TRANSPONDER LANDING SYSTEM
SYSTEMS DESCRIPTION

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SECTION 1: INTRODUCTION

1.1 Purpose

This document is to support an application for an FCC Experimental Radio License for the TLS engineering site at The Dalles Airport. ANPC has maintained an STA (callsign WA9XGD) for the installation since 1999. The intent is to transition from the STA process to obtaining an experimental license of longer duration.

1.2 Scope

This document provides the top-level system description for the Transponder Landing System (TLS), developed by Advanced Navigation and Positioning Corporation (ANPC) of Hood River, Oregon. The goal of the effort is to develop a navigational aid that provides improved all-weather access to runways by providing flexible installation requirements and not requiring new avionics on the aircraft.

A TLS implementation description and operational overview is presented in section 2.

SECTION 2: TRANSPONDER LANDING SYSTEM (TLS) OVERVIEW

2.1 Functionality

Transponder Landing System (TLS) is a precision guided-approach landing system primarily servicing aircraft flying terrain-challenged approach paths. TLS incorporates Secondary Surveillance Radar (SSR) interrogation schemes to identify and track cooperative aircraft within the service volume. To provide guidance to subject aircraft, TLS emulates Instrument Landing System (ILS) guidance signals but has more flexible siting criteria than ILS systems. This combination of capabilities enables TLS to support precision approach procedures to problematic runways without requiring additional equipment on board ILS equipped aircraft.

From a pilot's perspective a TLS approach is similar to an ILS approach except that transponder operation with a specific transponder code is required.

To facilitate acceptance and integration by regulatory bodies, the functions of the TLS guidance will be designed to:

- Satisfy ICAO signal-in-space requirements for a Category I ILS.
- Minimize transponder occupancy to that which provides the necessary track accuracy and system availability.

2.1.1 Tracking

The TLS can resolve and identify the transponder codes from the synchronous replies. The TLS maintains a position track for the transponder codes of interest (the criteria for code selection will be described in the operational description below). This position track is used to determine:

- the difference in azimuth of the approaching aircraft in reference to the centerline of the designed approach course and
- the difference in elevation of the approaching aircraft with respect to the desired Glide Slope for that approach.

The system then provides guidance information (equivalent to an ILS Localizer signal and a Glide Slope signal) to the aircraft. The guidance information on that uplink channel is only valid for the intended aircraft.

2.1.2 Guidance

TLS provides:

- the means for aircraft transitioning from en-route navigation to final runway approach.
- clearance signals for the pilot to complete the localizer and glide slope intercept. A clearance signal is defined as a full scale deflection on the CDI outside the proportional guidance volume.
- precision guidance to CAT I approach minimums.

2.2 Basic TLS Operation

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. The

TLS system is commanded to search the tracking area for this transponder identification code. The TLS transmits an interrogation signal which, when received by any transponder in the TLS service volume, stimulates a reply. At the same time the interrogation signal is broadcast, the TLS receive sensor arrays will 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 aircraft position angles to be computed. The TLS then searches the pulse returns for the assigned identification code. This interrogation and search cycle is repeated several times each second.

Note: For TLS Rev. A, an operator utilizes the Remote Control Unit (RCU) to control the system.

When the user aircraft enters tracking volume 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. Range is computed based on the Time-of-Arrival (TOA) of the transponder reply pulses relative to the start pulse. The azimuth and elevation angles are determined by the carrier signal phase measurements derived from the Angle-of-Arrival (AOA). 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. As long as the aircraft being tracked remains inside the service volume the cycle is continued until the aircraft reaches the runway approach threshold or leaves the TLS guidance volume. The TLS then terminates guidance and performs any required diagnostics. The system will then become available to await a command to search for the next user aircraft.

The following is a description of the functional steps in system operation after:

After the TLS is initialized and system acquisition has started, the TLS transmits interrogation pulses (1030 MHz). Any aircraft within the TLS service volume will be capable of receiving this signal.

The transponder(s) respond to the interrogation signal by sending a pulsed reply at 1090 MHz.

