Analysis of Alarm in Near Field Monitor ILS Thales 421 at AirNav Semarang Branch

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Abstract This study looks at the alarms on the Near Field Monitor ILS Thales 421 at AirNav Semarang Branch. We used a method called action research, which involves reviewing existing literature, performing corrective maintenance, and evaluating the system. The literature review helped us understand how the ILS system works and what factors can affect its performance. For corrective maintenance, we identified and fixed problems that were causing the alarms. This involved analyzing past data and observing how the system operates in real-time. After making these fixes, we evaluated how effective our actions were and what impact they had on the system's performance. Our findings showed that the alarms were triggered by several issues, including damaged cables and environmental factors. The repairs we made successfully returned the equipment to normal working conditions. Overall, this research emphasizes the importance of regular monitoring and maintenance to keep air navigation systems running smoothly. By addressing alarm issues before they escalate, we can improve the reliability and safety of air traffic management. This study provides valuable insights for those managing ILS systems, highlighting that proactive measures are key to ensuring safe and efficient operations in aviation.

Index Terms : Air Navigation Services, Corrective Maintenance, Instrument Landing System, Nearfield Monitor

I. INTRODUCTION

The Instrument Landing System is a widely used technology in aviation that assists pilots in the approach and landing phases of flight by providing precise guidance on the aircraft's horizontal and vertical position relative to the runway.[1] Proper functioning of this critical infrastructure is essential for maintaining the safety and efficiency of air traffic operations, as pilots rely on the accuracy and reliability of ILS signals to land aircraft safely, particularly in low visibility conditions.[2][3] The more accurate a navigation aid is, the closer the aircraft will stay to the center line of the runway, which reduces the chances of a crash during landing. [4]Recognizing the importance of the ILS, this study investigates the issues surrounding the alarms triggered on the Near Field Monitor ILS Thales 421 system installed at the AirNav Semarang Branch, the organization responsible for managing air navigation services in the region. Despite its advanced technology, issues can still arise within this system, one of which is alarms on the Near Field Monitor.

The alarms on the Near Field Monitor ILS Thales 421 are significant because they can disrupt flight operations and diminish pilots' confidence in navigation systems.[5] These alarms can be triggered by several factors, such as cable damage or unfavorable environmental conditions. When an alarm sounds, technicians must quickly analyze the situation to identify the cause and make repairs to restore the system's functionality. Therefore, this research is essential to gain a deeper understanding of what causes these alarms and how to address them effectively.

Given this background, the research questions for this study are: What factors contribute to alarms on the Near Field Monitor ILS Thales 421? How can corrective maintenance methods be applied to resolve these alarm issues? And to what extent can system evaluation help improve ILS performance? To maintain a clear focus for this study, certain limitations are set. This research will specifically analyze alarms occurring on the Near Field Monitor ILS Thales 421 at Airnav Semarang Branch. Additionally, it will only cover the analysis of alarm causes and corrective actions taken through maintenance and system evaluation.

This research aims to analyze the alarms on the Near Field Monitor ILS Thales 421 at the AirNav Semarang Branch. By utilizing an action research approach, the study seeks to determine the factors contributing to these alarms, implement corrective maintenance to address the existing issues, and evaluate the effectiveness of the actions taken to enhance system performance. The findings from this research are anticipated to benefit various stakeholders. For technicians and ILS operators, the results will offer insights into the effective and efficient management of alarm-related concerns.

Moreover, this research can serve as a reference for airport management in improving monitoring and maintenance systems for ILS to ensure they function well. Consequently, flight safety can be better maintained. Overall, this study aims not only to resolve existing technical problems but also to enhance knowledge and best practices in operating air navigation systems in Indonesia. By understanding the causes and solutions related to alarms on the Near Field Monitor ILS Thales 421, we can ensure that air navigation systems operate optimally and safely for all users.

II. METHODS

This research employs an action research method to analyze the alarms occurring on the Near Field Monitor of the ILS Thales 421 Localizer at AirNav Semarang Branch. This method consists of several steps, starting with a literature review, followed by corrective maintenance, and concluding with an evaluation of the repairs made. Each step plays a crucial role in gaining a better understanding of the issues at hand and how to address them effectively.

