Analysis of the Aircraft Guide Signal Interference in Mopah Airport

Roberto Corputty, R N Kaikatui, & Muriani

Department of Electrical Engineering, Faculty of Engineering, Musamus University, Jl. Kamizaun, Merauke, Indonesia

E-mail: roberto@unmus.ac.id

Abstract. Doppler Very High Omnidirectional Range (DVOR) is one of aviation navigation equipment which is in Mopah Airport which serves the best mamandu from and to the airport of destination. One recent years specifically the year 2018, there were complaints (criticism) of the pilot on beam interruption that caused it to equipment OBS (Omni-Bearing Selector) that there dipesawat not get an accurate azimuth as data information to the pilot could lead destination ground station where the airport is located. The method used is descriptive analysis method which describes the behavior of DVOR equipment, the environment around the equipment by using data that is processed by comparing the calculation parameters (antennas, transmit power, antenna gain, antenna sideband doppler effect, doppler effect) DVOR. The purpose of this research to know the influence of DVOR navigation equipment of the aircraft and determine the cause reception interference signals containing azimuth information to the pilot to find the destination airport. The result of the calculation parameters of the antenna with the speed of the sideband antenna 4147.7 feet per second to transmit power, gain and doppler effect that according to the standard equipment is the working frequency of 115.8 MHz to DVOR Mopah Airport so that the results obtained on the degree of 270-290 best get the signals radiated by the azimuth angle information is not accurate bearing caused by the emission of DVOR equipment obstructed by building new UPBU on Mopah Airport.

1. Introduction

One of the flight navigation equipment that is used at the airport for safety services known as navigation equipment Doppler Very High Omnidirectional Range (DVOR). DVOR as transmitter and flight navigation guides will transmit information is transmitted using the Doppler effect to the plane, will decrease the signal (loss) caused by a range of emission. By using the link budget calculation analysis using pathloss parameters and the attenuation of the Doppler effect with the plane object as a receiver, then when the approaching aircraft to the ground station DVOR the pathloss and the attenuation value becomes meaningless because the aircraft receives the greater frequency and stronger.[1]

Doppler Very High Omni-directional Range (DVOR) is a navigational aid that transmits signals flying form of radio waves received by the ground station and the aircraft, so pilots can determine the trajectory path and the azimuth angle relative to the destination airport. DVOR (Doppler Very High Frequency Omnidirectional Range) located in the south tower ATC (Air Traffic Control), west of the
runway in Mopah a navigation equipment which act as transmitters that will inform the azimuth angle and bearing to the aircraft as a receiver that works on the frequency 115.8 MHz. In the past year there were complaints from pilots and that houses the equipment, which to a certain degree when the aircraft will arrive at Mopah airport as the destination airport does not get the right information signal in the form of the azimuth angle of the aircraft receiver to the DVOR navigation equipment.

2. Literature review
Doppler Very High Frequency Omnidirectional Range (DVOR) is one of aviation navigation equipment that utilizes wireless communication as a medium of communication in line with the developments of radio technology applied to this equipment. The aircraft will receive information sent through the Doppler effect and will decrease the transmitted information signal DVOR caused by distance. By analyzing the link budget calculation using pathloss parameters and the attenuation of the Doppler effect with the plane object as a receiver, then the air when approached, will produce a change in pathloss and attenuation values are meaningless.[1]

The signals received by the aircraft in the form of azimuth bearing, obtained after the appointment azimuth DVOR performed during a modulation in the air because of the emission signal by sideband antennas and antenna reference and then be accepted by the receiver on the aircraft so that the aircraft can easily find out where to position DVOR. Signals such as azimuth information going through the process of identification that can be seen from blending the signal generated by the ground station by calculating the time difference between the sideband antenna beam with the other sideband antenna which is then converted into azimuth bearing as an information corner.[2]

Air navigation is to guide the activities are the air transport from one place to another to keep it out of the way. Signal transmission system on Doppler VHF Omnidirectional Range (DVOR) not optimum due to the percentage of the modulation signal is often increased which resulted in the emergence of over-modulated signal conditions. In Distance Measuring Equipment (DME) interrogation signal detection and signal reply experiencing barriers caused by distance pulses and the time delay that is not appropriate. This study will be conducted analysis of system performance naviagasi DVOR and DME equipment by comparing the normal condition and value parameters. Based on the analysis of system performance. [3]

3. Research methods

3.1 Literature Review
This method is used because to complete the data related to the research that is finding books, journals, and related materials regarding the device Doppler Very High Omni-directional Range (DVOR).

