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Analysis of False Alarms on DVOR Equipment at I Gusti Ngurah Rai International Airport

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ABSTRACT

According to the Government Regulation of the Republic of Indonesia No.71 of 1996 concerning Airports article 9 Paragraph (1) it is explained that flight navigation facilities can include Non Directional Beacons (NDB), Doppler VHF Omni Range (DVOR), Instrument Landing System (ILS), Radio Detection and Ranging (RADAR). Airports must provide navigation facilities, especially the Doppler VHF Omni Range (DVOR), which is a flight aid that has unlimited (continuous) capabilities, and transmits combined radio signals, including Morse code and data that can enable receiver equipment on aircraft to acquire magnetic bearings. from the station to the airplane using the frequency due to the doppler effect, not the actual azimuth direction to the aircraft but information about the Doppler VHF Omni Range (DVOR) ground station point at I Gusti Ngurah Rai Airport. This study used a qualitative descriptive method with physical checking at the Denpasar Branch of Perum LPPNPI, there was an alarm on the Doppler VHF Omni Range (DVOR) equipment caused by a lightning strike which could not be controlled using LMMS due to failure in several modules. So researchers need to replace several modules affected by the Alarm, namely the LCU (Local Control Unit), CSU (Control Sector Unit), and ASU (Air STARTER UNIT) and do the finishing by checking the power and settings on the monitor, resulting in a Doppler VHF Omni Range (DVOR) adjustment. back to normal.

Keywords: Doppler VHF Omni Range, False Alarm, Airport

INTRODUCTION

The increasingly advanced world of aviation requires researchers to create tools that minimize errors or usually called zero accidents. Punctuality is needed by technicians to reduce all risks of damage to equipment. A slight delay in handling equipment that experiences an alarm will result in damage that may be fatal.

Aviation safety is not only a business benefit, but a state of fulfillment of safety requirements in the use of airspace, aircraft, airports, air transportation, flight navigation and other supporting facilities and public facilities. This includes responsibility in fulfilling the guarantee of comfort, security, and safety of all passengers and workers in airport business entities.

One of the needs for air transportation operations is the fulfillment of Air Navigation requirements which is an activity to direct air transportation (in this case aircraft) from one place to

another so that it does not go out of its way safely and smoothly to avoid dangers or flight obstacles. Air navigation is carried out by two parties, namely *ground stations* and *aircraft* .

The agency that handles flight navigation in Indonesia is AirNav Indonesia. With the establishment of AirNav Indonesia, flight safety and navigation services can be carried out properly, causing a difference in the level of quality of navigation services and a lack of focus on flight navigation service providers. There are many air navigation equipment used in aviation, one of which is the *Doppler VHF Omnidirectional Range* (DVOR) device and *the Distance Measuring Equipment* (DME).

Doppler VHF Omnidirectional Range (DVOR) is a short-range navigation aid, which works using Very High Radio Frequency (VHF), the DVOR facility allows aircraft to reach their destination by utilizing DVOR stations on the ground regardless of weather conditions. DVOR plays an important role in flight safety and security, especially in guiding aircraft so that they can land perfectly at the intended airport. DVOR works on VHF frequencies from 108 to 117.95 MHz. If there is an alarm on the RCSU DVOR, it is very dangerous for flight safety. The presence of an alarm on the RCSU DVOR indicates a problem with the DVOR equipment itself, so it is necessary to carry out an analysis of handling or repairs to the DVOR equipment so that it can operate normally again and the realization of a good navigation system to ensure flight safety and security. The case study is located at the LPPNPI Denpasar branch.

LITERATURE REVIEW

Doppler VHF Omni-Directional Range (DVOR) is an air navigation device that functions to provide directional information to an aircraft towards an airport with a certain azimuth from 0 degrees to 360 degrees in the form of *a visual* display.

