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Superseding
MIL-C-7762
3 October 1951

MILITARY SPECIFICATION

COMPASSES, INSTALLATION OF

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope.- This specification establishes the general requirements for the installation of compasses in all types of aircraft.

* 2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATION

Military

MIL-C-26524 Calibration Set, Magnetic Compass, Type MC-1

STANDARD

Military

MIL-STD-765 Compass Swinging, Aircraft, General Requirements for

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. REQUIREMENTS

3.1 Compasses.- This specification covers the installation of the following types of compasses:

Type I - Direct indicating
Type II - Remote indicating
Type III - Remote indicating, precise (with precision directional requirements).

FSC 6605

3.2 Installation. - When a requirement exists for use of a directional reference as an output signal to allied equipment, the following precautionary measures shall be taken prior to installation of the compass in aircraft. Before the compass is considered acceptable for installation, it shall be determined, in a magnetically clean area, that it is accurate to within 0.5° with its magnetic deviation compensators removed, or that corrections are made for transmission errors. This accuracy shall pertain to the electrical output signal only. If necessary, errors shall be added to the visual indicators to achieve the accurate electrical signal output; however, a compass correction card shall be provided for these indicators if the deviation is in excess of 1°. The installation of panel-mounted compass components shall be in accordance with the applicable specification for the compass system involved.

3.2.1 Lubber line. - Direct-indicating compasses shall be so installed that the vertical plane through the lubber line and the center of the pivot will be parallel to the longitudinal axis of the airplane. Remote-indicating compass transmitters shall be so installed that the fore-and-aft line indicated by markings on the transmitter case will lie in a vertical plane parallel to the longitudinal axis of the airplane.

* 3.2.2 Leveling. - Direct-indicating compasses and remote-indicating compass transmitters shall be so installed that they will be in their normal level position when the airplane is in normal flight attitude. The top or bottom of the magnetic azimuth detector shall be not more than 3 inches from the access plate for top or bottom mounting, respectively. A 7-inch square access plate shall be used. The nearest edge of the magnetic azimuth dectector shall be not more than 3 inches from the access plate and the top of the detector shall be a minimum of 3.5 inches below the top of the access hole to facilitate the use of the optical alignment gear. The manufacturer's recommended screw size shall be used so that maximum rotation will be possible.

3.2.3 Shock mounting. - The shock mounting of direct-indicating compasses and remote-indicating compass transmitters, when required, shall be rigid with respect to rotation in azimuth.

3.2.4 D-C wiring to compass. - If the direct-indicating or the sensitive pickup element of a remote-indicating compass requires any direct current for its operation (lamps or otherwise), or if there are any other conductors carrying direct current in the vicinity of these items, both positive and negative conductors shall be installed and shall be twisted together or shall be in the form of an insulated concentric cable. These conductors shall not be grounded at any point, within the distance indicated in table I, from the center of the direct-indicating compass or the sensitive pickup element of a remote-indicating compass. For Government furnished equipment that does not provide a 2-pole electrical receptacle, installation will be considered satisfactory if the change in reading is not greater than that specified in 3.3.4 and 3.3.5. In some cases, it may be necessary to insulate such equipment from the aircraft structure in order to provide a 2-conductor electrical system that will meet this requirement.

TABLE I. Distance of nearest grounded point of negative electric conductor from compass

Compass	Distance (Inches) Minimum
Direct-Indicating	18
Remote-Indicating	24 (per each ampere)
Remote-Precise	As above, except 5 feet minimum

3.3 Performance of completed installation with standard test compass.-

3.3.1 Effect of climb and glide, ground swing.- Changing the airplane from the normal flight position to a 5° tail-down position shall not cause a change in compass reading in excess of the following:

Direct-Indicating	2.0°
Remote-Indicating	1.0°
Remote-Precise	0.25°

3.3.2 Effect of movable and removable magnetic parts.- The movement of individual parts or equipment or the presence of movable parts or equipment shall not cause a change in compass reading in excess of the following:

Direct-Indicating	1.0°
Remote-Indicating	1.0°
Remote-Precise	0.25°

3.3.3 Effect of engines.- The operation of the engine or engines shall not cause a change in compass reading in excess of the following:

Direct-Indicating	1.0°
Remote-Indicating	1.0°
Remote-Precise	0.25°

3.3.4 Effect of variable circuits. - Individual electrical circuits operated intermittently or carrying variable current shall not cause a change in compass reading in excess of the following:

Direct-Indicating	1.0°
Remote-Indicating	1.0°
Remote-Precise	0.25°

3.3.4.1 The sum of all individual positive changes for direct-indicating compasses, due to the effect of variable circuits and the effect of movable and removable magnetic parts, shall not exceed 2°. The sum of all individual negative changes for direct-indicating compasses shall not exceed 2°. For remote-indicating compasses, the tolerance shall be ±1° and shall not exceed 0.25° for precise compass installations.

3.3.5 Effect of continuously operated electrical circuits. - The sum of all individual positive changes caused by electrical circuits operated continuously during operation of the airplane shall not exceed 2° for direct-indicating compasses. The sum of all negative changes for direct-indicating compasses shall not exceed 2°. For remote-indicating compasses, the tolerance shall be ±1° and in precise compass installations, the tolerance shall be 0.25°.

3.3.6 Effect of electrical circuits - takeoff and landing. - Any electrical circuit which is operated only during takeoff or landings shall not cause a change in compass reading exceeding 10°. In the case of the precise directional reference installation, the change shall not exceed 1°.

3.3.7 Landing gear effect.- Changes in position of the landing gear shall not cause a change in reading in excess of 3° for the direct-indicating compass, 1° for the remote-indicating compass, nor 0.25° for precise compass installations.

3.3.8 Uncompensated deviation.- The spread between the maximum positive deviation and the maximum negative deviation, with all equipment in its normal position and all electrical circuits which are normally operated in flight (engine running with battery being charged) turned on, shall be not more than 24° for the direct-indicating compass nor more than 8° for the remote-indicating compass. In the magnesyn-type remote-indicating compass, there may be an additional spread due to an allowable 1° hysteresis error, 2° transmitter scale error, and 2° indicator scale error. With two repeater indicators installed, the indicator scale error may total 3°. The maximum allowable spread shall be a summation of the allowable deviation error and the specified additional errors, or a total of 13° for a single repeater installation and 14° for a dual repeater installation. For the precise directional reference installation, the maximum single-cycle deviation (coefficient B and C) shall not exceed ±2°, whereas the quadrantal deviation (coefficient D and E) shall not exceed ±0.35°.

3.3.9 Compensated deviations.- The spread between the maximum positive deviation and the maximum negative deviation after compensation, in accordance with MIL-STD-765, shall not exceed 5° for the direct-indicating compass nor 2° for the remote-indicating compass. The additional errors for the uncompensated deviation for the magnesyn-type compass shall still apply after compensation. The maximum allowable spread shall be 7° for a single remote indicator installation and 8° when two remote indicators are installed in the aircraft. The summation shall be as follows:

1 Remote Indicator	2 Remote Indicators
1° hysteresis error	1° hysteresis error
2° transmitter scale error	2° transmitter scale error
2° indicator scale error	3° indicator scale error
2° deviation error	2° deviation error
7° allowable error	8° allowable error

The precise directional reference installation shall not exceed 0.5° as the positive maximum, nor 0.5° as the negative maximum deviation after compensation.

3.4 Demagnetization of parts.- Demagnetization of parts after assembling into the airplane shall be performed only with the specified approval of the procuring activity.

3.5 Workmanship.- Compass installation shall be in accordance with high-grade aircraft practice.

4. QUALITY ASSURANCE PROVISIONS

4.1 Classification of tests.- The inspection and testing of compass installations shall be classified as acceptance tests.

* 4.2 Test conditions.-

4.2.1 Tapping.- The standard test compass shall be tapped lightly before any reading is taken unless the aircraft engine is running.

4.2.2 Observers.- When compensating the compasses, installation or maintenance personnel shall not have magnetic materials, such as screw drivers or other tools, pocket knives, mechanical pencils, wrist watches, bracelets, eye glasses with magnetic frame, officer's caps, badges, shop buttons, et cetera, on his person.

