CHANGE

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Change 7 to 8200.1C

03/17/2013

SUBJ: United States Standard Flight Inspection Manual

1. Purpose of This Change. This change transmits revisions to the United States Standard Flight Inspection Manual (USSFIM), FAA Order 8200.1C; Department of the Army Technical Manual TM 95-225; Department of the Navy Manual NAVAIR 16-1-520; and Department of the Air Force Manual AFMAN 11-225, dated October 1, 2005.

2. Audience. Air Traffic Technical Operations Eastern, Central, and Western Service Areas; Flight Inspection Operations Offices and crewmembers in Aviation System Standards; Flight Standards Flight Technologies and Procedures Division; NAS Implementation Centers; and special military addressees.

3. Where Can I Find This Change? Go to http://www.faa.gov/regulations_policies/orders_notices/#browseTopics. Distribution within the Department of Defense is handled by the National Geospatial Intelligence Agency. For the U.S. Air Force, this revision is included in the AF STDPUBs CD-ROM and is available on the Internet (http://afpubs.hq.af.mil/).

4. Explanation of Policy Changes.

a. Chapter 11, Removed all instances of "course sensitivity" because the check is no longer described in the chapter. Tolerance and method to check course sensitivity was removed in change 1 to 8200.1A.

b. Chapter 11, Paragraph 11.12. Removed last sentence; it contradicted the requirements in the VOT section.

c. Chapter 11, 11.12 Checklist. Added note 14 to emphasize when TACAN null checks should be performed.

d. Chapter 11, Paragraph 11.20.a. Removed the instructions to re-establish the reference radial and alignment orbit when during a periodic inspection Alignment Reference Radial (ARR) alignment is found to have shifted more than 1°. A new radial selection may be no better than the one replaced. It may also show an alignment shift the orbit will not confirm. Technical Operations Services Maintenance is not concerned with the ARR alignment as they use the orbital alignment as their reference for ground checks. The intent is to give maintenance a chance to evaluate the facility before any changes are made. If the ARR alignment shifts by more than 1° from previously established, perform an alignment orbit and then follow the requirements of paragraph 11.20f(1)(f) in the 8200.1C.

e. Chapter 11, Paragraph 11.20.e.(5)(a)1. Improved description of cases when a TACAN null check is required.

f. Chapter 11, Paragraph 11.20.f.(1)(b). Corrected due to a name changed.

g. Chapter 11, Paragraph 11.20.f.(2)(a). Changed the paragraph to add obstructions as a consideration during the preflight map study. Current coverage orbit required altitudes are 1000 ft (2000 ft in designated mountainous areas) above antenna elevation and intervening terrain. The change improves safety by keeping the aircraft above obstacles that may be in its path, and is consistent with earlier practices.

h. Chapter 11, Paragraph 11.33. Added coverage requirements for a stand-alone DME facility.

PAGE CONTROL CHART

REMOVE PAGES	DATED	INSERT PAGES	DATED
Page 11-1*	02/01/07	Page 11-1	02/01/07
Page 11-2	02/01/07	Page 11-2	03/17/13
Page 11-3	02/01/07	Page 11-3	03/17/13
Page 11-4*	02/01/07	Page 11-4	02/01/07
Page 11-5*	09/14/09	Page 11-5	09/14/09
Page 11-6	02/01/07	Page 11-6	03/17/13
Page 11-7*	02/01/07	Page 11-7	02/01/07
Page 11-8	11/05/07	Page 11-8	03/17/13
Page 11-27	02/01/07	Page 11-27	03/17/13
Page 11-28*	02/01/07	Page 11-28	02/01/07

*Page did not change

Edward W. Lucke, Jr.
Director
Flight Inspection Services

CHAPTER 11. RHO and THETA SYSTEMS

SECTION 1. GENERAL

11.10 INTRODUCTION. Rho and Theta Systems include VOR, TACAN, DME, and VOR Test (VOT) facilities.

11.11 PREFLIGHT REQUIREMENTS

a. Facilities Maintenance Personnel. Prepare for flight inspection IAW Chapter 4.

b. Flight Personnel. In addition to the preparation outlined in Chapter 4, the flight inspection personnel must prepare charts, plot the position of the facility, and depict the orbit and radial checkpoints that will be used during the evaluations. VOT flight inspection preflight requirements are described in Section 3.

