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MAINTENANCE ACTION ON COURSE POWER AMPLIFIER TRANSMITTER GLIDESLOPE SELEX 2110

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Abstract

The Instrument Landing System (ILS) equipment is one of the aviation navigation tools that provides aircraft with a 3° landing angle. The problem identified that the glideslope signal was out of tolerance. Pilots using the glideslope facility reported this out-of-tolerance signal. This study aimed to identify issues in signal transmission systems and give a solution. The research method was a descriptive analysis to determine the cause of the out-of-tolerance glideslope signal. The result found that the issue was that one of the power amplifiers of the glideslope transmitter was unable to process signals properly, resulting in suboptimal signal transmission power. The power amplifier was replaced to address this issue. This replacement was followed by adjusting the transmission parameters of the glideslope equipment. With the replacement of the power amplifier and the adjustments made to the transmission parameters, the glideslope signal returned to normal, as confirmed by the reports from pilots using the glideslope facility.

Keywords: *Instrument Landing System, Glideslope, Navigation*

Introduction

Perusahaan Umum Lembaga Penyelenggara Pelayanan Navigasi Penerbangan Indonesia (Perum LPPNPI) is an Indonesian state-owned enterprise engaged in the air navigation service sector. Perum LPPNPI was established on September 13, 2012, through Government Regulation No. 77 2012. Perum LPPNPI is divided into two airspaces based on Flight Information Regions (FIR): the Jakarta FIR and the Ujung Pandang FIR. Perum LPPNPI Pekanbaru Branch is one of the primary branches of Perum LPPNPI. One of the pieces of equipment at the Perum LPPNPI Pekanbaru Branch that provides landing guidance signals for aircraft is the Instrument Landing System. The Instrument Landing System is a non-visual landing aid that assists pilots in conducting approach procedures and landing aircraft on airport runways (Darwis et al., 2020).

The Instrument Landing System (ILS) is a crucial facility for airport operations, ensuring that aircraft can land safely, especially under challenging weather conditions such as low skies and limited visibility due to fog or rain. ILS is vital in guiding aircraft to land safely, particularly during bad weather (Apristia et al., 2019). The ILS ensures that aircraft on approach receive accurate positional information relative to both the centerline of the runway (ILS localizer) and the correct angle of descent to the touchdown point (ILS glideslope). Horizontal guidance is facilitated by an antenna array located at the runway's end. Emitting signals modulated with 90 Hz and 150 Hz amplitudes. These signals have equal intensities when received by a receiver positioned along the centerline of the runway (Geisc et al., 2019). One of the tasks and responsibilities of Perum LPPNPI Pekanbaru Branch is to ensure that the Instrument Landing System equipment operates optimally to provide the best navigation services for aircraft. The Instrument Landing System equipment is divided into three subsystems: Localizer, Glideslope, and Marker Beacon (Ji et al., 2023). The Localizer provides guidance signals to help aircraft land precisely in the runway's center.

The Glideslope provides a 3° angle guidance signal for aircraft landing. Glideslope guides pilots on their vertical position relative to the approach path formed using reflections from the ground. Irregular ground features are known to scatter electromagnetic waves and cause positional errors (Honda et al., 2019). The Marker Beacon provides information in the form of Morse code signals and indicator lights to inform the aircraft of its distance to the runway. The Instrument Landing System functions as critical infrastructure at airports to facilitate the safe and smooth landing of aircraft, especially under challenging weather conditions such as low skies and limited visibility due to fog or rain. Its crucial role is to guide aircraft to land safely in various weather conditions, particularly during bad weather. Pilots perform airport approach and landing procedures using the ILS device, a non-visual radio wave navigation aid (Purwaningtyas et al. 2022). Glideslope and localizer indications installed in the ILS (Kawamura et al., 2023).