The research procedure begins with a literature review related to Instrument Landing System (ILS) equipment and relevant maintenance procedures. A literature review is a crucial part of creating and sharing knowledge in all academic fields.[6] This review aims to gather information and develop a deep understanding of the theories and practices associated with ILS systems, particularly the Thales 421 Localizer. This information is essential for understanding the fundamentals of ILS equipment and identifying potential problems that may arise during its use. The information was obtained from various written sources, including books, scientific articles, and relevant technical reports, such as the manual for the Thales 421 Localizer equipment and operational manuals available at each AirNav branch.

Additionally, we studied various factors that could potentially influence the performance of the ILS monitor. For instance, we found that environmental conditions like inclement weather and the surrounding infrastructure of the shelter building could trigger alarms on the ILS equipment. By reviewing existing theories and practices, we were able to formulate hypotheses regarding the underlying causes of the alarms on the Near Field Monitor Localizer. The literature review also included an examination of previous studies related to similar issues. This allowed us to gain further insights into how other researchers have addressed alarm-related problems in ILS systems.

After completing the literature review, we proceeded to address the alarm issues on the Near Field Monitor Localizer through corrective maintenance. Corrective maintenance means fixing problems after they happen. This method helps save money on repairs and allows for longer intervals between maintenance, but it also increases the risk of the equipment being unavailable when needed.[7] This involved a systematic approach to identify and resolve the underlying problems. The initial stages entailed analyzing historical data and thoroughly inspecting the equipment to ensure all components were functioning normally. Technicians conducted detailed examinations of the ILS equipment, including the cables and other connections. Based on these inspections, it was determined that the alarms were triggered by damaged cables disrupting signal transmission. Additionally, an evaluation of the surrounding environmental conditions was carried out to rule out any external factors that could affect system performance.

Once we identified the source of the problems, we immediately took corrective actions. We replaced the damaged cables and ensured all connections were functioning properly. Furthermore, we conducted retesting on the system to confirm that all components were operating optimally after the repairs were completed. Following the corrective maintenance, the final step in this research method was to evaluate the effectiveness of the repairs made. The evaluation aimed to assess the impact of our actions on the overall performance of the ILS system. We monitored the equipment for a specific period after implementing the repairs to determine if any alarms occurred again. This allowed us to assess whether the corrective actions successfully addressed the alarm issues. The evaluation results indicated that the implemented corrective actions had successfully restored normal operation to the equipment and deactivated any existing alarms.

This research method allowed us to successfully analyze the alarms on the Near Field Monitor ILS Localizer Thales 421 at the AirNav Semarang Branch. The literature review provided a strong theoretical foundation for understanding the existing problems, while implementing corrective maintenance enabled us to identify and directly address the technical issues. Evaluating the repairs, in turn, helped us gauge the effectiveness of our actions and plan future steps accordingly. This structured approach not only addresses immediate technical challenges, but also enhances knowledge about best practices for operating aviation navigation systems in Indonesia. By understanding both the causes and solutions related to alarms on the Near Field Monitor ILS Thales 421, we can ensure that these vital air navigation systems operate optimally and safely for all users involved in air travel.

III. RESULTS AND DISCUSSION

A. literature Review

The Instrument Landing System is a navigation aid that uses radio waves for instrument (non-visual) landing guidance, assisting pilots in executing approach and landing procedures at an airport.[8] The ILS is designed to facilitate pilots' approaches to the runway, especially during poor weather conditions and limited visibility. It operates in conjunction with other navigation aids such as DME, VOR, and NDB, all of which are utilized according to the standards set by ICAO Annex 10, Vol 1 Chapter

3.[9] The ILS consists of three components: the localizer, glide path, and marker beacon.

