AN ANALYSIS OF ASRS MAINTENANCE REPORTS ON THE USE OF MINIMUM EQUIPMENT LISTS

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A review of 1140 Aviation Safety Reporting System (ASRS) maintenance reports was conducted to identify incidents specific to use of the Minimum Equipment List (MEL). A total of 143 reports was found. Reports were analyzed to determine errors most frequently associated with MEL use, factors most often contributing to these errors and personnel most likely to be involved. The most frequently reported error was making or authorizing a deferral not allowable under the MEL, followed by excluding a step in the MEL procedure. The most frequently cited factors contributing to these errors were Time, Unclear MEL documentation, Lack of familiarity, Misinterpretation of the MEL, and Communication.

Introduction

The Minimum Equipment List (MEL) is an important operational document, one with direct implications for flight safety. The International Civil Aviation Organization (ICAO) defines the Minimum Equipment List as a "list which provides for the operation of aircraft, subject to specified conditions, with particular equipment inoperative." In the U.S., an FAA-approved MEL contains the conditions, limitations, and procedures required for operating an aircraft with certain items inoperative (FAA, 1991). In other words, the MEL specifies under which circumstances equipment on an aircraft can be inoperative and still remain legal for flight. In addition, it allows for certain equipment repairs to be deferred for a limited period of time.

Clearly the MEL is a useful operational tool, one that can enhance an operator's flexibility since, under specific conditions and for a limited time, it allows aircraft with certain instruments or equipment inoperative to continue flying rather than be taken out of service (Flight Safety Foundation, 2002). Proper use requires, however, that the MEL be interpreted, applied and implemented in a consistent, unambiguous manner, with all required conditions and procedures complied with. The challenge in accomplishing this goal lies in the fact that many employee groups share responsibility for the status of the aircraft (flight crews, maintenance, dispatch, maintenance control, engineering, management, etc.), all of whom have their own responsibilities with regard to equipment, flight schedules, and daily airline operations.

While ideally the MEL should "ensure that those involved in the operation of the aircraft use the same information to evaluate a malfunction and its effect on continued operations" to "determin[e] what is safe, logical and legal" (Flight Safety Foundation, 2002), a review of reports filed with the NASA Aviation Safety Reporting System (ASRS) suggests that use of the minimum equipment list is not always as straightforward and unambiguous as intended.

Method

A review was conducted of 1140 reports filed using the NASA ASRS maintenance form between 1996 and April 2002. This review identified 143 reports related to the use of the MEL. Reports were identified on the basis of the information provided by reporters in their narrative description of the event involved. Narratives which mentioned the MEL, or detailed events involving its use merited inclusion in the current study.

Once reports were identified, additional analyses were conducted to identify the most commonly cited errors related to the use of the MEL, the factors most frequently identified as contributing to an incident, the personnel most often involved, as well as the most common outcomes. Though reports were filed using the ASRS maintenance form, reporters were not exclusively maintenance personnel; rather, any aviation personnel involved in the application of the MEL (e.g., Dispatch, Maintenance Control, Technical Services, Engineering, etc.) are eligible to and did make use of this form.

Types of Errors

The most frequently cited error related to use of the MEL was making or authorizing a deferral that was not legal under the MEL, an error cited in 13% of reports. This error was not limited to any one group,

but was reported across groups. Examples of this error include the following:
"The crew called me to advise me of the MEL added to the aircraft, and I consulted the MEL and determined that the deferral was a legal deferral, and all of the provisions were met. Only after...was I made aware of the limitation of the aircraft which had been added as a temporary revision... Therefore the flights were operated with an illegal deferral" (report #409468)

"With assistance of lead AMT, we deferred center tank fuel quantity indicator per MEL. ...The lead AMT researched the change order authorizations and we both agreed that the change order authorization had been accomplished...I was wrong. ... After aircraft departed, line maintenance noticed the error and grounded the aircraft..." (report #443452)