The Glide Slope is a transmitter that provides guidance signals for the landing path angle, operating in the UHF frequency range between 328.6 MHz and 335.4 MHz. Navigation is directing an aircraft in the air from one point to another. Navigation can be carried out using two-way communication and aviation navigation telecommunications equipment installed on the ground (Fatiha, 2022). The background of this research stems from reports by aircraft pilots utilizing glideslope equipment during the approach process. It was discovered that the glideslope equipment can emit an angle information signal of 3° that is out of tolerance. Signals out of tolerance and received by the aircraft can compromise flight safety. (Darwis et al., 2020) The tolerance range for the 3° angle is -7.5% to +10%. -7.5% is the lower limit, and +10% is the upper limit. If the landing angle is less than -7.5% or more than +10%, the glideslope equipment can be considered out of tolerance. Mountains in front of the glideslope transmission area can cause issues because the glideslope relies on signal reflections in front of the glideslope antenna. In 2014, the research by Poulose also stated that the performance of the instrument landing system is greatly influenced by the characteristics of the location where the instrument landing system is installed. However, at Sultan Syarif Kasim II Airport in Pekanbaru, the terrain is flat and low-lying without mountains, with a smooth land contour. In this study, the author will analyze the causes of out-of-tolerance signal transmissions and perform maintenance actions.

Methods

In this research, the author employed a qualitative descriptive method. Hendra et al., (2023) stated that a Qualitative Descriptive (QD) is a research method that adopts a simple qualitative approach with an inductive approach. Qualitative descriptive research (QD) follows an inductive approach whereby processes or occurrences are first described, leading to the eventual conclusion or events being drawn as generalizations (Iyus & Oka, 2020). The goal of descriptive research is to provide an explanation for a phenomenon, event, or occurrence that is now taking place (Yuliani, 2018). The research was conducted in December 2022 at the LPPNPI Airnav Branch in Pekanbaru. The data collection technique was carried out by directly observing the equipment. The problem data collected includes reports of glideslope signal out of tolerance, abnormal readings of glideslope parameters, and indicator alarm readings on the glideslope equipment. Based on this problem data, maintenance and direct troubleshooting actions were taken on the glideslope equipment to address the issues.