The working frequency area of the DVOR is 108 Mhz – 118 MHz. The system used in the DVOR is an antenna that seems to rotate horizontally with a fixed antenna located in the center of the antenna. An aircraft located at a certain distance will receive a change in frequency during rotation towards the aircraft and will experience a decrease in frequency when the antenna rotates away from the aircraft (Doppler Effect). DVOR has 48 sideband antennas on the edges and one carrier antenna placed in the middle. DVOR antennas in principle function to transmit a variable signal of 30 Hz modulated in FM and a reference signal of 30 Hz modulated in AM. DVOR uses a single antenna system that provides an omni-directional beam and 48 non-directional antennas placed around the central antenna in a 44 ft diameter circle that provides Doppler beams. The emission pattern of the DVOR is generated between the reference signal emitted by the carrier antenna and the variable signal emitted by the sideband antenna. A Very High Frequency Omnirange Station (VOR) is a type of short-range radio navigation system for aircraft, which allows an aircraft with a receiving unit to determine its position and stay on track by receiving radio signals emitted by a fixed-beacon terrestrial radio network. It uses frequencies in the very high frequency band (VHF) from 108.00 to 117.95 MHz.

Developed in the United States starting in 1937 and put into use in 1946, the VOR became the standard air navigation system in the world. Used in commercial and general aviation, until in the 21st century it was replaced by satellite navigation systems (GPS). Thus, VOR stations are gradually deactivated. In 2000 there were about 3000 VOR stations worldwide including 1,003 in the US, but in 2013 the number in the US was reduced to 967. The United States is decommissioning about half of the VOR and other legacy navigation aids as part of the move to performance-based navigation,

while still retaining the "Minimum Operational Network" of different VOR stations that can be used as a backup for GPS. In 2015, the United Kingdom planned to reduce the number of stations from 44 to 19 by 2020. VOR ground stations use a special antenna system to transmit amplitude-modulated and frequency-modulated signals. Both modulations are done with a 30 Hz signal, but the phases are different. The phase of one modulation signal depends on the direction of transmission, while the other phase of the modulation signal does not, to serve as a reference. The receiver will demodulate both signals and measure the phase difference. The phase difference indicates the bearing from the VOR station to the receiver relative to the magnetic north. This position line is called the "radial" VOR. The radial junction of two different VOR stations can be used to correct the position of the aircraft, as in the previous *Radio Direction Finding* (RDF) system.

METHOD

This type of research uses qualitative descriptive methods and physical checks. With the data collection technique using field observation, namely checking Ident using *HT airband* and it was found that Ident equipment did not come out on the DVOR DME monitor in the OB building that was disconnected. Then a direct check was carried out on the *airside* to further analyze the damage.

Observation observations were carried out by checking directly at the DVOR which is located, namely I Gusti Ngurah Rai International Airport, Tuban Village, Kuta District, Badung Regency, Bali, Indonesia. The work is carried out directly on the PLN panel and DVOR equipment after getting permission from the authorities.

RESULTS AND DISCUSSION

Based on the results of the analysis of the damage to the DVOR equipment work system due to lightning strikes at I Gusti Ngurah Rai Airport. The following is the solution to these problems, namely:

1) Technician Analyzes equipment that is problematic due to induction due to lightning strikes that cause *alarms* on DVOR equipment

Alarms on DVOR equipment
Source: Author's documentation, 2022

2) The technician checked the voltage from PLN, which is 220 VAC in the DVOR equipment panel.

Voltage check from PLN

Source: Author's documentation, 2022

3) Technicians check the voltage supply on the equipment, namely on the AC/DC1 (28VDC), AC/DC2 (28VDC), DC/DC1 (+5, +7, +15, -15, 27 VDC) and DC/DC (+5, +7, +15, -15, 28 VDC) modules. After checking, it turned out that all the voltage supply on the equipment was normal.

