Analysis of Causes Damage in Flight Compartment Windows Due to Heating System Failure in Boeing 737-800 Airport Using Weibull Analysis Distribution

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Abstract, An aircraft is a means of transportation used to transport people or cargo from one place to another with a shorter travel time than using land and sea transportation modes. The relatively short travel time and affordable ticket prices make this mode of transportation increasingly desirable by people who want to travel from one place to another with the distance to many days if using land and sea transportation modes.The window on the airplane was installed in order to enable the crew (captain and first officer) to see the conditions outside the aircraft that support the aircraft control process. Windows must be designed as strong and lightweight as the window in the cabin. Windows must withstand the pressure generated by the pressurized cabin. The pressurized cabin is very important for aircraft flying at altitudes of more than 10,000 feet because it will affect the comfort of passengers during the flight. Additional requirements that must be possessed by the windows are that they must be able to provide clear vision to pilots in certain natural conditions such as rain, must be able to be opened so that it can be a way out for the crew during an emergency, and be able to withstand bird strikes so that flight safety and security can reached.From the results of the calculation of the analysis by the method of Weibull Flight Compartment Windows components on Boeing 737-800 aircraft, it is known that the best maintenance effectiveness for Windows Flight Compartment components is gradual degradation with a value (β)> 1,0 (1,305) is a type of wear out (wear out) . While the resulting b value is 0.766. In accordance with the provisions that for b = 0,1 (probability 0,1%) is categorized as a serious failure, so special attention needs to be paid to the Flight Compartment Windows component.

1. Introduction

An airplane is a means of transportation used to transport people or goods from one place to another with a shorter travel time than using land and sea transportation modes. The relatively short travel time and affordable ticket prices make this mode of transportation increasingly desirable by people who want to travel from one place to another with the distance to many days if using land and sea transportation modes. The aviation industry is an industry that has the most advanced technology and is one of the pioneering industries in technological development. Most of the technology applied in the transportation industry stems from the aviation industry. Thus, the aviation industry is an industry that is very important to be

developed by a country. Indonesia as a country already has experience in the aviation industry. The experience will certainly be better if it continues to be developed in order to bring the aviation industry in Indonesia to a better direction. Indonesia must be able to stimulate the emergence of aviation industries in the country so that Indonesia does not need to depend on foreign parties in terms of technology. Aviation industries that have the potential to be developed in Indonesia are the aircraft manufacturing industry, the air transportation industry, the aircraft support parts industry, and the Maintenance, Repair and Overhaul (MRO) industry.

The window on the aircraft is set up so that passengers can see the situation outside the cabin. Visual access to conditions outside the cabin is also one of the requirements that must be met by aircraft manufacturing companies as part of airworthiness regulations. Windows on aircraft make passengers more aware and responsive to conditions outside the cabin. This certainly increases the level of safety in flight operations. Airplanes have two types of windows based on where they are installed, namely the window on the cabin and the window on the Flight Compartment (windshield). The window on the cabin is mounted on the cabin and allows passengers to see conditions outside the cabin. Windshield is a glass and frame in the front flight compartment area. Windshield allows the crew (captain and first officer) to see conditions outside the aircraft that support the aircraft control process. Windshield must be designed as strong and lightweight as the window in the cabin. The windshield must withstand the pressure generated by the pressurized cabin. The pressurized cabin is very important for aircraft flying at altitudes of more than 10,000 feet because it will affect the comfort of passengers during the flight. Additional conditions that must be owned by the windshield are that they must be able to provide clear vision to pilots in certain natural conditions such as rain, must be able to be opened so that it can be a way out for the crew during an emergency, and be able to withstand bird strikes so that flight safety and security can be achieved

Formulation of the problem

Based on the identification of the problems that have been described above can be formulated a problem that will be discussed as follows:

1. Conditions such as whether the damage occurred in Flight Compartment windows due to heating system failure.
2. How the effectiveness of maintenance performed on the Windows Flight Compartment component on Boeing 737-800 according to Weibull analysis
3. What is the type of failure rate of the Windows Flight Compartment component on Boeing 737-800 in the April 2019-June 2019 period theoretical basis

Heat Transfer

Heat transfer is one of the thermal engineering disciplines that studies how to produce heat, use heat, convert heat, and exchange heat between physical systems. Heat transfer is classified into thermal conductivity, thermal convection, and thermal radiation. Thermal conduction is the direct microscopic exchange of the kinetic energy of particles through the boundary between two systems. When an object has a different temperature than the object or the environment around it, heat flows so that both have the same temperature at a point of thermal balance. Convection is the transfer of heat from one place to another due to fluid transfer, the process of heat transfer through mass transfer. Thermal radiation is the energy released by objects as electromagnetic waves, due to the heap of thermal energy in all objects with temperatures above absolute zero. Thermal radiation is the energy released by objects as electromagnetic waves, due to the heap of thermal energy in all objects with temperatures above absolute zero. Thermal radiation arises as a result of random displacement of atoms and molecules of objects.