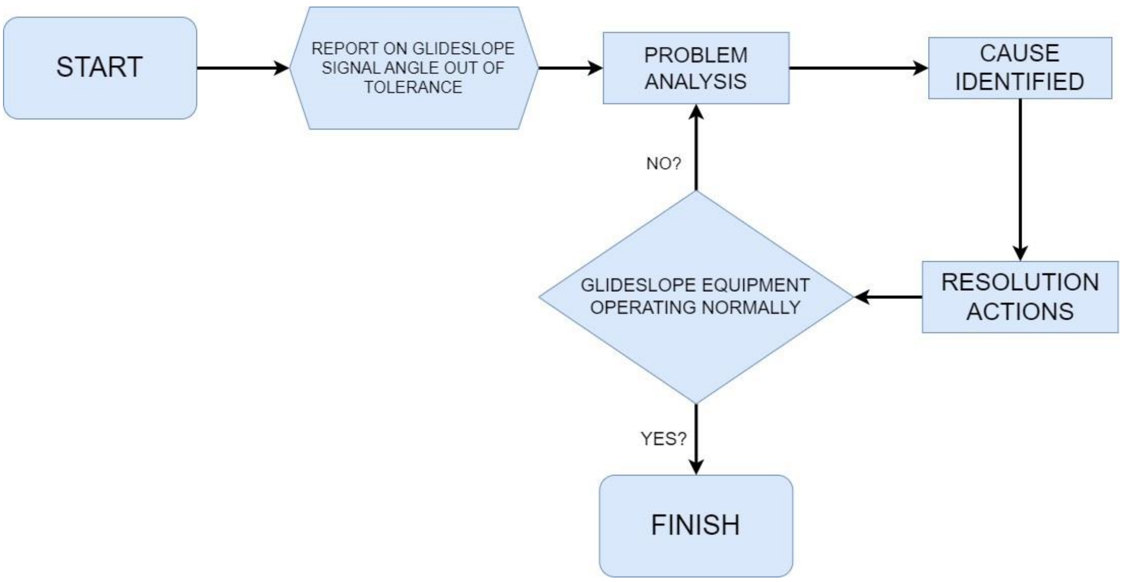


Figure 1. Flowchart in This Research

Results And Discussions

This research was conducted considering that glideslope equipment is crucial in the aircraft landing process, which impacts Runway Occupancy Time, as indicated by the study (Lim et al., 2020). Problem Analysis identify on December 27, 2022, there was a report from Approach Control Pekanbaru and Tower Pekanbaru that the glideslope signal for the aircraft was out of tolerance by 3°. Following up on this report, an analysis was conducted by directly inspecting the glideslope equipment shelter. It was found that the LCU monitor on the integral transmitter (transmitter 1) showed a Glideslope alarm, and the RF SBO Power reading on the Wattmeter was 0 watts. An inspection was also carried out using PMDT, and the reading for the width DDM was out of tolerance.

Figure 2. Alarm Condition on Monitor LCU

Figure 3. Reading of the Wattmeter on the SBO Power Parameter

The action of checking the equipment monitor and reading the power parameter on the Glideslope equipment is carried out to determine the cause of the aircraft receiving a Glideslope signal that is too high (Ariba et al., 2017). Subsequently, further checking of the transmission parameters using PMDT is conducted.

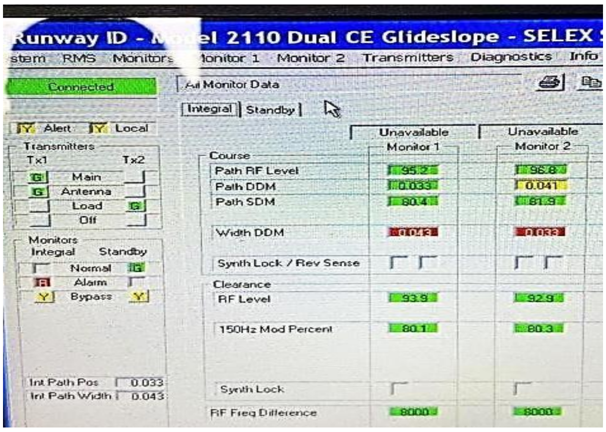


Figure 4. Reading of the Transmission Parameters on the PMDT

Checking the transmission using PMDT on all monitor data of the integral transmitter yielded parameter readings indicating that the width DDM was below the normal limit, triggering an alarm. Several findings were noted alarm on the LCU Integral transmitter monitor, parameter reading of RF Power SBO at 0 Watt parameter reading of the integral transmitter's transmission on PMDT showed Width DDM below the normal limit. The subsequent action taken is to disconnect the power amplifier module of transmitter 1 for further investigation into the several issues found in transmitter 1.

Problem Solutions states that it is imperative to confirm that all equipment is off and that no AC or DC current is flowing before unplugging the power amplifier module on the Glideslope equipment rack. It is done according to the method while disconnecting the power amplifier module. The next step is to remove the power amplifier and open the component covers to examine the electronic circuitry.

Figure 5. The Power Amplifier Module is in the Checking Process

The checking of the Power Amplifier module circuitry was conducted according to the schematic diagram provided by the manufacturer, Selex AMS Inc. However, an issue arose when it was discovered that the module was from the latest series, and Selex AMS Inc. did not produce a schematic diagram for the latest series. This was found after confirming with other branches that also use Selex AMS Inc. flight navigation equipment. Consequently, the technicians analyzed the Power Amplifier module because the schematic diagram and block diagram of Selex AMS Inc. navigation equipment showed that the Power Amplifiers between PA Course and PA Clearance had the same schematic diagram and produced the same signal output. The difference between PA Course and PA Clearance lied in their SBO signal output. PA Course produced CSB and SBO signals, both of which were used and routed to the transfer/recombiner unit block, whereas for PA Clearance, the SBO signal output was attenuated using a dummy load because the clearance signal in Glideslope only required a CSB 150 Hz signal in the lower sector of the

Glideslope transmission (Wan et al., 2015). Since PA Course and PA Clearance served the same function and only differed in their transfer outputs, the technicians analyzed a modification by swapping the Power Amplifiers between PA Course and PA Clearance. This action was taken as an analysis of the malfunction of the Power Amplifier.