"N1 tach gauge failed on the #1 engine. The airplane was configured with mixed engines... I referred to the MEL and conferred by phone with the Maintenance Controller... We determined the applicable DMI number and filed the N1 tach gauge as deferred.... Upon arriving in XXX it was learned that deferring the N1 tach gauge was improper due to the intermixed engine configuration" (report # 335640)

"I was the dispatcher on an aircraft with multiple MELs... After conferring with Maintenance Control, it was determined that since the MELs were on opposite sides of the aircraft, all parties agreed this aircraft could be dispatched. Later, we found that we could not operate that flight with both MELs and cleared one" (report #356080)

Other errors appeared to be more exclusive to maintenance and tended to involve the failure to accomplish some required hands-on step in the MEL procedure, such as not locking out an item (10%), not placarding an item (9%), or not making a required logbook entry (9%). (See Figure 1).

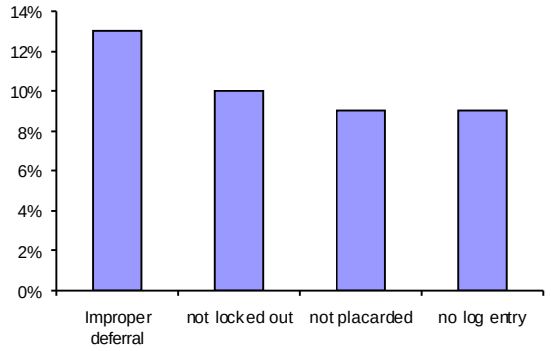

Figure 1. Top 4 most frequently reported MEL errors

Contributing factors

An analysis was conducted to identify those factors identified by reporters as most often contributing to MEL incidents. These items were identified by the frequency of their occurrence in report narratives. The most frequently cited factors were Time (25%), Unclear MEL, (20%), Lack of Familiarity (19%), Interpretation of the MEL (16%), and Communication (11%). A more detailed analysis of these findings follows. (See Figure 2).

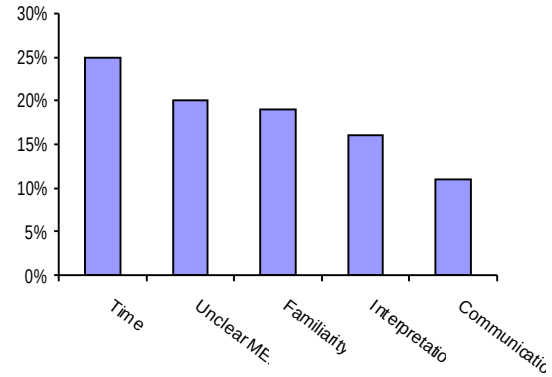

Figure 2. Top 5 most frequently cited contributing factors

1. Time

Time was the most commonly cited contributing factor, named in 25% of all reports. Its influence included self-imposed pressures such as wanting to finish a task before the end of a shift, or poor task planning, as well as externally-imposed time pressures to make sure flights departed on time, to maintain schedules, etc. Some representative examples of the impact of time include:

"The first, and biggest, contributing factor is that I allowed myself to be rushed. It seemed like a 10-15 minute job but took an hour" (report #3999111)

"I did not want maintenance to take a delay. I was pressured to get the aircraft on the gate. I felt it was my sole responsibility to get it there with enough time to make its departure." (report # 401483)

"the discrepancy required more time than I had to give due to the minimal down time so I decided to defer..." (report #535881)

"At departure time… aircraft on delay… I believe the above could be prevented if there had been less pressure to move the aircraft" (report # 474713)

2. Unclear MEL

The second most frequently cited factor was the "Unclear MEL", which was cited in 20% of reports reviewed. In these instances reporters felt that non-compliance with the Minimum Equipment List was tied directly to a lack of detail or to conflicting details in the MEL, or in the way the information was presented in the MEL documentation. Examples provided in such reports follow.

