TLS FLIGHT INSPECTION PROCEDURE

ADVANCED NAVIGATION & POSITIONING CORPORATION

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TLS FLIGHT INSPECTION PROCEDURES
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C	2018Sep17	Add RNP and Surveillance verification criteria	02068
D	2020Sep21	Add calculation of emanation points	ECA-00197

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SECTION 1: SCOPE

The Transponder Landing System (TLS) tracks and provides landing approach guidance to an individual aircraft returning an assigned transponder identification code. TLS guidance signals emulate Instrument Landing System (ILS) signals that would exist at the current position of the tracked aircraft.

TLS performance meets Federal Aviation Administration and International Civil Aviation Organization Annex 10 requirements for a Category I approach.

The TLS determines the location of the aircraft by interrogating the aircraft transponder and then measuring the transponder range, azimuth angle, and elevation angle with two sensors located adjacent to the runway. Localizer and glide slope corrections are then computed as necessary to guide the aircraft to the desired course. This guidance information is transmitted throughout the TLS service volume using Very High Frequency (VHF) localizer and Ultra High Frequency (UHF) glide slope signals modulated with 90 and 150 Hz tones. The TLS guidance signals are dynamic in that they change with time as the tracked aircraft moves.

This document provides a brief overview of the TLS in Section 2. Section 3 describes the flight procedures used for positioning the aircraft to make measurements and Section 4 contains the tolerances to apply to the measurements gathered in Section 3.

It is important to note an important difference between the TLS and ILS in that the TLS produces a virtual flight path to a virtual emanation point for the localizer and a virtual emanation point for the glide slope. There are no antennas physically located at either of the points from which the TLS signals appear to emanate. A form for listing these important flight inspection points for the localizer and the glide slope is included in Appendix E.

The Appendices include the following information:

- Appendix A: Acronyms and Abbreviations
- Appendix B: Drawings: Glide Slope, Localizer Points and Zones
- Appendix C: Flight Inspection Verification and Data Sheets
- Appendix D: Flight Inspection Profile Summary
- Appendix E: Facility Data Sheet

SECTION 2: BASIC TLS OPERATION

2.1 Operational Sequence Overview

The operational sequence for establishing track and providing guidance to a landing aircraft is as follows.

An aircraft operating under Air Traffic Control (ATC) Instrument Flight Rules (IFR) procedures intending to make an approach is assigned a transponder identification code by ATC for use enroute. The operator of the TLS system must input the code to the TLS Remote Control Unit (RCU). The TLS transmits an interrogation signal which, when received by any transponder in the TLS service volume, triggers a reply. At the same time the interrogation signal is broadcast, a "start pulse" signal is sent to the two TLS sensors to begin a data collection cycle. For a period following the start pulse, the sensors store the transponder pulse returns from all aircraft in the tracking area, along with carrier signal measurements that allow angles to be computed. The TLS system software then searches the pulse returns for the assigned identification code. This interrogation and search cycle is repeated ten times each second. Interrogator Side Lobe Suppression (SLS) is used to block replies from outside the service volume.

When the user aircraft enters the interrogation airspace and its identification code begins to show up in the data from the sensors, the TLS identifies that aircraft as the one to be tracked and starts computing its position. If the TLS identifies two or more aircraft providing replies with the identical selected identification code, no guidance is generated.

Position is computed based on the Time-of-Arrival (TOA) of the code relative to the start pulse, giving range to the aircraft, and the carrier signal phase measurements, Angle-of-Arrival (AOA), from which azimuth and elevation angles are derived. Once confidence criteria on the accuracy of the tracking solution are satisfied, the TLS begins to transmit guidance corrections based on the aircraft's horizontal and vertical offset from the predefined approach path. Interrogations, position measurements, and guidance transmissions then continue cyclically several times per second. The cycle is continued until the aircraft reaches the threshold of the runway or flies out of the top of the service volume (seven degrees.) The TLS then terminates guidance but continues to provide surveillance data at a 2 Hz rate, versus 10 Hz for guidance.

2.2 TLS Operational Sequence

The steps below describe the TLS operational sequence:

1. When the assigned aircraft enters the interrogated airspace, its transponder receives the interrogation signal.
2. The aircraft transponder replies with its preset identification code.
3. The reply is received by the TLS sensors.
4. The azimuth sensor array (ASA) and the elevation sensor array (ESA) measure the time difference between the start pulse and aircraft transponder response to compute the time-of-arrival and the phase angle of the reply signal. The sensors send this data to the TLS Base Station
5. The Base Station computers receive the ASA and ESA data and calculate the location and track of the aircraft.
6. Localizer and glide slope modulation ratios are calculated for guiding the aircraft to the desired course.
7. These modulations are applied to the carrier signals transmitted to the aircraft and drive the CDI display.

2.3 TLS Components

The TLS is comprised of the following principal components (Figure 2-1).

- Azimuth Sensor Array (ASA) which includes infrastructure and antennas
- Elevation Sensor Array (ESA) which includes infrastructure and antennas
- Alternate Time of Arrival (ATA) which includes infrastructure and an antenna
- Calibration/Built-in-Test (Cal/BIT) which includes infrastructure and antenna
- Base Station: containing primary electronics rack and optional reserve electronics rack.

- Ethernet network, including fiber-optic cabling
- Remote Control Unit (RCU)

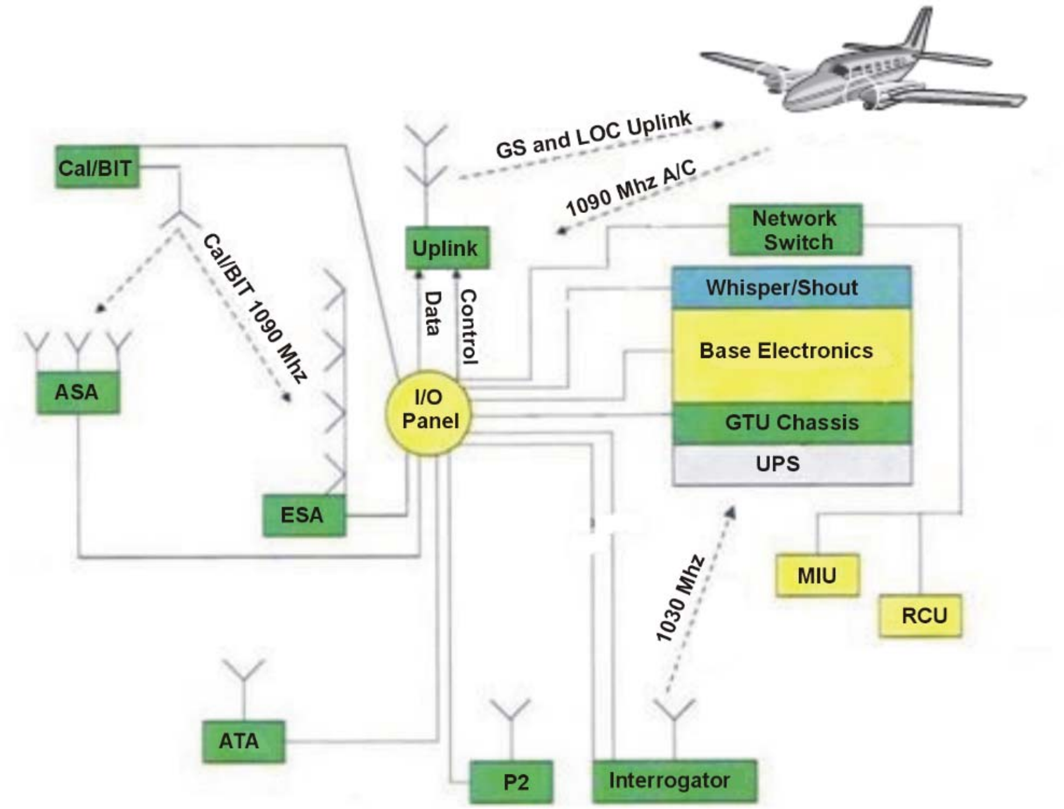


Figure 2-1 TLS Block Diagram

SECTION 3: FLIGHT INSPECTION EVALUATION OF THE TLS

3.1 Flight Inspection Requirements

This section presents flight inspection requirements for TLS approaches. It is intended to provide guidance to the manufacturer, user/sponsor, and flight inspection personnel concerning the airborne data required for commissioning and periodic system evaluations. Flight inspection techniques and procedures are accomplished the same as for ILS, except as noted in this order.