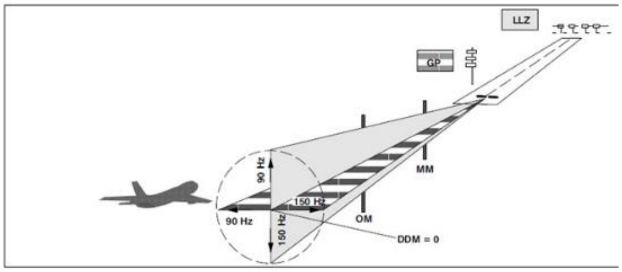


Fig. 1 scenario of an aircraft approaching a runway equipped with a Localizer (LLZ) and a Glide Path (GP) system

The localizer is a transmitter that uses a method called space modulation to provides azimuth guidance in the horizontal plane, indicating the aircraft's alignment with the runway centerline.[10] Operating on VHF frequencies between 108 and 111.975 MHz, the localizer has a coverage range extending up to 25 nautical miles. It emits a radiation pattern from two antennas, one positioned on the right and the other on the left, both with equal amplitudes. One antenna's pattern is modulated at 90 Hz, while the other is modulated at 150 Hz. The Course Line is the intersection line between these 90 Hz and 150 Hz modulations, where the modulation percentages are equal, resulting in a difference depth of modulation (DDM) is zero. This Course Line corresponds to the position of the straight extension of the runway centerline.

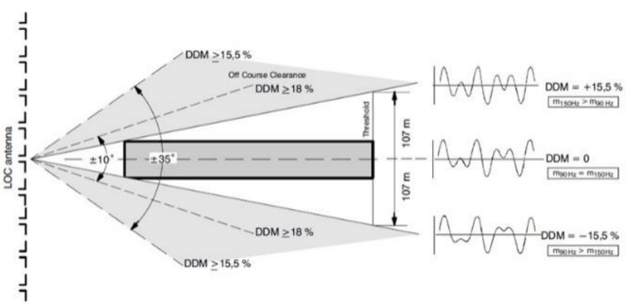


Fig. 2 Characteristics of the Localizer Value

The localizer emits a radiation pattern from two antennas, one on the right and one on the left, with equal amplitudes. One antenna's pattern is modulated at 90 Hz, while the other is modulated at 150 Hz. The Course Line, where the modulation percentages are equal and the difference depth of modulation (DDM) is zero, corresponds to the position of the straight extension of the runway centerline.[11] The sum of depth modulation represents the total modulation depth from the two different frequencies, 90 Hz and 150 Hz. With a modulation depth of ±20% for each frequency, the ideal SDM value for the localizer is approximately ±40%.

The localizer features two types of monitoring systems: the integrated monitor and the field monitor. The integrated monitor is an additional monitor directly connected to the radiation elements (localizer antennas), while the field monitor consists of antennas positioned in front of the localizer antennas. The field monitor includes a nearfield antenna located approximately 40 meters in front of the localizer antenna and a farfield antenna situated at the inner marker. At the localizer in Semarang Airport, a nearfield antenna is used to monitor the radiation produced by the localizer antenna. From this nearfield antenna, parameters obtained include the RF level (Nearfield Position RF Level), difference of depth modulation (Nearfield Position DDM), and sum of depth modulation (Nearfield Position SDM).

Literature studies on Standard Operating Procedures (SOP) and the equipment manual for the Localizer are essential for understanding how this system works and how to maintain it. SOPs serve as official guidelines that outline the steps to be followed in the operation and maintenance of the ILS equipment. By adhering to these procedures, operators can ensure that all tasks are performed correctly, minimizing the risk of errors during operation and maintenance. Additionally, the Localizer equipment manual contains detailed technical information about the specifications, functions, and workings of the components within the Localizer system. This manual also includes troubleshooting guides that assist technicians in identifying and resolving potential issues. With the manual, users can gain insights into how each part of the system interacts and functions optimally. This understanding is crucial for both preventive and corrective maintenance to ensure that all devices operate effectively. Once the SOP and the Localizer manual are understood, a flowchart can be created as a guide for implementing corrective maintenance procedures.

