MILITARY STANDARD
COMPASS SWINGING, AIRCRAFT, GENERAL REQUIREMENTS FOR

TO ALL HOLDERS OF MIL-STD-765A.

1. THE FOLLOWING PAGES OF MIL-STD-765A HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
ii		ii	4 January 1967
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2. THE FOLLOWING NEW PAGES ARE TO BE INSERTED AS LISTED:

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3. RETAIN THIS NOTICE PAGE AND INSERT BEFORE THE TABLE OF CONTENTS.

4. Holders of MIL-STD-765A will verify that page changes and additions indicated above have been entered. The 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 Standard is completely revised or cancelled.

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(Project 6605-0260)

FSC 6605

DEPARTMENT OF DEFENSE
Washington, DC 20301

Compass Swinging, Aircraft, General Requirement For

MIL-STD-765A

1. This Military Standard is approved for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to the Aeronautical Systems Division, Attn: ASD/ENESS, Wright-Patterson Air Force Base, Ohio 45433, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1. SCOPE

1.1 Purpose. This standard provides general requirements governing the swinging of compasses in aircraft compensation and calibration. It pertains specifically to accurate swinging of compasses in all fighter, bomber, cargo, or helicopter type aircraft utilizing a standard magnetic compass.

1.2 Classification. Methods of swinging compasses outlined herein are as follows:

Method I - Ground swinging

Method II - Air swinging

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The issues of the following documents, in effect on date of invitation for bids, form a part of this standard to the extent specified herein:

SPECIFICATIONS

MILITARY

MIL-C-7762	Compasses, Installation Of
MIL-T-9145	Transmitter, Remote Compass, Bombing, Navigational Computer, Type C-3
MIL-T-19576	Transmitter, Remote Compass, Thin-Wing, Type ML-1 (Unstabilized)
MIL-T-25193	Transmitter, Remote Compass, Type C-2 (Unstabilized)
MIL-D-26503	Detector, Magnetic Azimuth, and Compensator, Detector, Magnetic Azimuth
MIL-C-26524	Calibrator Set, Magnetic Compass, Type A/E37T-10
MIL-D-38134	Detector, Magnetic Azimuth DSU-4/A, High Temperature

STANDARDS

MILITARY

AN5823	Card-Compass Correction

PUBLICATIONS

NAVAIR 17-15CAA-45 Calibrator Set, Magnetic Compass, Type MC-2

NAVY DEPARTMENT OCEANOGRAPHIC OFFICE

H.O. 211 Dead Reckoning Altitude and Azimuth Table

H.O. 214 Tables of Computed Altitude and Azimuth

H.O. 218 Astronomical Navigational Tables

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

3. DEFINITIONS (Not applicable)

4. GENERAL REQUIREMENTS

4.1 Method I - ground swinging. Compass swinging may be accomplished on the ground by any one of the six following procedures:

I(a) Compass rose

I(b) Sighting compass

I(c) Magnetic method, using transit

I(d) Transit method

I(e) Electrical method: Any aircraft compass system utilizing a remote transmitter, detector or calibrator set specified below may be swung electrically without the necessity of rotating the aircraft.

1. Type C-2 Remote Compass Transmitter conforming to MIL-T-25193.
2. Type C-3 Remote Compass Transmitter conforming to MIL-T-9145.
3. Type ML-1 Remote Compass Transmitter conforming to MIL-T-19576.
4. Type DT309/AJN, DT310/AJN Magnetic Azimuth Detector, CN1072/AJN Magnetic Azimuth Compensator conforming to MIL-D-26503.
5. Type DSU-4/A Magnetic Azimuth Detector conforming to MIL-D-38134.
6. Type DSU-4A/A Detector Magnetic Azimuth High Temperature conforming to Sperry Rand Corporation Part Number 4017288 or equal.
7. Type A/E37T-10 (Previous Type MC-1/MC-1 Modified) Magnetic Compass Calibrator Set conforming to MIL-C-26524.
8. Type MC-2 Calibrator Set conforming to Sperry Rand Corporation Part Number 259 2080-5 or equal.

