Maintenance Check

Incorrect installation, inadequate control are highlighted in U.K. maintenance-error reports.

BY RICK DARBY

Among 21 "high-risk" maintenance-error reports studied by the U.K. Civil Aviation Authority (CAA) from 1996 through 2005, 12, or 57.1 percent, involved "incorrect maintenance actions," six, or 28.6 percent, involved "incomplete maintenance" and three, or 14.3 percent, involved poor "maintenance control."[1]

Of a much larger number of maintenance-error incidents of all risk levels in the same study period, about half were attributed to "incorrect maintenance actions," and about a quarter each to "ineffective maintenance control" and "incomplete maintenance."

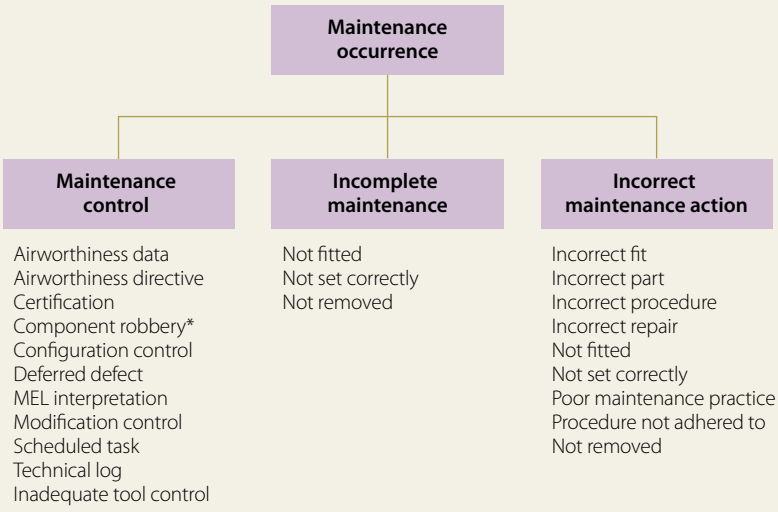
The data were derived from the CAA's mandatory occurrence reporting (MOR) program and included reports involving jet aircraft heavier than 5,700 kg — considered equivalent to 12,500 lb — maximum takeoff weight.[2] The analysis began with a database of 3,535 MORs citing maintenance error, although 611 reports were eliminated from the study because they were judged nonpertinent, leaving 2,924.

An earlier study limited to 312 MORs had developed a taxonomy that sorts maintenance incidents into "maintenance control," "incomplete maintenance" and "incorrect maintenance action" categories.[3] For this latest study's data set, the CAA added second-level descriptors and Air Transport Association of America (ATA) chapters categorizing the affected components (Figure 1, p. 50).[4]

Table 1 (p. 50) shows the distribution of MORs among the three maintenance-error types and the second-level descriptors within each type. The three most frequent ATA chapters in the data set were chapter 25, "equipment and furnishings," with 19.2 percent of the total; chapter 32, "landing gear," with 11.0 percent; and chapter 27, "flight controls," with 9.0 percent. When all the chapters, 71–80, related to engines were combined, however, the maintenance errors represented 15.0 percent of the data set, making engine maintenance error second only to "equipment and furnishings."

Figure 2 (p. 51) shows the breakdown of selected reports under the ATA chapter "equipment and furnishings." The CAA report said, "By far the most common problem is with escape slides, accounting for 42.0 percent of the occurrences in ATA [chapter] 25. Cabin dividers

Maintenance Error Types and Second-Level Descriptors



MEL = minimum equipment list

* E.g., inadequate control of parts removed from one component or aircraft to be fitted to another.

Source: U.K. Civil Aviation Authority

Figure 1

U.K Reported Maintenance Errors, 1996–2005

Type	Number	Percent Within Type
Maintenance control		
Scheduled task	223	30.4
Inadequate tool control	84	11.5
Deferred defect	81	11.0
Airworthiness data	78	10.7
Tech log	67	9.2
Airworthiness directive	66	9.0
Modification control	55	7.5
MEL interpretation	37	5.0
Configuration control	23	3.1
Certification	13	1.8
Component robbery	6	0.8
Total	**733**	
Incomplete maintenance		
Not fitted	268	44.5
Not set correctly	229	38.0
Not removed	105	17.5
Total	**602**	
Incorrect maintenance		
Incorrect fit	619	39.0
Not set correctly	447	28.1
Incorrect part	160	10.1
Poor maintenance practice	94	5.9
Procedure not adhered to	83	5.2
Not fitted	78	4.9
Incorrect repair	62	3.9
Incorrect procedure	24	1.5
Not removed	22	1.4
Total	**1,589**	
Grand total	**2,924**	

MEL = minimum equipment list

Note: Maintenance errors were reported in the U.K. Civil Aviation Authority mandatory occurrence reporting (MOR) program.

