

Burian, B. K., & Barshi, I. (2003). Emergency and abnormal situations: A review of ASRS reports. In R. Jensen (Ed.) *Proceedings of the 12<sup>th</sup> International Symposium on Aviation Psychology*. Dayton, Ohio: Wright State University Press.

## EMERGENCY AND ABNORMAL SITUATIONS: A REVIEW OF ASRS REPORTS

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Emergency and abnormal situations in flight operations are relatively rare. When they do occur, though, we would like them handled as smoothly as possible. However, we know things don't always work out as planned. A review of ASRS reports involving emergency or abnormal situations revealed that many complications do occur while flight crews work to resolve their problems. These complications often arose from issues around materials used to assist the pilots in these situations, as well as issues concerning the crews' response to the emergency or abnormal situation. Moreover, it appears that current training practices prepared pilots for only a very small number of the types of situations that actually occurred. Thus, in reports we reviewed, even though pilots usually resolved well those emergency situations for which they had been trained, they often found themselves ill equipped and ill trained for what they had to face.

Nothing can change the quality of a flight or the quantity of pilot workload more quickly than an abnormal or emergency situation. Even a seemingly innocuous light on the overhead panel and a relatively minor abnormality can cause a flight crew's adrenaline to pump and blood pressure to rise. Abnormal and emergency situations are among the most challenging that pilots face during their careers; attention to pilots' proper response to and handling of such situations is typically an important part of their training. However, despite this training and the timely reaction of skilled and knowledgeable pilots, things can and do go awry during emergency and abnormal situations. At times, these things are so specific to the situation that no amount of training or prior preparation would seem to have equipped the pilots for it or lessened its impact as the situation unfolded. Nevertheless, too often, preventable events, actions, and circumstances exist which could have serious repercussions for the outcome of emergency and abnormal situations. A review of incident reports filed with the Aviation Safety Reporting System (ASRS) was undertaken to identify some of these events, actions, and circumstances.

ASRS reports can be submitted voluntarily by anyone in the aviation industry, and subjectively describe the events surrounding a safety-related incident. No attempt is made to verify the events described in the reporter's narrative. Additionally, because the ASRS program is a voluntary one, baseline rates of occurrence of such incidents cannot be determined. However, a reader can generally assume that if one such incident has been reported, it is likely that other similar incidents have also occurred but have not

been reported.

A search of the ASRS database was conducted using search terms such as "emergency" and "abnormal procedure" and slightly over 250 reports filed from January 1999 to July 2000 were identified; pilots had submitted all the reports in this data set. Fewer than half (107) were found to be pertinent to this study, however; the remaining reports typically described situations in which pilots had mistakenly flown through assigned headings, or unknowingly deviated from their assigned course. As such, they did not represent the types of situations that were of current interest.

A team of aviation human factors researchers and Part 121 pilots reviewed the pertinent reports and identified several common themes underlying many of the reports. These themes concern issues around the materials used to assist the pilots in these situations, as well as issues concerning the crews' responses to the emergency or abnormal situation.

One of these themes related to the **availability and accessibility of needed resources**. In the narrative sections of some ASRS reports, pilots indicated that company guidelines did not exist for certain situations – for example, how to respond to medical emergencies. Other pilots described difficulty in actually locating the needed information within the many different documents available to them: the Quick Reference Handbook (QRH; typically used for the compilation of emergency and abnormal or non-normal checklists), Flight Crew Operations Manual (FCOM), Minimum Equipment List (MEL), Standard

Operating Procedures (SOPs), etc. Some pilots indicated that their companies require that they access information from several of these resources to respond to a single situation but that they find it cumbersome to switch between them and to remember the order in which they are to do so. Similarly, several pilots described needing to switch back and forth between normal procedures and checklists and abnormal or emergency checklists as a non-normal situation unfolded.

Some pilots expressed concerns that needed resources were not available to them on the flight deck. For example, one pilot described having to land at an alternate airport and indicated relief that a landing at a different airport, over-flown earlier in the flight, had not been necessary as the company did not provide approach plates to that (and many other) airports – only for those to which the company provided service. (Accession #431847)

Some pilots indicated that checklists or procedures did not exist for some types of emergency or abnormal situations that might be classified as somewhat “common.”