11.12 CHECKLIST. The checklist prescribes the items to be inspected on each specific type of inspection. When evaluating airways or expanded service volumes (ESV(s)) of a VORTAC or VDME, both VOR and TACAN/ DME must be recorded. When inspecting a VORTAC that has published VOR SIAP(s) but no published TACAN SIAP(s), record both the VOR and TACAN component. Report the VOR component of the SIAP, and the TACAN and VOR component of the ARR and alignment orbit. Due to antenna nulling, the TACAN azimuth may not support an approach that is satisfactory for VOR use. This inability to support a TACAN approach should not incur a facility restriction. Victor airways connect VOR, VORTAC, and VOR/ DME stations and are predicated on VOR signals. When evaluating an airway of a VORTAC, do not deny the use of a Victor airway due to an out-of-tolerance value found on the TACAN azimuth or DME. If a TACAN parameter is found out of tolerance within the flight inspection standard service volume, a facility restriction and NOTAM must be required.

RHO AND THETA SYSTEMS FLIGHT INSPECTION REQUIREMENTS

CHECK	REFERENCE PARAGRAPH	SITE EVALUATION	COMMISSIONING (12)	PERIODIC	ANTENNA CHANGE (9), (12)	FREQUENCY CHANGE (12)	FACILITY ROTATE (2), (11)
Reference Radial Check	11.20a 11.31		X	X	X, (8)	X	X
Monitors	11.20b		(3)		(3)	(3)	(3)
En Route Radials (10)	11.20c 11.31		X				
Intersection Radials/ DME Fixes (10)	11.20d 11.31		X	(5)	(5)	(5)	(5)
Terminal Radials	11.20e	X, (14)	X,(14)	X, (6)	X, (6), (8), (14)	X, (14)	X, (6)
Orbits Coverage (10) (13)	11.20f 11.20f(2)	X	X		(3), (7)	X	
Alignment (1)	11.20f(1)	X	X	(1)	X	X	X
Differential	11.20f		X		X		X
Ground Receiver Checkpoints	11.20h 11.20h(1)		X	X	X, (8)	X	X
Airborne Receiver Checkpoint	11.20h 11.20h(2)		X	X	X, (8)	X	X
Standby Transmitters	11.20i 4.33		X	X	X, (8)	X	X
Standby Power (10)	11.20j 4.33c		X				
Associated NAVAID(s)	11.20k		X	X	X	X	X
Identification	11.21a		X	X	X	X	X
Voice	11.21b		X	X	X	X	X
Sensing and Rotation	11.21c	X	X	X	X	X	X
Modulation Levels	11.21d 11.21h	X	X	X	X	X	X
Polarization (4) (10)	11.21e	X	X	X	X	X	X
Frequency Interference	11.21f	X	X	X	X	X	X
Course Structure	11.22	X	X	X	X	X	X
Signal Strength	11.23	X	X	X	X	X	X
DME	11.30 11.24	X	X	X	X	X	X

FOOTNOTES:

(1) An alignment orbit (Paragraph 11.20f) is required for all facilities every 1,080 days, including those facilities where VOR and TACAN components do not support a SIAP or receiver checkpoint.

(2) Required if facility rotation is more than 1° from maintenance reference alignment.

(3) Maintenance request.

(4) TACAN requirement – Check and report polarization on at least one radial.

(5) Fixes depicted on a SIAP in final approach segment must be evaluated concurrently with the SIAP.

(6) Check final approach segment of the SIAP(s). SID(s), STAR(s), and DP(s) are not required.

(7) First time replacement with a new type antenna, such as a Low Power TACAN Antenna (LPTA) or DOD OE-258 electronic antenna requires a coverage orbit and revalidation of all ESV(s) supporting a procedure.

(8) Evaluate on DME antenna change (same type antenna). Inspect the final approach segment on SIAP(s) that use DME.

(9) Also applies to a RANTEC TACAN Modulation Generator change.

(10) One transmitter only.

(11) For a Magnetic Variation Change, use the facility rotation checklist.

