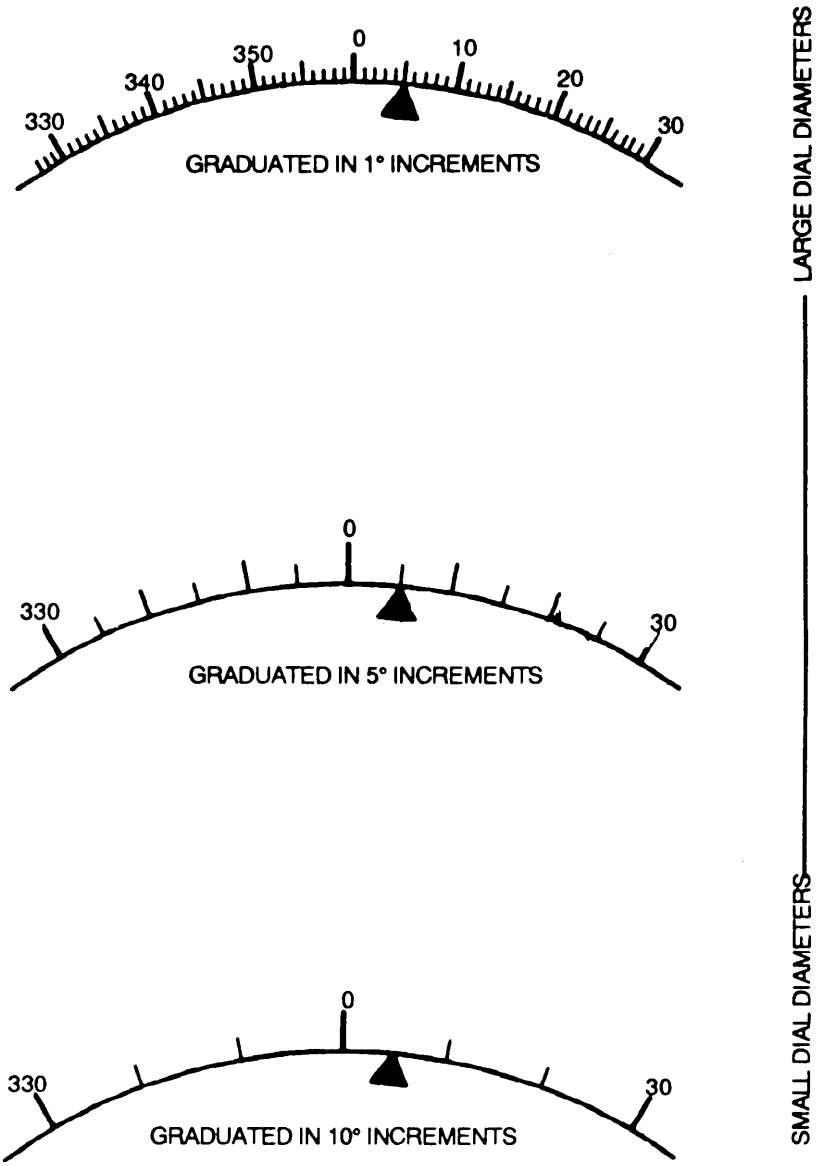
5.2.2.3.1.4.4 Starting point. Display scales should start at zero, except where this would be inappropriate for the function involved.

5.2.2.3.1.5 Pointers.

5.2.2.3.1.5.1 General. For best legibility, indicators with scales should have pointers that are relatively wide at the pivot, tapering gradually to a fine tip, arrowhead, or teardrop that is the same width as the smallest graduation mark.

5.2.2.3.1.5.2 Relaltionship of Tip to Graduation Marks. Pointers should meet, but not overlap, the shortest scale-graduation mark. The tips should never be more than 1.5 mm from the scale graduations. The tip should be equal in width to the minor scale graduations.

5.2.2.3.1.5.3 Normal Pointer Position. The normal (or zero) pointer position of a scalar indicator should be at 12 o'clock for right-left directional information, and 9 o'clock for up-down information. For purely quantitative information, either position may be used.



*NOTE: THE ABOVE GENERAL SCALE MARKING CONCEPTS ALSO APPLY TO DISPLAYS IN WHICH MEASURE IS IN MILS.

FIGURE 28. Fixed-scale azimuth dials

5.2.2.3.1.5.4 Pivot Point. Pointers should be pivoted at the right for vertical scales, and at the bottom for horizontal scales.

5.2.2.3.1.5.5 Mounting. The pointer should be mounted as close as possible to the face of the dial to minimize parallax.

5.2.2.3.1.5.6 Luminance contrast. Luminance contrast of at least 75% should be provided between the scale face and the markings and pointer.

5.2.2.3.1.5.7 Color. Pointer color from the tip to the center of the dial should be the same as the color of the marks. The tail of the pointer should be the same color as the dial face unless the tail is used as an indicator itself or unless the pointer is used for horizontal alignment.

5.2.2.3.1.5.8 Pointers per shaft. There should not be more than two pointers on a single shaft.

5.2.2.3.1.5.9 Reciprocal pointers. With reciprocal (double-ended) pointers, it should be easy to distinguish the end that indicates the reading.

5.2.2.3.1.5.10 Edgewise indicators. In edgewise indicators, such as rectangular meters with straight scales, only the tip of the pointer may be visible. If so, it should be distinctive and obvious: a flag, spade, or target pointer.

5.2.2.3.1.5.11 Dial faces. If the display is used for making a setting, such as tuning in a desired wavelength, it is usualiy advisable to cover the unused portion of the dial face. The open window should be large enough to show at least one numbered graduation on each side of any setting. If the display is one used in tracking, such as a heading indicator, the whole dial face should be exposed.

5.2.2.3.1.5.12 Coding. When certain operating conditions (such as normal operating temperature or dangerous pressure level) always fall within a limited range of the total scale, these ranges should be made readily identifiable by means of pattern, color, or shape coding applied to the face of the instrument. Use of red color coding should be limited to critical situations. Operating zones may be shape coded when the indicator should be viewed in very low-light-level work environments (0.07-0.7 cd/m^2) or where the illuminant color will cause difficulty in discrimination of colors (see Figure 29).

5.2.2.3.2 Moving-pointer, fixed-scale indicators.

5.2.2.3.2.1 Numerical progression. Numbered scales show increase clockwise, from left to right, or from bottom to top, depending on the scale layout (circumferential, or linear in horizontal or vertical axis).

5.2.2 .3.2.2 Orientation of numerals. Numbers on fixed scales should appear vertical (upright) to the observer.