

Analysis of IAS Disagree Indicator Problems on ATR 72-600 using Fault Tree Analysis (FTA) Method

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The IAS Disagree system on the ATR 72-600 aircraft is a critical indicator that detects the difference in speed between the pilot's and copilot's sides. This study aims to identify and analyze the root causes of IAS Disagree indications using the Fault Tree Analysis (FTA) method. The research data was obtained from pilot reports and maintenance reports collected from Batam Aero Technic (E-MRO) servers over a period of two years and six months, namely from January 2023 to July 2025. The research sample consisted of 80 ATR 72-600 aircraft grouped by aircraft age, namely aircraft more than ten years old and less than ten years old. The FTA method is used to identify failure paths from basic events to top events through qualitative and quantitative analysis approaches. The results showed that of the 45 IAS Disagree incidents recorded, 31 occurred in aircraft more than ten years old with a probability of 0.69 or 69%. The FTA analysis identified six basic events as the root causes, with the pitot component having the highest contribution of 0.64 and the water computer data of 0.35. The baseline event with the highest probability is pitot debris blockage of 0.38, indicating that blockage by debris is the greatest risk factor. The probability of a top event occurring reaches 0.99, indicating a very high probability of failure without adequate precautions. This study recommends increasing the frequency of inspection of pitot components, strengthening preventive maintenance programs on older aircraft, and implementing digital-based documentation systems to improve system reliability and flight safety.

Keywords: IAS Disagree, ATR 72-600, Fault Tree Analysis, pitot system, aviation safety

I. INTRODUCTION

The mode of air transportation using airplanes has a popularity that has never decreased along with the need for people to travel long distances in a short time. The low risk of accidents and the comfort of traveling are the main supporting factors for the general public to choose air transportation. One of the aircraft that is widely used in commercial aviation is the ATR 72-600. Modern commercial aircraft such as the ATR 72-600 are equipped with several redundant *airspeed* sensors, including *pitot-static systems* and *air data computers* (ADCs) [1]. These sensors are supposed to provide accurate and consistent speed data to support flight safety. However, in operation, there is a phenomenon of data disagreement between one sensor and another known as "*Airspeed Disagree*".

The issue of *airspeed* data mismatch is becoming increasingly relevant in the digital aviation era, where the automation of aviation systems relies heavily on accurate

sensor input [2]. When sensors provide incorrect or out of sync data, pilots are faced with the great challenge of taking over manual control and interpreting the situation quickly in high-pressure conditions. The *Airspeed Disagree* phenomenon can have serious consequences for flight safety if not handled appropriately. Therefore, it is important to study this phenomenon more deeply, both from a technical perspective such as system design, sensors, and redundancy, as well as from an operational perspective that includes pilot actions, training, and *standard operating procedures* (SOPs), to safety regulations implemented by aviation authority bodies such as the FAA and EASA.

This study aims to identify and understand the components and *airspeed* measurement systems on the ATR 72-600 aircraft, including *pitot* tubes, *static* ports, and *Air Data Computer* (ADC) [3]. In addition, this study also analyzes the potential causes of *Air Speed Disagree* conditions based on technical data, literature studies, and operational scenarios. To achieve this goal, this study builds a *Fault Tree Analysis* (FTA) model to identify the *root causes* and failure pathways that can cause *Air Speed Disagree* [4]. The FTA method was chosen because of its ability to analyze system failures in a systematic and structured manner, so that it can provide a comprehensive overview of the factors that contribute to the problem of *IAS Disagree* indicators.

The scope of this study was limited to ATR 72-600 aircraft, with aircraft samples grouped based on aircraft age, namely aircraft more than ten years old and less than ten years old. The data used in this study is in the form of *pilot reports* and *maintenance reports* obtained from the Batam Aero Technic (E-MRO) server. Data collection was carried out on the report in the last three years, namely from 2023 to 2025. The analysis was carried out on the *Air Speed Disagree* indicator, not on the entire *Air Data System* as a whole. The approach used is *Fault Tree Analysis* (FTA), which does not involve in-depth quantitative analysis such as the numerical probability of components unless data is available.