(12) VOR Polarization – Check at least one radial in each quadrant.

(13) ESV(s) must be revalidated any time a coverage orbit is required by this order.

(14) On site, commissioning, antenna change, frequency change type inspections, and applicable changes to the final approach segment, check VOR 5° offsets and TACAN nulls. For changes to FAF altitude of 300' or greater on existing procedures, inspect TACAN nulls.

SECTION 2. VHF OMNIRANGE (VOR) and TACAN/ DME FLIGHT INSPECTION SPECIFICATIONS

11.20 FLIGHT INSPECTION SPECIFICATIONS. An approved automated flight inspection system (AFIS) is the preferred method for conducting a facility flight inspection using procedures contained in appropriate agency directives. If a theodolite is used to evaluate facility performance, it must be positioned and operated by a properly trained operator. The theodolite azimuth bearings must be referenced to magnetic bearings "from" the facility. Prior to performing the checks listed below, sensing and rotation must be verified.

a. Reference Radial Check. A reference radial must be established when establishing an orbital reference and evaluated during subsequent checks. An approach radial is recommended as the reference. When course roughness and scalloping occur during an alignment evaluation, the graphic average of the deviations must be used. This reference will be used for subsequent checks of course alignment and airborne monitor reference evaluation. Determine DME accuracy as described in Paragraph 11.31.

(1) Following an antenna change, optimize the orbital alignment, then re-establish the reference.

(2) During a periodic evaluation, if the alignment is found more than 1° than previously established, perform an alignment orbit. If a change in mean course alignment of more than 1° is found, contact Facilities Maintenance. Facilities Maintenance will conduct an evaluation to determine if the change in the facility was caused by a maintenance problem or caused by an environmental change.

b. Monitor Reference Evaluation

(1) The monitor reference evaluation determines the minimum amount of azimuth course shift required to activate the ground facility monitor alarm system.

(2) Monitor reference may be established either in the air or on the ground. Once established, the check must become the reference for all subsequent checks. The procedure for establishing a monitor reference is as follows:

(a) With the course in the normal operating condition.

(b) With the course shifted to the monitor reference point.

(c) With the course shifted to the monitor reference point in the opposite direction from Step (b) above.

(d) With the course returned to the normal operating condition.

NOTE: Step (d). There is no requirement that the course return to the measurement in Step (a). Monitor shifts of more than 1° will be brought to the attention of appropriate engineering personnel to determine if environmental or equipment related.

In each of these conditions, the course alignment will be compared by reference to recorded data to determine the amount of shift to the alarm point and to verify that it has returned to a normal condition.

(3) Facilities that have dual parallel monitors require a monitor evaluation on one transmitter only. Facilities that have two individual monitors require evaluations on each transmitter.

c. En Route Radials

(1) FISSV. Radials flown to determine the facility's ability to support the FISSV must be flown at a minimum altitude of 1,000 ft (2,000 ft in designated mountainous terrain) above the site elevation, or the highest terrain or obstruction, to a distance of 40 miles for “L” and “H” class facilities, or 25 miles for "T" class facilities. The 40-mile or 25-mile distances are considered the standard flight inspection coverage distances.

(2) All radials supporting instrument flight procedures must be checked for signal quality and accuracy. Fly Airways, Off-Airway Routes, or route segments throughout the length of the intended use, at or below the minimum requested altitudes. If these radials have procedural requirements beyond the Flight Inspection Standard Service Volume (FISSV) distance, they must be inspected to the additional distances at the minimum requested altitudes.

(3) Changeover Points. The minimum en route altitude (MEA) for an airway change-over point (COP) must be the altitude where usable signals exist from the supporting stations. There is no requirement to check coverage beyond the COP.

(4) Evaluate azimuth alignment, modulations, polarization, roughness and scalloping, bends, identification, voice features, sensing, and signal strength while flying the desired azimuth.

d. Intersection Radials/ DME Fixes

(1) Intersections are used to identify azimuth positions in space. These intersections can be used for navigational fixes, reporting points, DME fixes, COP(s), etc. Establish a minimum reception altitude (MRA) for each intersection that does not meet the minimum en route IFR altitude (MEA). The MRA is the lowest altitude where reliable signals can be received within the procedural design area.

