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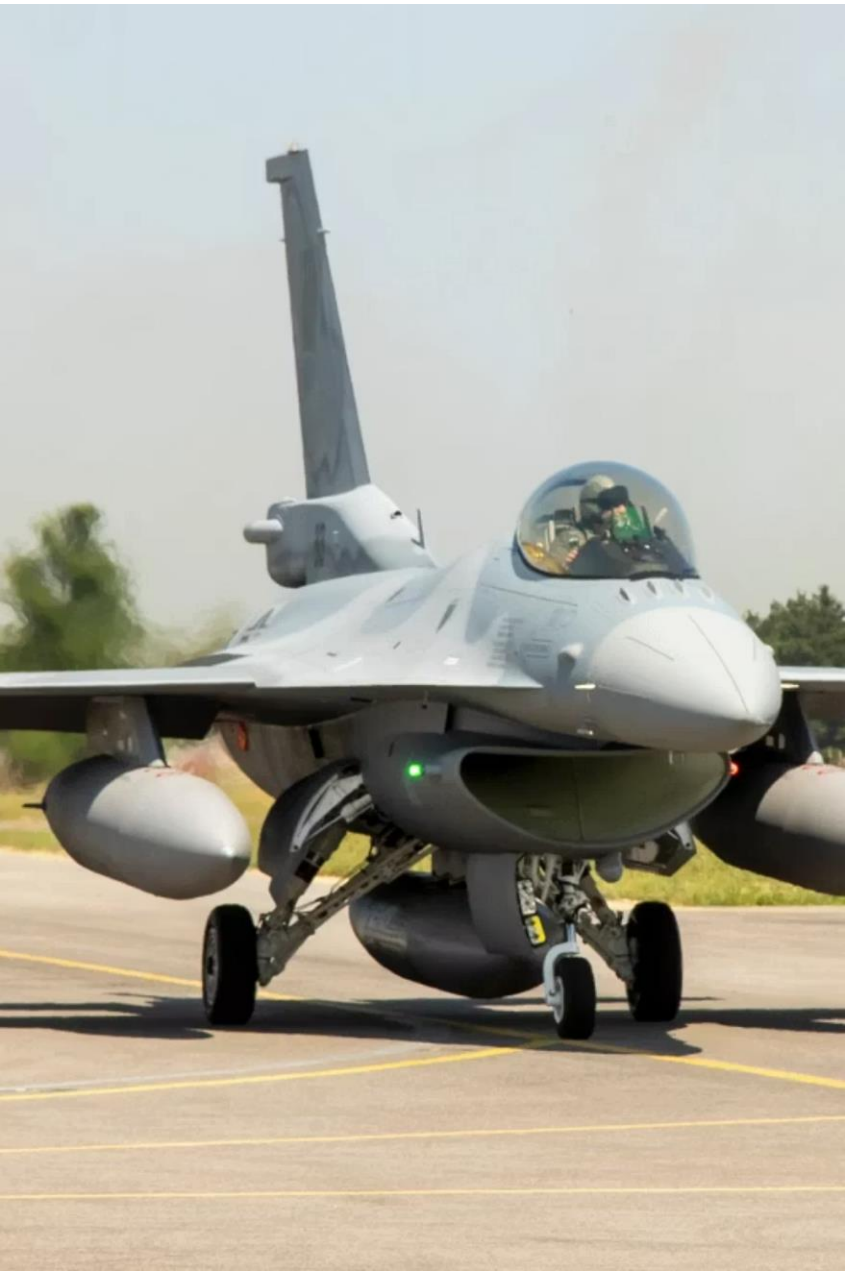

Case Study: F-16 Main Landing Gear Gear Wheel Assembly Error

A human factors analysis of a serious incident involving improper torque torque application during routine maintenance

Incident Overview

Key Details

- **Aircraft:** F-16C Fighting Falcon
- **Date:** March 2019
- **Type:** Serious incident (no crash)
- **Phase:** Post-maintenance taxi test

The Problem

During a routine taxi test following scheduled wheel and brake assembly replacement, the aircraft experienced severe vibration and handling difficulties. The pilot immediately aborted the test and returned to the maintenance hangar.

Investigation revealed that the main landing gear wheel assembly had been been installed with incorrect torque values, creating a dangerous condition that condition that could have led to wheel separation during takeoff or landing. landing.

Sequence of Events Leading to the Error

1

Day 1: Task Assignment

A Senior Airman received work order to replace main landing gear wheel and brake assemblies on F-16C tail number 89-2137. Task scheduled during night shift with compressed timeline due to operational requirements.