3.2 Study of Observation
In the process of this study, an observational study carried out by:
   a. Review the Field
   b. Measurement of the variables DVOR
Processing of data on the parameters of the Doppler Very High Omni-directional Range (DVOR).

3.3 Method of Analysis
The analytical method used is descriptive, which describes the behavior of the DVOR navigation equipment in the form of an omnidirectional radiance in the direction transmit Line Of Sight to the parameters of the navigation equipment Doppler Very High Omnidirectional Range (DVOR).

3.4 Research Variables
The parameters to be analyzed include: antennas, transmit power, antenna gain, antenna Sideband Doppler effect, and the Doppler effect.
3.5 Illustration Signal Beam DVOR

In Figure 1 Illustration DVOR Transmit Signals: Rx will emit signals modulated FM variables and reference signals modulated AM. Aircraft (Rx) which is located at a distance of 126 Km (70 nautical miles) will receive the frequency change during a round into the plane and experience a reduction in frequency when the velocity of the antenna (radiance) away from the air (the Doppler effect), in short the best will get the frequency change if the plane approached DVOR station located on land, and will lose with a transmission signal when away from the DVOR station to shore.

VOR frequency omnidirectional radio emits a signal and the signal provides information azimuth of 0 to 360 degrees. By choosing a VOR frequency (115.8 MHz) pilots would get direction / azimuth “TO” towards the VOR station or the “FROM” left / from the VOR station and fly right above where the VOR station, then the aircraft can not receive VOR signals for through ” cone of Silence “ (cone area without radio signal) and each have a VOR station identification code transmitted by Morse code.

4. Results and Discussion

4.1 Flight Check

Flight Check or calibration testing is conducted by officers flight inspector in the air to electronic equipment used for servicing air traffic, the calibration is done on penerlitian this is against aviation navigation equipment DVOR using a special aircraft that is best calibration of the type King Air B 200 GT PK-CAN.

| DVOR | DME | Azimuth Information |
|------|-----|---------------------|
| √    | √   | periodic inspection |
| Transmitter 2 | Transmitter 2 | Error (Tolerance ± 1°) |
| √    | -   | 50°, 20°            |
| √    | -   | 170°, 110°          |
| √    | -   | 270°                |
| √    | √   | Roughness (Error) 2.5° to 6.5° |
| √    | √   | Equipment classified as dangerous |

Points above have been presented that the navigation equipment DVOR ie the transmitter 2 (Tx2) experienced a technical issue that relates directly to the equipment transmitter 2 (Tx2) at DVOR that can not be used and can not be repaired in the short term because the component of the equipment does not sold in Merauke that takes reservations for the next component can be repaired.

In addition there is a point where presented that the navigation equipment for checking orbital DVOR / swivel area of the emission of radio waves discovered azimuth error out of tolerance, it was
because there is a high form of building 2-story building right next to the position DVOR navigation equipment. The building structure was established early in 2018 and operates today. The building is owned offices UPBU Mopah Airport with a height of about 10 meters and a width of about 60 meters and the building is ± 100 meters from DVOR navigation equipment. So that the emission of DVOR navigation equipment can be received by the receiver aircraft but with azimuth bearing inaccurate outside of tolerance, DVOR placement scheme can be seen in figure 2:

![Figure 2. placement DVOR](image)

In addition to data check flight 2018, below is a chart check flight data results in 2019 which took place on June 27, 2019.

![Figure 3. Check the Flight graph (calibration) DVOR 2019](image)

Information:
During the orbital checking, found azimuth (position / units of degrees) error out of tolerance. DVOR with azimuth that can not be used in radial (angle when the orbit / turning) as described below:

a. azimuth 270° up to 280° CCW (counter-clockwise) are error 2.0° - 2.2° out of tolerance (with a tolerance of ± 1 °)
b. azimuth 290° to 320° CCW (counter-clockwise) are error 2.0° - 1.5° out of tolerance (with a tolerance of ± 1 °)

From check flight data results above we can conclude such as data flight check check 2018. In 2019 flight level for the Restricted traffic is low because there is azimuth error, meaning that pilots get a signal on the degree but the azimuth position obtained is not accurate as the other degrees. This is because the emission DVOR hindered by the 2-story building located UPBU either side.

