ENOUGH SAID ABOUT AIR/GROUND CREW ERRORS: LET'S INVESTIGATE INVESTIGATION ERRORS

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by

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Enough said about Air/Ground Crew Errors: Let's Investigate Investigation Errors

It was bright, sunny, and a perfect flying day on March 28, 2011. Two F-7[1] fighter aircraft of the Pakistan Air Force (PAF) were scheduled for a training mission. At about 11:00 PST, the Number 2 pilot in the formation reported a main landing gear door open to the formation leader. Following standard procedures, a safe landing was made at the air force base. This was the 19th[2] case of its kind since the inception of F-7 aircraft in the PAF. An investigation was ordered (PAF, 2011); however, the management was convinced that an investigation into this occurrence would be like finding a needle in a haystack, as it was a known case. Earlier investigations had been declared "undetermined" due to unavailability of conclusive evidence.

On the other hand, the Investigating Officer[3] (IO) was determined not to finalize the investigation on "what happened" but rather on "why it happened." The IO went through the database and looked at the past investigations pertaining to similar cases. In most occurrences, the investigations were "undetermined" and concluded by precautionary replacement of the doors, followed by subsequent rigging. Although it was impossible to simulate the in-flight characteristics on the ground, the IO made efforts to replicate the conditions as close as possible. The aircraft was jacked up, and multiple landing gear retraction/extension cycles were completed. Initially, the operation was found normal with no duplication on the ground. Based upon an exhaustive study of the electro-mechanical system and considering the phenomenon of structural vibrations due to aerodynamic loads during flight, the position of landing gear Adapting Joint was disturbed manually followed by the retraction cycles. The landing gear door closed but remained "unlocked."

[1] F-7, also known as J-7, is a single-engine, lightweight fighter aircraft designed and developed by Chengdu Aircraft Corporation (CAC), China.
[2] Retrieved from the historical database of Aircraft Occurrence Reports.
[3] In PAF, an IO is responsible for the investigation, and preparing a formal report which covers findings, causes, and recommendations, including the human factor element.

An analysis of the incident revealed that a small nut was overtightened during a recent periodic rigging of the landing gear (see Figure 1). This hindered the free movement of Adapting Joint, disturbing its angle subtly from 80º to 110º, resulting in the door locking hook to remain open in the air. The methodical and systematic approach by a prudent IO led to a breakthrough that resolved the issue which was labelled as "undetermined" for years by previous investigations.