“There was no checklist in the aircraft or company publications that addressed a ‘landing gear cannot be retracted’ scenario. Had there been one, the problem may have been easily rectified.” (Accession #468755)

An issue related to this is a checklist that existed for one but not all phases of flight where it might be needed. For example, one pilot described trying to use a hydraulic failure checklist when hydraulics were lost during taxi-out. The procedure referenced, however, was only designed for use in-flight and the aircraft ran off the end of the taxi-way (Accession #437817).

A second theme discovered through the review of the ASRS reports pertained to **keeping documentation current and cross-documentation problems**. One pilot wrote (concerning electrical fires caused by the seat wiring harness in a type of aircraft):

“My question is ‘Why hasn’t anything been issued informing the pilots about the known problem and a temporary emergency procedure been released?’ The problem has been known for months.” (Accession #476597)

In a similar vein, another pilot wrote:

“Briefing message—stabilizer trim red box.

This message has appeared on MD80 flight plans for at least 5 months, if not 6 months. This is supposedly a critical emergency procedure that is to be committed to memory, yet there has been no change whatsoever to the MD80 operating manual on the subject. No revisions. No change bulletin. Nothing. During the last 6 months, there have been several bulletins issued, yet nothing on this critical red box change. Is the caution text supposed to be memorized? Is the note at the bottom supposed to be memorized? The lack of consistent publication of this red box item is only bound to cause problems for the airline and crews if there is an actual problem.” (Accession #478230)

Some reports described inconsistencies or contradictions between flight crew checklists and procedures, flight attendant checklists and procedures, MELs, SOPs, and other company guidelines or resources related to the same problem or non-normal situation. One reporter described having referred to abnormal/emergency procedures checklists in response to an alert received during taxi-out, as per company procedures. According to the reporter, the checklist indicated that the particular alert they received was listed as a maintenance item that had no flight-related consequences. After take-off, and after again consulting the abnormal/emergency checklists, the crew referred to their aircraft’s MEL. The MEL indicated that they should have had maintenance see to the problem prior to taking off.

“I feel that the current wording in our abnormal procedures manual led us to make this mistake, as this alert is listed as a ‘maintenance’ item not as a ‘no takeoff’ item.” (Accession #471564)

Another pilot reported the following confusion regarding inconsistencies also between QRH procedures and the MEL:

“I knew that there was a procedure in the QRH to use center tank fuel with either the forward or aft center tank boost pump inoperative. Because the aircraft was released with the fuel state onboard, I assumed that this procedure was what we were expected to accomplish. When I looked at the MEL for the center tank pump I had to read it again to make sure I was understanding it correctly, I became concerned because it said that with an inoperative center tank pump, ‘consider center

tank fuel unusable’.” (Accession #465836)

Several of the reports described problems or concerns with **the structure or design of abnormal and emergency checklists** or the QRH. Many made reference to checklists that contain a number of memory items that are to be completed prior to referencing printed checklists; this was particularly the case in reports from pilots who appear to be flying for smaller air carriers. Some pilots made reference to this requirement but did not express concern. Others believe that the requirement to complete some actions by memory could actually lead to greater safety problems than might be prevented:

“Due to the high stress environment and increased likelihood of mistakes, I recommend the QRH procedures not be memory items. The time consumed by using QRH is justified in the higher certainty of doing things correctly.” (Accession #464839)

Deficiencies in the procedures or checklists were identified in several of the reports. Some checklists were described as confusing or unclear or were missing needed action items. Some included all the needed actions but did not provide enough information about how or when they were to be performed, or the ordering of information and actions to be performed within the checklist was problematic.