(2) Fixes located within the FISSV. When fixes are located within the FISSV, coverage throughout the fix displacement area can be predicted (fix displacement evaluation is not required). Inspect these fixes for azimuth alignment, modulations, identification, roughness and scalloping, and signal strength along the radial track used to define the fix at the proposed procedural use altitude.

NOTE: Flight inspection of ESV is described in Chapter 22 of this order.

e. Terminal Radials/ Fixes (Approach, Missed Approach)

(1) Evaluate all the radial segments that comprise the STAR, SID/ DP, or SIAP on commissioning and frequency change inspections. All final segments must be flown in the direction of intended use. Ensure the procedure is compatible with human factors (see Paragraph 6.15c) and the navigational guidance is satisfactory. On commissioning and frequency change inspections, the radials must be evaluated to include the holding patterns, procedure turns, approach and missed approach, or departure routings. During periodic, antenna change, and facility rotation inspections evaluate only the final approach segment of the SIAP(s). Evaluate other terminal radials on a surveillance basis.

(2) All evaluations must be conducted at the procedural altitudes except the final approach segment. This segment is evaluated from the FAF (or final descent point) descending to 100 ft below the lowest MDA to the MAP. During site, commissioning, reconfiguration, antenna change, frequency change, and applicable changes to the final approach segment, evaluate VOR radials 5° on each side of the final approach radial. Evaluate the offset VOR radials on one transmitter at the same altitudes as the final approach radial segment.

(3) When terminal fixes are located within the facility's FISSV or below the FISSV but within the standard service volume, coverage, throughout the fix displacement area, can be predicted (fix displacement evaluation is not required).

(4) During a periodic evaluation, verify that the crossing radial identifying the fix supports the procedure. Verification may be by recording trace or analysis of the cockpit instrumentation. There is no requirement to evaluate the fix displacement area.

(5) TACAN Azimuth Null Checks will be flown as follows:

(a) Approved Procedure

1 On site, commissioning, reconfiguration, frequency change, antenna change, changes to the location of the FAF, and changes in FAF altitude of 300 ft or more on existing procedures, the following null checks are required:

a Approach radial

b 5° either side of the approach radial

The radials will be flown inbound or outbound on a level flight from 3 miles outside the final approach fix (FAF) to 3 miles inside the FAF at the lowest minimum altitude for FAF.

(b) Nulls, defined as any repeatable out-of-tolerance crosspointer action or condition of unlock usually accompanied by rapid changes in the automatic gain control (AGC) and oscilloscope indications of a loss or distortion of the 15 and 135 cycle modulation components, are not permitted in this area. If a null is found, measure the vertical angle by flight in the area described above at an altitude 500 ft above or below the minimum FAF altitude, and inform Maintenance so that the problem can be corrected if possible. If the null cannot be corrected by antenna change or height adjustment, a new procedure will be developed which will avoid the affected area. Null checks are required on only one transponder. Due to the effect of the station cone on azimuth performance, null checks are not required when the TACAN facility is located at the FAF.

(6) Commissioning Inspections. On commissioning inspections, missed approach, and SID/ DP radials for facilities located within the airfield, boundary must be evaluated from overhead the station outbound to the limits depicted for the procedure. If no termination point is depicted, the radial must be checked to where it joins the en route structure or the expected coverage limit of the facility category, i.e., 25 miles for a “T” class and 40 miles for “L” or “H” class facilities.

(7) Evaluate the radials for signal quality and accuracy. The final approach course must deliver the aircraft to the desired aiming point. Evaluate azimuth alignment, modulations, polarization (when within 5 to 20 nm of the station), roughness and scalloping, bends, identification, and signal strength when flying the radials. Evaluate the 5° offset radials for modulations, roughness and scalloping, spectrum analysis, identification, and signal strength.