Voltage checking on AC/DC modules
Source: Author's documentation, 2022

+5 and +7 VDC voltage checks in DC/DC modules
Source: Author's documentation, 2022

+28 VDC voltage check on DC/DC modules
Source: Author's documentation, 2022

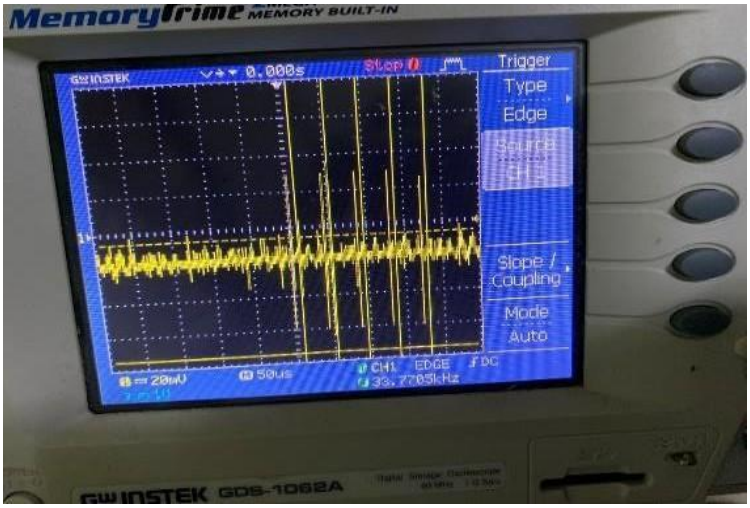
4) DVOR equipment cannot be controlled using LMMS. Here the technician analyzed that the DVOR equipment could not be controlled through the LMMS because there was a *failure* in the LCU module where this LCU module was directly connected as a communication *interface* with the LMMS and was the *Local Control Unit* of an equipment. Therefore, the LCU module was replaced.

LCU module replacement

Source: Author's documentation, 2022

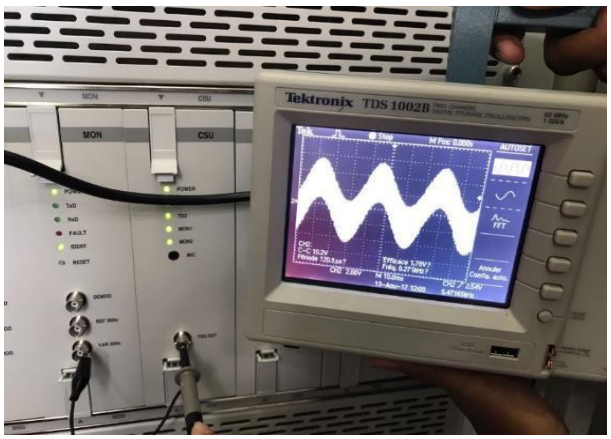
5) After replacing the LCU module, the technician tried to move the *transmitter* from TX2 to TX1 but could not.

The technician analyzed that *the transmitter* could not move from TX2 to TX1 due to a *failure* in the CSU module. After that, the CSU module was replaced, as a result the *changeover* could operate normally



***CSU composite signal* at the time of damage**

Source: Author's documentation, 2022



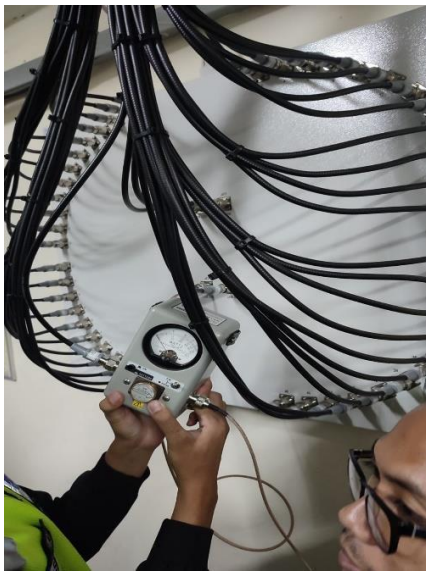
***CSU Composite Signal* at Normal Time**

Source: Author's documentation, 2022

Spare CSU modules that have been installed

Source: Author's documentation, 2022

6) In the LMMS DVOR there is an *alarm* on the *sideband* antenna, the technician checks each *output* on the ASU module that is directly connected to the *sideband antenna* using a wattage meter. As a result, there are some antennas where the power received is greater than the power emitted. Therefore, the ASU module was replaced.