* 4.2.3 Magnetic heading.- The magnetic heading of the aircraft on the ground and in flight shall be determined in accordance with MIL-STD-765.

4.2.4 Local field strength.- The changes in compass reading due to magnetic materials and electric currents as specified herein apply only to locations at which the strength of the horizontal component of the earth's magnetic field (aircraft removed) is 0.18 oersted. When tests are conducted at locations where the strength of the horizontal

component of the earth's field differs from 0.18 oersted, the allowable changes specified herein shall be corrected in accordance with table II.

4.2.5 Records.- Permanent records shall be kept of all the data obtained during testing.

4.2.6 Readings.- All readings on the ground shall be taken to the nearest 1/2°, and readings in the air shall be taken to 1°. When noting changes of compass readings, both magnitude and direction of the changes shall be recorded. An increase of reading shall be taken as positive and a decrease of reading shall be taken as negative. The output signal readings for the precise directional-reference installation shall be determined by electrical means, both on the ground and in the air, to 0.1°.

4.2.6.1 Deviation.- Deviation of an aircraft compass is the difference between the compass reading and the corresponding magnetic heading of the aircraft in which it is installed. Deviation is computed by subtracting the compass reading from the magnetic heading of the aircraft.

4.3 Test equipment.

4.3.1 Standard direct-indicating test compass.- The standard test compass shall be a direct-indicating compass which has been previously calibrated at each 5° magnetic heading so that it will indicate within 1/2° the angle between the vertical plane containing the horizontal component of the earth's magnetic field and the vertical plane which contains the lubber line and pivot of the compass. The standard compass shall be provided with a standard universal-type compensator.

4.3.2 Standard remote-indicating test compass.- A remote-indicating compass consisting of a transmitter, an indicator, and such auxiliary equipment as required, shall be used as the standard remote-indicating test compass. The transmitter shall be installed with compensator removed at the compass location. Prior to installation, the remote-indicating compass shall be calibrated at each 5° magnetic heading so that the errors of the compass system will be known to within 1°. All readings taken with this compass shall be corrected for the errors of the compass system.

* 4.3.3 Standard precise directional-reference test compass. - The precise directional-reference compass shall consist of a remote-indicating compass system in which the errors are known to 0.2°. The output signal only shall be read and shall be analyzed by use of a precise synchro (±0.1°) in a special indexing head assembly having the vernier drive readable to 1 minute of arc, the null of which shall be determined by a Ballantine, or equal, vacuum-tube voltmeter. A remote compass transmitter in conjunction with the Type MC-1 magnetic compass calibrator set conforming to MIL-C-26524 may be used as an alternate to the remote indicating compass system.

4.3.4 Installation of standard test compass.- Unless otherwise specified, the standard test compass, with compensator removed, shall be installed on a suitable bracket in the location at which the inspection is to be made. It shall be installed in such a manner that the plane through the lubber line and the pivot will be parallel to the longitudinal axis of the aircraft.