“A very poorly written QRH emergency checklist, I believe, should be modified and improved.” (Accession #437817)

“The poorly written checklist, with reference to flaps 20 degrees landing buried in the context of the abnormal procedure, caused both pilots to miss flaps 20 degrees reference. Corrective action would be to rewrite abnormal flap procedure in a more bold face format...” (Accession #465060)

“This particular checklist was rather vague but the last thing it said was to ‘consider engine shutdown.’” (Accession #467386)

At times, the checklists and procedures described did not appear to have been designed, tested, and trained for realistic situations, which involve real time pressures. In some reports the checklists and procedures used did not work as intended or resolve the problem. It is unknown if this reflects the degree of malfunction being addressed or a deficiency in the checklist or procedure being used. However, there

were some reports that described incidents in which the proper use of a checklist or procedure, in a situation for which it was intended, actually led to an undesirable outcome:

“Accomplishing the red box item for cockpit/cabin smoke on the ground in the B757 aircraft induces the abnormal procedure of equipment overheat due to the step of the turning off left and right recirculation fans, the left recirculation fan being the primary equipment cooling on the ground. This may be an acceptable consequence in a situation with fire or smoke but could also add to overheating of equipment. I just want to make sure that we have a look at this consequence of turning left recirculation fan off during a procedure on the ground—in flight it does not pose a problem. Also, should we reinstate the left recirculation for equipment cooling, if it is not causing the smoke?” (Accession #473359)

Another theme found in the ASRS reports pertained to **emergency and abnormal checklist usage**. No guidance seemed to exist for many pilots regarding the number of times that a particular procedure should be completed in response to a single occurrence of a situation. The procedure to be used when the landing gear will not extend was completed by one pilot six times in a row.

Some pilots reported that they had not complied with prescribed emergency or abnormal procedures, had skipped checklist items on purpose, or had tried other actions to deal with the situation prior to consulting the checklists.

“Procedures and checklists worked well, but we did not don goggles (and ended up not needing them). The thing about goggles is they must be donned first—before the mask! But procedure/training and habit all result in donning the mask first. Then, if the goggles are required, the mask has to be removed. ‘Smoke Procedure’ should call for goggles first without analysis for need.” (Accession #463186)

In some narratives there was no mention of consulting or using the QRH or checklists upon the completion of memory items, although they may have been used. Other narratives described situations in which the QRH procedures were started but not completed – at times, because of high workload and at other times, because the situation appeared to have been resolved. It did not appear that there was

guidance for the pilots about the degree to which this practice is acceptable, and under what kinds of conditions it might be so.

A theme regarding the **relationship between aircraft problems and flight crew response** also emerged from our review of the ASRS reports. Several narratives described longstanding problems with various aircraft systems that have, according to the reporters, been ignored by their companies. Some of these problems appeared to be “false warnings” and a concern was expressed by many of the reporters that pilots may become complacent in their response to them.

“This has happened to me numerous times in the 7 years I’ve been flying this type of aircraft.” (Accession #426768)

“The cargo compartment smoke alarm system has a maintenance history of false warnings. The frequency of these reports is going to lead some crews to ignore the warnings.” (Accession #426361)

Many different issues related to **crew response to and behavior during emergencies and abnormal situations** were discovered in the report narratives. Many narratives described fights that, effectively, became single-pilot operations as one crew member focused on responding to the abnormality while all regular flight, communication, and navigation responsibilities fell to the other. It also appeared that “abnormals = distractions”; many crew errors described in the reports related to one or both crew members being distracted by an abnormal situation especially during already high-workload phases of flight.

“Checklist for flap procedure was reviewed and discovered to have been misread. The proper procedure was to land with flaps 20 degrees, not 30 degrees as we had.” (Accession #465060)

Some of the distractions were related to the flight crews’ lack of recent experience with hand-flying the aircraft and using back-up instruments.

“We were both very ‘absorbed’ in flying the aircraft by hand as it’s something we don’t often do. In the process of working through the checklist and trying to get the EFIS back up, we ended up approximately 30 miles from SWF at FL330.” (Accession #468861)

Prioritization of duties and distribution of workload in the middle of an emergency or abnormal situation was particularly challenging for flight crews.