Source: U.K. Civil Aviation Authority

Table 1

were a particular problem that one operator had and generated 67 occurrences between 1996 and 2004. Issues relating to passenger seats were mainly associated with inadequate attachment to the aircraft structure."

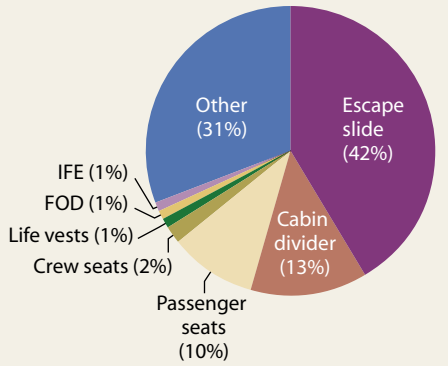
Maintenance-error reports classified as "landing gear" were fairly evenly divided among wheels, gear and brakes (Figure 3). "The most frequent problem with wheels was associated with fitting the wheel itself (34.0 percent of the wheel issues), while by far the most frequent issue with 'landing gear' was associated with landing gear safety pins, accounting for 42.0 percent of the 'landing gear' occurrences," said the report.

For the ATA "flight controls" chapter, the most frequent reports involved the flaps/slats system, the report said (Figure 4). Among MORs related to the combined ATA engine chapters, further analysis "showed little of significance," the report said. Errors involving foreign object debris, borescopes, latches, bolts, seals, panels and compressor washes accounted for 3 percent or less each. Fully 80.0 percent were categorized as involving "other" engine components or events.

Maintenance-error MORs as a percentage of total MORs received during the study period varied from a high of 5.9 percent in 1997 to a low of 3.0 percent in 2005.

Maintenance-error MORs as a percentage of total MORs received during the study period

U.K. Reported 'Equipment and Furnishings' Maintenance Errors, 1996–2005



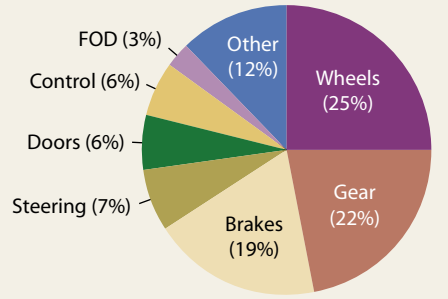
FOD = foreign object debris
IFE = in-flight entertainment system

Note: Categories are based on the Air Transport Association of America (ATA) Specification 100 Code, Chapter 25, "Equipment and Furnishings."

Source: U.K. Civil Aviation Authority

Figure 2

U.K. Reported 'Landing Gear' Maintenance Errors, 1996–2005



FOD = foreign object debris

Note: Categories are based on the Air Transport Association of America (ATA) Specification 100 code, Chapter 32, "Landing Gear."

Source: U.K. Civil Aviation Authority

Figure 3

varied from a high of 5.9 percent in 1997 to a low of 3.0 percent in 2005.

The 21 MORs during the study period that the CAA classified as "high risk" were distributed according to second-level descriptors as shown in Table 2 (p. 52). The three individual ATA chapters associated with the reports were "landing gear," with five events, or 23.8 percent; "flight controls," with four events, or 19.0 percent; and "engine," with three events, or 14.3 percent. Maintenance errors for the combined engine-related ATA chapters, including chapter 72, "engines," totaled five.

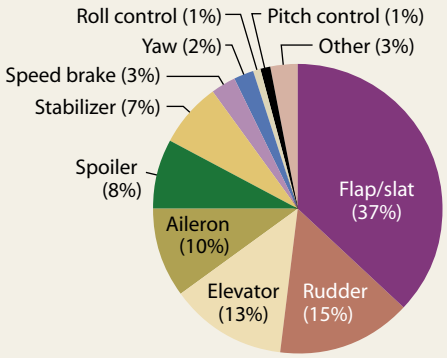
The report discussed the three maintenance error types:

Incorrect maintenance action: The report said that this was "clearly the most common category," and "the issues are largely focused around the incorrect installation of components, although it is not possible from the data available to determine the underlying attributable causes."

Maintenance control: "The focus of human factors initiatives has largely been on understanding and preventing maintenance error based upon the premise that the system, designed to support the engineers [maintenance technicians], is robust and effective," the report said. "As can be shown from the data, maintenance control issues contribute just as significantly to maintenance error in terms of their effect. Errors associated with configuration control, deferred defects and control of airworthiness directives can impact the integrity of the aircraft in the same way as the actions of the maintenance [technician]."