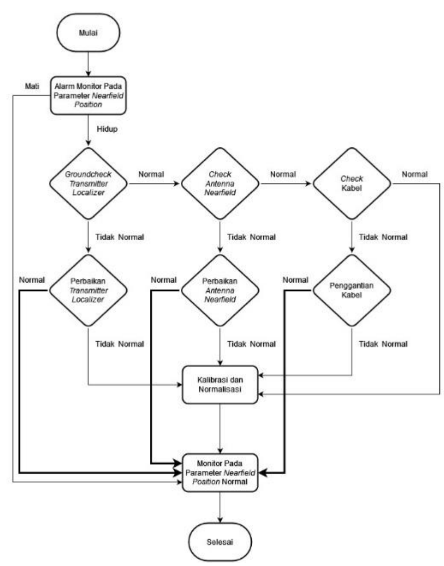


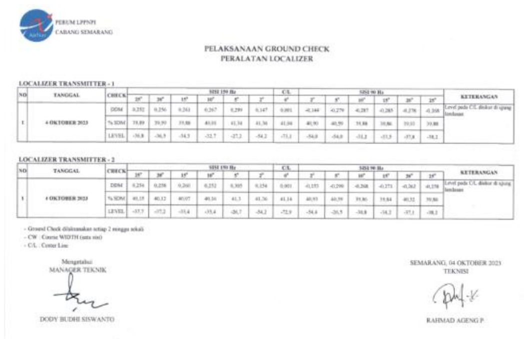
Fig. 3 Problem Solving Flowchart

B. *Corrective Maintenance*

After conducting the literature review explained in the previous step, the next step is to carry out an investigation to identify the causes of the incident, following these steps:

1. When the Localizer monitor displays an alarm status, the first action taken by the technician is to check the transmission from the Localizer Transmitter using a Portable Instrument Landing System Receiver (PIR).

After the check, the results transmitted by the Localizer Transmitter are found to be normal.



PERUM LPPNPI
CABANG SEMARANG

PELAKSANAAN GROUND CHECK
PERALATAN LOCALIZER

LOCALIZER TRANSMITTER - 1

NO	TANGGAL	CHECK	SISI 150 Hz						C/L	SISI 90 Hz						KETERANGAN
			25°	20°	15°	10°	5°	2°	0°	2°	5°	10°	15°	20°	25°	
1	4 OKTOBER 2023	DDM	0,252	0,256	0,261	0,267	0,299	0,147	0,001	-0,144	-0,279	-0,287	-0,285	-0,278	-0,308	Level pada C/L diukur di ujung landasan
		% SDM	39,89	39,99	39,88	40,01	41,34	41,36	41,04	40,90	40,59	39,88	39,86	39,93	39,88	
		LEVEL	-36,8	-36,5	-34,3	-32,7	-27,2	-54,2	-73,1	-54,0	-54,0	-31,2	-33,5	-37,8	-38,2	

LOCALIZER TRANSMITTER - 2

NO	TANGGAL	CHECK	SISI 150 Hz						C/L	SISI 90 Hz						KETERANGAN
			25°	20°	15°	10°	5°	2°	0°	2°	5°	10°	15°	20°	25°	
1	4 OKTOBER 2023	DDM	0,254	0,258	0,260	0,252	0,305	0,154	0,001	-0,153	-0,299	-0,268	-0,273	-0,262	-0,258	Level pada C/L diukur di ujung landasan
		% SDM	40,15	40,12	40,07	40,16	41,3	41,36	41,14	40,93	40,59	39,86	39,84	40,32	39,86	
		LEVEL	-37,7	-37,2	-33,4	-33,4	-26,7	-54,2	-72,9	-54,4	-26,5	-30,8	-34,2	-37,1	-38,2	

- Ground Check dilaksanakan setiap 2 minggu sekali
- CW : Course WIDTH (satu sisi)
- C/L : Center Line

Mengetahui
MANAGER TEKNIK

DODY BUDHI SISWANTO

SEMARANG, 04 OKTOBER 2023
TEKNISI

RAHMAD AGENG P.

Fig. 4 Results of Ground Check for Localizer

2. Then, the technician measures the RF Level on the Nearfield input cable located above the Localizer equipment rack using the PIR. The measurement yields a result of -42.5 dB. This result indicates signal attenuation, as the previous measurement showed a result of -19.3 dB.

Fig. 5 Results of PIR Measurement on Nearfield Input Cable

3. Next, the technician measures the RF Level at the panel box behind the Localizer shelter and the Nearfield antenna using the PIR. The measurement yields a result of -8.9 dB from the Nearfield antenna.