TABLE II. Deviation at Location for Places with H not Equal to 0.18 Oersted

Deviation at H = 0.18														
H	0.1°	1/4°	1/2°	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°	12°
.06	0.3	3/4	1-1/2	3	6	9	12	14-1/2	17-1/2	20	23	25-1/2	28	32-1/2
.07	0.3	1/2	1-1/2	2-1/2	5	7-1/2	10	12-1/2	15	17-1/2	20	22	24-1/2	28-1/2
.08	0.2	1/2	1	2	4-1/2	6-1/2	9	11	13-1/2	15-1/2	17-1/2	19-1/2	21-1/2	25-1/2
.09	0.2	1/2	1	2	4	6	8	10	12	14	15-1/2	17-1/2	19-1/2	23
.10	0.2	1/2	1	2	3-1/2	5-1/2	7	9	10-1/2	12-1/2	14	16	17-1/2	21
.11	0.2	1/2	3/4	1-1/2	3-1/2	5	6-1/2	8	10	11	13	14-1/2	16	19
.12	0.2	1/2	3/4	1-1/2	3	4	6	7-1/2	9	10-1/2	12	13-1/2	15	17-1/2
.13	0.1	1/4	3/4	1-1/2	3	4	5-1/2	7	8-1/2	9-1/2	11	12-1/2	13-1/2	16-1/2
.14	0.1	1/4	1/2	1-1/2	2-1/2	4	5	6-1/2	7-1/2	9	10	11-1/2	12-1/2	15
.15	0.1	1/4	1/2	1	2-1/2	3-1/2	5	6	7	8-1/2	9-1/2	10-1/2	12	14-1/2
.16	0.1	1/4	1/2	1	2	3-1/2	4-1/2	5-1/2	7	8	9	10	11	13-1/2
.17	0.1	1/4	1/2	1	2	3	4	5-1/2	6-1/2	7-1/2	8-1/2	9-1/2	10-1/2	12-1/2
.18	0.1	1/4	1/2	1	2	3	4	5	6	7	8	9	10	12
.21	0.1	1/4	1/2	1	1-1/2	2-1/2	3-1/2	4-1/2	5	6	7	7-1/2	8-1/2	10-1/2
.24	0.1	1/4	1/2	1	1-1/2	2	3	4	4-1/2	5	6	7	7-1/2	9
.27	0.1	0.15	1/2	1/2	1-1/2	2	2-1/2	3-1/2	4	4-1/2	5-1/2	6	6-1/2	8
.30	0.1	0.15	1/4	1/2	1	2	2-1/2	3	3-1/2	4	5	5-1/2	6	7-1/2
.33	0.1	0.15	1/4	1/2	1	1-1/2	2	2-1/2	3-1/2	4	4-1/2	5	5-1/2	6-1/2
.36	0.1	0.15	1/4	1/2	1	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5	6
.39	0.1	0.15	1/4	1/2	1	1-1/2	2	2-1/2	3	3	3-1/2	4	4-1/2	5-1/2
.42	0.1	0.1	1/4	1/2	1	1-1/2	1-1/2	2	2-1/2	3	3-1/2	4	4-1/2	5
.45	0.1	0.1	1/4	1/2	1	1	1-1/2	2	2-1/2	3	3	3-1/2	4	5

4.4 Test methods.-

4.4.1 Installation inspection.- The installation shall be inspected to determine compliance with the requirements of this specification with respect to workmanship.

4.4.2 Prototype inspection.- One of the first 10 production aircraft of any design, and such additional aircraft as specified by the procuring activity, shall be selected for subjection to the following tests.

4.4.2.1 Effect of climb and glide, ground swing.- On an east or west heading, the airplane shall be placed in an attitude of horizontal flight and in an attitude of 5° tail down. With no electrical circuits on, the compass shall be read in both attitudes. In each attitude, the circuits specified in 3.3.4 and 3.3.5 shall be energized and the compass readings noted. All remaining tests, with the exception of the tests specified under 4.4.2.8, shall be performed with the airplane in the horizontal flight attitude. This test need not be repeated on other headings. If a nonmagnetic jack or dolly is unavailable, a jack or dolly having magnetic materials may be used provided the following requirement is met: The jack (or dolly) shall be moved in a circle about the compass or sensitive earth inductor in the position in which, and at the distance at which, it will be used to swing the airplane. Such movement of the dolly shall not cause a change in compass reading greater than 1/2°, except that for precise installations, no deviation shall be greater than 0.25°.

4.4.2.2 Effect of movable and removable magnetic parts.- With the airplane on an east or west heading on the ground, the change of compass reading shall be noted while each item is moved through the entire range of movement. During this procedure, the equipment shall be held stationary at the normal position, at the extreme limits of the motion, and at any position where the effect upon the compass is at a maximum for sufficient time for the compass to settle. Each item shall be tested with all other items in their normal position. This test shall include such items as controls, gun turrets, tail hooks, et cetera. For ammunition, bomb and torpedo loads, and other removable items, the compass reading shall be noted with the equipment in place and removed from the airplane. This test shall be repeated on a north or south heading.

4.4.2.3 Effect of engine.- With the airplane on an east or west magnetic heading on the ground, the engine, or engines, shall be run and the change in compass deviation from that with the engines not running shall be noted. The battery shall not be charging during this test. This test shall be repeated on a north or south heading. The voltage and frequency shall be controlled at their nominal values if the electrical circuits in question are to supply power to the precise compass installation.