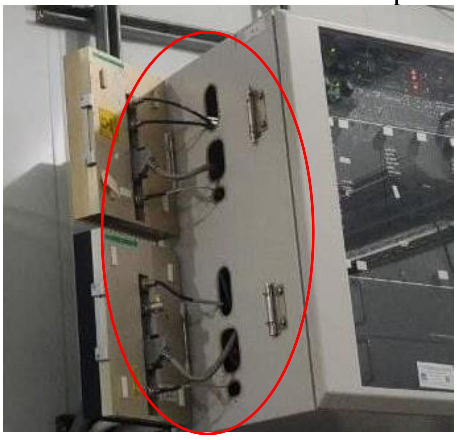


Figure 6. Power Amplifier Exchange

Then, after exchanging the PA, the technician used PMDT to determine the parameters resulting from the PA exchange.

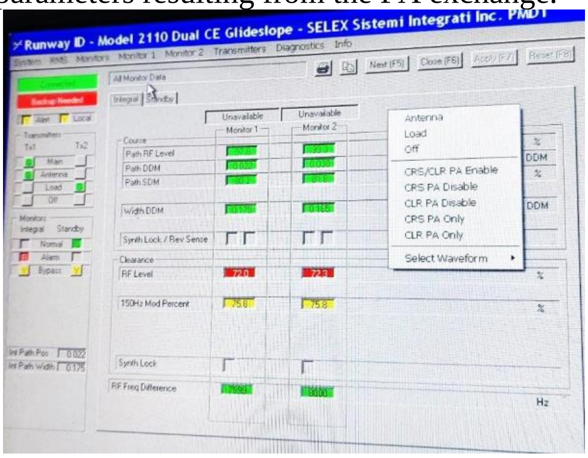
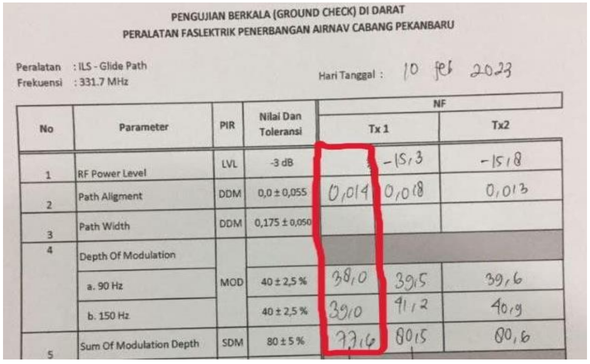


Figure 7. Parameter Reading on PMDT After Power Amplifier Module change

The results of the PMDT reading after the PA exchange indicated an integral transmitter alarm and the RF Level Clearance reading also showed an alarm indicator. The technicians then followed up on these alarms by adjusting the parameters on the PMDT. The parameter setting was followed by a ground check to assess the transmission results directly.



PENGUJIAN BERKALA (GROUND CHECK) DI DARAT
PERALATAN FASLEKTRIK PENERBANGAN AIRNAV CABANG PEKANBARU

Peralatan : ILS - Glide Path
Frekuensi : 331.7 MHz

Hari Tanggal : 10 feb 2023

No	Parameter	PIR	Nilai Dan Toleransi	NF Tx 1		Tx2
1	RF Power Level	LVL	-3 dB		-15,3	-15,8
2	Path Aligment	DDM	0,0 ± 0,055	0,014	0,018	0,013
3	Path Width	DDM	0,175 ± 0,050			
4	Depth Of Modulation					
	a. 90 Hz	MOD	40 ± 2,5 %	38,0	39,5	39,6
	b. 150 Hz		40 ± 2,5 %	39,0	41,2	40,9
5	Sum Of Modulation Depth	SDM	80 ± 5 %	77,6	80,5	80,6