(8) Facility Rotation for MAGVAR Change Inspection. Evaluate one TACAN null and VOR offset radial 5° beyond the final approach radial, IAW Paragraph 11.20e(2), to ensure a minimum of 5° has been checked each side of the published final approach radial. For example, when the published approach radial is changed from R090 to R087, based on a MAGVAR change from 2° East to 5° East, fly R082 as the null/ offset radial. R095 will have been flown previously to support the R090 approach, and provides the 5° minimum requirement. Ensure the published facility restriction, receiver checkpoint, and ESV radials, changed per the facility rotation check, are reported on the flight inspection report.

f. Orbit Evaluations. Orbit evaluations are used to determine azimuth error distribution and signal quality. Orbit data are used as reference information. Establish reference alignment during commissioning, antenna change, frequency change, facility rotation, if no orbital reference exists, or if the ARR and alignment orbit dates on the AVNIS Data Sheet do not match. Evaluate for deviation from the reference during all subsequent orbital evaluations. When optimizing alignment, the mean orbital alignment should be within ± 0.5°, and the system differential between a collocated VOR and TACAN should not exceed 1°. For dual transmitter systems, use the primary transmitter as the reference. Inform maintenance when alignment references are established/ re-established. Notification may be accomplished through Flight Inspection Central Operations if maintenance is not on site and/or abnormal delays occur.

(1) Alignment Orbit

(a) The alignment orbit is used to determine the accuracy and optimum error distribution of the azimuth. The evaluation is conducted for 360° of azimuth. An orbit radius of 5 nm and beyond may be used when using GPS hybrid or equivalent for updating and 10 nm and beyond when using distance measuring equipment updating. When using theodolite, the orbit radius must be the maximum visual range for the theodolite operator. The orbit may be flown clockwise (CW) or counterclockwise (CCW), but once established, it must be flown in the same direction, at the same distance and altitude, on each subsequent inspection. Compute a tapeline altitude to fly the orbit at a standard angle of 4 to 6° from the site. The objective of the check is to help Facilities Maintenance personnel determine environmental problems close in to the facility. The ratio between distance and altitude becomes critical when looking for low angle reflections or shadowing. Altitudes and distance may be modified when conditions prevent establishing them at the recommended 4 to 6° (air traffic requirements, engineering or maintenance support, and site conditions). Indicate deviations from the standard on the flight inspection report and Facility Data Sheet.

(b) If alignment cannot be determined orbitally, it may be measured by flying one radial in each quadrant. A partial orbit, augmented with radial alignment, is preferred over alignment determined solely by radial means. Notify the Flight Inspection Services Technical Services if the use of radial flight is accomplished in lieu of orbital alignment.

(c) One orbit may be flown on dual transmitter facilities during any inspection, except commissioning, by requesting transmitter changes. If sufficient transmitter changes cannot be accommodated (at least one in every 40^{o}), fly an orbit on each transmitter.

(d) During the orbit, evaluate azimuth alignment, modulations, sensing and rotation, roughness and scalloping, identification, and signal strength (a minimum of 1 evaluation every 20°). Out-of-tolerance conditions found during an orbital inspection must be confirmed by a radial evaluation before restricting a facility or issuing a NOTAM. The radial evaluations normally have priority.

(e) Course error distribution must be determined prior to rotation (if required) to achieve optimum station balance. It is not necessary to refly the orbit after this facility rotation, provided the direction and magnitude of the adjustment can be confirmed radially. Apply the confirmed azimuth shift to the alignment orbit for final error spread determination and plotting. Complete the remaining facility rotation checklist items after the rotation.

(f) Course Alignment. On periodics, if a change in mean course alignment of more than 1° is found, contact Facilities Maintenance. Facilities Maintenance will conduct an evaluation to determine if the change in the facility was caused by a maintenance problem or caused by an environmental change.

(2) Coverage

(a) This check is conducted to determine the facility's ability to support the Flight Inspection Standard Service Volume (FISSV). The FISSV must be established as follows: On "T" class facilities, the FISSV is 25 nm and 1,000 ft above facility antenna elevation, or the minimum altitude which will provide 1,000 ft (2,000 ft in designated mountainous areas) above intervening terrain or obstruction as determined by map study**.** On "L" and "H" class facilities, the distance extends to 40 nm, and the altitudes are the same as for the "T" class. Establish facility restrictions and performance status based on the FISSV. One complete orbit (one transmitter only) must be flown at either:

1 The applicable FISSV

2 Altitudes high enough to receive in-tolerance signals. If these altitudes are higher than the altitudes in paragraph (1) above, facility restrictions and NOTAM action are required.