The academic benefits of this research are expected to add to the scientific treasures in the field of aviation engineering, especially in avionics system analysis and *reliability analysis* [5]. This research can also be a scientific reference for students, lecturers, and researchers who are interested in the topic of aviation safety and

decision support systems based on failure *analysis*. The application of the *Fault Tree Analysis* (FTA) method in the real context of aviation systems can be used as a practical case study in learning systems engineering and risk management [6]. Practically, this study provides a comprehensive overview of the potential causes of *Air Speed Disagree* on ATR 72-600 aircraft, so that it can be an input for aircraft maintenance technicians (AMTs), *flight safety* officers, and *engineers*.

The contribution of this research to the aviation industry is that the results of the analysis can be used as a basis for improving inspection, *troubleshooting*, and risk mitigation procedures in *pitot-static* and ADC systems [7], [8]. In addition, this research can be used by regulators such as the Directorate of Airworthiness and Aircraft Operations (DKPPU), FAA, or EASA as material for system evaluation and safety recommendations. This research supports efforts to improve aviation safety with a proactive approach to data-based system failures, analysis, and risk structure. Thus, this research is expected to make a significant contribution in improving the reliability of air speed measurement systems on modern commercial aircraft and supporting better decision-making in aviation safety management.

II. METHOD

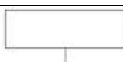
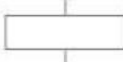
Research Design

This study uses the *Fault Tree Analysis* (FTA) method as the main approach to identify the root of the *IAS Disagree* problem in ATR 72-600 aircraft. *Fault Tree Analysis* (FTA) is a method or technique used to find the root cause of a failure and is one of the tools in risk management [4]. This method works by looking for a problem that occurs to deal with system failure. The purpose of this method is to determine the causative factors that are most likely to cause failures and investigate a failure systematically. The *fault tree analysis method* is based on logical diagrams, revealing the relationship between *basic events* and *top events* through *logic gates* and is able to provide quantitative and qualitative analysis of system failures.

Symbol Fault Tree Analysis

In the application of the FTA method, there are standard symbols that are used to represent different types of events and logical relationships in the error tree diagram. These symbols can be seen in the following Table 1:

Tabel 1. Simbol Fault Tree Analysis

Symbols	Remarks
	Top event
	Intermediate event
	Undeveloped event

	Basic event
	Logic event AND

Research Location and Time

This research was conducted at Batam Aero Technic which is located at the Airport (Airport). The selection of the research location was based on the availability of the research object, namely the ATR 72-600 aircraft operating at the location, making it easier for the author to take the necessary data samples. Data collection is carried out on *pilot reports* and *maintenance reports* in the last three years, namely from 2023 to 2025. Data was obtained from the Batam Aero Technic (E-MRO) server which documented all maintenance activities and aircraft problem reports.

Research Object

The object of research in this study is the ATR 72-600 aircraft, specifically the airspeed measurement system (*airspeed*) which consists of the *pitot tube*, *static port*, and *Air Data Computer* (ADC) [3]. Aircraft samples are grouped based on aircraft age, i.e. aircraft are more than ten years old and less than ten years old. This grouping is carried out to identify whether there are differences in failure patterns based on the operational age of the aircraft. This research focuses on the analysis of indicators *Air Speed Disagree*, not against the entire system *Air Data System* thoroughly.

Data Sources and Data Collection Techniques

The data used in this study is secondary data obtained from two main sources, namely *literature study* and aircraft operational data. Data collection techniques are carried out in several ways as follows:

Literature Study

Collection and study of literature related to the problems studied based on aircraft technical documents, namely:

1. The ATR 72-600 Training Manual, is used to learn how the speed indication works on the ATR 72-600 aircraft as well as the operational principles of the *data water* system.
2. The *Aircraft Maintenance Manual* (AMM) [7], contains procedures used in aircraft maintenance according to *manufacturer's* standards and serves as a reference for inspecting and repairing airspeed system components.
3. The *Troubleshooting Manual* (TSM), contains steps in troubleshooting that occurs on aircraft, especially related to the *IAS Disagree* problem.

4. *Illustrated Part Catalog* (IPC), contains the *part number* of components needed in the air velocity measurement system and the reference of replacement components.