Figure 8. Ground Check Results After PA Module Swap

Then, the ground check results of the PA after the PA module swap were compared with the ground check results after calibration. This comparison was conducted by the technicians to analyze the glideslope transmission, ensuring that the transmission after the PA swap matched the ground check results post-calibration. This is because the post-calibration transmission results had confirmed that the Glideslope equipment was operating according to the parameter values, and the equipment was calibrated and working optimally. To match the calibration results, parameter settings on the PMDT were adjusted accordingly to achieve a transmission that aligns with the post-calibration ground check results.

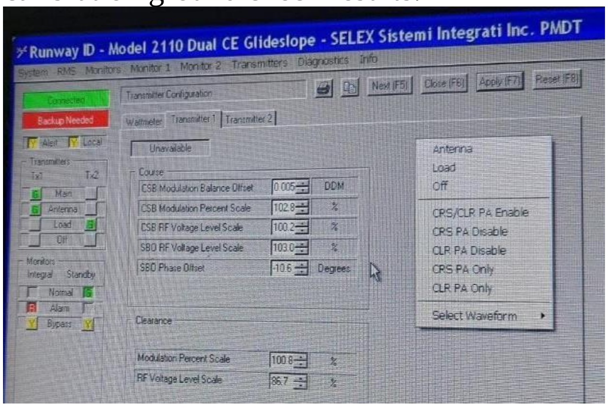
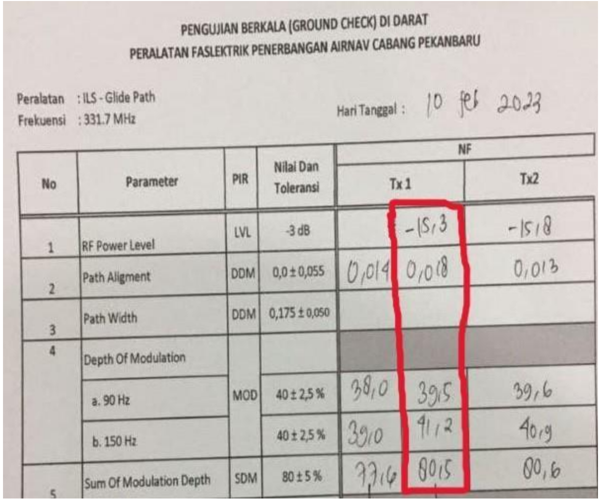


Figure 9. Parameter Setting On PMDT

After adjusting and aligning the parameters with the ground check parameters, the transmission results matched the post-calibration ground check results.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3	Path Width	DDM	0,175 ± 0,050			
4	Depth Of Modulation					
	a. 90 Hz	MOD	40 ± 2,5 %	38,0	39,5	39,6
	b. 150 Hz		40 ± 2,5 %	39,0	41,2	40,9
5	Sum Of Modulation Depth	SDM	80 ± 5 %	77,6	80,5	80,6

Figure 10. Ground Check After Parameter Adjustment and Alignment

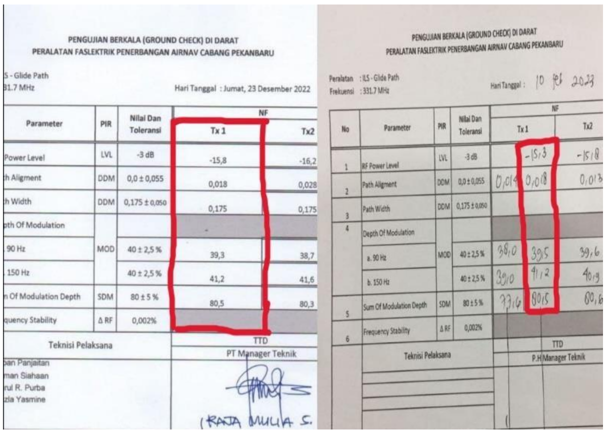


Figure 11. Ground Check Results Post-Calibration and Post-Parameter Adjustment Following PA Swap

Then, the technicians checked the parameters in the all monitor data section of the PMDT for the integral transmitter and found that the transmission parameters were within normal limits without any alarms.