4.2 Ground Check
Testing ground (Ground Check) is a test that is done on the ground to the electronics and electrical equipment used for the flying air traffic services. In this study conducted a ground check is a ground
check of the navigation equipment DVOR. Ground check carried out on the equipment DVOR done every month and not based on the date. Data from the first ground check of the transmitter (Tx 1) and a second transmitter (Tx 2) is taken within a period of 4 months, starting in June 2019 until September 2019.

Table 2. Data Ground Check from June to September 2019

| No. | Month   | Information   |
|-----|---------|---------------|
| 1   | June    | In Tolerance  |
| 2   | July    | In Tolerance  |
| 3   | August  | In Tolerance  |
| 4   | September | In Tolerance |

Based on data from ground check conducted on DVOR equipment on land, there is no indication of damage to the equipment so that it is in conformity with the standards of the existing equipment in the user's manual DVOR equipment.

4.3 Analysis Calculation
From the data results of calculations performed using the link budget in navigation equipment DVOR, all the results of the calculations are in accordance with the standard value of the equipment that was supposed to navigation equipment that operates under normal conditions, there is no damage to the equipment both transmitter 1 and transmitter 2 so there is no excuse causes of signal interference from the DVOR equipment.

4.4 Descriptive Analysis
DVOR at Mopah Airport serves as a homing, meaning that navigation equipment is used to guide the aircraft flying toward the destination airport. Mopah Airport DVOR at work on VHF frequency 115.8 MHz, so when will enter the region of destination airport, pilots can obtain information such as the position of the aircraft manual form azimuth bearing by changing the DVOR mode on the receiver aircraft using the working frequencies in the 115.8 MHz.

DVOR equipment at Mopah Airport has an antenna height of approximately 4 meters above the ground with a radius of 6.71 meter antenna which is placed in Mopah Airport must meet the requirements of the placement criteria DVOR locations, based on the national standard criteria for placing Indonesia on the transmitter signal to all directions very high frequency (VHF omnidirectional Range). Height of buildings surrounding the antenna to the VOR is not an obstacle to the emission VOR. Within a radius of 100 meters from the center of the antenna must be free of objects grow and buildings, except buildings VOR (DVOR Placement Figure 4). Altitude grow objects and buildings is of a radius of 100 meters to 200 meters radius from the midpoint of the antenna and do not exceed the elevation of the field counterpoise. Then the height of the object grows and the building at a radius of 200 meters does not exceed the surface of the cone 2° as figure 4.[4]

![Figure 4. Building Height Limits Requirements and Growing Around Objects Tools VOR](image.png)

Source: Indonesia and BS SN National
Based on descriptive analysis above, DVOR navigation equipment must be free of buildings around the equipment in order to jet aircraft that will be accepted is not compromised.

Figure 5. The antenna emission Unobstructed Building

Figure 5 is a real picture of how the emission DVOR obstructed by buildings. In the above picture DVOR antenna has a height of 4 meters above the ground, then high building 10 meters from the ground and has a width of 60 meters with ± 100 meters distance from the antenna DVOR so at 270-290 degrees beam wave can not be efficient up to the aircraft. Because based on the Indonesian National Standard (SNI) issued by the National Standardization Agency (BSN) in 2004 on the criteria for the placement of the transmitter signal in all directions certain frequency is very high VHF Omnidirectional Range found within a radius of 100 meters from the center of the antenna is free of objects grow and buildings, except buildings VOR .[4]

5. Conclusion
Based on technical analysis, check flight data analysis, data analysis using formulas, data analysis results, a ground check, descriptive analysis and SNI criteria DVOR equipment placement can be concluded as follows:
1. DVOR navigation equipment is very influential in flight navigation services, as pilots require azimuth bearing information to be able to guide the plane to the destination airport.
2. Check flight from 2018 and 2019 indicated check flight are errors on the degree azimuth of 270° - 290° with a value of up to 6.5° error caused by the building maintenance and new TX2 UPBU is built adjacent to AMS 1150 DVOR navigation equipment so that jets disrupted.
3. Antenna parameter calculation results with speed sideband antenna 4147.7 feet per second, with transmit power, gain, and the Doppler effect in accordance with the standards DVOR equipment working at a frequency of 115.8 MHz and a data field, a ground check, that the equipment is operating normally according DVOR standard equipment and there is no indication of damage to the equipment.
4. Based on flight data comparison check with the calculation data showed interference with the surrounding environment, namely DVOR UPBU 2-story building that was built ± 100 meters to the west of DVOR.

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