Fig. 6 Results of PIR Measurement on Nearfield Antenna

4. Due to indications of signal attenuation received from the Nearfield antenna to the Localizer shelter, the technician checks the cable from the Nearfield antenna to the panel box behind the Localizer shelter. The steps taken are as follows:
   a. The technician removes the connector from the Nearfield antenna and the connector from the panel box behind the Localizer shelter. Then, they perform a continuity test on those connectors.
   b. The continuity test on the cable is performed by connecting the inner and outer at one end of the cable. During the test, the connector being measured is the one located behind the shelter, while the connector directly connected to the antenna is "shorted" by connecting its inner and outer parts.
   c. Turn on the Avometer and set the selector to the buzzer position, then attach one probe tip to the inner cable and the other probe tip to the outer connector. The condition of the cable being measured can be observed from the following indications:

1) If the cable is in "good" condition, when one end of the cable is shorted, the buzzer will sound, and when the short is removed, the buzzer will not sound.

2) If the cable is in a "short" condition, when the short at the end of the cable is removed, the buzzer will continue to sound.

3) If the cable is in a "broken" condition, when one end of the cable is shorted, the buzzer will not sound.

   d. In the field, the results from the check using the Avometer showed the outcome as in point c number two: when the short at one end of the cable was removed, the buzzer continued to sound, indicating that the cable is in a short condition. Therefore, it is necessary to replace the cable due to the old cable's condition, which is no longer suitable for use.

After investigation, it was found that the cable from the nearfield antenna to the panel box behind the localizer shelter was experiencing a short. Therefore, the technician addressed the issue with the following steps:

1. Before replacing the cable, the technician measured the length of the cable from the nearfield antenna to the panel box behind the localizer shelter using a surveyor's wheel. From this measurement, a length of approximately ±160 meters was obtained, which will be used as a reference for the replacement cable length.

Fig. 7 Results of Cable Length Measurement

2. Next, the excavation of the route and the laying of the new cable were carried out by the vendor. The new cable used is of the same type and specification as the one used previously, which is the Heliax LDF4-50A cable.

Fig. 8 Excavation and Cable Laying Work by Vendor

3. After the cable replacement, the technician installed N Type Male connectors on each end of the cable to connect the nearfield antenna and the panel box behind the localizer shelter.

Fig. 9 Installation of N Type Male Connectors

4. After the connectors were properly installed, the technician and the trainee conducted a recheck on the cable using an Avometer, with the result showing that the cable was not shorted. This was done to ensure that the cable to be reconnected to the nearfield antenna and the panel box was in good condition.
5. Then, the technician connects the connector to the Nearfield antenna and the panel box at the back of the Localizer shelter.

Fig. 10 Installation of Cable on Nearfield Antenna

6. After connecting the cables, the technician rechecks the monitor to ensure that values are now displayed on the monitor, which previously showed a value of 0.

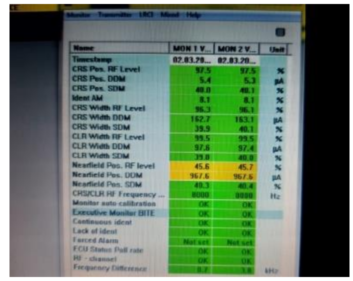


Fig. 11 Values on Monitor Before Calibration and Normalization

7. The values on the monitor have reappeared but are still not correct. Following the guidelines in the Localizer THALES 420 manual Part 1, page 5-15, the technician perform calibration and normalization on the control monitor in the Localizer shelter to adjust the reference parameters entered. The steps taken are as follows:
   a. Configure the equipment to "bypass" mode to prevent it from shutting down by selecting the "Commands" menu in the top left corner and then choosing "Set all BYPASS ON" on the remote PC.

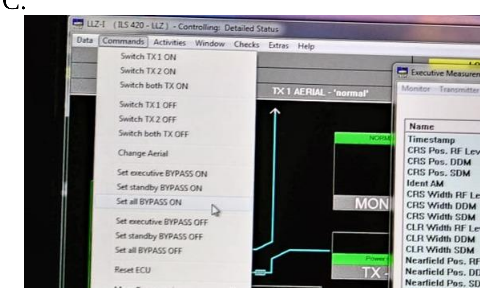


Fig. 12 Display on ADRACS Windows

   b. After enabling bypass on the local remote PC, click the “On Off” icon located at the bottom left to display the command window.