Sideband antenna check

Source: Author's documentation, 2022

ASU module replacement Source: Author's documentation, 2022

7) On the LMMS monitor, there is still an alarm due to *the high power carrier*. So a *ground check was carried out*, the results of *the ground check* showed that the equipment was operating normally. The technician analyzed that it was necessary to set the monitor.

Ground check DVOR
Source: Author's documentation, 2022

GROUND CHECK DVOR

Tanggal Pelaksana : 24 Oktober 2022
: - I Ketut Edy P.
- Denny rachmad A.
- Eplevanny M. Presley
- Adellia Avianti K.
- OJT

PERUM LPPNPI CABANG DENPASAR
FREQUENCY : 116.2 MHz
DVOR MOPHIENS TYPE MARU 220

TRANSMITTER	PARAMETER	STANDARD	RADIAL			
			0°	90° (EAST)	180° (SOUTH)	248° (NEAR FIELD)
TX 1	Azimuth	(Sesuai Radial)	0	90	180	248
	AF (1020)	1020 Hz	1020	1020	1020	1020
	Deviasi (FM Index)	16.00 ± 1	16.6	16.7	16.6	16.5
	Modulasi 30 Hz AM	30% ± 2%	30.3	30	30.2	30.5
	Modulasi 9960	30% ± 2%	28.9	28.8	29.3	28.1
	Modulasi 1020	9% ± 2%	7.3	7.2	7.2	7.1
TX 2	Azimuth	(Sesuai Radial)	0	90	180	248
	AF (1020)	1020 Hz	1020	1020	1020	1020
	Deviasi (FM Index)	16.00 ± 1	16.5	16.7	16.6	16.6
	Modulasi 30 Hz AM	30% ± 2%	30.3	30	30.2	30.7
	Modulasi 9960	30% ± 2%	29	27.9	28	27.2
	Modulasi 1020	9% ± 2%	7.2	7.5	7.2	7.3

Denpasar, 24 Oktober 2022
Mengetahui,
PH.Manager Teknik

Febrini Mersy S.

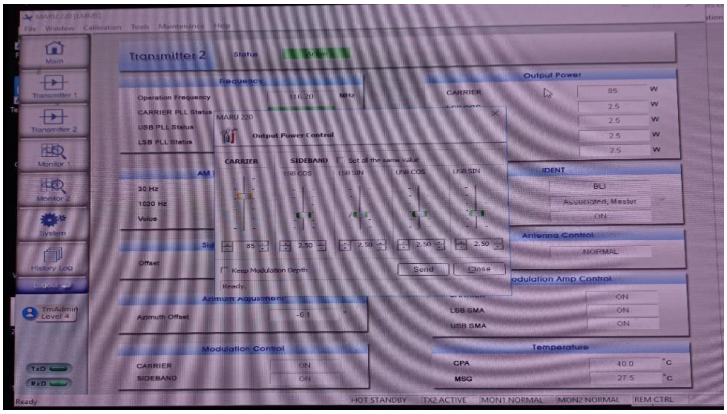
DVOR *ground check* results Source:
Author's documentation, 2022

8) The technique of checking *the power* on the carrier antenna and the results of the check showed that *the power* on the *carrier antenna* was normal. Power carrir tolerances range from 50-100 watts, and in power cerrier equipment 85 watts.