3.1.1 Preflight Requirements

- The instrument approach procedure must be drafted so that the threshold crossing height, glide path angle, localizer course width, navigation Morse identifier and Localizer frequencies have been determined.
- Engineering personnel shall supply data as required for each runway served, on the facility data form included in Appendix E, or its equivalent. Particularly important are the locations of the virtual Localizer and virtual Glide Slope transmission points.
- Facilities maintenance personnel must prepare for flight inspection in accordance with pertinent sections of the TLS Technical Instruction Manual
- Flight personnel must prepare for flight inspection in accordance with this document and pertinent regulatory instructions.
- The Latitude and Longitude of the virtual emanation points for both the TLS localizer and the glide slope must be entered in the flight inspection database.
- Special equipment requirements: AFIS equipped aircraft capable of Transponder Mode 3 A/C as a minimum. A Radio Telemetering Theodolite (RTT) may be used if AFIS is not available. Survey crew personnel shall compute the theodolite location during initial layout of the site for installation.

3.1.2 Checklist

The checklists below in Table 3-1 and Table 3-2 outline the minimum evaluations required to satisfactorily perform the type of check indicated. Maintenance may request profiles for facility optimization not required by the checklist or referenced in the text. Coordinate the requirement and results expected with maintenance prior to accomplishing the flight inspection.

NOTE: In the tables below, the Inspection heading **C** represents commissioning; **P** represents periodic.

CHECKLIST A

Table 3-1 Localizer

Type Check	Ref. Para.	Inspection C	Inspection P	Facility Config.	MOD	WIDTH	SYM	CLR	ALIGN	STRUC
Ident & Voice	3.2.2	X	X	Normal						X
Coverage	3.2.2	X		Reduced Guidance Power				X		X
Modulation Level	3.2.2	X	X	Normal	X					
Width	3.2.3	X	X	Normal		X	X	X		
Clearance at Lowest LCA	3.2.3	X	X	Normal		X	X	X		
High Angle Clearance	3.2.3	X		Normal				X		
Alignment	3.2.4	X	X	Normal	X				X	
Structure	3.2.4	X	X	Normal	X					X
Polarization	3.2.4	X	X	Normal						X
SIAP	3.2.9	X	X	Normal						

CHECKLIST B

Table 3-2 Glide Slope

Type Check	Ref. Para.	Inspection C	Inspection P	Facility Config.	MOD	WIDTH	ANGLE	SYM	BELOW PATH STRUC	CLR STRUC	
Modulation Level	3.2.4	X	X	Normal	X						
Width	3.2.5	X	X	Normal		X		X	X		
Mean Width	3.2.6	X		Normal		X		X			
Angle	3.2.4	X	X	Normal			X				
Structure	3.2.4	X	X	Normal	X						X
Clearance	3.2.7	X	X	Normal						X	
Off-course Clearance	3.2.7	X		Normal	X					X	
Coverage	3.2.8	X		Reduced Guidance Power						X	

CHECKLIST C

Table 3-3 Glide Slope

Type Check	Ref. Para.	Inspection		Facility Config.	MOD	WIDTH	SYM	CLR	ALIGN
		C	P						
Ident and Voice	3.2.2	X	X	Normal					
Coverage	3.2.2	X		Reduced Guidance Power				X	
Modulation Level	3.2.2	X	X	Normal	X				
Width	3.2.3	X	X	Normal		X	X	X	
Clearance at Lowest LCA	3.2.3	X	X	Normal		X	X	X	
High Angle Clearance	3.2.3	X		Normal				X	
Alignment	3.2.4	X	X	Normal	X				X
Structure	3.2.4	X	X	Normal	X				
Polarization	3.2.4	X	X	Normal					
SIAP	3.2.9	X	X	Normal					

3.1.3 Periodic Inspection Interval

Periodic flight inspections shall be accomplished as follows: The first inspection following commissioning will occur in 90 days, the second 180 days from the first, and, finally, at 270 day intervals, or as directed by the regulatory authority.

3.1.4 Zones and Points

Flight inspection of the TLS shall be based on the zones and points described by the diagram and definitions in Appendix B.

3.2 Flight Inspection Procedures

As the TLS does not transmit guidance until placed in the "ACQUIRE" mode and a suitable track on the desired aircraft is established, the flight inspection crew must anticipate a 5 to 10-second delay between requesting "ACQUISITION" and receiving a signal. Additional lead time should be planned for each profile. At the end of some profiles, depending on whether or not the aircraft is inside the service volume, the aircraft may receive a loss of guidance signal.

Leaving the service volume automatically causes the TLS to terminate guidance. If entering an area of adequate signal coverage from an area without line-of-sight coverage, the system delay in "acquiring" the transponder and transmitting guidance signals may falsely indicate inadequate coverage. This would most likely occur on course crossing arcs. If this situation occurs, recheck coverage in the suspect area with a profile originating in an area of good signal and ensure that the system has acquired the aircraft prior to commencing the profile. Flight inspection profiles should not be 'EXECUTED" until after signal reception to avoid erroneous structure results.

Flight inspection should be accomplished via the RCU interface with the TLS in its normal operating configuration.

The aircraft's transponder settings shall be in LOW POWER / LOW SENSITIVITY (ON / ON) for all profiles; document the transponder codes used during the flight inspection on the flight inspection report in the Remarks section.

3.2.1 Localizer Standard Service Volume or Expanded Service Volume

The Localizer Standard Service Volume (SSV) or Expanded Service Volume (ESV) arc inspection is conducted to determine that the localizer guidance meets specified tolerances throughout the service volume while operating at reduced power. Check for interference, signal strength, clearances, proper flag indication, identification, and structure as directed in the procedure below:

1. Fly an arc across the localizer course at 18 nautical miles (nmi)* from the antenna (or ESV distance, whichever is greater), at 4,500 feet above site elevation (or ESV altitude, whichever is higher) through Sector 1.
2. Repeat the first step, except fly across the localizer at the Lowest Coverage Altitude (LCA).
3. Proceed on course, inbound from 18 nmi* (or ESV, whichever is greater), maintaining the LCA to 10 nmi**.
4. Fly an arc across the localizer course at 10 nmi** from the antenna, at the LCA, throughout Sectors 1 and 2.
5. Maintain the LCA and proceed inbound on-course until reaching 7° above the horizontal as measured from the vertex of glide path intercept (GPI).
6. Automatic voice or marker-like transmissions may be generated at specific aircraft positions. Determine from the operators the status of these features in the approach design and check for their usability at the appropriate locations.
7. If an ESV is requested, fly the following in addition to profiles (1) through (5):
   a. Fly an arc across the localizer at the ESV distance and the highest ESV requested altitude, throughout Sector 1.
   b. Repeat step (1), except fly at the lowest requested ESV altitude.

      Note: If only one procedural altitude is requested, only one arc is required

   c. Proceed inbound at the lowest ESV altitude to 18 nmi.*
      * 25 nmi for ICAO Service Volume
      ** 17 nmi for ICAO Service Volumes

3.2.2 Localizer Width and Clearance Check

The purpose of this check is to establish and maintain a course sector width and ratio between half-course sectors that will provide the desired displacement sensitivity as referenced to the threshold.

1. **Width, Symmetry, and Clearance**: Fly an arc at a distance of 4 to 10 nmi (10 nmi preferred) across the localizer course at the LCA throughout Sectors 1 and 2 (flight procedure 4 above). Check clearances, course sector width, and symmetry. Clearances produced by the TLS are of a SAT/ UNSAT type, the amount of which is controlled in the transmitter. Coverage factors (masking) may block the entire signal, but the amount in unshaded areas should not vary appreciably. During Commissioning checks, the results obtained in reduced power in accordance with Paragraph 3.2.1, Step 5 may be used to fulfill this requirement.
2. **High Angle Arc (Commissioning)**: Fly an arc across the localizer course at 10 nmi from the antenna at 4,500 feet above site elevation throughout Sectors 1 and 2. Check clearances, course sector width, and symmetry. If clearances are out of tolerance, additional checks will be made at decreasing altitudes to determine the highest altitude at which the facility may be used.
3. **Width Requirements (Tailoring)**: Localizer sensitivity shall be tailored for a linear sector width of 700 ft at Point T, not to exceed a course sector width of 60.

3.2.3 Localizer/Glide Slope Approach (Course Alignment and Structure)

These checks measure the quality and alignment of the on-course signal. The alignment and structure checks are usually performed simultaneously; therefore, use the same procedures to check alignment and structure.