NOTE: Other electrical calibration sets and detectors which have been Government approved may be used.

I(f) Comparison swinging

The aircraft communication and electrical systems shall be in operation during each of these entire procedures.

4.1.1 Method I(a) - compass rose procedure

4.1.1.1 Compass swinging base. The compass swinging base (compass rose) shall consist of a level circular area, having a smooth surface of sufficient strength to support the weight of the aircraft without cracking or forming depressions under the wheels. No magnetic materials shall be used in the construction of the compass rose. The direction of the horizontal component of the Earth's magnetic field (magnetic declination) measured at any point within a space between 2 and 6 feet above the surface of the compass rose, and extending over the required area of the compass rose, shall not differ by more than 0.2 degree from the direction measured at any other point within this area. The direction and uniformity of the Earth's field shall be determined by a licensed surveyor prior to the use of the area for compass swinging. The swinging area shall be checked annually thereafter for compliance with the above requirement and also after any magnetic material, such as buildings, railroad tracks, direct-current powerlines, etc., are installed within 200 yards of the swinging area. These periodic checks will be performed by a licensed surveyor or when use of certified compass calibrator equipment is permitted, a trained/qualified specialist may be specified as the operator.

The date of observation and the mean magnetic declination of the area, as determined from the survey, shall be durably and legibly marked on the surface of the rose. Copies of the survey with all declination readings shall be retained by the custodian of the compass rose for a minimum of 2 years. A copy of each annual survey shall be forwarded to the cognizant higher command as designated.

4.1.1.2 Means for aligning aircraft. The compass rose shall be provided with the following means for alignment of aircraft:

4.1.1.2.1 Radial lines for use with plumb bobs. The compass rose shall be provided with a series of 24 radial lines, either painted on or inlaid in the surface, extending toward magnetic directions every 15 degrees beginning with magnetic North. Each line shall be clearly labeled to indicate the direction along which it lies. The magnetic direction of each of the lines shall agree with the corresponding markings of the line within 1/2 degree. If any line is more than 1/2 degree off, it shall be relaid or repainted. Accuracy of direction of the radial lines shall be checked by a licensed surveyor or when use of certified compass calibrator equipment is permitted, a trained/qualified specialist may be specified as the operator. In addition to the radial lines, the compass rose shall be provided with two circular lines, either painted on or inlaid in the surface. One circular line shall have a radius of 50 feet and the other shall have a radius of 85 feet.

4.1.1.2.2 Radial bar for use as wheel chock. If this method is used, the compass rose shall be provided in addition to the radial lines, with a rigid non-magnetic bar which pivots about the center of the rose and can be locked in each of 24 positions 15 degrees apart, including magnetic North. Each position of the bar shall be clearly marked in order to indicate the magnetic heading of an aircraft whose wheels rest against the bar. The surface of the bar against which the wheels of the aircraft are to rest shall be so beveled that a flat or approximately flat surface shall be exposed to the wheels. The magnetic direction of the bar in each position shall differ by

90 ±1/2 degrees from the corresponding marking of the rose. If any position of the bar is more than 1/2 degree off, the locked position shall be relocated.

4.1.1.3 Methods of aligning aircraft.

4.1.1.3.1 Compass rose with radial lines. Two plumb bobs shall be hung from points on the centerline of the aircraft, one near the nose, and the other near the tail. The aircraft shall be placed on the desired magnetic heading in such a way that the tips of the plumb bobs hang either directly over the appropriate line on the compass rose or on the same side of the line at equal perpendicular distances from it. The differences between the perpendicular distances of the tips of the bobs from the line shall not exceed 1/2 inch for each 15-foot separation of the bobs. If a wind is blowing, care shall be taken to shield the plumb bobs and their cords from the wind.