(b) During the orbit, evaluate azimuth alignment, modulations, sensing and rotation, roughness and scalloping, identification, and signal strength (a minimum of 1 evaluation every 20°).

(c) Out-of-tolerance conditions discovered during orbital inspections must be confirmed by a radial inspection before restricting a facility or issuing a NOTAM. An orbit segment used to establish a restriction may be defined laterally by orbital means. Radials flown through the most severe out-of-tolerance area may be used to define the distance and altitude limits of the entire segment. The radial inspection results normally have priority over orbital inspection data. In areas of multiple restricted segments, it may be appropriate to group those segments into larger, easier to understand restrictions. The advantages of this possible over-restriction in some areas must be weighed against user requirements. Fly an arc at the FISSV of the facility at the restricted altitude to encompass the restricted area to determine usable signal coverage.

(d) Procedures flown below or outside the FISSV, which are found unsatisfactory, must be denied, but a facility restriction is not required.

g. Expanded Service Volumes (ESV(s)) are required only when procedural use is predicated on a NAVAID's performance outside of the SSV, as illustrated in Appendix 3, Figures A3-5A – F. Evaluate ESV(s) on one transmitter only. When required, an ESV may be revalidated by orbital flight at the ESV distance and lowest approved altitude. Lateral limits of the area should encompass allowable radial misalignment or applicable fix displacement area. There is no need to inspect the upper limits of an ESV unless interference is reported or suspected.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Polarization	11.21e	X	X	Less than or equal to 2.0°
Radials	11.20a	X	X	
Alignment				Alignment of all electronic radials must not exceed ± 2.5° of correct magnetic azimuth except: Deviations of the course due to bends must not exceed 3.5° from the correct magnetic azimuth and must not exceed 3.5° from the average electronic radial alignment.
Structure	11.22			Roughness/ Scalloping/ Course Aberrations: Deviations from the course, greater than 3.0° are acceptable, provided the aggregate does not exceed the following: .05 nm in any 1.0 nm segment from FAF to the MAP. 0.25 nm in any 5 nm segment from sea level up to 10,000 ft MSL. 0.5 nm in any 10 nm segment from 10,001 to 20,000 ft MSL. 1.0 nm in any 20 nm segment above 20,000 ft MSL. Flyability: The effects of any one, or combination of any alignment and/or structure criteria, even though individually in tolerance, must not render the radial unusable or unsafe.
Signal Strength	11.23	X	X	Received RF signal strength must equal or exceed 5 μv or –93 dbm.
Receiver Checkpoints	11.20h	X	X	Airborne Receiver Checkpoints. All parameters must meet tolerances, and the alignment must be within ± 1.5° of the published azimuth. Ground receiver checkpoints must equal or exceed 15 μv or –83 dbm. Ground Receiver Checkpoints. All parameters must meet tolerances, and the alignment must be within ± 2.0° of the published azimuth. Inability of the facility to provide a ground or airborne receiver checkpoint according to the tolerances specified above must not cause a restriction to be placed on the facility.

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Monitor	11.20b			The transmitter azimuth monitor reference must not exceed ± 1.0°.
Standby Equipment	11.20i 4.33	X	X	The standby transmitter must meet all tolerances and the difference in azimuth alignment between transmitters must not exceed 2.0°.
Standby Power	11.20j 4.33	X		Operation on standby power must not cause any parameters to exceed tolerances.
Orbital Alignment	11.20f		X	Notify maintenance if found to exceed ± 1° from the reference.

b. TACAN Tolerances

Parameter	Reference Paragraph	Inspection C	Inspection P	Tolerance/Limit
Identification	11.21a 11.21g	X	X	Code identification must be correct, clear, distinct, without background noise, and not affect course characteristics throughout the coverage limits of the facility. TACAN/ DME identification must be correctly sequenced with the VOR identification when collocated.
Sensing and Rotation	11.21c	X	X	Sensing and rotation must be correct.
Distance Accuracy	11.30	X	X	0.20 nm.
Polarization	11.21e	X	X	Maximum ± 2.0° course deviation caused by horizontal polarization