1. **Precision Approach**: All approaches will be evaluated on the designed procedural azimuth and the commissioned glide path unless otherwise indicated. For the purpose of evaluating structure, optimizing localizer and glide slope alignment, and conducting periodic inspections, start the approach at a distance not closer than the published final approach fix point or 6 nmi from the runway threshold, whichever is greater.
2. **Course Alignment Determination**: Use the area beginning 1 nmi from the threshold, to the threshold. When a restriction occurs in an area where alignment is normally analyzed, measure the alignment by manual or AFIS analyzation of the average course signal from 1 nmi from the start of the restriction, to the start of the restriction. Measure glide path angle in the area from Point “A” to Point “B”. Measure both localizer and glide slope modulation in the area between 7 and 3 nmi from the threshold.
3. **Polarization effect**: The purpose of this check is to determine the effects that vertical polarization may have on the course structure. As a non-phase dependent system, unwanted polarization would only affect localizer or glide slope signal strength. This check may be accomplished concurrently with the course structure check. Fly inbound on-course at a distance between 12 and 6 nmi from the threshold and roll the aircraft to a 20° bank left and right. Actuate the event mark at the maximum banked attitude.
4. **Structure Optimization**: The TLS alignment and structure are adjustable through changes to the approach calibration files. The calibration files compensate for both overall misalignment and ground multi-path effects that account for most structure. The localizer will normally need only alignment adjustment, but the glide slope may need some structure reduction. The key to reduction of structure is effective communication of results to the facility installers.

   The most effective method is to record at least two approaches, then land for engineering analysis of the corrected error traces. The approach calibration files will be broken into segments where the structure is relatively linear in trend. These segments may be in irregular distance units (e.g., 4.0 nmi to 1.6 nmi, 1.6 nmi to 0.9 nmi, 0.9 nmi to 0.5 nmi, 0.5 nmi to 0.1 nmi) to best fit the trends of the structure. Once the calibration segments are determined, file changes are made for each segment. The initial corrections may be to all segments, but subsequent changes are best made to each segment independently.

   During the engineering analysis, determine the distance definition needed to communicate results from the Airborne Electronics Technician (AET) to the ground personnel. The engineers may need results in some small critical segments, each 0.5 nmi increment, while larger increments may be appropriate in more stable segments. Report Zone 2 results from the first corrected error trace and Zone 3 from the second corrected error trace. Once the segments and reporting increments are determined, the AET should report the results in microamps above or below the measured angle in each segment to be adjusted. The facility engineers will use reported deviations to facilitate their adjustments utilizing the flight check tool.

3.2.4 Marker Indications

The TLS can produce marker indications received through the ILS receiver audio circuitry. The Outer Marker (OM) indication is a series of dashes, 700 Hz, keyed at a 120-characters-per-minute rate. The Middle Marker (MM) indication is alternating dots and dashes, 2000 Hz, keyed at the rate of 180 characters per minute. As these marker indications are not from a 75 MHz system, they will not illuminate the normal marker lights and will not be displayed on the printer/ plotter.

Coverage of marker indications is not dependent upon aircraft height. The TLS marker tone transmissions will be received at full strength throughout the marker coverage area in contrast to traditional marker tones which grow to peak directly over the physical marker antenna and then fade as the aircraft continues on it path. To measure the marker duration, activate the printer/plotter event marks at the beginning and end of the audible indications. Compare these event marks to AFIS distance marks. On all inspections, measure along-course (minor axis) duration on localizer centerline.

3.2.5 Glide Slope Level Profile (Width, Symmetry, Structure below Path)

These parameters may be measured from the results of one level profile. Position the aircraft beyond the 190 µA/150 Hz glide slope point on the localizer course. The altitude for the level profile shall be the Glide Slope Intercept (GSI) corrected to true altitude to obtain 190 µA outside the normal path measurement area.

1. **Structure-Below-Path**: This check determines that the 190 µA/150 Hz point occurs at an angle above the horizontal that is at least 30 percent of the commissioned angle. The structure below path is determined from the data obtained during the level run angle or width measurements. Altitudes lower than GSI may be required to make this measurement.
2. **Width**: Path width is the width in degrees of the glide path width sector as normally measured from 75 µA below path, 0 µA, and 75 µA above path.

a. Non-linear transitions may preclude the use of the 75 µA points. If this occurs, determine the path width of the facility between points other than 75 µA (maximum 90 µA, minimum 60 µA).

The path width shall be determined by proportioning the value obtained at the selected points to 75 µA.

b. If a point other than 75 µA is used to measure path widths, that point shall be used on all subsequent checks and inspections.

3. **Symmetry**: Symmetry is the balance of the 150 Hz and 90 Hz width sectors as is determined from the data obtained during level profile width measurements. If points other than the 75 µA points are used from measuring the path width, they shall also be used for the symmetry measurements. The glide path envelope should be as symmetrical as possible.
4. **Clearance-Above-Path**. Check that 150 µA fly-down occurs prior to receiving the flag alarm.

3.2.6 Glide Slope Mean Width Procedure

This check is used to determine the mean width of a glide path between Points “A” and “B”. This check may also be used to determine the mean symmetry of the glide path.

The path width should be established, as nearly as possible, to 0.7° prior to the check. Fly an approach, maintaining 75 µA above the glide path between Points “A” and “B”. Repeat the same profile at 75 µA below the glide path, and again while on the glide path. Determine the mean width from the angle found above and below the glide path and calculate symmetry from the on-path angle. It is important that the aircraft not deviate too far beyond 75 µA on these profiles, as the TLS will sense the aircraft track as beyond the limits of normal flight and automatically abort the guidance.

3.2.7 Glide Slope Clearance

This check is performed to assure that positive fly-up indications exist between the bottom of the glide path sector and obstructions. Glide slope clearances will not exceed approximately 195 µA, regardless of deviation from the correct angle. Below path profiles are more difficult than on standard ILS, due to the absence of proportionality beyond the maximum µA value. Pilot/ET coordination and situational awareness are essential during this check. Clearances above the path are checked to ensure that positive fly-down indication is received prior to receiving the flag alarm

1. **Clearance-Below-Path**: This check is performed to assure that positive fly-up indications exist between the bottom of the glide path sector and obstructions. Below path profiles are more difficult than on standard ILS, due to the limited area of proportionality beyond the minimum tolerance. Flying beyond the lower limit of the TLS service volume will result in guidance termination. Attempt to maintain approximately half the commissioned angle by reference to the AFIS on these profiles. Pilot/

AET coordination and situational awareness are essential during this check. Check that adequate obstacle clearance exists with at least 180 µA of fly-up between the FAF or GSI, whichever is further, and:

a. Centerline Clearances. ILS Point “C” for an unrestricted glide slope; or, the point at which the glide slope is restricted...
b. Off-Course Clearances. At localizer extremities, ILS Point "B"; for an unrestricted glide slope; or, the point at which the glide slope is restricted.

2. **Clearance-Above-Path** - Clearances above the path are checked to ensure that positive fly-down indication is received prior to receiving the flag alarm. Check that 150 µA fly-down occurs prior to receiving the flag alarm. Perform this check during the level profiles.

3.2.8 Glide Slope Standard Service Volume (SSV)

The glide path transmitter shall be placed in reduced power setting for this check. This check shall be made on the localizer on-course and 8° on each side of the localizer on-course. For localizer service aligned on or within 3° of runway centerline, the vertex of this 8° angle shall be abeam the glide slope origination point; for LDA service beyond 3.0°, it shall be the point abeam the actual runway threshold. For level profile, while maintaining the LCA, fly inbound from 10 nmi from the facility, or ESV (whichever is further), to the interception of the lower sector of the glide path (i.e., the point nearest the glide path at which 150 µA occurs). Fly through the glide path sector; check fly-up clearances below, and fly down clearances above the path.

3.2.9 Glide Slope Expanded Service Volume (ESV)

The ESV defined only by distance shall meet all coverage tolerances at an altitude corresponding to 0.30 of the glide path angle or 0.90° for a 3.0 degree glide path angle, at the required distance. If the system does not meet tolerances at that altitude, the minimum altitude where these parameters are met must be published as the lower limit of the ESV.

3.2.10 Standard Instrument Approach Procedure (SIAP)

The SIAP shall be evaluated with the following focus in mind: Flight inspection determines that the procedure is safe and flyable. If a new instrument approach procedure is unsatisfactory, the flight inspector shall coordinate with the procedure designer to determine the necessary changes. When an existing instrument approach procedure is found unsatisfactory due to obstructions, navigation source, charting error, etc., initiate NOTAM action immediately and advise the procedure designer.