“We did find communication difficult and use of oxygen masks, intercom, trying to talk to ATC was a handful. At night made it that much harder to read/accomplish checklist items. Turning cockpit lights on sooner would have helped.” (Accession #472755)  
“The timing of the ... events took place over a time span of less than 4 minutes during a critical phase of flight. Some of the events occurred simultaneously with radio transmissions, configuration changes, airspeed changes and constantly changing altitude.” (Accession #437830)

“In the heat of the operation close to the ground, the captain and crew were faced with applying all of their training, utilizing all available assistance (i.e., emergency procedure checklists), flying the airplane and successfully landing with a failing electrical system. What we learned from this event is that running the emergency procedures checklists may not be a classical situation where one has plenty of time for analysis and application of curative measures.” (Accession #437830)

Such prioritization of duties was even more difficult when the crew was faced with multiple emergencies and had not only to prioritize regular flight duties and respond to a non-normal situation, but also had to prioritize which emergency was to be dealt with first.

“Within seconds I heard circuit breakers begin to pop. It sounded like a popcorn machine in that none popped simultaneously or in any particular sequence. The flight engineer advised that we were losing fuel boost pump electrical power....We lost the equipment cooling fan which led me to believe that a large number of flight instruments were in imminent danger of failure....I directed the flight engineer to check the hydraulic system and anti-skid to ensure that we had adequate hydraulics and braking system to successfully complete the landing.” (Accession #437830)

Some pilots reported serious situations for which they elected not to declare an emergency, although doing so seemed warranted in some cases.

“We experienced a loss of both generators.

Due to the immediate failure of the autopilot and primary flight instrumentation, which froze in the position they were in at the time of the electrical loss, we were required to take control of the aircraft manually and operate using the standby instruments. The activity level on the flight deck intensified as we attempted to determine what the failure was.... We were unable to adhere to the issued clearance to turn to the 280 degree heading.... ATC questioned us as to our heading.... We had not declared an emergency, nor did we feel the need to do so..." (Accession #438348)

In other cases, a few pilots used their "emergency authority" to justify violating company SOPs, typically, after the violation already took place.

"Encountered icing conditions. Switched on all anti-icing.... Wing anti-ice faulted.... Reset wing anti-icing and [it] faulted again.... Approach was apprised of situation and diversion necessity.... An uneventful landing followed at ORD.... What I realized after landing and speaking with dispatch was that ORD was not an alternate. This action on my part may therefore constitute exercise of my emergency authority." Accession # 434589

It was also evident that some confusion exists regarding who can declare an emergency for a particular flight and what requirements pilots will have to meet after an emergency has been declared and the situation has been resolved.

"At no time was an emergency declared.... Upon landing, we found that the tower controller had of his own volition called the emergency equipment to be standing by.... Even though no emergency existed, the fact that the tower controller called the trucks might generate some paperwork that ends up in our local FSDO." (Accession #426768)

There were also reports in which the pilots, or someone else (e.g., ATC), seemed to lack an appreciation for the seriousness of the problem and a few occasions in which the pilots did not assume the authority they rightfully had to override the decisions made by others in order to take actions that were safest for their flights.

"We were told to execute a left 360 degrees turn. We questioned this with Center, but he

said it was necessary for separation. We reluctantly complied since we did not have a need to land immediately. I felt that this was not acceptable, as we were an emergency." (Accession #433902)

Some of the report narratives described instances in which coordination between the flight crew members or between the flight and cabin crews broke down or was not used effectively. For example, in one report, the captain described hearing a loud noise during taxi-out. The cabin crew notified the captain that they too, had heard the noise and smelled a "rubber smell." The captain told the flight attendants that it was probably from driving over the runway centerline lights while positioning the aircraft for takeoff. During climb-out further conversations with the cabin crew occurred and, as a result, the captain decided to return for a precautionary landing.

"I feel we could have been more assertive in getting more information from flight attendants and maybe flight attendants being more assertive with me. A question to ask after an interphone conversation should be 'do you feel comfortable taking off.'" (Accession #474670)

Although not issues of poor crew resource management (CRM) or cases in which the flight crews did not assert their authority, a few of the reports revealed that the behavior of others negatively affected the flight crews' ability to respond to an emergency or abnormal situation.