Operational Data

Operational data collection was carried out to support analysis in the form of aircraft problem data obtained from the Batam Aero Technic (E-MRO) server. The data is in the form of *troubleshooting* and problems documented from pilot reports (*pilot report*) or from the current report *maintenance* (*maintenance report*) about the indications *IAS Disagree* on ATR 72-600 aircraft. This research is also based on facts that occur in the field or *line maintenance* at the time *flight crew report*. This means that the object of research cannot be forced as the researcher wills, but based on actual events documented in the reporting system.

Data Processing Techniques

After the collection of data related to *IAS Disagree*, data processing is carried out according to references *Aircraft Maintenance Manual* (AMM) [7], *Troubleshooting Manual* (TSM), and *Illustrated Part Catalog* (IPC) on *IAS Disagree*. Data processing is carried out by classifying the types of failures based on the components involved, the frequency of events, and corrective actions that have been taken. The data is then compiled systematically to facilitate the analysis process using the FTA method. All collected data is verified with technical documents to ensure the accuracy and validity of the information before further analysis is carried out.

Data Analysis Techniques

From the results of data collection and processing, the causes *IAS Disagree* can be found by using the *Fault Tree Analysis* (FTA) [4]. The analysis was carried out in the following stages:

1. Determine *the top event*, namely *the IAS Disagree event* that is the focus of the analysis.
2. Identify *intermediate events* or intermediate events that contribute to the occurrence of *top events*.
3. Identify *the basic events* that are the root cause of each *intermediate event*.
4. Linking each event using *logic gates* (AND or OR) according to the causal relationship between events.
5. Compile a complete FTA diagram that illustrates the entire failure path that can lead to *IAS Disagree*.

From this method, it will be obtained *root cause analysis* So which components often cause the indicator *IAS Disagree* light can be known. The results of this analysis are expected to be used to minimize the incidence *IAS Disagree* in the future to improve safety in the flight of the ATR 72-600 aircraft.

Research Flow

Based on the stages of the research method described above, the overall research flow can be outlined in the form of a flowchart as follows:

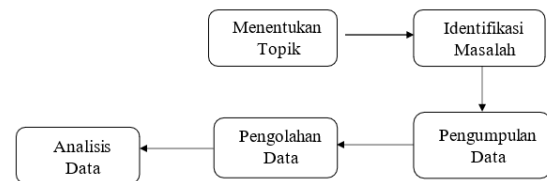


Figure 1. Research Flow Diagram

The research flow diagram shows the systematic stages that start from the determination of research topics based on events in the field, which often occur *IAS Disagree* on the ATR 72-600 aircraft, identify the problem through *literature study* and observation, data collection from the E-MRO server, data processing based on technical manuals, data analysis using the FTA method, to drawing conclusions and recommendations.

III. RESULTS AND DISCUSSION

Description of *IAS Disagree* System on ATR 72-600 Aircraft

The *IAS Disagree system* on the ATR 72-600 is a critical component in the aircraft's flight control system, particularly in relation to speed indications. The system is designed to detect significant speed differences between the speed indications on the pilot and copilot sides. An *illuminated IAS Disagree* indication is an important warning indicating a mismatch of velocity data between the two measurement systems [1]. The *maintenance design* for this system is designed to ensure the reliability, safety, and optimal performance of all related components. Maintenance design is the process of designing and determining procedures and maintenance methods for a system or equipment to keep it functioning optimally throughout its life cycle.

Determination of maintenance frequency is a critical step in *maintenance design* that aims to ensure that *the IAS Disagree system* remains optimally and safely functioning. The frequency of maintenance is determined based on the manufacturer's recommendations contained in documents such as *the Maintenance Planning Document* (MPD). Aircraft operators take recommendations from the factory and adapt them to their own operating conditions, which involve considerations such as flight routes, the intensity of aircraft use, and the environmental conditions in which the aircraft operates. This maintenance program is then implemented by trained maintenance technicians with maintenance frequencies described in units of time such as *flight hours* (FH) or *flight cycles* (FC).

Maintenance procedures are the steps that must be followed to maintain and ensure that the aircraft system functions properly and safely. This procedure must be carried out based on the aircraft manual issued by the aircraft manufacturer or manufacturer [7]. Aircraft

manuals that are the basis for carrying out maintenance procedures include the *Aircraft Maintenance Manual* (AMM), *Troubleshooting Manual* (TSM), *Illustrated Part Catalogue* (IPC), and other manuals. Maintenance documentation is the process of compiling and maintaining a comprehensive record of all maintenance activities performed on an aircraft, which aims to help ensure that all activities are carried out according to procedures that contribute to the reliability and safety of the aircraft. By implementing a comprehensive and structured maintenance design, the ATR 72-600 operator can ensure that the indication system remains in optimal function, minimizing the risk of failure, and maintaining a high level of safety.