3.2.11 Standard Procedure for Verification of Surveillance Coverage

The concepts for verification of the TLS surveillance coverage are identical to those used for the verification of SSR or other multilateration systems. Line-of-sight signal expectations should be modeled or measured and incorporated into the flight plan prior to commencing the flight check verification procedure. The Administrator should perform the procedure normally used in that member states airspace to verify the surveillance coverage and accuracy of the TLS.

SECTION 4: FLIGHT INSPECTION ANALYSIS

4.1 Application of Localizer/Course/Glide Path Structure

Application of course structure analysis contained in this paragraph applies to all zones (1, 2, and 3) of glide paths and all zones of localizers (1, 2 & 3). If course or path tolerances are exceeded, analyze the course/path structure as follows:

1. Where course/path structure is out-of-tolerance in any region of the approach, the flight recordings will be analyzed in distance intervals of 7,089 feet (1.17 nmi) centered about the region where the out-of-tolerance or aggregate of out-of-tolerance condition(s) occurs. Two 7,089 foot areas shall not overlap.
2. Where necessary to avoid overlap, centering the interval about the out-of-tolerance region may be disregarded.
3. It is not permissible to extend the 7,089 foot segment beyond the area checked, i.e., service volume or ESV, whichever is greater, or the point closest to the runway where analyzation stops.
4. The course/path structure is acceptable if the aggregate structure is out-of-tolerance for a distance equal to or less than 354 feet within each 7,089 foot segment.

4.1.1 Rate of Change /Reversal in the Slope of the Glide Path

The following analysis of the path angle recording shall be accomplished during all inspections where AFIS, RTT, or other tracking devices are being used. It applies to all categories of ILS.

1. Inspect the glide path corrected error trace/differential trace in Zones 2 and 3 for changes and/or reversals in the trend of the slope of the path trace.
2. Determine if the trace (or trend), on either or both sides of the point where a change in direction occurs, extends for at least 1,500 ft along the approach with an essentially continuous slope.
3. If one or more changes/reversals meet the condition in Step 2, draw a straight line through the average slope that covers at least a 1,500 ft segment each side of the point of change. It is permissible to extend the straight line of the average slope to inside Point C if required, in order to obtain the 1,500 ft segment. Determine the change-in-slope by measuring the divergence of the two lines at a point 1,000 ft from their intersection.
4. NOTAM Action: Facilities which do not meet the tolerance shall not be classified as restricted, but shall have an autopilot use limitation imposed by NOTAM. Autopilot coupled approaches are not authorized below an altitude (MSL) that is 50 ft higher on the glide path than the altitude at which the out-of-tolerance change in slope occurs. Compute the MSL altitude of such a limitation based on the commissioned angle of the facility. Advise the appropriate procedures specialist.

4.2 Application of the Localizer Coverage Requirements

The localizer shall meet all applicable tolerances for the checks defined in this order throughout the Standard Service Volume to be assigned a facility classification of "UNRESTRICTED". The localizer may still be usable when coverage does not meet tolerances throughout the standard service volume, depending on the effect of the restriction on procedural use.

The TLS will often be installed in those sites unsuitable for standard ILS. While it will work in more adverse terrain, it can be expected to suffer from terrain factors, including terrain masking. Any line-of-sight masking would most likely degrade the interrogator and/or transponder signal and as a consequence, no guidance signal will be available in the masked area. In evaluating such effects, all coverage criteria must be considered; however, to be procedurally usable with a "RESTRICTED" classification, the following criteria must also be met.

1. Clearances Restrictions: If a localizer is restricted in Sector 2, it shall not be used for arcs on the restricted side, unless the inbound course guidance is provided by some other facility, such as a VOR, NDB, etc.
2. Distance Requirements:
    a. Restrictions to localizer coverage at distances less than the standard service volume are permitted, provided the localizer meets all coverage tolerances throughout all procedural approach segments and at the maximum distance at which the arc or turn may be completed.

   b. Restrictions above the LCA are acceptable, provided a step-down fix, etc., can be added to the appropriate approach segment which restricts descent to within the altitude/distance at which acceptable coverage at the LCA was achieved.
3. Vertical Angle Requirements:
   a. If in-tolerance coverage cannot be maintained up to 7° as required by paragraph 3.2.1. (#5), coverage is restricted. The localizer shall be classified as "unusable" if in-tolerance coverage cannot be maintained up to 4° or 1° greater than the commissioned glide path angle, whichever is greater.
   b. If vertical angle coverage is limited but the localizer can be used on a restricted basis, a NOTAM shall be issued which restricts the localizer as "unusable" above a specified altitude, both at the threshold and at least one other point, usually the FAF. Note the angle at which unsatisfactory coverage occurred and evaluate its effect on the non-precision MDA, maximum holding altitudes, and missed approach instructions/ protected areas.

NOTE: In the tables below, the Inspection heading **C** represents commissioning; **P** represents periodic.

Table 4-1 Localizer Tolerances

Parameter	Reference	Inspection		Tolerance/Limit
		C	P	
Modulation Level	3.2.2	X	X	36 – 44%
Width	3.2.3			Maximum -- 6.0° Precision approach -- 400 feet minimum course width at the threshold
		X		± 0.1° of the commissioned width
			X	Within 17% of the commissioned width.
Symmetry	3.2.3	X	X	45 - 55%
Alignment	3.2.4	X		Within 3 μA of the designed procedural azimuth
			X	From the designed procedural azimuth: ± 15 μA for CAT I ± 20 μA for offset localizer/LDA
Structure	3.2.4	X	X	Zone 1 -- from the graphical average course: ± 30 μA to Point A Zone 2 -- from the actual course alignment ± 30 μA at Point A; linear decrease to ± 15 μA at Point B. Zone 3 -- from the actual course alignment ± 15 μA at Point B; ± 15 μA at Point C. Exception: An aggregate out-of-tolerance condition for 354 feet may be acceptable in a 7,089-foot segment. NOTE: For offset localizer and LDA installations, measure structure from graphical average course.
Polarization	3.2.4	X	X	Polarization error not greater than ± 15 μa
Coverage	3.2.2	X	X	Signal Strength -- ≥ 5 μV Flag Alarm – No Flag Clearance and Structure -- in tolerance Interference -- shall not cause an out-of-tolerance condition.

Clearances	3.2.3	X	X	Sector 1 -- linear increase to 175 µA then maintain 175 µA to 10° Sector 2 -- 150 µA
Identification and Voice	3.2.2	X	X	Clear, correct; audio level of the voice equal to the identification level. The identification shall have no effect on the course. Voice shall not cause more than 5 µA of course disturbance.

Table 4-2 Glide Slope Tolerances

Parameter	Reference	Inspection		Tolerance/Limit
		C	P	
Modulation Level	3.2.5	X		78 - 82%
			X	75 - 85%
Width	3.2.5	X		0.7° ± 0.05°
			X	0.7° ± 0.2°
Angle	3.2.4	X		± 0.05° of the commissioned angle
			X	+10.0% to -7.5% of the commissioned angle
Symmetry	3.2.5	X	X	67 - 33%
Structure below Path	3.2.5	X	X	190 µA of fly-up signal occurs at an angle which is at least 30% of the commissioned angle.
		X	X	Exception: If this tolerance cannot be met, apply clearance procedures and tolerances.
Clearance	3.2.7	X	X	Below Path: Adequate obstacle clearance at 180 µA or greater of fly-up signal Above Path: 150 µA of fly-down signal
Structure	3.2.4	X	X	Zone 1 -- 30µA from graphical average path Zone 2 -- 30µA from actual path angle Zone 3 -- 30µA from graphical average path Exception: An aggregate out-of-tolerance condition for 354 feet may be acceptable in a 7,089-foot segment.
Change/Reversal	4.11	X	X	25 µA per 1,000 ft in a 1,500 ft segment
Coverage	3.2.8	X	X	Signal Level -- ≥ 15 µV Flag Alarm – No Flag Fly-up Signal -- ≥ 150 µA Fly-down Signal -- ≥ 150 µA Clearance and Structure -- in-tolerance Interference -- shall not cause an out-of-tolerance condition.