The process of generating heat electrically on a material can be carried out using a heat-producing element in the form of a conductor material that can conduct heat by conduction, convection or radiation. Therefore the heating element as a heat-producing material becomes a very determining factor in the

process of heat transfer from the heating element to the heated material. So that the physical and chemical characteristics of the heating element greatly determine the quality of the heat generated by a heating device. The characteristics of the heating element are as follows:
1. Is a material that is an electrical conductor
2. Getting supply from electricity through contacts, terminal blocks or leads
3. Requires position (mechanical support)
4. Solid material
5. Has economic value for the operating period of the environment or process to be used.

Materials used as heating elements are generally in the form of good electrical conductors, but to achieve a higher level of heat dissipation, there are times when electrical conductors are mixed with other materials that can increase the ability (capacity) of heat generated by electrical conductors such as insulating layers or ceramic wrapping conductor section The history of glass [1] dates back to 3000 BC, the Syrians discovered how to make glass by mixing soda ash, lemon and sand which eventually formed glass when it was still hot. In 1400 BC, Egypt had made vases and cutlery using glass elements inside. Glass has been enhanced with the addition of color to the surface and glass began to be discovered by using metal pipes to blow. In 1291 Rome used glass as a window, light could enter but people could not see out. In the Hali archipelago, still in the Roman region Murano glass techniques were discovered, namely in the form of clear glass and almost transparent commonly referred to as "cristallo", but better known as Murano glass. The 14th century was the age of the Roman empire, with the city of Venice being the center of glass production. But with the Roman collapse, the glass processing plant moved to the east, namely Syria and Byzantium. In the 16th century Britain began to find that using coal in the glass making process would produce clearer glass. In 1688, Louis Lucas de Nehon, a Frenchman made a manual process of making glass plates and took 16 days to produce good glass. In the 19th century the development of technology made it possible to produce glass on a large scale using soda ash and algae ash as firewood so that high temperatures were easily reached. In 1959 Pilkington Brothers in London, England, discovered float glass, which was a process of perfecting glass production. Glass was first introduced by the Dutch, whose use was limited to buildings belonging to certain circles because it was considered a classy item, including in palaces, palaces, churches, houses of Dutch officials. The development of design and technology has resulted in glass of various shapes and colors, but the type of glass is generally divided into the following.

Flight Compartment Windows
On the Boeing 737-800 there are six windows in the flight compartment, namely window number 1, number 2, and number 3 on the left and right. Window numbers 1 and 3 are designed not to be opened while window number 2 can be opened (sliding window). The construction in each window is laminated glass which serves to protect the glass from air pressure in the cockpit (pressure load) and also bird impact, while Window number 3 uses a two pane air-gap design that serves to hold the pressurized load in the cockpit. Each window is vinyl or urethane coated. Vinyl interlayer layer serves to withstand the burden caused by bird impact and fail-safe pressure conditions. In window number 1 installed using bolts from inside the plane and attached to the fuselage structure. The number 1 window weighs around 50lb (23 kg)

2. Research Method

Data Collection Methods
In this study data collection techniques are an important factor for the success of the study. This relates to how to collect data, who is the source and what tools are used. The type of data source is about where data is obtained, whether data is obtained from direct sources (primary data) or data obtained from indirect sources (secondary data). The method designates a way so that its use can be demonstrated through

questionnaires, interviews, observations, tests, documentation, and so on. The data collection techniques that researchers do are observation, interviews, and research results.

Place and Time of Research

The time of this research is planned for two months starting on June 10, 2019 until August 10, 2019. The place where this research was conducted is PT. Batam Aero Teknik and Tangerang Soekarno Hatta Airport

3. Analysis and Discussion

Calculation Weibull Distribution Analysis

In the Weibull distribution analysis obtained several calculations including failure time rank, x value, y value, a value, r coefficient, β value and η. Distribution analysis consists of several stages including:

Calculation of Adjusted Rank

Adjusted Rank = $\frac{\{(Invers\ rank)\ (previous\ adjusted\ rank)+ (N+1)\}}{(invers\ rank+1)}$

Where N is the number of samples. Example: For 1st order where inverse rank = 8, previos adjusted rank = 0

$$I_1 = \frac{(0 \text{ x } 8) + (8+1)}{(8+1)} = \frac{9}{9} = 1$$

$$I_2 = \frac{(1 \text{ x } 7) + (8+1)}{(7+1)} = \frac{16}{8} = 2$$

$$I_3 = \frac{(2 \text{ x } 6) + (8+1)}{(6+1)} = \frac{21}{7} = 3$$

$$I_4 = \frac{(3 \text{ x } 5) + (8+1)}{(5+1)} = \frac{24}{6} = 4$$

$$I_1 = \frac{(4 \text{ x } 4) + (8+1)}{(4+1)} = \frac{25}{5} = 5$$

$$I_2 = \frac{(5 \text{ x } 3) + (8+1)}{(3+1)} = \frac{24}{4} = 6$$

$$I_3 = \frac{(6 \text{ x } 2) + (8+1)}{(2+1)} = \frac{21}{3} = 7$$

$$I_4 = \frac{(7 \text{ x } 1) + (8+1)}{(1+1)} = \frac{16}{2} = 8$$

Calculation of Median Rank

In calculating the median rank can be done with Benard's formula. Where i is adjusted rank. Median rank is expressed in decimal numbers. Example for the 1st order, where i = 1