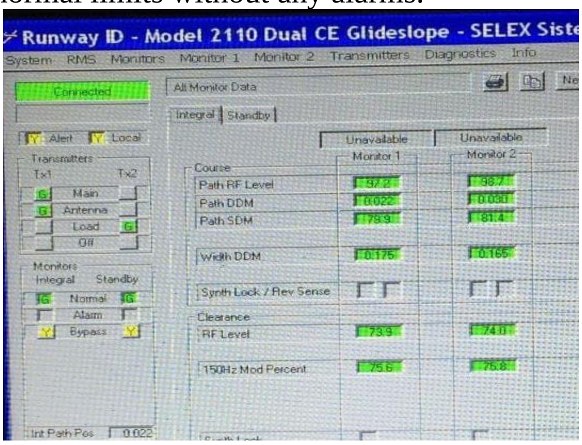


Figure 12. The PMDT Parameter Reading Results After Ground Check Alignment

The findings of the PMDT's parameter measurements following the power amplifier exchange and a ground check are displayed in Figure 12. The green light in the image indicates that the parameters are normal.

Figure 13. LCU Monitor Of Glideslope

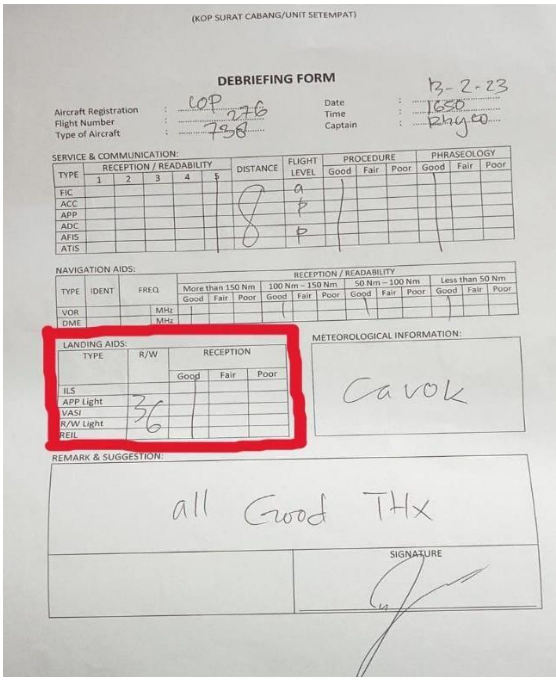
The Local Control Unit (LCU) situation is depicted in Figure 13, where the green light indicates normal transmission characteristics following the power amplifier exchange.

Figure 14. Wattmeter Power SBO Forward Reading Normal

The parameter readings returned to normal on the PMDT, followed by the normal condition of the LCU Monitor on the integral transmitter, along with stable readings of SBO power. Subsequently, the technicians experimented to determine the Glideslope transmission results after swapping the PA and adjusting parameters for an aircraft undergoing landing procedures using the ILS navigation facility.

Figure 15. Wattmeter Power SBO Reflected

Figure 15 explains the reading of normal reflected SBO power.



(KOP SURAT CABANG/UNIT SETEMPAT)

DEBRIEFING FORM

Aircraft Registration : COP
Flight Number : 276
Type of Aircraft : 738

Date : 13-2-23
Time : 1650
Captain : Rhyco

SERVICE & COMMUNICATION:

TYPE	RECEPTION / READABILITY 1	2	3	4	5	DISTANCE	FLIGHT LEVEL	PROCEDURE Good	Fair	Poor	PHRASEOLOGY Good	Fair	Poor
FIC					|	8	a	|			|		
ACC							p						
APP							p						
ADC													
AFIS													
ATIS													