Table 4-3 RNP Localizer Tolerances- RNP to ILS Transition Segment(s)

Parameter	Reference	Inspection		Tolerance/Limit
		C	P	
Modulation Level	3.2.2	X		36 – 44%
Width	3.2.2			Maximum: RNP level 0.1 nm
		X	X	± 0.02 nm (120 ft)
Symmetry	3.2.2	X		45 - 55%

Alignment	3.2.4	X	X	Within 0.02 degrees of the designed procedural course
Coverage	3.2.2	X	X	Signal Strength -- ≥ 5 µV Flag Alarm – No Flag Clearance and Structure -- in tolerance Interference -- shall not cause an out-of-tolerance condition.
Clearances	3.2.3	X		linear increase to 175 µA then maintain 175 µA to 2 x RNP from procedure centerline
Identification and Voice	3.2.2	X		Clear, correct; audio level of the voice equal to the identification level. The identification shall have no effect on the course. Voice shall not cause more than 5 µA of course disturbance.

Table 4-4 Surveillance Tolerances

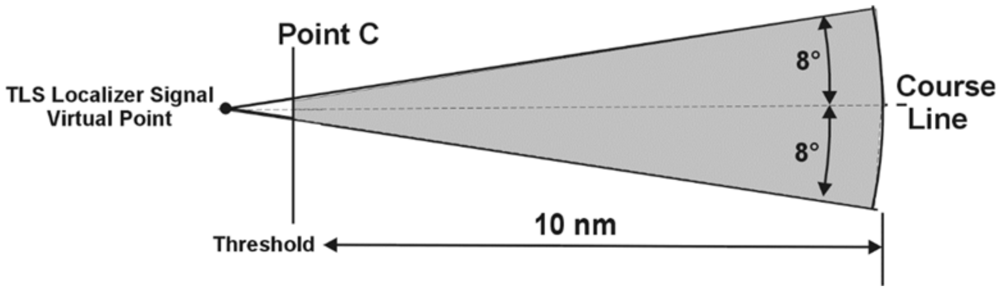
Parameter	Reference	Inspection		Tolerance/Limit
		C	P	
Sector accuracy	3.2.11	X	X	2°
Coverage	3.2.11	X	X	60 nm line-of-sight
Range accuracy	3.2.11	X	X	± 250 feet (75 meters)
Mode C	3.2.11	X	X	± 150 feet. (45 meters)

Appendix A Acronyms & Abbreviations

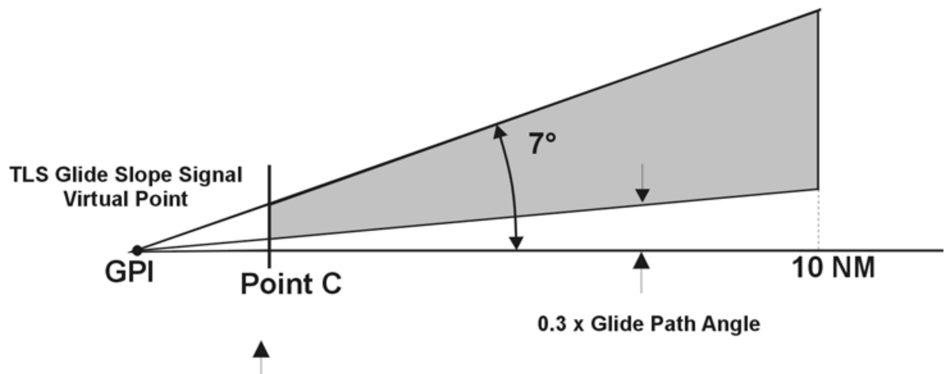
Acronym	Definition
AET	Airborne Electronics Technicians
AFIS	Aerodrome Flight Information Service
ANPC	Advanced Navigation And Positioning Corporation
CDI	Course Deviation Indicator
ECU	Environmental Control Unit
ESV	Expanded Service Volume
FAA	Federal Aviation Administration
FAF	Final Approach Fix
FCC	Federal Communications Commission
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
ILS	Instrument Landing System
GHz	Gigahertz
GPI	Ground Point Intercept
GSI	Glide Slope Intercept
LCA	Lowest Coverage Altitude
nmi	Nautical Miles
MAP	Missed Approach Point
MSL	Mean Sea Level
MHz	Megahertz
MM	Middle Marker
OM	Outer Marker
RTT	Radio Telemetering Theodolite
SAT	Site Acceptance Test
SIAP	Standard Instrument Approach Procedure
SSV	Standard Service Volume
TCH	Threshold Crossing Height
TLS	Transponder Landing System
UPS	Uninterruptible Power Supply
UHF	Ultra High Frequency
VHF	Very High Frequency

Appendix B Drawings: Glide Slope, Localizer, Points and Zones

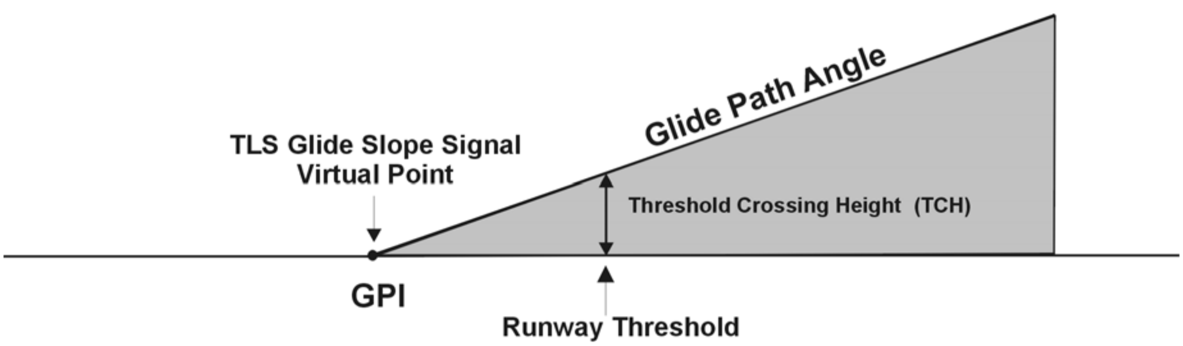
Figure B-1 Glide Slope Coverage Requirements