Identify the Components That Cause IAS Disagree

Based on the *Troubleshooting Manual* (TSM), the *IAS Disagree* issue occurs due to several possible causes. In this study, several main causes can be identified based on data from pilot reports and *maintenance records* collected. The first identification of the cause of *IAS Disagree* ignition came from the *pitot component* [1]. *Pitot* is a critical component that functions to measure dynamic air pressure which is then used by *air data computers* to display speed indications on aircraft. Damage or contamination of the *pitot* can lead to inaccurate air pressure readings, which in turn can trigger an *indication of IAS Disagree*.



Figure 1. IAS Disagree Indicator Illuminated

Source: Personal Documentation

Damage that often occurs in the *pitot* is the *pitot resistance out of range* or *resistance values* that are not in accordance with specifications (48 ± 8 Ohm), so that the *heater* does not function properly and can cause *icing* in the *pitot* when the aircraft is flying [9]. Another damage is *pitot leakage* which causes a loss of *pressure* that will be sent to the *computer data water* [8]. If this happens, the *pitot* must be replaced so that it can resume its function when the aircraft is in a flying condition. In addition, *pitot* can also occur due to contamination or *debris*, usually insects [10]. If this happens, then the *pitot* must be flushed.

The second identification of the cause of the *IAS Disagree* ignition came from the *computer data water* component. The *air data computer* is the brain of the *IAS Disagree* system, responsible for processing the inputs and displaying them on the *primary flight display* indicators [3]. Failure of this component may directly affect the *primary flight display* indication. Failures that occur can

be caused by damage to the *electrical connector* circuit, unstable electrical voltage or power surges, inaccurate readings of sensors connected to the *computer's data water*, and also leakage in the *computer's data water* itself.

An *illuminated IAS Disagree* indication indicates a significant indication difference between the speed of the pilot and copilot systems. This condition can have an impact on aircraft operations both directly and indirectly [2]. The direct impact is the disruption of flight comfort and control, where the difference in speed can cause the loss of the *auto pilot* system, thereby interfering with flight comfort and control. In extreme cases, large speed differences can significantly interfere with the functioning of the control system, potentially compromising the stability and flight control of the aircraft. The indirect impact is that if this *IAS Disagree* problem occurs, it can cause delays or even flight cancellations for safety reasons, as well as increase the cost of maintenance and repair of the aircraft.

IAS Disagree Incident Data Analysis

Based on data from the Batam Aero Technic (E-MRO) server for two years and six months, starting from January 2023 to July 2025, it was found that *IAS Disagree* incidents often occur. The data collected is grouped based on the age of the aircraft, i.e. aircraft are more than ten years old and aircraft are less than ten years old. From the data collected from 80 aircraft, 45 incidents of *IAS Disagree* were recorded. Of these, 31 incidents occurred on aircraft with a life of more than ten years, while 14 incidents occurred on aircraft with a life of less than ten years.

No	Aircraft age	Number of events	Probability	Percentage
1	More than 10 years	31	0.69	69%
2	Less than 10 years	14	0.31	31%

Table 1. Probability and Percentage of IAS Disagree Occurrence

Based on the frequency of this incident, it can be seen that *IAS Disagree* is more common in aircraft that are more than ten years old with a percentage of 69%. This suggests that the age factor of the aircraft has an influence on the incidence rate of *IAS Disagree*, likely due to the degradation of components over operational time.



Figure 2. Percentage Chart of IAS Disagree Occurrence in Two Years and Six Months

IAS Disagree events are also grouped by component that causes the indication to ignite. The top three causes of IAS Disagree indications come from *electrical bad contact*, *pitot line block*, and *pitot heating*. From the analysis of this data, it can be identified that problems in the *pitot* system are the main contributors to the occurrence of IAS Disagree.