4.1.1.3.2 Compass rose with radial bar. If the radial bar-type of rose is used, the bar shall be locked in the desired position and the aircraft shall be aligned by pushing the wheels against the bar. Care shall be taken that both tires are correctly inflated, that both wheels actually touch the bar, and that neither wheel is pressed against the bar so tightly as to dent the tire. Landing gear alignment shall be checked by using plumb bobs as described above for alignment with the corresponding radial line in the first position. If any error in alignment is revealed, suitable allowance shall be made in all subsequent swing positions for that aircraft.

4.1.2 Method I(b) - sighting compass method.

4.1.2.1 Sighting compass. The sighting compass shall consist of a compass approved for this application to which has been attached a suitable sighting device. The sighting compass shall be calibrated by means of a compass test stand or other suitable apparatus in such manner that magnetic bearings taken with it will be accurate to the nearest 1/2 degree. The friction error shall not exceed 1 degree.

4.1.2.2 Check for local variations in magnetic field. The direction of the horizontal component of the magnetic field should be constant to within the tolerances specified in 4.1.1.1. The direction and uniformity of the Earth's field shall be determined by a licensed surveyor prior to the use of the area for compass swinging. The swinging area shall be checked annually thereafter for compliance with the above requirement and also after any magnetic material, such as buildings, railroad tracks, direct-current powerlines, etc., are installed within 200 yards of the swinging area. These periodic checks will be performed by a licensed surveyor or when use of a certified compass calibrator equipment is permitted, a trained/qualified specialist may be specified as the operator. In the event the area does not conform to the above requirement, the reason shall be determined and corrected or a new position located.

4.1.2.3 Method of determining magnetic heading of aircraft. The aircraft shall be placed in position on the swinging area. The sighting compass shall be placed in such position that a sight may be taken along a fore-and-aft reference line of the aircraft. If no fore-and-aft line is available, a

lateral (athwartship) reference line shall be used. The sighting compass shall be at least 150 feet away from the aircraft, or far enough away to be undisturbed by any magnetic effects of the aircraft. Sights may be taken from in front of or behind, or from either side of the aircraft, depending on which provides the most accurate sight. Readings obtained from lateral sights shall be corrected by adding or subtracting 90 degrees, depending on the direction in which the sight is taken. Readings obtained by an observer standing in front of the aircraft shall be corrected by adding or subtracting 180 degrees, unless the compass has been remagnetized to read directly the heading of the aircraft when sighting on it from the front.

4.1.3 Method I(c) - Magnetic method, using transit. An aircraft heading can be determined by means of surveyor's transit such as Eugene Dietzgen Company No. 6334C, or equivalent, to accuracies of 0.25 degree.

4.1.3.1 Practical requirements of precision ground swinging. The practical requirements of precision ground swinging of compass systems are as follows:

a. A compass swinging area consisting of a smooth surface of sufficient size and strength to support the weight of the aircraft without cracking or forming depressions under the wheels, and to permit turning the aircraft through 360 degrees. The area must be free of all magnetic materials, and must be located away from power lines, buildings, and other aircraft in order that the direction of the Earth's magnetic field is known and is constant throughout the area to within 0.2 of 1 degree. The direction and uniformity of the Earth's field shall be determined by a licensed surveyor prior to the use of the area for compass swinging. The swinging area shall be checked annually thereafter for compliance with the above requirement and also after any magnetic material, such as buildings, railroad tracks, direct-current powerlines, etc., are installed within 200 yards of the swinging area. These periodic checks will be performed by a licensed surveyor or when use of a certified compass calibrator equipment is permitted, a trained/qualified specialist may be specified as the operator.

b. An object such as a radio antenna, water tower, or mountain peak which is visible through a transit from the selected area and which is not closer to the area than 6 land-miles.

c. A surveyor's transit to facilitate accurate determination of the magnetic heading of the aircraft.

4.1.3.2 Transit location. The transit mounted on its tripod shall be so located that its optical axis is on the centerline (longitudinal axis) of the aircraft at least 150 feet in front of the aircraft. This position shall be of the same magnetic quality as that of the immediate vicinity of the aircraft, or the difference between the two shall be fixed and known.