Glide Slope Coverage in Azimuth

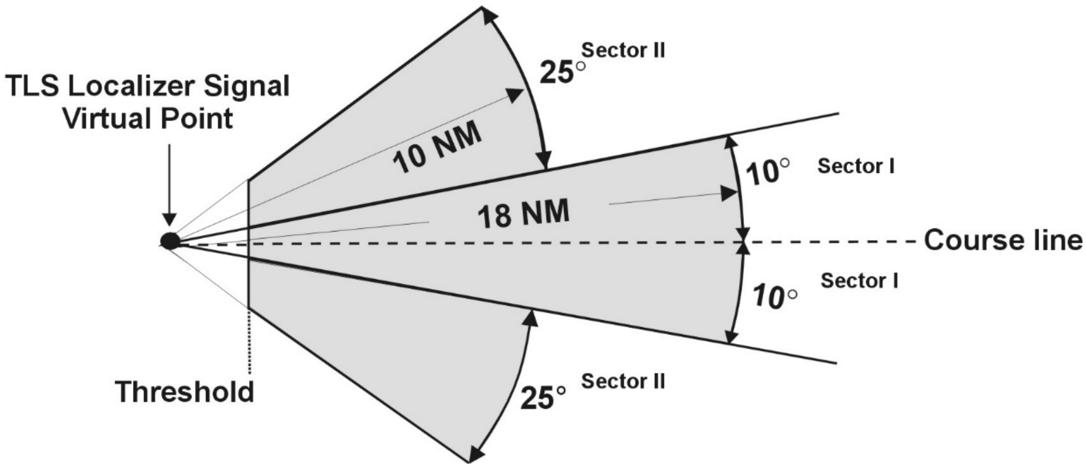


Glide Slope Coverage in Elevation

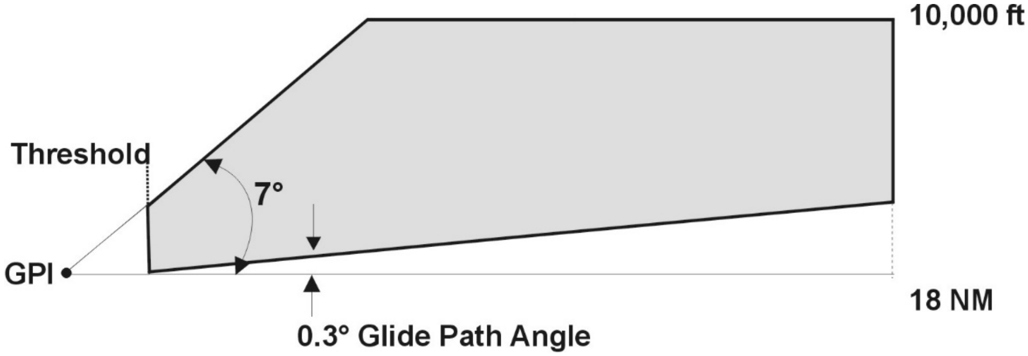


Glide Slope Signal Virtual Point

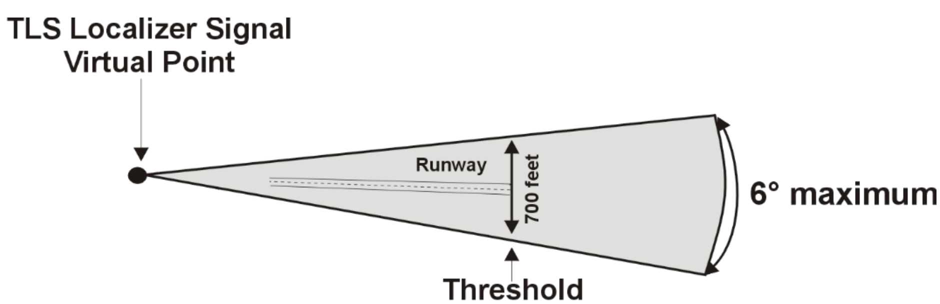
Figure B-2 Localizer Guidance Coverage Requirements



Localizer Coverage in Azimuth



Localizer Coverage in Elevation



Localizer Signal Virtual Point Determination

Figure B-3 Definition of ICAO Points and Zones

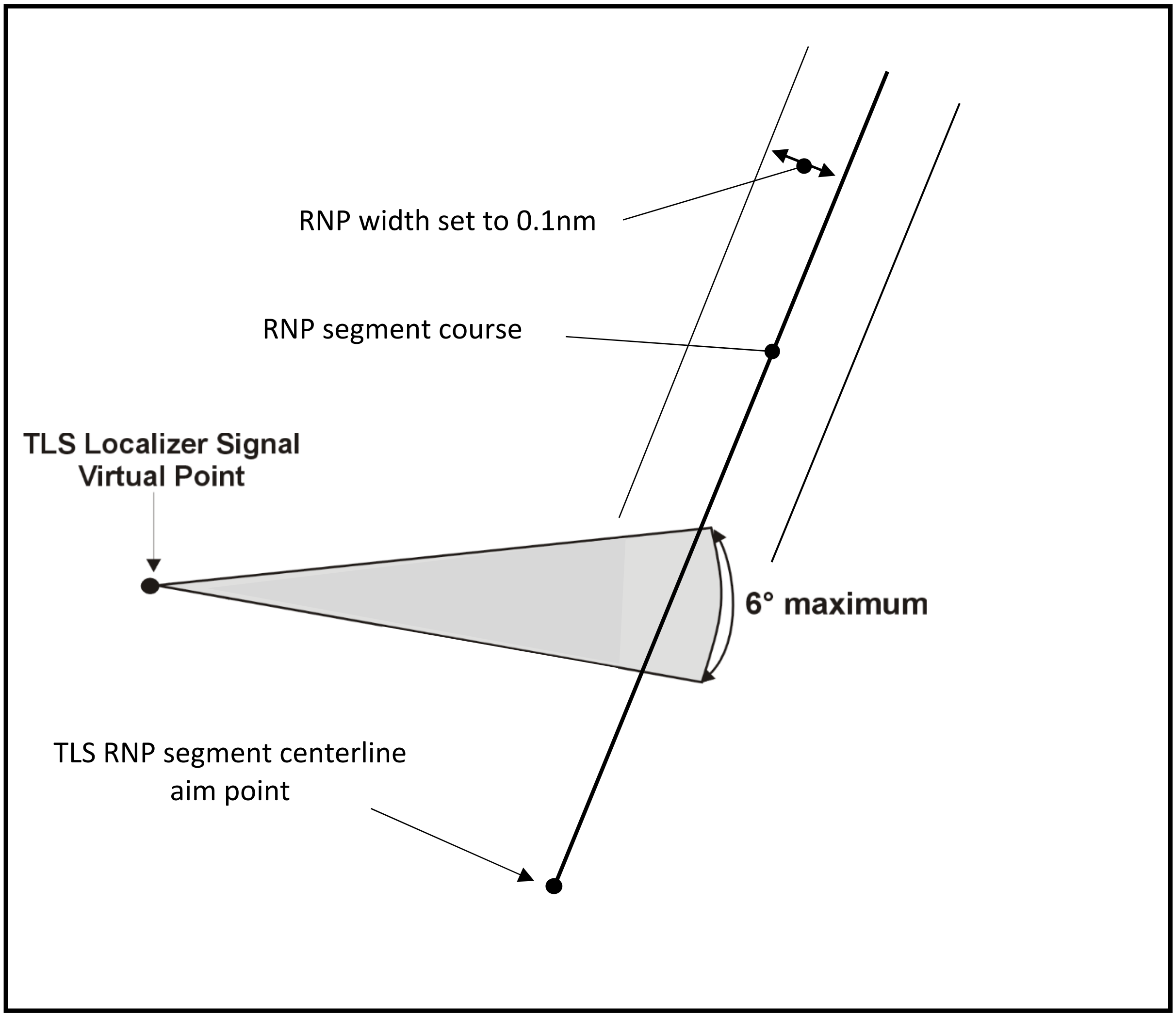
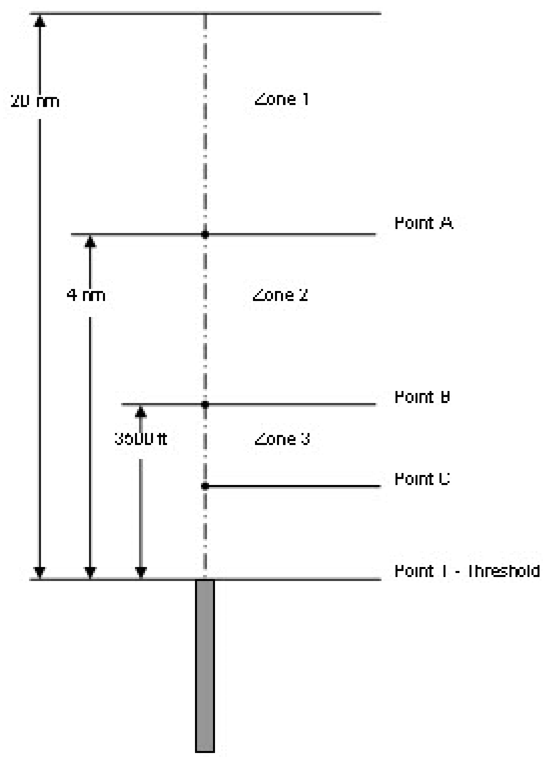


Figure B-4 Localizer Segment Based on RNP Transition



NOTE: Virtual localizer antenna may be located on the runway.

The following definitions for flight inspection points and zones shall apply to analysis of the TLS flight inspection data

Point A	A point on-course located 4 nmi from the runway threshold measured along the runway center line extended.
Point B	A point on-course located 3500 feet from the runway threshold measured along the runway centerline extended.
Point C	A point through which the glide path (as commissioned) passes at a height of 100 feet above the horizontal plan containing the runway threshold. For operations without a glide path, Point C is the MAP.
Zone 1	The distance from the localizer/glide path coverage limit to Point A
Zone 2	The distance from Point A to Point B on-course
Zone 3	The distance from Point B to Point C on-course

Appendix C Flight Inspection Verification Sheet

ANPC Flight Inspection Verification Sheet

Facility Type:			
Name & Identification:			
FI Type:			
Inspected:			
FI System:			
Inertial System 1 S/N:			
Inertial System 2 S/N:			
DFIS S/W Rev:			
DFIS DB Rev:			
SCAPE S/W Rev:			
SCAPE DB Rev:			
FI System:			
The undersigned certify that the facility meets operational requirements:			
Pilot:			
Signature:		**Date:**	
The radiated parameters are within technical tolerances:			
Technical officer:			
Signature:		**Date:**	

ANPC Flight Inspection Data Sheet

Airfield	Inspector	Organization	Equipment
Identification	**Frequency**	**Manufacturer**	**Inspection Date**
		ANPC	
Inspection Type (Choose one)	Periodic	Commissioning -	