4.4.2.4 Effect of variable circuits.- With the airplane on an east or west magnetic heading on the ground, the change of compass reading produced by the operation of each direct-current electrical circuit which carries a variable current or which is intermittently operated during flight shall be noted. This test shall include such circuits as generator circuits, including auxiliary power plants, pitot static tube heaters, cockpit and cabin heaters, galley grilles, inverters, and dynamotors for radio and other equipment, motors for gun turrets and other equipment, cockpit and cabin lights, navigation

lights, et cetera. This test may be conducted with the engines either running or not running, at the discretion of the procuring activity. The generator circuit test may be made with engines running, or if desired, the generator may be replaced by an external source to produce normal generator output current. This test shall be repeated on a north or south heading.

4.4.2.5 Effect of continuously operated electrical circuits. This test shall be conducted in accordance with 4.4.2.4, except that it shall be performed on circuits which draw a steady current.

4.4.2.6 Effect of electrical circuits - take-off and landing. This test shall be conducted as specified in 4.4.2.4, except that it shall be run on the circuits for wing flap motors, landing gear and float motors, landing lights, et cetera.

4.4.2.7 Effect of landing gear. The effect of landing gear may be tested either on the ground or in flight, at the discretion of the procuring activity.

4.4.2.7.1 Ground test. The airplane shall be supported on a north or south magnetic heading by means of suitable jacks or hoists and the compass reading recorded with the landing gear successively in the retracted, lowered, and then retracted position. The apparatus which supports the airplane should be nonmagnetic.

4.4.2.7.2 Flight test. The airplane may be flown by automatic pilot or by reference to directional gyro on a straight level course on an approximate north magnetic heading with the landing gear retracted. The average compass reading shall be estimated carefully and recorded. The landing gear shall be lowered and the compass reading again recorded. The landing gear shall be retracted and the third compass reading recorded. This procedure shall be repeated with the airplane on an approximate east, south, and west magnetic heading, and the maximum change of compass reading on any heading noted.

4.4.2.8 Uncompensated deviation

4.4.2.8.1 Ground swing. With the airplane on an east or west heading, the compass reading shall be noted under the conditions specified in paragraph 3.3.8. The readings shall then be noted for each 30° heading throughout a complete revolution, except for the precise installation, wherein the incremental headings shall be every 15°. The ground swing method shall be utilized for all precise compass installations.

4.4.2.8.2 Airswing. With the airplane in normal flight conditions, the airswing shall be carried out on 12 approximately evenly spaced magnetic headings. A graph of deviation shall be plotted against magnetic heading from which the deviation at the 30° heading shall be taken. This test may be conducted at the discretion of the procuring activity.

4.4.2.9 Compensated deviation. The compensator shall be attached to the standard test compass and the compass compensated in accordance with MIL-STD-765 except that the alignment of the compass on the panel or mount need not be compensated (coefficient A).

5. PREPARATION FOR DELIVERY

5.1 Section 5 is not applicable to this specification.

6. NOTES

6.1 Tolerance. It is the intent that no effect will be contributed by those items permitting a 0.25° tolerance, with the exception of uncompensated coefficient D which should be of a very low order, if existent; however, this tolerance is permitted primarily to cover compass repeatability and reading errors.

6.2 Marginal indicia.- The margins of this specification are marked to indicate where changes, deletions, or additions to the previous issue have been made. This is done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content as written, irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
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Navy - AS
Air Force - 11

Preparing activity:
Air Force - 11

(Project Number 6605-0084)

SPECIFICATION ANALYSIS SHEET

Form Approved Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity.

SPECIFICATION MIL-C-7762A Compasses, Installation of

ORGANIZATION | CITY AND STATE

CONTRACT NO. | QUANTITY OF ITEMS PROCURED | DOLLAR AMOUNT $

MATERIAL PROCURED UNDER A
☐ Direct Government Contract ☐ Subcontract

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
   A. GIVE PARAGRAPH NUMBER AND WORDING

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?
   ☐ YES ☐ NO IF "YES" IN WHAT WAY?

4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.)

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