4.1.3.2.1 From the fore end of the aircraft the surveyor shall sight two or more visible projections of the aircraft which have been determined from the aircraft manufacturer's drawings, to be located on the longitudinal axis. These projections, i. e., antennae, rivet line, tail skid, nose wheel, etc., shall be located, one near the fore and the other near the aft end of the aircraft. (The vertical stabilizer cross hair of the transit shall be made to coincide with two projections on the longitudinal axis by moving the transit by trial and error until the desired condition exists when the transit bubbles indicate level.) The magnetic needle shall then be freed and allowed to come to rest.

This needle can be read to 1/10 of 1 degree. In north latitude the pointer end with the balance weight is the south end of the needle. The magnetic heading is then determined from the reading of the south end of the pointer and the following formulae.

a. If the south end of the pointer is in the northeast quadrant, the magnetic heading of the aircraft is the pointer reading.

b. If the south end of the pointer is in the southeast quadrant, the magnetic heading of the aircraft is 180 degrees minus the pointer reading.

d. Continue moving, leveling, and sighting the transit until transit is level and aligned on fore-and-aft axes of aircraft.

e. Loosen bottom plate or lower fast motion, and azimuth scale fast motion on the transit and set 180 degrees opposite lubber line of the inside scale.

f. Lock the azimuth fast motion and adjust to exactly 180 degrees with azimuth slow motion.

g. Resight on nose of aircraft with lower fast motion unlocked.

h. Lock lower fast motion scales and make final sighting adjustment with lower slow motion.

i. Do not touch either of the lower motion knobs hereafter. The instrument is in alignment with the fore-and-aft axes of the aircraft and pointed at aircraft.

j. Loosen the azimuth fast motion and the telescope elevation fast motion.

k. Make initial adjustment in such manner that the cross hairs of the scope appear tangent to the left edge of the Sun and lock both fast motions. Place filter on telescope and adjust azimuth with azimuth slow motion.

l. Read and record time and indicated relative bearing.

m. Keep filter over end of telescope while on Sun to prevent burning cross hair.

n. With the cross hair appearing on the left edge of the Sun in the field of the scope, subtract 0.25 degree from the relative bearing reading. When on the right side, add 0.25 degree to the indicated relative bearing reading.

o. True heading may then be determined by computing true azimuth for the time of the observation and applying the formula TH=TA+RB.

4.1.5 Method 1(e) electrical method. Any aircraft compass system utilizing the instruments specified in 4.1 or equal may be swung electrically, without the necessity of rotating the aircraft.

4.1.5.1 Practical requirements of electrical swinging. The practical requirements of electrical swinging are:

a. An area consisting of a smooth surface of sufficient size and strength to support the weight of the aircraft without cracking or forming depression. It should be such that the aircraft can be towed in and aligned to magnetic North with as little trouble as possible. A straight-in approach is recommended. The area

shall be magnetically surveyed and the magnetic North line marked in accordance with the appropriate operation and service instruction manual pertinent to the type of calibrator set being used; i. e., NAVAIR-17-15CAA-45, T.O. 5N3-3-7-1, et cetera.

b. An object such as a radio antenna, water tower, or mountain peak which is visible with the naked eye from the selected area and which is not closer to the area than 1/2 land mile.

c. A Type A/E37T-10 magnetic compass calibrator set conforming to MIL-C-26524 or Type MC-2 calibrator set conforming to Sperry Rand Corporation Part No. 259 2080-5, or equal, or approved equivalents.