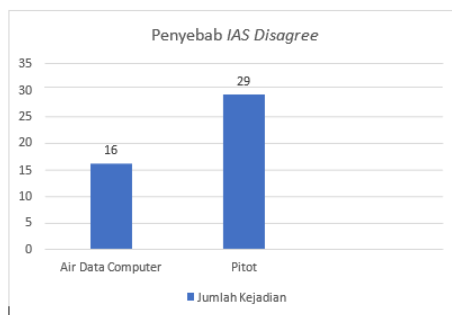


Figure 3. Causes of IAS Disagree

Analysis Using the Fault Tree Analysis (FTA) Method

FTA Diagram Construction

To identify the underlying causes of the ignition of IAS Disagree indications, the analysis was carried out using the *Fault Tree Analysis* (FTA) method [4]. FTA is a deductive analysis technique that focuses on a single undesirable event called a *top event*, and then determines all the ways in the system that can cause that *top event* to occur. The *top event* determined in the FTA analysis is the indication that IAS Disagree is on, a crucial issue that has the potential to affect flight performance and safety.

After determining the *top events*, the direct causes (*intermediate events*) are identified based on the results of data collection that has been carried out. Each of these direct causes is then further analyzed to find the underlying causes (*basic events*). Problems with *pitot* are caused by three basic events, namely *pitot resistance out of range*, *pitot debris blockage*, and *pitot leakage* [8]. For problems with *air data computers*, it is caused by three basic events, namely *electrical connector problems*, *electrical source problems*, and *air data computer leakage* [3].

Based on the constructed FTA diagram, the "OR" logic gate is used to connect the direct cause to the *top event*, as each direct cause can cause the occurrence of the *top event*

independently [4]. This means that the occurrence of one of the direct causes (*pitot* problem or *water problem data computer*) is enough to trigger an indication of IAS Disagree.

FTA Qualitative Analysis

The analysis was carried out with a qualitative approach, namely by converting the *logical gate* in the system failure tree model into a *cut set* [4]. One of the main steps is to identify the *minimum cut sets*, which are the smallest combinations of underlying causes that if they occur, will cause a *top event*. The *minimum cut sets* for this IAS Disagree issue are outlined as follows:

$$\text{Top Event (A)} = B + C = (B_1 + B_2 + B_3) + (C_1 + C_2 + C_3) = B_1 + B_2 + B_3 + C_1 + C_2 + C_3$$

From the results of the *minimum cut set*, it can be concluded that there are six *basic events* that can cause *top events*. The following is an explanation of each *basic event* that can cause IAS Disagree issues:

- Code B1 – Pitot Resistance Out of Range:** A condition where the *resistance* value is not up to specification (48 ± 8 Ohms), so the *heater* does not function properly and can cause *icing* in the *pitot* when the aircraft is flying [9].
- Code B2 – Pitot Debris Blockage:** A condition in which the ducts in the *pitot* are blocked by dust, insects, and other foreign objects, which inhibits the air pressure that should be delivered to the *computer data water* [10].
- Code B3 – Pitot Leakage:** The condition of a leak in the *pitot* that causes a loss of air pressure that should be sent to the *computer data water* [8].
- Code C1 – Electrical Connector Problem:** A condition where a problem occurs in the electrical connector that inhibits the flow of electricity that should be properly channeled to the related components.
- Code C2 – Electrical Source Problem:** A condition where a problem occurs in the power source that results in the absence of the electric current needed to operate the *computer's data water*.
- Code C3 – Air Data Computer Leakage:** The condition of a leak in the *computer data water* that causes a malfunction in this component [3].

FTA Quantitative Analysis

The analysis is carried out with a quantitative approach, namely by directly calculating the *top event* probability based on the probability of *basic events*. In the *Fault Tree Analysis* (FTA) analysis of the IAS Disagree system, the approach used is *quantitative stochastic* [4]. Based on the data that has been collected over the past two years and six months, the number of events and the probabilities of each base event have been calculated and grouped.

Discussion

The results of the analysis carried out on the *IAS Disagree* system on the ATR 72-600 aircraft using the *Fault Tree Analysis* (FTA) method succeeded in identifying the paths of failure in the system, starting from basic events to top events) [4]. Quantitative analysis conducted by calculating the probabilities of each direct cause and baseline event based on data collected over two years and six months showed significant results.