"Failure to perform scheduled tasks" was the most common error among the second-level descriptors within the "maintenance control" type, with 223 MORs, or 30.4 percent, falling into that category. "The second largest number of errors within 'maintenance control' was hazards relating to inadequate tool control," the report said. "There were 84 occurrences where this was the primary cause of the hazard affecting the aircraft. Of these 84 events, 43 (51.0 percent) were due to personnel inadequately controlling their own personal tools or belongings. … Just three (4.0 percent) of the

U.K. Reported 'Flight Controls' Maintenance Errors, 1996–2005



Note: Categories are based on the Air Transport Association of America (ATA) Specification 100 code, Chapter 27, "Flight Controls."

Source: U.K. Civil Aviation Authority

Figure 4

U.K Reported 'High Risk' Maintenance Errors, 1996–2005

Type	Number	Percent Within Type
High-risk incidents — maintenance control		
Scheduled task	3	100.0
Airworthiness data	0	0.0
Airworthiness directive	0	0.0
Certification	0	0.0
Component robbery	0	0.0
Configuration control	0	0.0
Deferred defect	0	0.0
Inadequate tool control	0	0.0
MEL interpretation	0	0.0
Modification control	0	0.0
Tech log	0	0.0
Total	**3**	
High-risk incidents — incomplete maintenance		
Not fitted	4	66.0
Not set correctly	1	17.0
Not removed	1	17.0
Total	**6**	
High-risk incidents — incorrect maintenance		
Incorrect fit	6	50.0
Not set correctly	3	25.0
Incorrect part	1	8.3
Poor maintenance practice	1	8.3
Procedure not adhered to	0	0.0
Not fitted	0	0.0
Incorrect repair	1	8.3
Incorrect procedure	0	0.0
Not removed	0	0.0
Total	**12**	
Grand Total	**21**	

MEL = minimum equipment list

Note: Maintenance errors were reported in the U.K. Civil Aviation Authority mandatory occurrence reporting (MOR) program.

Source: U.K. Civil Aviation Authority

Table 2

events involved tools that would have been issued to personnel for which the system would have demanded their return to stores after the work had been completed."

Aircraft maintenance personnel in the United Kingdom invariably own their own standard equipment, the report said. "These tools are not subject to a real system of control other than the owner being responsible for ensuring that he does not leave any in the aircraft after completing the task. … The data suggest that the control of company-owned special tools is performing its job, but the control of personal tools is not as robust."

Incomplete maintenance: "Occurrences related to incomplete maintenance typically involved such things as not tightening pipes or screws at the end of a task or omitting wire locking," the report said. "These errors are more typical of a human error or lapse than performing the job incorrectly, as is the case with occurrences categorized as incorrect maintenance."

Noting that there was a decrease in maintenance MORs as a percentage of all MORs, particularly between 2001 and 2002, the report speculated that the drop "may be explained by the CAA campaigns, conferences and road shows in 1999 and 2000 on maintenance error management, culminating in the issuing of Airworthiness Notice 71 in March 2000.[5] Airworthiness Notice 71 laid out CAA's policy on error management and the expectation that maintenance organizations adopt good human factors principles and practices in the form of instituting error management programs in their organizations." ●

Notes

1. CAA Safety Regulation Group. "Aircraft Maintenance Incident Analysis." CAA Paper 2007/04, December 2007. Available via the Internet at <www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=2971>.
2. CAA, Safety Regulation Group. CAP 382, *The Mandatory Occurrence Reporting Scheme: Information and Guidance.* November 2005. Available via the Internet at <www.caa.co.uk/docs/33/CAP382.PDF>.
3. *Maintenance control* was defined as "an event attributed to an ineffective maintenance control system."

   Incomplete maintenance was defined as "an event where the prescribed maintenance activity is prematurely terminated. In these circumstances, the correct maintenance procedures appear to have been followed, but something was not removed, not fitted or not set correctly towards the end of the process."

   Incorrect maintenance action was defined as "an event where the maintenance procedure was completed but did not achieve its aim through the actions or omissions of the maintainer." The report said, "In these circumstances, it appears that an incorrect maintenance procedure or practice was being used. This has resulted in a larger number of second-level descriptors than incomplete maintenance, but includes the actions of not removing, not fitting or not setting something correctly by virtue of not performing the task correctly, rather than as an error or omission."
4. ATA chapters are based on its Specification 100 codes for failed components.
5. CAA. Airworthiness Notice 71. Available via the Internet at <www.chirp.co.uk/New/Downloads/MEMS/Notice71.htm>.