NAVIGATION AIDS:

TYPE	IDENT	FREQ	More than 150 Nm Good	Fair	Poor	100 Nm – 150 Nm Good	Fair	Poor	50 Nm – 100 Nm Good	Fair	Poor	Less than 50 Nm Good	Fair	Poor
VOR		MHz	|			|			|			|		
DME		MHz												

LANDING AIDS:

TYPE	R/W	RECEPTION Good	Fair	Poor
ILS	36	|		
APP Light				
VASI				
R/W Light				
REIL				

METEOROLOGICAL INFORMATION:

Cavok

REMARK & SUGGESTION:

all Good THx

SIGNATURE

Figure 16. Debrifieng Form 1

The results of the Glideslope transmission experiment on the aircraft are attached as a debriefing form. On the Debriefing Form, the Glideslope transmission received by the aircraft from the course power amplifier transmitter one (integral transmitter) is reported as satisfactory. Overall, after analyzing the actions of the PA swap, parameter adjustment on the PMDT, and conducting the Glideslope transmission experiment on the aircraft, as documented in the attached Debriefing Form, it is concluded that the Glideslope transmission from the course power amplifier transmitter one (integral transmitter) has returned to normal within its normal parameter limits.

Based on the literature review, the discussion shows that glideslope equipment plays a vital role in guiding aircraft to land at a 3-degree angle. If pilots report that the glideslope signal is out of tolerance, it must be addressed immediately to prevent aircraft accidents during the landing process. In previous research (Lin et al. 2023), it was found that terrain can affect the transmission of the glideslope signal. However, in this study, it is also identified that damage to one of the power amplifier modules of the glideslope can disrupt the glideslope signal transmission.

Conclusion

After exchanging the power amplifier, adjusting parameters on the PMDT, aligning the post-exchange ground check results with the initial post-calibration ground check results, and conducting the Glideslope transmission experiment on the aircraft as documented in the debriefing form, the analysis reveals that the course power amplifier transmitter one (integral transmitter) of the Selex type 2110 manufacturer has the same signal output for both the course and clearance power amplifiers. This similarity arises because they share the same schematic diagram. The distinguishing factor between the two power amplifiers lies in the output directed to the Glideslope transfer/recombine unit module. The course power amplifier outputs CSB and SBO signals, while the clearance power amplifier also has the same outputs, but the SBO signal is attenuated using a dummy load. The clearance signal is attenuated because the Glideslope equipment only requires a CSB 150 Hz signal in the lower sector of the transmission, serving as a reference indicator for aircraft fly-up and as an obstacle cleaner around the Glideslope lower sector transmission. The current condition of the course power amplifier transmitter one (integral transmitter) Glideslope indicates normal parameters according to the PMDT, post-power amplifier exchange-ground check results with parameter adjustments, and the reception of signal transmission to the aircraft as documented in the debriefing form. The course power amplifier transmitter one (integral transmitter) is now operational again.

References

Apristia, Y., Irfansyah, A., & Sukma, M. M. (2019). Analisa Pengaruh Width Clearance Terhadap Pancaran Localizer Merk AMS 2100 Menggunakan Metode Regresi Linier Sederhana Di Bandar Udara Internasional I Gusti Ngurah Rai Bali, 3.

Ariba, Y., Arzelier, D., & Sofia Urbina, L. (2017). A New Glideslope Guidance Algorithm for Minimum-Fuel Fixed-Time Elliptic Rendezvous Using Semidefinite Programming. In *IFAC-PapersOnLine* (Vol. 50). Retrieved from https://doi.org/10.1016/j.ifacol.2017.08.1369

Darwis, Hendra, O., & Purnomo, S. (2020). Penyimpangan Parameter GP. *Jurnal Ilmiah Aviasi Langit Biru*, 13.