"MEL xx-2 is for engine reverser unlock light indicator sys. The maintenance procedure for this MEL tells you to make sure latch indication arm (at engine) is not extended prior to each departure. This particular engine reverser does not have this indicator arm. It has hydraulic latches with no other visual indicators. MEL xx-2 misleads me to think no other maintenance procedure needs to be completed except to see that reverser is checked for proper stowage in the retracted position as stated in MEL xx-2. … MEL xx-1 tells you [all of the steps necessary to verify and lockout system]…The problem being that without a referral on MEL xx2[back to MEL xx1] you don't think you have to do any deactivate of the thrust reverser... if it has hydraulic latches." (report #426703)

"I believe that the MEL is very unclear on the matter and should state how to verify the change order authorizations have/have not been completed. …thus the deferral was not legal. … I believe that future problems could be avoided if the MEL stated where to look for completion of change order authorizations" (report #439939)

"the MEL for deferring center tank fuel quantity is very confusing. Tech must research a total of 4 change order authorizations in the computer. If some have been accomplished, deferral is allowed.… MEL should be precise in which change order authorization display to use. More training in this area and a less confusing MEL would prevent this from happening again" (report #443452)

"the MEL provides info to identify the proper valve, however, this info is not revealed in good chronological order. The MEL ref for an inop valve is on page xxa for –200 series a/c. Page xxb discusses the –300 series aircraft, page xxc discusses the –800 series aircraft and page xxd finally discusses additional procedures for deferring the valve open. There is nothing on page xxa to refer the mechanic to the info on page xxd. I feel this contributed to the incident." (report #435239)

3. Lack of Familiarity

Lack of Familiarity was most often cited by reporters to express that they were working on a system or component with which they had little or no previous operational experience, no formal training, or for which they felt unsuited to work on. The following examples serve to illustrate this concept, which was named in 19% of reports:

"Being unfamiliar with APU placarding and having my crew chief obtain auth from maintenance tech for the placard led to an incomplete compliance for the MEL" (report #428403)

"Contributing factors I believe were…personal unfamiliarity with the PW4060 engine." (report # 451888)

"[I] was unfamiliar with the purpose of the lights on the handle so the entire autospoiler system was deferred…. Deferral of both lights was not permitted" (report #429812).

"a preliminary investigation revealed that proper procedures for returning the aircraft to service were not followed as prescribed….I have had no avionics training. Since I am not qualified to work avionics problems I am rarely assigned to aircraft with avionics probs. I have had very little experience placing MELs on avionics systems" (report #435254)

4. Interpretation of the MEL

There were a number of incidents reported in which the MEL was interpreted differently by different personnel. For example, one person might have read the MEL and concluded that an item was not "MEL-able", while someone else read the same MEL and concluded the item indeed could be legally deferred. This was cited as a factor in 16% of reports. Examples of such instances include the following:

"dispatcher conferred with maintenance and agreed to use MEL relief for the APU. Some question later arose as to the legality of inop'ing the APU since the MEL for the APU fuel heat stipulates the APU must operate normally. I believe… the intent of the statement was to allow operation of the APU with the fuel heat inop…..the interpretation of the MEL seems

misleading and is currently under scrutiny by flight ops and maintenance" (report #414470)

"during morning daily aircraft check… pilot's ADI was inop. My first instinct was it could not be MEL'ed. Further discussions convinced me it could. …the next day another pilot reviewed the logs…and disagreed…." (report #408929)

"placed some #2 galley miscellaneous carrier latches on maintenance carryover MEL xxxx in concurrence with maintenance coordinator…..I interpreted the cabin discrepancy list "miscellaneous carrier" item to mean these latches and consequently a non-MEL item…… FAA inspector wanted to know under what auth/ref was the MEL restriction removed. It was determined the MEL should not have been lifted and the aircraft incurred a delay while repairs were effected." (report #523508)

"I deferred flight recorder inop per MEL…..MEL special notes states 'airplane is not dispatched from an airport where repairs or replacements can be made.' I understand this to mean that deferral is ok if no parts are available for repair. Our maintenance controller called… statement means 'cannot depart from a maintenance station'. MEL terminology should never have possible dual meanings" (report #410043)

Analysis of the non-maintenance personnel most often involved in incidents related to the interpretation of the MEL revealed Maintenance Control named most often (53%), followed by Flight crews (37%) Dispatch (26%), Engineering (16%) and the FAA (11%).

