Functional Hazard Assessment Aircraft Electrical System

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Abstract . The Aircraft electrical system used to supply electrical power for any systems such as navigation, communication, flight control, and others. The failure in the electrical system results in disruption of the supply of electrical energy which results in accidents and fatal accidents. For this reason, it is important to carry out inspection and analysis of the aircraft electrical system to maintain flight safety levels which is any its failure in this system is still in toleranced airworthiness. The case reviewed in this study is a hypothetical RSL aircraft that uses a fly by wire flight control system. The first step carrying out in this research using Functional Hazard Assessment (FHA) are The initial steps carried out by the Functional Hazard Assessment (FHA) are identifying any posibility of failure in the electrical system, categorizing its functions, identifying failure conditions, and analyze the effects of failure. Aerospace Recommended Practice (ARP) 4761 is used as a guide in completing this research.The RSL aircraft electrical systems are categorized into three user functions which are called as critical functions, essential functions and service functions. A malfunction of this system can result in the aircraft being unable to be controlled which results in fatal accident.

Keywords: Failure, Electrical, Accident.

1 INTRODUCTION

The RSL aircraft is an aircraft capable of carrying up to two hundred passengers and crew, with a fly by wire control system. This aircraft is equipped with two turbofan engines mounted under the right and left wings. The electrical system on this aircraft is useful for supplying electricity to user systems such as navigation systems, communication systems, control systems, and other systems that use electrical power[2].

The RSL aircraft Electrical System generates, distributes, and manages the supply of electricity to the user systems. This system has two generators mounted on the engine, one generator mounted on the Ram Air Turbine, and has two battery storage. This electrical system also has an Electrical Power Management System (EPMS) which is useful for managing and distributing electricity from generators and batteries to user systems[3]. If there is a shortage of electricity supply, the EPMS will determine

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which electricity users will be supplied and which will be cut off. EPMS will also cut off electricity users who experience a short circuit.

The RSL aircraft electrical system has three electrical systems called the left power module, standby power module, and right power module. If all of these electrical systems fail, the supply of electricity uses a battery that is limited for a certain time.

2 RESEARCH METHOD

Functional Hazard Assessment (FHA) is carried out in the early stages of aircraft manufacturing[1]. This assessment shall identify and classify the failure conditions associated with aircraft function. Classification of failure conditions is used as a reference in setting safety goals in the form of failure effects and failure classification[5]. The failure classification according to aviation regulations from the Federal Aviation Administration (FAA) and Joint Aviation Authorities (JAA) as though, Minor with a failure probability of 10^{-3}, Major with a failure probability of 10^{-6}, Hazardous with a failure probability of 10^{-7} , and Catastrophic with a failure probability of 10^{-9}[4],[6],[8].

The purpose of carrying out FHA is to clearly identify each failure condition along with the reasons for determining its classification[6]. The results of this FHA will be used as a starting point for conducting a Preliminary System Safety Assessment (PSSA). FHA is a qualitative and quantitative analysis. Figure 1 show the functional hazard assessment in safety assessment process.

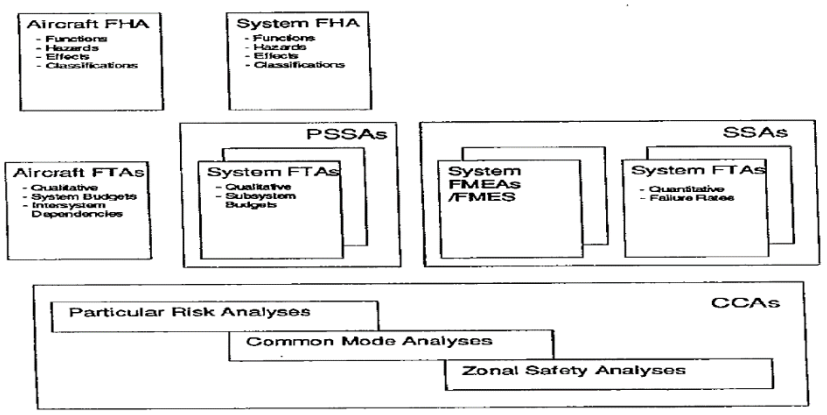

Fig. 1. Safety Assessment Process[6]

The step of first conducting FHA is to identify the function of an aircraft system. The next step is to identify possible failure conditions. The more failure conditions identified, the more secure the system is. After identifying the failure conditions, an analysis of the possible failure effects is carried out. The final stage classifies the

effects of the failure with reference to flight regulations. Table 1 shows the definition of failure effects as a basis for classifying failure conditions

Table 1. Classification of Failure Effects

	Minor	Major	Hazardous	Catastrophic
Failure Effect	• Slight reduction in safety margins • Slight increase in crew workload • Same inconvenlence to occupants	• Significant reduction in safety margins or functional capabilities • Significant increase in crew workload or inconditions impairing crew efficiency • Same discomfort to occupants	• Large reduction in safety margins or function capabilities • Higher workload or physical distess such that the crew could not be relied upon to perform tasks occurately or completely • Adverse effects upon occupants	• All failure conditions which prevent continued safe flight and landing

3 RESULTS AND DISCUSSION

3.1 Identified Functions and Category Supplied Electrical System

Identified Functions of the electrical system are[3]:

- To generate electrical power within specified ouput limits
- To distribute AC and DC electrical power
- To protect AC and DC electrical distribution

The electrical system supplies three categories of user namely the critical function, the essencial function, and service function category:

Critical function which consists of:

- Flight control system
- Radio VHF 1
- Emergency Light
- Fire Extinguisher

- Engine control
- Critical Warning System (fire warning and engine flame out)

Essential function which consists of :

- All avionic systems
- Engine no-battery start
- De-icing system
- Wind shield wiper
- Hydraulic EMDP
- Wind shield heater
- Air circular fan
- Fuel booster pump
- Exterior light
- Battery Engine Starting system

AC service function which consists of:

- Galley
- Interior light
- Entertainment system

3.2 Identified Failure Conditions

1. The function To generate electrical power within specified ouput limits has the following failure conditions:
    - Total loss of electrical power generation capability
    - Loss all of DC electrical power generation capability
    - Loss all of AC electrical power generation capability
    - Loss of capability to disconnect generator to engine

2. The function To distribute AC and DC electrical power has the following failure conditions:
    - Inability to distribute electricity via DC critical bus
    - Inability to distribute electricity via DC essential bus
    - Inability to distribute electricity via AC essential bus
    - Inability to distribute electricity via AC service bus

3. The function To protect AC and DC electrical distribution has the following failure conditions:
    - Inability to protect aircraft electrical system from over voltage/current condition on DC critical bus distribution
    - Inability to protect aircraft electrical system from over/under voltage or current condition on AC/DC essential bus distribution
    - Inability to protect aircraft electrical system from over/under voltage or current condition on AC service bus distribution.

3.3 Effects and classification of failures

The failure effects and classification of the failure conditions that have been presented above will be shown in table 2 below.

Table 2. Effects and classification of failures

FAILURE CONDITION	EFFECTS OF FAILURE CONDITION ON AIRCARFT/CREW/OCCUPANTS	HAZZARD CLASS
Total loss of electrical power generation capability	Acft: No electrical supply to fly by wire system and other critical aircraft systems, it causes aircraft out of control. Crew: Pilot try control the aircraft but fly by wire inoperative. Occupants: May be subjected to fatality.	Catastrophic
Loss all of DC electrical power generation capability	Acft: No DC electrical supply to critical and essential aircraft systems, it causes loss of some aircraft system functions. Crew: Pilot will notice the problem and active the TRUs. Pilot may perform go around and return to base. Occupants: No effect	Minor
Loss all of AC electrical power generation capability	Acft: No AC electrical supply to essential aircraft system and causes loss of some aircraft system functions. Crew: Pilot will notice the problem, isolates the affected systems, and performs go around and return to base. Occupants: No effect.	Minor
Loss of capability to disconnect generator to engine	Acft: Engine may be damage and flame out. Crew: Pilot do not have enough time to control the aircraft and aircraft will be crashed. Occupant: May be subjected to fatality.	Catastrophic
Inability to distribute electricity via DC critical bus	Acft: Critical aircraft system will be supplied via DC essential bus. Crew: Pilot will be notice the problem. Pilot perform go around and return to base. Pilot will perform emergency landing. Occupant: No effect.	No effect*
Inability to distribute electricity via DC essential bus	Acft: Critical aircraft system will be supplied via DC critical bus. Crew: Pilot will notice the problem. Pilot perform emergency landing. Occupant: No effect.	No effect

Inability to distribute electricity via AC essential bus	Acft: Aircraft will lose some essential aircraft system function. Crew: Pilot will notice the problem, isolates the affected systems, perform an emergency landing in accordance with the AFM procedures. Occupant: No effect	Minor
Inability to distribute electricity via AC service bus	Afct: Aircraft will loss service aircraft system function. Crew: Pilot continues the flight and no special action. Occupant: No effect.	No effect
Inability to protect aircraft electrical system from over voltage/current condition on DC critical bus distribution	Acft: Aircraft critical system will be supllied with inappropriate electrical power and it may result in the failure of the system or fire. Crew: Pilot will not able to control the aircraft and aicraft will be crashed. Occupants: may be subjected to fatality.	Catastrophic
Inability to protect aircraft electrical system from over/under voltage or current condition on AC/DC essential bus distribution	Acft: Aircraft essential system will be supllied with inappropriate electrical power and it may result in the failure of the system or fire. Crew: Pilot will perform emergency landing. Occupants: may be subjected to adverse condition.	Hazardous
Inability to protect aircraft electrical system from over/under voltage or current condition on AC service bus distribution	Acft: Aircraft service system will be supllied with inappropriate electrical power and it may result in the failure of the system or fire. Crew: Pilot will perform emergency landing. Occupants: may be subjected to adverse condition.	Hazardous

4 CONCLUSION

Failure conditions as though Total loss of electrical power generation capability, Loss of capability to disconnect generator to engine, and Inability to protect aircraft electrical system from over voltage/current condition on DC critical bus distribution are classified as catastrophic. This failure is acceptable if the probability of occurrence is 10-9. Therefore the components that support this system must be reliable

which has the smallest failure rate or there is redundancy in components that have a large failure rate.

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