Transponder Landing System					
Localizer			**Glide Slope**		
Inspection Parameters			**Inspection Parameters**		
Item	**Transmitter 1**	**Transmitter 2**	**Item**	**Transmitter 1**	**Transmitter 2**
Identification			Modulation		
Modulation			Ramp/incline width		
Course Width			Actual Angle		
90 Hz clearance			Structure Below Path		
150 Hz clearance			Clearance		
Zone 1 Structure			Zone 1 Structure		
Zone 2 Structure			Zone 2 Structure	.	
Zone 3 Structure			Zone 3 Structure		
Course Alignment			90 Hz Symmetry		
90 Hz Symmetry			150 Hz Symmetry		
150 Hz Symmetry				**Flight Inspection Result**	
Comments:				**Pass**	**No Pass**

Inspector's Typed Name:

Inspector's Signature:

Appendix D Flight Inspection Profile Summary Sheet

Profile	Test Item	Flight profile	Distance	Altitude	Checks
Localizer Standard Service Volume					
1	Localizer SSV	Fly an arc from +10 to -10 degrees	18 nmi	4500 feet	Interference, signal strength, clearances, flag indications, ident, markers, structure
2	Loc SSV	Fly an arc from +10 to -10 degrees	18 nmi	LCA	Same as above
3	Loc SSV	Proceed inbound on course	18-10 nmi	LCA	Same as above
4	Loc SSV	Fly an arc from +35 to -35 degrees	10 nmi	LCA	Same as above
5	Loc SSV	Proceed inbound on course until 7 degrees elevation	10 nmi	LCA	Same as above
Localizer Width and Clearance Check (ILS-1 Profile)					
6	Width, Sym & CLR	Fly an arc from +35 to -35 degrees	10 nmi	LCA	Clearances, Course Sector Width, Symmetry
7	High Angle Arc	Fly an arc from +35 to -35 degrees	10 nmi	4500 feet	Clearances, Course Sector Width, Symmetry
Localizer / Glide Slope Approach (ILS-3 Profile)					
8	Approach	Fly published azimuth and glide path (20 deg angle bank left and right for polarization check)	FAF or at least 6 nmi	GSI	Course Alignment, Glide Path Angle, Structure, Polarization and Modulation
9	Polarization	Fly LOC and GP centerline and roll aircraft to 20 degree bank left and right	FAF or at least 6 nmi	GSI	Polarization
10	Marker Check	Fly published azimuth and glide path	Outside Published Markers	GSI	Check marker position and width - ensure Identification turned up
11	Optimization	As needed	FAF or at least 6 nmi	GSI	To optimize multipath database
Glide Slope Level Profile (ILS-3 Profile)					
12	Level Profile	Fly from below 190µa/150Hz inbound	10nmi	GSI	Structure Below Path, Width of Glide Path, Symmetry of Glide Path, Clearance Above Path.

Mean Width					
13	Mean Width	Fly Approach 75µa above GP between Points A and B	at least 6 nmi	GSI	Mean Width and Symmetry
14	Mean Width	Fly Approach 75µa below GP between Points A and B	at least 6 nmi	GSI	Mean Width and Symmetry
Clearance					
15	Clearance Below Path	Check adequate obstacle clearance at 180µa fly up	FAF to Point C	1^0 to 1.5^0 above GPI	Signal may be lost if aircraft flies beyond service volume lower limit
16	Clearance Above Path	Check adequate obstacle clearance at 150µa fly down	FAF to Point C	1^0 to 1.5^0 above GPI	Can be performed during profile 12

Appendix E TLS Facility Data Sheet

Airport		**Completed by**		**Dates**	
No.	**Items**	**Data**	**No.**	**Items**	**Data**
01	FACILITY ID		17	RWY THR LAT	
02	AIRPORT ID		18	RWY THR LONG	
03	RWY NO.		19	RWY THR ELEV	
04	MAG VAR		20	RWY END LAT	
05	FACILITY FREQUENCY		21	RWY END LONG	
06	FACILITY CATEGORY		22	RWY END ELEV	
07	LOCALIZER		23	GLIDE PATH	
08	LOC TRUE HEADING IS		24	G/P virtual point LAT	
09	LOC virtual point LAT		25	G/P virtual point LONG	
10	LOC virtual point LONG		26	G/P virtual point ELEV (same as THR ELEV)	
11	LOC ELEV		27	G/P WIDTH	
12	LOC WIDTH		28	ANGLE	
13	OFF-SET LOC		29	G/P INTCEPT LAT	
14	COURSE LINE POINT LAT		30	G/P INTCEPT LONG	
15	COURSE LINE POINT LONG		31	G/P INTCEPT ELEV	
16	COURSE LINE POINT ELEV		32	MISSED APPROACH DIST	

TLS Facility Data Sheet – RNP Transition

Use multiple forms, one for each segment

Airport:	**Completed by:**	
No.	**Items**	**Data**
01	FACILITY ID	
02	AIRPORT ID	
03	RWY NO.	
04	MAG VAR	
05	FACILITY FREQUENCY	
06	FACILITY CATEGORY	
07	LOCALIZER	
08	LOC TRUE HEADING IS	
09	LOC aim point LAT	
10	LOC aim point LONG	
11	LOC ELEV	
12	LOC WIDTH	0.1 nm
13	OFF-SET LOC	
14	COURSE LINE POINT LAT	
15	COURSE LINE POINT LONG	
16	COURSE LINE POINT ELEV	

TLS Facility Data Sheet – Surveillance

Airport:	**Completed by:**				
No.	**Items**	**Data**			
1.	FACILITY ID				
2.	AIRPORT ID				
3.	MAG VAR				
4.		Coverage		Accuracy	
5.	Sector	Range	Elevation	Range	Azimuth
6.	0-30				
7.	30-60				
8.	60-90				
9.	90-120				
10.	120-150				
11.	150-180				
12.	210-240				
13.	270-300				
14.	330-360				

Appendix F TLS Emanation point calculation

SECTION 1: STRAIGHT-IN APPROACHES

TLS has two emanation points that must be calculated, one for the localizer and one for the glide slope. These are points from which each signal appears to emanate and flight inspection must use these points to verify the TLS signal-in-space. There is no physical TLS antenna located at the point of emanation. There is no benefit derived from a physical survey of the emanation points, they are imaginary points calculated as described below based on the coordinates of the runway. These instructions are aimed at assisting with determining the points for a straight-in approach aligned with the runway centerline.

ICAO Annex 10 Volume 3 provides important guidance that can be used to determine these emanation points:

- From paragraph 3.1.3.7.1 *The maximum course angle shall not exceed 6 degrees* and…
- *Use a nominal sector width of 210 m (700 ft) … at the ILS reference datum*

The geometry for this situation as it affects the localizer emanation point is shown in the figure below.

A specific installed ILS localizer will have a width that is established base on the runway length and can vary from near 3.5 degrees at long runways to as wide as 6 degrees on short runways. For the TLS the course width is a setting not dependent on runway length. The TLS is normally set to a course width of 5 degrees to preserve the requirement to remain comfortably less than 6 degrees while also achieving a localizer displacement sensitivity that feels to a pilot similar to the majority of ILS.

Flight inspection must enter this coordinate to check the TLS localizer width, alignment and structure:

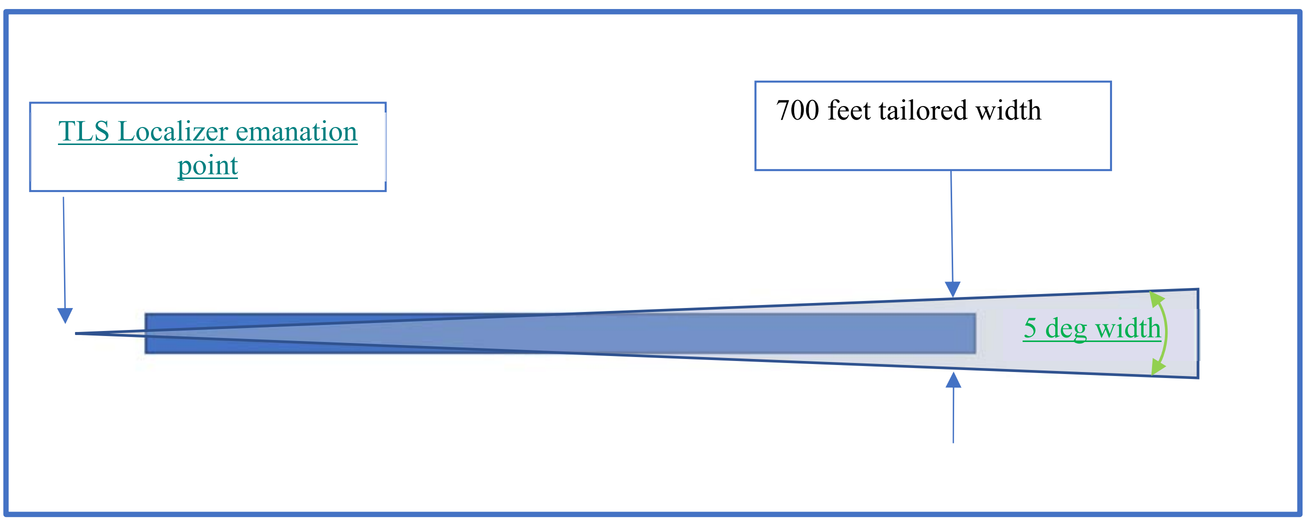


Figure 2 – the localizer emanation point is determined using tailored width (700 feet) and nominal angular width (5 degrees)

The equation for determining the localizer setback from the runway threshold is:

$$\frac{\frac{700ft}{2}}{\tan(2.5deg)} = 8016.32ft$$

Next, the geometry for glide slope emanation point is shown in the figure below.