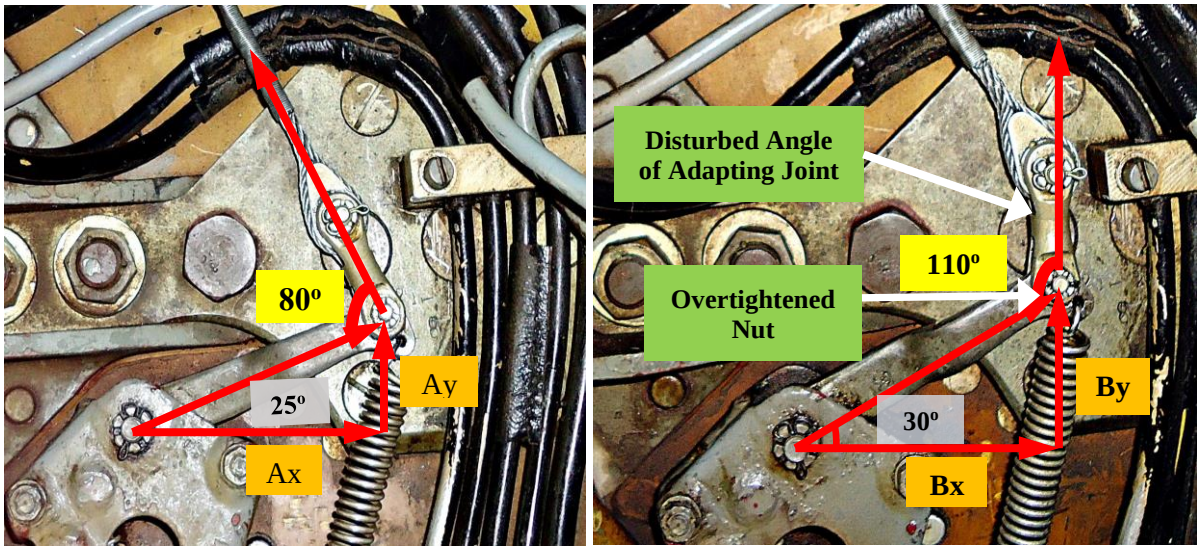

Figure 1. Change of Adapting Joint angle. The left figure shows the normal/desired angle of 80º, whereas the figure on right shows the disturbed angle of 110º due to overtightened nut.

In another occurrence (PAF, 2010), following completion of a night training mission on August 17, 2010, red indication lights remained illuminated after landing gear were lowered prior to landing. Checklist actions were taken and the gears were recycled; subsequently, the aircraft landed safely. Upon investigation of the incident, the cause was finalized by the IO as a "one time malfunction of landing gear up/down switch." In the very next sortie, the same problem was repeated—only this time, it was more serious. Upon failure of the normal extension procedure, an attempt was made to lower the landing gear through emergency checklist procedures; however, the effort was useless. Before attempting ejection, the aircraft was flown to the designated area to carry out one last attempt to extend the gears with the help of a special maneuver. The effort was

successful and an immediate recovery was made, saving the precious life of the pilot and a valuable aircraft. This time, the same IO and a more experienced officer were appointed as investigating officers. Upon a detailed investigation, the cause was found to be electrical short-circuiting due to a hairline crack caused by chaffing of the landing gear electrical wire (see Figure 2). The shortcomings and errors committed by the investigator during the initial investigation resulted in a repeat occurrence. It was realized that the initial investigation was carried out in haste to reinstate the aircraft for operational requirements. A methodical investigation in the first place would not have resulted in such a close call.

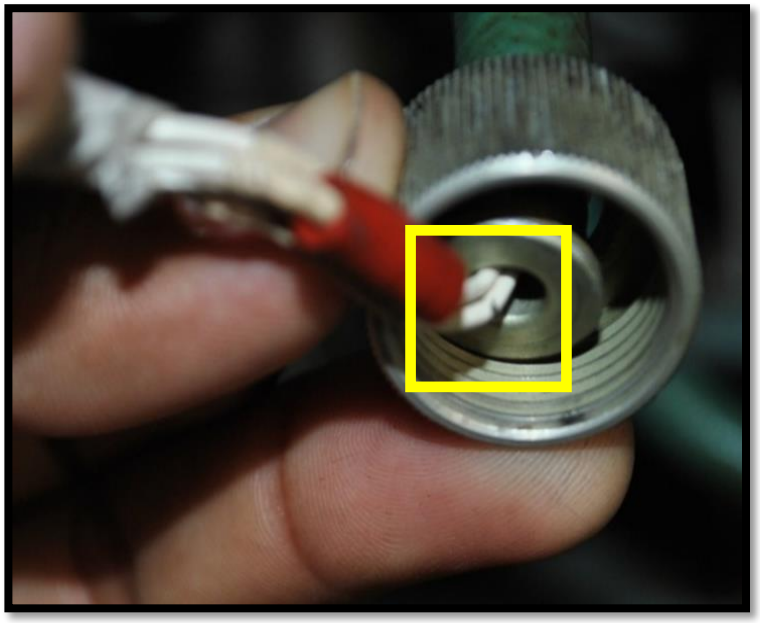

Figure 2. Hairline crack on electrical wire due to chaffing.