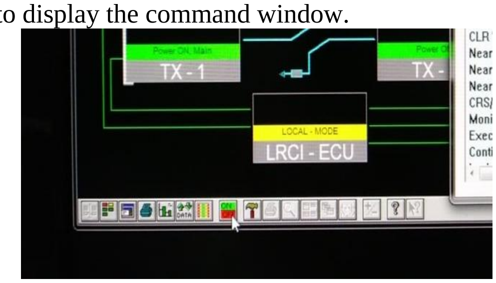


Fig. 13 Types of Toolbars in ADRACS Application

   c. Once the command window appears, select "LRCI," which will display two LRCI options. Then, choose "LRCI Miscellaneous."

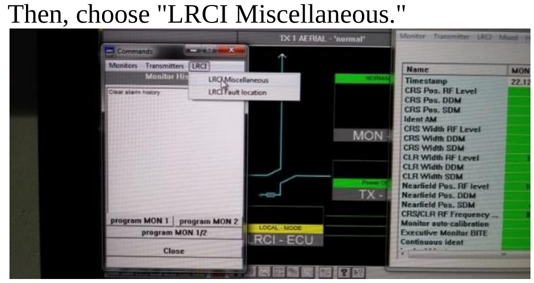


Fig. 14 Display of Windows Commands in ADRACS Application

d. Next, three options will appear, and click on "Automatic Calibration/Normalization".

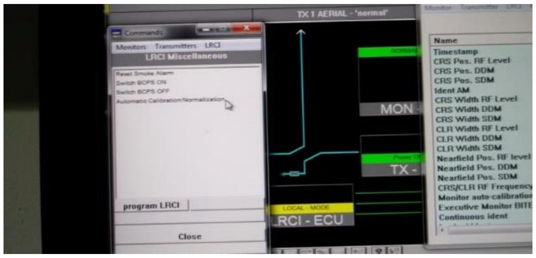


Fig. 15 Display of Menu in LRCI Miscellaneous

e. Then click "Calibrate" on Nearfield Pos Monitor one to perform the calibration. After the calibration process is complete, click "Normalize" on Nearfield Pos Monitor one to carry out the normalization. Once the calibration and normalization are finished, click the red cross at the top right corner of the Automatic Calibration and Normalization commands box.

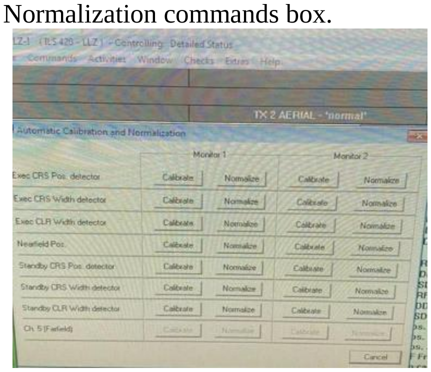


Fig. 16 Display of Menu in Automatic Calibration and Normalization

f. Turn off the bypass by clicking the "Commands" menu in the top left corner and then selecting "Set all BYPASS OFF".

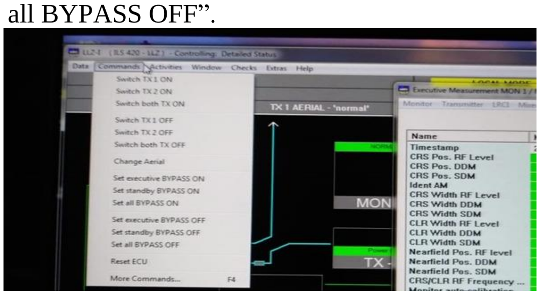


Fig. 17 Display on ADRACS Windows

8. After calibration and normalization have been completed, the red indicator (alarm) on the Nearfield Position monitor has changed back to green (normal). This indicates that the readings on the Nearfield Position monitor are now operating normally again.