The transponder reply signals are received at the sensors where pulse characteristic information about the aircraft replies is measured. This data is sent to Base Station computers where software determines the position of the approaching aircraft.

The TLS determines the displacement from the desired approach path that is stored in the system and then determines the message content of the Glide Slope and Localizer signals.

The TLS generates the required ILS guidance signals and broadcasts these signals into the service volume over standard ILS frequencies.

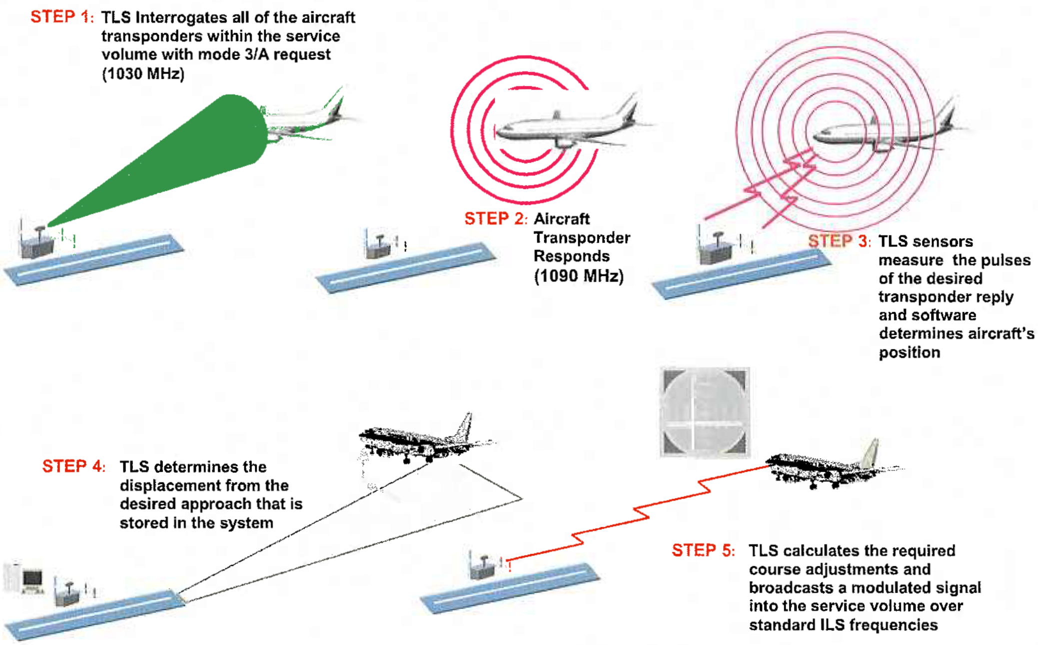

Figure 1 TLS Operation

TLS version Rev. – and Rev. A requires a ground-based person, the Remote Control Unit (RCU) operator, to enter the transponder code of the approaching aircraft. Guidance is only valid for aircraft transmitting this transponder code. Since the RCU operator is unique to TLS, special pilot training is required and therefore TLS is a special approach.

SECTION 1: INTRODUCTION

1.1 Purpose

This paper was prepared to address a request for more information in support of application for a FCC transmit license for the Transponder Landing System (TLS) installed at the Columbia Gorge Regional Airport in Dallesport, WA. The purpose of this license application is to facilitate the development and demonstration of the Transponder Landing System technology.

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1.2 Background

Advanced Navigation & Positioning Corporation (ANPC) uses its TLS installation at the Columbia Gorge Regional Airport for engineering and testing, as well as demonstration. For this purpose, ANPC has been renewing FCC STA's for the site since 1998. Last fall, Don Nellis, FAA Spectrum Management, recommended that ANPC apply for a license to eliminate the need to renew the STA every 6 months.

1.3 Operational Description

The TLS uses ground based equipment to produce a high accuracy track of aircraft equipped with Mode A transponders. The TLS can then broadcast ILS-like guidance to provide a Category I instrument approach for that aircraft.

The system is only interrogating (1030 MHz) and broadcasting VHF and UHF signals once an approach operation has been initiated. After the approach operation has completed the system transitions to Standby mode and is idle.