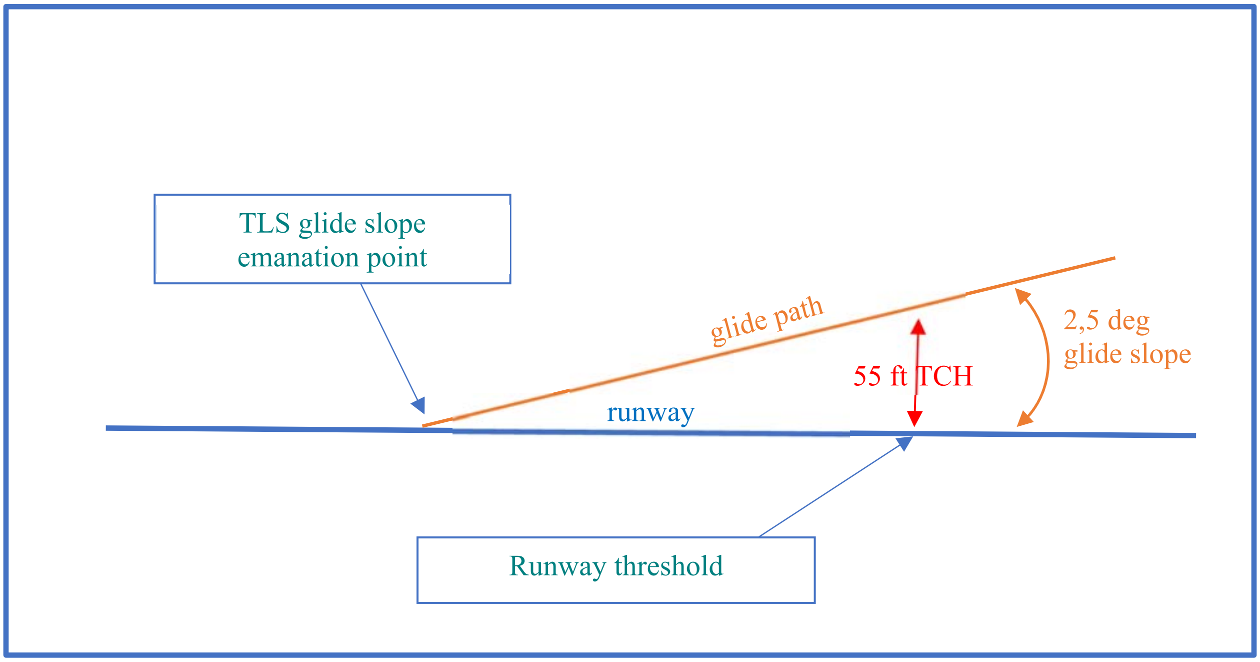


Figure 3 – the glide slope emanation point is determined using TCH and glide slope

The equation for determining the glides slope point of intercept is:

$$\frac{55ft}{\tan(2.5deg)} = 1259.7\ ft$$

The runway endpoints should be available from the most recent survey. Enter the runway endpoint coordinates to the FAA spreadsheet in the fields marked AER and SER. Enter the offset distances computed above for the localizer and the glide slope into the FAA spreadsheet to determine the coordinates of the localizer and glide slope emanation points.

Acronyms used in the spreadsheet are as follows:	Abbreviation used in the spreadsheet
Approach End Runway (AER) Stop End Runway (SER) Threshold Crossing Height (TCH)	DIST = Distance LAT = Latitude LON = Longitude ABM = a beam the point C/L = Centerline

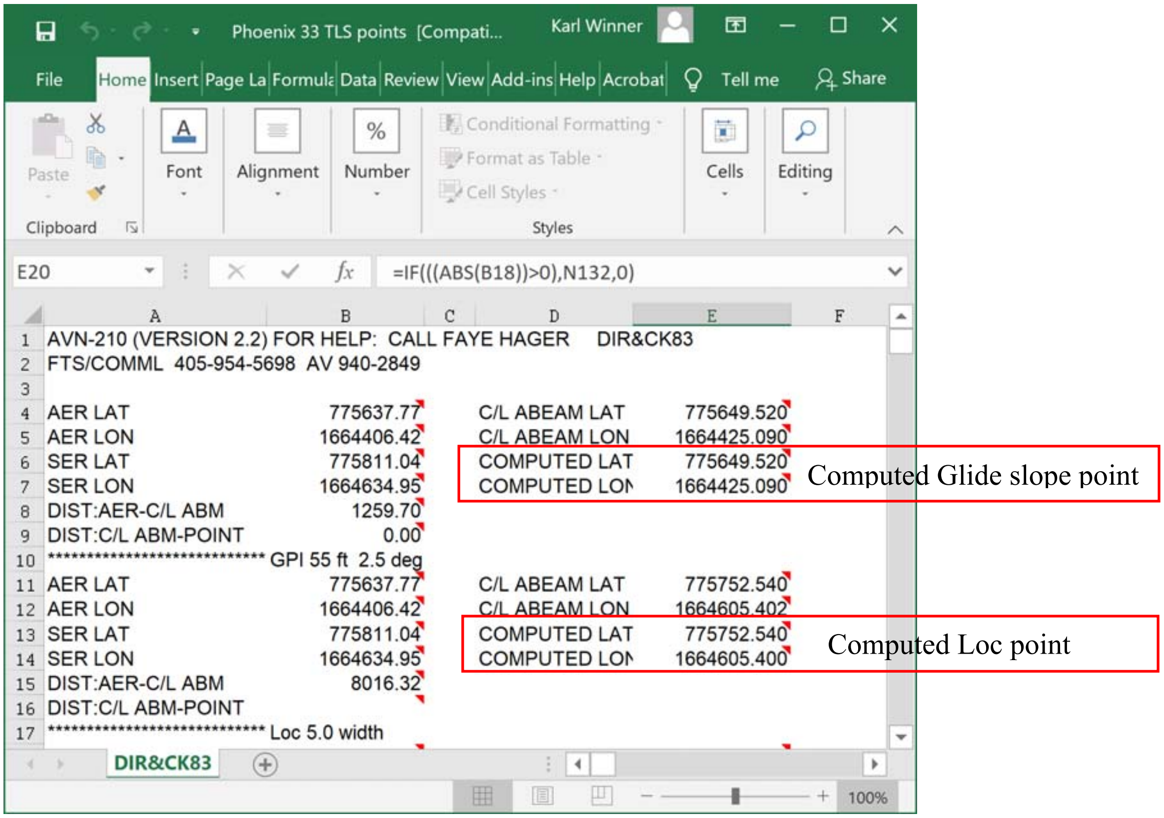


Figure 4 - FAA spreadsheet for calculating emanation points

Leave the field labeled “DIST:C/L ABM-POINT” as 0.0 unless there is an offset in the approach heading that does not match the runway centerline heading.

Next, Enter the computed latitude and longitude for both localizer and glide slope into the facility data sheet for the flight inspectors use during the TLS flight inspection.

Figure 5 - Example of TLS localizer emanation point with an 8,016 foot distance from threshold

Figure 6 –TLS glide slope emanation point for a 55 TCH, 3.0 glide slope and 1049 foot distance from threshold

SECTION 2: EMANATION POINTS FOR OFFSET APPROACHES

TBD