2

Day 1: Initial Work

The Airman removed old assemblies following technical order procedures. However, he was interrupted twice by supervisors requesting assistance on higher-priority tasks. Left work area for approximately 90 minutes total.

3

Day 2: Installation Begins

Returning to complete installation, the Airman could not locate the torque wrench torque wrench he had been using. Borrowed a different torque wrench from from another technician without verifying its calibration status or setting.

4

Day 2: Critical Error

The Airman applied what he believed was correct torque (250 ft-lbs) to wheel wheel retaining nuts. In reality, the borrowed wrench was preset to 150 ft-lbs and ft-lbs and he failed to verify the setting before use. He relied on "feel" rather than rather than checking the wrench indicator.

5

Day 2: Incomplete Documentation

Rushed to complete paperwork before shift end, the Airman signed off the work as the work as complete. The required independent inspection was delayed due to due to inspector shortage, and the Airman’s shift ended before inspection occurred. inspection occurred.

6

Day 3: Discovery

During taxi test, pilot reported severe vibration and unusual handling. Post-incident Post-incident inspection revealed under-torqued wheel nuts and early signs of signs of loosening. Aircraft immediately grounded for corrective maintenance. maintenance.

Investigation Findings: Contributing Human Factors

Task Interruption Effects

Multiple interruptions broke the Airman’s concentration and disrupted his disrupted his mental model of task completion. Post-incident interview interview revealed he could not clearly recall which steps he had completed before interruptions.

Time Pressure

Compressed maintenance schedule and approaching shift end created created production pressure. The Airman admitted feeling rushed to rushed to complete paperwork and "get the jet back to the line" rather rather than methodically verifying his work.

Equipment Substitution

Using an unfamiliar torque wrench without verification violated established procedures. The Airman stated he assumed all shop torque wrenches were "pretty much the same" and did not appreciate the critical importance of tool verification.

Procedural Violations

Failed to follow technical order requirement to verify torque wrench wrench setting before use. Also did not complete the required secondary secondary check of torque values after installation, relying instead on instead on "muscle memory" from previous similar tasks.

Technician's Own Words: "I've done this job dozens of times. I thought I knew the feel of proper torque. I never imagined the wrench could be set wrench could be set wrong—that was my biggest mistake."

Systemic and Organisational Issues Identified

Root Causes Beyond Individual Error

The investigation identified multiple organisational weaknesses that created conditions conducive to human error,

demonstrating that individual blame alone fails to address systemic safety issues.

Inadequate Staffing Levels

Maintenance unit operating at 73% of authorised strength, creating chronic workload pressure and fatigue. Inspector shortage meant independent inspections were frequently delayed or rushed, reducing their effectiveness as a safety barrier.

Tool Control Programme Deficiencies

Tool room lacked rigorous calibration tracking system. The borrowed torque wrench had not been calibrated for 14 months, exceeding the required 12-month interval. No visual indicators on tools showed calibration status.

Training Gaps

Human factors training emphasised individual responsibility but responsibility but did not adequately address managing interruptions, time pressure, or the importance of tool verification. The Airman had received only two hours of human human factors instruction in past 18 months.

Normalisation of Deviation

Supervisors routinely pulled technicians off assigned tasks to tasks to handle "priority" issues, creating a culture where where interruptions were accepted as normal. Technical order Technical order compliance was emphasised in theory but but compromised in practice by operational pressures.

Weak Error Detection Systems

The independent inspection process, designed as a critical safety barrier, was undermined by staffing shortages and production pressure. Inspectors often felt pressured to "trust" experienced technicians rather than conduct thorough verification.

Key Lessons for Maintenance Safety

1 Individual vigilance alone cannot overcome overcome systemic pressures

Organisations must design work systems that support error-free performance rather than relying solely on technician attention and and motivation. Production pressure and resource constraints create create predictable failure modes.

2 Interruptions are high-risk events requiring formal management

Develop protocols for managing task interruptions, including documentation of completion status and structured return-to-work procedures. Consider interruptions as safety-critical events, not merely efficiency issues.

3 Tool control is a critical safety barrier, not administrative burden

Rigorous calibration tracking, visual status indicators, and verification verification requirements before use must be non-negotiable. Equipment Equipment substitution without verification should be treated as a serious a serious procedural violation.

4 Safety culture requires alignment between stated stated values and operational reality

When production demands consistently override safety procedures, procedures, workers learn that compliance is optional. Leadership must Leadership must ensure adequate resources and support procedural procedural compliance even under operational pressure.

Outcome: Following this incident, the Base implemented enhanced tool control procedures, revised duty scheduling to reduce chronic understaffing chronic understaffing effects, and developed a structured interruption management protocol. No similar incidents have occurred in the subsequent the subsequent four years.

Notes