5. Communication

Communication issues were identified in 11% of reports. Reporters identified instances of miscommunication about what work had already been done to an aircraft, how a particular task had been done, or about the overall status of the aircraft. For example:

"lead tech returned from the job turnover briefing from the previous shift lead and said nothing about the #2 reverser being still activated for troubleshooting….the airplane was dispatched with the reverser deferred as inop but not locked out per MEL requirements" (report #441911)

"lack of communication between radio elec tech and A&P for proper deferral. A&P assumed that the radio elec tech had pulled indicator bulbs when in fact radio elec tech felt the panel was 1 piece and the bulbs did not or could not be pulled, telling the A&P everything was set" (report# 475899)

"I assisted another mechanic on deactivation of autospoilers per MEL. A miscommunication may have occurred, after the procedure was fully accomplished, resulting in circuit breakers xx and yy being pulled and collared." (report #481759

"I requested MEL for ILS indication on standby indicator….I asked for the lower minimum performance number/downgrade, but was told there was none. I asked again and was told there was none. When I made it back to the office, I called tech services to clarify. Apparently tech services thought I was talking about the ILS indicator on the standby horizon" (report # 459382)

"I called maintenance control…to get an auth for deferring an item on the MEL from a logbook writeup…at no time during my conversation with maintenance control was I informed that there was an open MEL item on the deferred log….also, I was never informed that parts were being sent to fix this problem…I released the aircraft for service… after aircraft departure maintenance control called and talked to my supervisor asking him if we had fixed [items]. To my knowledge and everyone on our end, no one had seen or heard of parts being sent to fix or that that MEL was about to run out of time" (report #413549).

Outcomes

Given the impact non-operative equipment could have on flight safety, one might assume that a majority of reports involving MELs involved critical, or emergency, outcomes. This, however, was not the case. ASRS coding uses a two-tiered strategy to identify outcomes of incidents. The first level is the "Resolution" -- any immediate action taken to resolve an incident, for example, an air turnback, diversion, etc. In the current sample, just 15 reports, or 10% of the 143 reports, identified any such immediate resolution. Of these, 40% involved declaring an emergency, 20% involved either diverting a flight to an alternate air field, canceling a flight, or a return to the gate, 13% a return to the field, 6% required an emergency landing, and 6% a rejected takeoff. (See Figure 5).

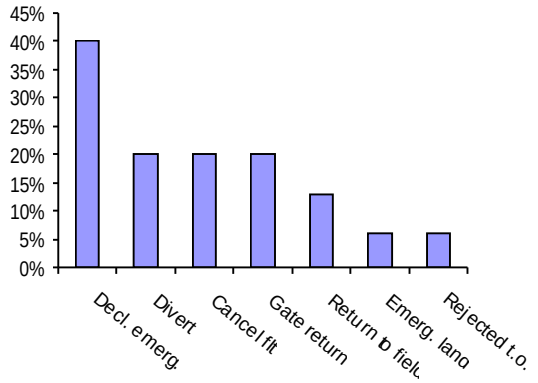

Figure 3. Most frequent emergency resolutions. (Percentages may total more than 100% as some incidents involved more than one resolution).

The second level of outcome in the ASRS report is the "Consequence"-- a less immediate but broader, operational outcome of an incident. Of the 143 reports analyzed, 118 had identified "Consequences". Of these, the majority (48%) had as their primary consequence a Company Review of the incident, while 37% percent led to some form of Maintenance Action being taken and 9% led to an FAA Investigation. A smaller number of reports (n=65) also included a secondary Consequence. Of these, almost all (97%) cited Maintenance Action, with the remaining 3% Cancellation of Flight.