4.1.5.2 Procedures for electrical compass swinging. The typical procedures for electrical compass swinging using a type A/E37T-10 magnetic compass calibrator set conforming to MIL-C-26524 or a Type MC-2 calibrator set conforming to Sperry Rand Corporation Part No. 259 2080-5, or equal, or approved equivalent are as follows. These procedures may be modified to conform to the special requirements as determined by the exact type of compass calibrator set being used.

a. Set up the turntable over the spot where the remote compass transmitter will be located when the aircraft is positioned on the north line.

b. Remove the remote compass transmitter from the aircraft and mount the transmitter on the turntable.

c. Determine the alignment of the transmitter to magnetic North and its electrical calibration to the ambient magnetic field.

d. Mount the necessary optical alignment equipment to the remote compass transmitter and align the telescope to some suitable target 1/2 mile or more away.

e. Tow the aircraft into position on the north line and measure the displacement relative to the line per the plumb bob method specified in 4.1.1.3.1.

f. Compute the optical alignment correction, insert into the optical alignment scope, and replace the compass transmitter in the aircraft sighting on the same target as used in 4.1.5.2(d).

g. With the transmitter fastened down, reconnect the leads.

h. Using the appropriate adapter cables, connect the compass calibrator set into the compass system. The aircraft magnetic headings are set in which the heading selector of the control console and the errors are recorded as the difference between the indicated heading and that set in with the heading selector.

4.1.6 Method I(f) - comparison swinging. Any aircraft which has had its remote compass system swung electrically by Method I(e), may have its standby compass swung against the calibrated system utilizing any area sufficiently large to rotate the aircraft. Runways or taxiways may be utilized, provided the area is free from magnetic disturbances.

be plotted or a table constructed showing the azimuth of the selected celestial body against the time at the center of the selected flying area for the period of time during which the air swing is to be carried out. The values of azimuth for a number of points on the graph or the values of azimuth contained in the table may be determined by the method of Navy Department Oceanographic Office publications H. O. No. 211, H. O. No. 214, or H. O. No. 218, the assumed position being the latitude and longitude of the center of the selected flying area, or by any other suitable accurate method. The flying area shall be a circular region of radius not exceeding 10 land miles.

4.2.1.1.3.2 Method of aligning aircraft. Air swings shall be carried out in smooth air. Visibility shall be such that the aircraft can be located with respect to reference to a directional gyro over the area previously selected while sights are being taken. With the aircraft on the desired heading, the average reading of the compass for a 20- to 30-second period shall be estimated. At the same time, the astrocompass shall be read. The azimuth set into the astrocompass shall be determined from the graph for table of azimuth against time. The true headings indicated by the astrocompass shall be converted to magnetic headings by applying the local variation, which may be taken from the local air map corrected for the date, or from any other suitable source.

4.2.2 Method II(b) - terrestrial bearings.

4.2.2.1 Drift sight. A drift sight, a type which provides a reticle containing parallel grid lines, shall be used. The drift sight shall be installed in such a way that the grid lines are parallel to the fore-and-aft axis of the aircraft when the instrument is adjusted for zero drift.

4.2.2.1.1 Alignment of drift sight. A string shall be stretched under the drift sight parallel to the fore-and-aft axis of the aircraft. If the alignment is correct, the grid lines will be parallel to the string when the instrument is adjusted for zero drift. If the grid lines are not parallel to the string, the drift sight shall be realigned.

4.2.2.1.2 Method of aligning aircraft. Air swings shall be carried out in smooth air. Visibility shall be such that the landmark is not obscured by clouds or haze at any time during the swing. A suitable reference landmark shall be used such as a straight railroad, highway, or pipeline whose magnetic direction is known. The aircraft shall be flown by an automatic pilot or by reference to a directional gyro over the reference landmark and a line of the drift sight shall be aligned parallel to the landmark. The average of the compass readings for a 20- to 30-second period shall be estimated. The aircraft shall be on a straight level course during this time. The magnetic heading shall be determined by subtracting the bearing of the landmark relative to the aircraft from the magnetic direction of the landmark.

4.2.3. Method II(c) - comparison bearings. Air swings may be accomplished on compass systems which cannot be swung electrically, by comparing readings against those obtained from an electrically swung and compensated system or against those obtained from an inertial navigation system.

4.3 Preliminary precautions. Prior to the swinging procedure, the following precautions shall be observed