Fatiha, H. (2022). Analisis Performa Alat Bantu Pendaratan DVOR VB-53D dengan Ketepatan Periodisasi Kalibrasi pada Masa Pandemi COVID-19 di Airnav Cabang Batam. *Airman: Jurnal Teknik Dan Keselamatan Transportasi*, 5(2), 22–31. Retrieved from https://doi.org/10.46509/ajtk.v5i2.262

Geisc, R., Neubauer, B., & Zimmer, G. (2019). Scaled Measurements of Multipath Propagation and Navigations Systems - a Practical Example for ILS. In *2019 Joint International Symposium on Electromagnetic Compatibility, Sapporo and Asia-Pacific International Symposium on Electromagnetic Compatibility (EMC Sapporo/APEMC)* (pp. 482–485). Retrieved from https://doi.org/10.23919/EMCTokyo.2019.8893769

Hendra, O., Sadiatmi, R., & Hidayat, Z. (2023). Governance Network on Aviation Safety: A Systematic Literature Review. *Journal of Airport Engineering Technology (JAET)*, 4(1), 01–11. Retrieved 19 June 2024 from https://doi.org/10.52989/JAET.V4I1.114

Honda, J., Tajima, H., & Yokoyama, H. (2019). Numerical Simulation of Glide Slope Signal Interferences by Irregular Ground. In L. Barolli, M. Takizawa, F. Xhafa, & T. Enokido (Eds.), *Web, Artificial Intelligence and Network Applications* (pp. 224–233). Cham: Springer International Publishing.

Iyus, J., & Oka, S. (2020). Studi Deskriptif Kuantitatif Tentang Aktivitas Belajar Mahasiswa dengan Menggunakan Media Pembelajaran Edmodo dalam Pembelajaran Sejarah. *Artefak*.

Ji, X., Hua, G., An, H., Shen, Z., & Xu, L. (2023). Analysis of the Electromagnetic Effect of the EAT Screen on the Localizer Antenna and Glide-Slope Localizer Antenna in the Airport. In *2023 IEEE MTT-S International Wireless Symposium (IWS)* (pp. 1–3). Retrieved from https://doi.org/10.1109/IWS58240.2023.10222240

Kawamura, E., Dolph, C., Kannan, K., Lombaerts, T., & Ippolito, C. A. (2023). Simulated Vision-based Approach and Landing System for Advanced Air Mobility. In *AIAA SCITECH 2023 Forum*. Reston, Virginia: American Institute of Aeronautics and Astronautics. Retrieved from https://doi.org/10.2514/6.2023-2195

Lim, Z. J., Goh, S. K., Dhief, I., & Alam, S. (2020). Causal Effects of Landing Parameters on Runway Occupancy Time using Causal Machine Learning Models. In *2020 IEEE Symposium Series on Computational Intelligence (SSCI)* (pp. 2713–2722). Retrieved from https://doi.org/10.1109/SSCI47803.2020.9308243

Lin, H., Liang, F., Ye, J., & Li, Y. (2023). Analysis of the influence of the mountain in front of the GP on signal quality. In *Proc.SPIE* (Vol. 12970, p. 1297023). Retrieved from https://doi.org/10.1117/12.3012421

Purwaningtyas, D. A., Eriyandi, E., Fatonah, F., Suparlan, S., & Agustini, W. D. (2022). Sosilasisasi Kriteria Penempatan Peralatan Komunikasi, Navigasi dan Pengamatan Penerbangan Pada Dinas Perhubungan Kabupaten Tangerang. *Sasambo: Jurnal Abdimas (Journal of Community Service)*, 4(1). Retrieved from https://doi.org/10.36312/sasambo.v4i1.616

Wan, J., Li, K., Gao, P., & Wang, L. (2015). Enhanced instrument landing system based on the aided inertial navigation. *Journal of Computational Information Systems*, 11(21). Retrieved from https://doi.org/10.12733/jcis16051

Yuliani, W. (2018). Metode Penelitian Deskriptif Kualitatif Dalam Perspektif Bimbingan dan Konseling, 2(2). Retrieved from https://doi.org/10.22460/q.v2i1p21-30.642