"While in a vectored holding pattern while we were performing a system 'A' hydraulic failure procedure (we had declared an emergency). ATC advised us of traffic approaching from our right at 500 feet above us, type unknown. Visual contact was made close in.... TCASII RA occurred to monitor descent. We were then given 180 degree turn and as we rolled out, a second TCASII RA occurred 'Monitor descent and then indicated climb.'" (Accession #441860)

Issues related to **company and flight crew philosophies** as well as to **economic, regulatory, and personal pressures** that impacted situation response were also found through the ASRS report review.

"At 3500 feet MSL the aircraft was yawing to the right and vibrating, [this was] followed by a loud bang and flash of white light. The #2

engine failed. We completed all the memory items for engine fire/severe damage inflight and completed all appropriate QRH procedures. An emergency was declared...right after the engine failed....Landing was uneventful and normal. We were told that another aircraft was ready for use to fly....Company advised us there was no [other] crew available. The captain, the first officer, and the flight attendant refused to continue. Duty day 12 hours, 53 minutes, emergency occurred on the 7<sup>th</sup> leg. If we accepted that assignment our duty would exceed 14 hours.” (Accession #478532)

It appeared that for many pilots, the completion of the QRH and abnormal or emergency checklists led them to a “this flight is normal again” mindset. In these cases, the pilots had a “system perspective” (e.g., electrical) rather than a “situation perspective” – the focus was on responding to the particular system abnormality rather than in taking a look at the “big picture” and the implications that abnormality may have had for the flight as a whole.

“At cruise flight level, #2 hydraulic system failed. Crew completed abnormal procedure in manual. Contacted dispatch and maintenance control....We elected to continue to destination with everyone’s approval. Advised ATC of problem and declared an emergency.” (Accession #479512)

In a related vein, some flight crews and companies appeared to lack sufficient appreciation for the effect that an emergency or abnormal situation can have on a flight crew and their ability to respond appropriately during subsequent flights. As illustrated earlier, a few of the reports described companies scheduling replacement flights following a crews’ successful handling of some fairly serious emergency situations. In a couple of the reports, the flight crews described being distracted and even reported making errors on the later flights because they were still thinking of or affected by the earlier emergencies.

Some pilots seemed to feel the need to “continue the mission at all costs.” In a few of the reports, the pilots admitted to being influenced by “get-there-itis” and described flying to final destinations under emergency or abnormal conditions where, upon later reflection, they felt that the safer actions would have been to divert. Finally, a few of the pilots reported pressure from their companies (real or imagined) that

had negative effects on the ways in which they responded to non-normal situations.

“Had there been an actual engine fire, the fear of being punished by my employer for causing a customer delay may have raised safety concerns because of my reluctance to perform the required engine shutdown.” (Accession #465051)

It should be noted that almost one-quarter of the reports (25) described **situations that appeared to have been handled well**; the procedures were well-written, easily used and used as intended; and good CRM seemed to exist between the flight crew, cabin crew, ATC and others.

“All known procedures were followed and were adequate, and prior training for this situation is considered appropriate. The successful outcome of this emergency was due to the professional conduct of the entire crew.” (Accession #464512)

The majority of these well-handled events involved what might be called “textbook” abnormal or emergency situations – those situations that generally involved only one malfunction (as opposed to multiple problems), that were highly trained and practiced in the simulator, and for which well-written checklists existed. There were only 22 reports out of the 107 we reviewed that represented such types of emergencies, however.

“Our simulator training really paid off. This was my first engine shutdown in 20 years of flying and it felt like I had done it a thousand times before!” (Accession #466167)

Thus, the encouraging news is that most flight crews reporting incidents in our data set were able to respond well to textbook situations and the handling of them appeared to go smoothly and as planned. The less encouraging news is that problems existed in responding to even a few of the textbook situations (3). Moreover, the majority of the reports reviewed (85) did not involve textbook situations. They did concern some type of problem with the way in which the crew or others responded to the situation and/or the materials and resources they were to use.

We are currently undertaking a more thorough examination of the issues identified in our review of these ASRS reports to find ways to better support crews as they respond to all types of emergency and

abnormal situations.

#### References

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