Median rank = $\frac{i-0,3}{N+0,4}$

1. $\frac{1-0,3}{8+0,4} = 0,083$
2. $\frac{2-0,3}{8+0,4} = 0,202$

3. $\frac{3-0,3}{8+0,4} = 0,321$
4. $\frac{4-0,3}{8+0,4} = 0,440$
5. $\frac{5-0,3}{8+0,4} = 0,560$
6. $\frac{6-0,3}{8+0,4} = 0,679$
7. $\frac{7-0,3}{8+0,4} = 0,798$
8. $\frac{8-0,3}{8+0,4} = 0,916$

4. Discussion Results

From the calculation, the value β> 1 is 1.305, which indicates the occurrence of wear out where the failure to wear is caused by a decrease in the ability (quality) of one or several parts of the component because it is operated continuously. For the whole system, the effects of wear failure are less economically important. This is because wear failure is generally predictable. Therefore, to prevent high costs due to wear failure, periodic replacement of components or parts that are likely to be worn is required. This failure is marked by an increase in the failure rate at a certain age, and the achievement of items will decrease little by little (gradual degradation) along with the use of the system. For the type of wear out preventive maintenance (Preventive Maintenance) will be effective for this type of degradation. This type of treatment is a preventative measure for the occurrence of damage to units or products that can still function properly. The purpose of Preventive Maintenance is to increase the ability of certain units or parts, reducing the amount of primary failure. As a result other default or secondary failure (secondary failure) can be avoided and prevented. Included in the Preventive Maintenance actions are Inspections, Parts Replacement, and Overhauls. For ages of unknown malfunctions, inspections may be needed to determine the status of performance. If a potential failure has been identified, then corrective or replacement actions can be taken. This means that corrective actions are carried out depending on the conditions of achievement (on condition).

5. Conclusion

Based on the results of the discussion that has been done, it is concluded that:

1. Damage conditions that occur in Flight compartment Windows due to heating system failure have different characteristics. It is important for a technician to know the symptoms that arise with the aim of preventing the replacement of components that arrive prematurely so that the company's efficiency in changing components can be carried out properly.
2. Good maintenance effectiveness for Windows Flight Compartment component with gradual degradation type (β)> 1.0 (1,305), wear out type is preventive maintenance by periodically checking or replacing components.
3. The failure rate of the Windows Flight Compartment Component on a Boeing 737-800 is increasing, with a gradual type of degradation. This is evidenced by the acquisition value of β = 1.305 so that it is included in the category of wear out or wear failure. While the resulting b value is b = 0.766. In

accordance with the provisions that for b = 0.1 (probability 0.1%) categorized as serious failure, so special attention needs to be paid to the component

References

[1]. Ahmad, R. 2007 . *Bahan Bangunan sebagai Dasar Pengetahuan*. Edisi Pertama. Jakarta: BCPU.
[2]. Batam Aero Teknik. 2019. *Evaluation Of Window Anti Ice/Window Heat Problem On Lion 737NG*. Engineering Information
[3]. Boeing Company. 2019. *Flight Compartment Windows Schematic Description Section*. Aircraft Maintenance Manual Boeing 737-600/700/800/900ER
[4]. Cadika, I. 2017. *Analisis Keandalan Komponen Starter Generator pada pesawat Cessna Grand Caravan 208 B Menggunakan Metode Weibull.* Yogyakarta. Jurusan Teknik Penerbangan, STTA.
[5]. Charles E. Ebeling. 1993. *an introduction to reliability and mantainability engineering*. Amerika: McGraw-Hill Companies.
[6]. Dr. Abernethy, R. B. 1993. *The New Weibull Handbook.* Author and Publisher.
[7]. Hatanti. Grace, Setiawan. Budi, 2014, *Jurnal Aplikasi kaca pada perancangan,* Jakarta. *Humaniora*. 5(2): 756-765
[8]. Paul Barringer, P.E. 2009. *Weibull Analysis*. Diambil dari: https://www.academia.edu/33574921/Weibull_Analysis
[9]. Supandi. 1990. *Manajemen perawatan industri*. Bandung: Ganeca Exact.
[10]. Suwondo, Edy. 2001. *Diktat Manajemen Perawatan Pesawat*. Fakultas Teknologi Industri, Institut Teknologi Bandung, Bandung,