From the analysis calculations, it was found that the problem with the *Air Data Computer* has a probability of 0.35. This suggests that problems with these electronic components, especially related to electrical connector problems, power sources, and leaks in the *Air Data Computer*, are factors that contribute to the *IAS Disagree* system failure [3]. On the other hand, the problem in *Pitot* has the highest contribution with a probability value of 0.64. The main causes in this category are *pitot resistance* that is beyond the specification value, blockage by *debris*, and leakage in the *pitot* [8]. This probability value is higher than the problem with the *Air Data Computer*, indicating that *pitot* components are an area that requires special attention in the maintenance program.

The results of the calculation of the base event show that the highest probability value is the problem in the *Pitot Debris Blockage* (B2) with a value of 0.38, which means that the problem of clogging by *debris* is the biggest risk factor in this system [10]. This can be caused by the aircraft's operational environmental factors that allow the entry of foreign objects such as insects or dust particles into the *pitot system*. On the other hand, the baseline event with the lowest probability is *Pitot Leakage* (B3) with a value of 0.04, indicating that although this problem exists, its contribution to overall system failure is relatively small [8].

From the results of this analysis, it can be concluded that the main priority in risk mitigation should be given to the components with the highest probability of failure, especially in the *pitot* [2]. Steps that can be taken include quality improvement and routine inspections of the cleanliness and integrity of the *pitot* to avoid blockages and leaks that can interfere with the function of the airspeed indicator. The implementation of stricter *pre-flight inspection* procedures, especially visual inspections and periodic *flushing* of the *pitot system*, can reduce the probability of *debris blockage* [10].

Overall, from the results of this quantitative calculation, the probability of the occurrence of the peak occurrence of *IAS Disagree* is 0.99. This suggests that under current conditions, in the absence of further precautions or improvements, the failure of this system has a very high probability of occurring. This interpretation emphasizes the importance of developing a comprehensive risk mitigation strategy to lower the probability of the most dominant baseline events [4]. Thus, repair and preventive measures can be focused on the components that have the greatest impact on the safety and reliability of the system.

In a practical context, the results of this study suggest that preventive maintenance programs should be strengthened, particularly in aircraft with an operational

life of more than ten years that exhibit a higher incidence rate of *IAS Disagree* (69%) [5]. This indicates that component degradation over operational time is a factor that needs to be considered in the preparation of maintenance schedules. A thorough and planned maintenance approach is essential to ensure that all system components are working optimally and can prevent failures that could jeopardize flight safety [7].

This discussion not only provides a comprehensive interpretation of the results of the quantitative analysis that has been carried out, but also leads to the development of practical steps that can be taken to improve the reliability of the airspeed indicator system on the ATR 72-600 aircraft. The implementation of the recommendations from this study is expected to reduce the frequency of *IAS Disagree* incidents and improve overall aviation safety.

IV. CONCLUSIONS AND SUGGESTIONS

Based on the results of the research and discussion of the analysis of the *IAS Disagree* indicator problem on the ATR 72-600 aircraft using the *Fault Tree Analysis* (FTA) method, it can be concluded that the *IAS Disagree system* is a critical component that requires special attention in the aircraft maintenance program. From the data collected over two years and six months from 80 aircraft, there were 45 incidents of *IAS Disagree* with a distribution of 31 incidents in aircraft more than ten years old and 14 incidents in aircraft less than ten years old. This shows that the age factor of the aircraft has a significant influence on the incidence rate of *IAS Disagree* with a probability of 0.69 or 69% occurring in older aircraft.

The analysis using the FTA method succeeded in identifying six basic events that are the root causes of *IAS Disagree*, namely *pitot out of range resistance*, *pitot debris blockage*, *pitot leakage*, *electrical connector problem*, *electrical source problem*, and *air data computer leakage*. From the quantitative analysis, the *pitot* component has the highest contribution with a probability of 0.64, while the *water data computer* has a probability of 0.35. The baseline event with the highest probability is *pitot debris blockage* of 0.38, which indicates that blockage by *debris* is the greatest risk factor in this system. The probability of the occurrence of a top event of *IAS Disagree* reaches 0.99, indicating that without adequate precautions, a system failure has a very high probability of occurring. Therefore, a comprehensive risk mitigation strategy and a strengthened preventive maintenance program are needed to improve system reliability and flight safety.

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