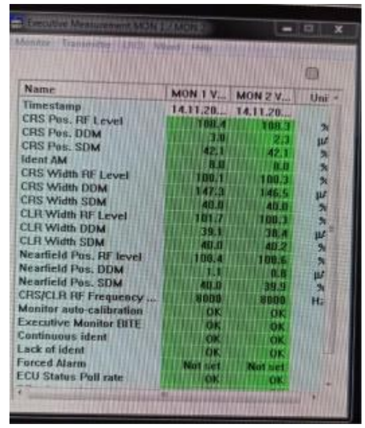


Fig. 18 Parameter Values on Monitor Return to Normal

C. *Evaluation*

The corrective maintenance activities conducted to address the alarm status of the Localizer monitor were systematic and thorough. The initial step involved using a Portable Instrument Landing System Receiver (PIR) to check the transmission from the Localizer Transmitter, which confirmed that the transmitter was functioning normally. This initial verification is crucial as it helps to rule out potential issues with the transmitter itself, allowing technicians to focus on downstream components. The subsequent measurements of RF levels indicated significant signal attenuation, prompting further investigation into the cable connections. This methodical approach ensured that all potential causes were explored before deciding on a solution.

Upon identifying that the cable from the Nearfield antenna to the panel box was shorted, the technicians proceeded with a well-defined plan for replacement. Measuring the cable length accurately and coordinating with a vendor for excavation and installation of a new Heliax LDF4-50A cable demonstrated effective project management and adherence to technical specifications. The installation of N Type Male connectors ensured compatibility and reliability in the connection points. Following installation, rechecking the cable condition using an Avometer confirmed that the new cable was functioning properly, which is essential for maintaining system integrity.

Finally, the calibration and normalization processes were executed according to the guidelines provided in the Localizer THALES 420 manual. This step was critical in ensuring that all parameters were correctly set after replacing the faulty cable. The successful transition of the monitor's alarm from red to green indicated that normal operations were restored. Overall, this corrective maintenance activity not only resolved the immediate issue but also reinforced best practices in monitoring, troubleshooting, and equipment management, thereby enhancing operational reliability in future scenarios.

IV. CONCLUSION

The study focuses on the Instrument Landing System (ILS), which is crucial for helping pilots land aircraft safely, especially in poor visibility conditions. The research specifically examines alarm issues in the Near Field Monitor of the ILS Thales 421 at AirNav Semarang Branch. These alarms can disrupt flight operations and affect pilot confidence, often caused by factors like damaged cables or environmental conditions. Understanding these issues is vital for ensuring the safety and efficiency of air traffic operations.

To address the alarm problems, a systematic approach was taken. This involved reviewing existing literature to understand the ILS and its components, followed by corrective maintenance to identify and fix the underlying issues. Technicians found that damaged cables were causing signal disruptions, leading to alarms. After replacing the faulty cables and ensuring proper connections, they retested the system to confirm that it was functioning correctly. If the problem is not resolved, it will result in no input on the monitor, causing the equipment to be continuously bypassed. This situation can hinder the device's ability to provide identification while in bypass mode.

The recommendation for this issue is to add cable protection along the cable route. This protection can take the form of iron pipes installed along the cable path to reduce the risk of damage from heavy vehicles passing over the cable. Additionally, it can protect the cables from soil erosion around the shelter and antennas caused by rainwater. The results of this research highlight the importance of effective maintenance and monitoring of ILS systems. By identifying the causes of alarms and implementing corrective actions, the study aims to improve the overall performance of air navigation systems. This not only resolves immediate technical problems but also enhances knowledge and best practices for operating these critical systems, ultimately contributing to safer air travel for everyone.

Acknowledgment

Thanks to AirNav Semarang Branch for their support and cooperation throughout this research on the Instrument Landing System (ILS). Special appreciation goes to the technicians who provided invaluable assistance during the investigation and corrective maintenance processes, ensuring that the alarm issues on the Near Field Monitor ILS Thales 421 were effectively addressed. Additionally, gratitude is extended to the contributors of the literature reviewed, which formed a solid foundation for understanding the complexities of ILS operations and maintenance. This research was made possible by the financial support received, enabling a thorough exploration of the challenges faced in air navigation systems.

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