Check antenna power using a wattmeter

Source: Author's documentation, 2022

9) *The power* on the *carrier antenna* after checking the results is normal, here the technician analyzes that it is necessary to set *the transmitter* on the LMMS



Antenna power settings on the LMMS

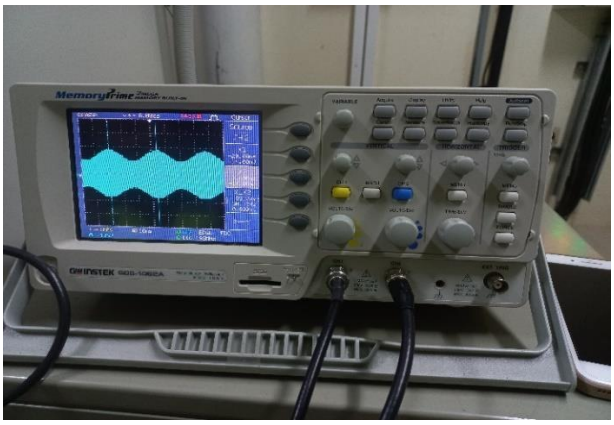
Source: Author's documentation, 2022

10) After checking *the power* and adjusting the settings on the monitor, the result was that the equipment functioned normally.

Normal display of DVOR equipment

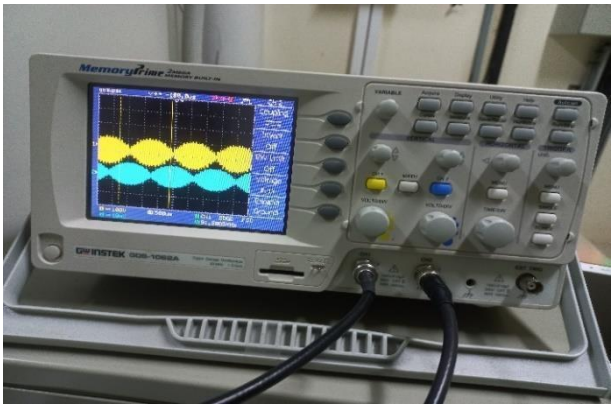
Source: Author's documentation, 2022

11) To ensure that the equipment is functioning properly, a signal check is carried out on the DVOR equipment.



Sinyal CAR FWD

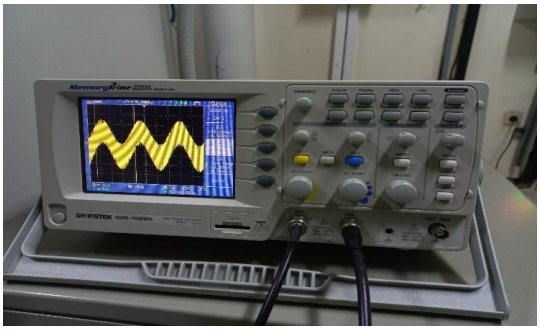
Source: Author's documentation



Sinyal *blending function*

Source: Author's documentation, 2022

***Composite* signals on the CSU when the**



equipment is normal

Source: Author's documentation, 2022

CONCLUSION

After carrying out OJT activities for approximately 5 (five) months, starting from September 5, 2022 – January 20, 2023. The author explained about the problem, the cause of the problem and the solution of the problem that occurred at Perum LPPNPI Denpasar Branch, namely the discovery of *an alarm* on DVOR equipment, it is known that the result is a lightning strike, the solution to this problem is the replacement of several modules that are *alarms* such as LCU, CSU and ASU modules. After the module change was carried out, the DVOR results function normally.

After the author solves the problem, the author gives the following suggestions:

a. It is recommended to carry out regular checks on DVOR and DME monitors in the BO Building to prevent alarms due to lightning strikes coming from radio link antennas connected to the equipment.
b. Lightning resistance checks are carried out during the rainy season and bad weather to minimize the possibility of damage.
c. A repair design is carried out by preparing *spare parts for* the DVOR module so that at the time of damage it can be overcome quickly and can return the DVOR in accordance with the provisions that have been set so as to increase the reliability of navigation equipment and airport operational activities can run normally.

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