Safety occurrence investigation, a major component of an organization's safety management system, helps in preventing future untoward events (FAA, 2010). Without a structured investigation methodology, it is difficult to collect and analyze all pertinent information, assess risks, and produce recommendations that would help improve safety. The above-mentioned occurrences may seem less consequential but show the contrasting nature of incident investigations carried out in the same operating environment. While the human factor aspect of the air and ground crew continues to be

the greatest contributor to aviation accidents (FAA, 2016; Reinhart, 2008, p. 241), it is beyond doubt that there is a human factor associated with investigators as well, which poses a serious challenge to modern investigators. An error made in an investigation can be as grave as the cause of an incident itself. If the above cases are studied and analyzed, they have serious hidden messages and tell us how the quality of incident investigations can enormously impact the safety of human lives and assets.

In the first occurrence, the landing gear doors opening in air were known cases. Based upon the findings of earlier investigations, they were accepted by the organization as a design limitation. It wasn't until the 19th incident when a determined investigator followed a logical approach to find the exact cause, thus defying earlier investigations. In case he had been unenthusiastic like the second case study above, and had followed the past methodology, it would have been no more than just another "undetermined" investigation. Therefore, the determination and inquisitive nature of an investigator is a first step toward finding the exact cause.

Although previous investigation reports may play a part in identifying the history of an occurrence, they may negatively influence both the approach and thinking of an investigator—especially of an inexperienced one. A sole reliance on previous reports can lead to tunnel vision, narrowing the scope of an investigation. Therefore, past investigations may only be referred to as a starting point toward determining the root cause. The aim should be to identify additional contributing factors that may have led to the occurrence followed by ruling them out one by one based on evidence.

For both aforementioned case studies, the real causes were finally found by simulating and replicating the in-flight characteristics. In many cases, the exact replication of the failure process may not be feasible; however, as incidents occur during aircraft operation in the air or on ground,

simulation of the events during an investigation should be an investigator's priority. Trying to replicate is a good way to duplicate the in-flight events and record the evidence before it is lost while trying to follow a pre-determined checklist. This can be as simple as blocking the Pt_2 probe on Engine Number 1 with duct tape to simulate the in-flight icing conditions as it was done during the investigation of Air Florida Flight 90 accident (NTSB, 1982). Therefore, physical reenactment of the scenario or even the data retrieved from Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR), and other test equipment can be instrumental in the investigation process.

Sound technical analysis serves as the cornerstone of investigations concerned with determining why systems fail (Kolly & Blanchet, 2005). Consideration of minor details while investigating an occurrence is therefore paramount. A slight change of angle in the first case study and a hair line crack on the wire in the second are testament to the fact of how these little details, which are difficult to ascertain, can adversely affect the performance of a system. Therefore, a thorough study and understanding of the system involved and keen observations by the investigator are necessary to isolate the cause of an occurrence.

The repetition of the same occurrence in subsequent sorties/operation of the aircraft discredits the incident investigator's ability and professionalism. A recurrence means a human error on the part of an investigator failing to prevent the repetition by not finding the cause in the first place. Hence, for or an investigator to establish his or her competency, it is essential that all available resources be utilized effectively the very first time to determine the exact cause and provide suitable recommendations to avoid recurrence.

A significant difference between incident and accident investigations is that the incident investigations are usually carried out in a time-compressed environment. In a fast-paced, operations-and business-driven environment like the military, commercial, and even corporate

aviation, there is less time for occurrence/incident investigation, which creates an additional pressure on the investigator. At one point or another, an investigator encounters such pressures, which may lead investigators to make unnecessary errors like the second case study above. To overcome this, it is imperative for the investigators to induce the quality of assertiveness so that these pressures can be mitigated without compromising the quality of an investigation.

Inferring from the definition given by ICAO (2010), the principal objective of an investigation is to prevent recurrence, reduce risk, and advance aviation safety performance. Like the much-discussed air and ground crew errors, commonly attributed as human factors, there are human errors committed by air safety investigators, which—instead of reducing the risk—can result in substitute or residual risks. These errors are less talked about and can be detrimental to aviation safety. Therefore, there is a dire need to stress upon and research this facet of human errors, as unsafe events will continue to happen in aviation industry. Quality investigations—which determine failure causation—prevent future accidents, and that really makes a difference in aviation.

(Words count: 1641, including the title and figure captions)

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