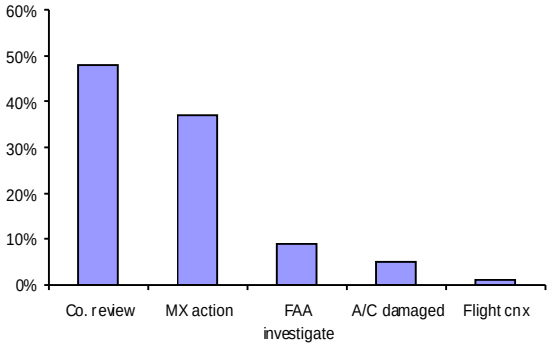

Figure 4. Primary consequences of MEL incidents

Detectors

The majority (53%) of incidents reported involving use of the MEL were detected by maintenance personnel. While this might seem obvious given that this is an analysis of maintenance reports, it is important to reiterate that maintenance forms are not restricted to use solely by maintenance personnel. It is also important to note that there is often a difference between the person who detected an error and the person reporting the event to NASA. It is not uncommon for a reporter to have detected an error made by someone else, or to have contributed to an error of which he was unaware until someone else detected it.

After maintenance, flight crews were the second most frequent detectors of MEL anomalies (36%), followed by the FAA (9%), with a nominal percentage detected by Dispatch (1%).

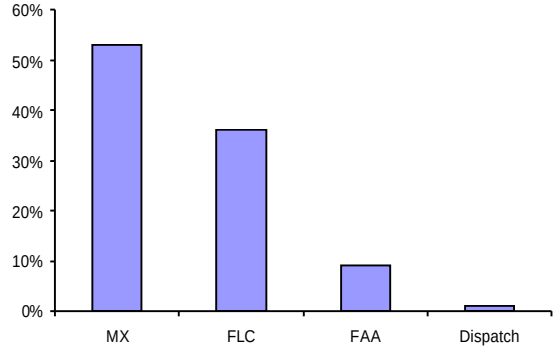

Figure 5. Most frequent error detectors

Perhaps not surprisingly, nearly all the incidents resulting in emergency Resolutions were detected by flight crews. The only Resolution for which maintenance was the detector of the precipitating anomaly was the cancellation of a flight.

Discussion

The most frequently reported error related to the MEL was making or authorizing a deferral that was not in fact permissible under the MEL. This was followed by several errors involving omission of a step in an MEL procedure, such as not locking out or placarding an item or forgetting to make the appropriate logbook entry.

These errors occurred in an environment where there was often pressure to complete tasks within a highly constrained time-frame to maintain flight schedules. In some instances personnel found themselves working on equipment with which they had little experience or training. The documentation to which they referred was at times unclear or poorly organized, thus allowing differing and sometimes conflicting interpretations of the same MEL. Communication regarding the status of the aircraft or the applicability of the MEL often led to mis-understandings or to the mis-application of the MEL.

The relationship between contributing factors and specific error types suggests that both Time and Lack of Familiarity contribute to all error types. Being unfamiliar with a task and rushing to complete it creates opportunity for error across the board. However Misinterpretation of the MEL and Unclear MEL were cited as major contributing factors mainly in errors involving improper deferrals. They were rarely mentioned in errors in which a step was omitted. On the other hand Communication was cited as a key factor in errors of omission, while it was rarely mentioned as a factor in deferral errors.

Given that deferral errors were found to occur across employee groups, while errors of omission occurred almost exclusively within maintenance, these findings suggest that within maintenance, face-to-face communication is utilized and relied upon more than written communication (i.e., documentation) as a source of information. Maintenance is a more shared-task working environment, and mis-communication here can lead to misunderstandings about what has been done to the aircraft, what still remains to be done and who will do it.

When working across groups, however, there is generally more utilization of and reliance on documentation as a source of information. Hence referencing documents that are unclear and interpreting the information they contain without an understanding of how other groups may interpret that same information can lead to misinterpretations between groups and, ultimately, improper deferrals.

Summary

The current study examined ASRS reports regarding the use of the Minimum Equipment List. It identified the most common types of errors reported and the most commonly-cited contributing factors. Relationships among error type, personnel involved and contributing factors were suggested. Future analyses might consider restructuring categories of error and other factors to more clearly define the relationships between these variables and to identify potential intervention strategies.

References

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