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Ramp Incidents Take Toll in Equipment Losses and Personnel Injuries

Flight and ground crew awareness of hazards during ramp operations is critical in further reducing injuries and equipment damage in gate and taxiway areas, a U.S. study says.

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Ramp incidents continue to account for significant equipment damage and personnel injuries, despite recent efforts by airlines to reduce them. Since 1986, the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) has received more than 370 incident reports describing aircraft and equipment damage and ground personnel injuries during ramp operations.

ASRS was launched in 1982 to analyze and interpret data about aviation safety incidents submitted by pilots, air traffic controllers and others involved in aviation, and to inform the aviation community at-large of incidents and trends. Those who submit reports are guaranteed confidentiality.

[Reports are accepted from any aviation-related source — pilots, air traffic controllers, cabin crew, dispatchers, ground crew or maintenance technicians — but approximately 96 percent are submitted by pilots.[2] Of these, airline pilots contribute the majority, but submittals are received from corporate and other general aviation pilots as well as military pilots. Reports can concern incidents anywhere in the world, although the large majority are about incidents in U.S. airspace.

[That pilots contribute the vast majority of reports, compared with the approximately 3 percent of the total submitted by controllers, means that the ASRS data base contains many more records of pilot errors than of controller errors.

[Because they are submitted voluntarily, ASRS reports do not represent a statistically valid sample of all aviation incidents (a problem known as "self-reporting bias"). The numbers, types and percentages of incidents in ASRS records or in a particular study do not represent the numbers, types and percentages actually occurring, reported or not.

[The only reasonable inference is that the number of incidents of a particular type reported to ASRS is the minimum number that actually occurred. Although that number might be considerably lower than the unknowable actual total, it is often all that decision makers need to determine that a problem exists and requires attention.]

A study of 182 reports received by ASRS was conducted to identify the major areas of risk in ramp operations and to identify the flight crew and ground crew performance factors that contributed to these incidents.

To be included in the ASRS study set, an incident had to meet all of the following criteria:

- Involve a ramp operation of a U.S. Federal Aviation Regulations (FARs) Part 121 aircraft, a FARs Part 135 aircraft or a two-person flight crew corporate aircraft;
- Mention damage to aircraft or ground equipment or mention injury to flight crew members, ground personnel or passengers; and,

- Directly involve the flight crew. (The flight crew occupied the cockpit at the time of the incident, and their actions or inactions might have contributed to the incident.)

[Although the events in the study set involved damage to equipment or injury to persons, they were classified by ASRS as "incidents" rather than "accidents" as defined by FARs Part 830.2:

["*Aircraft accident* means an occurrence associated with the operation of an aircraft ... in which any person suffers death or serious injury, or in which the aircraft receives substantial damage. ... *Incident* means an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations. ...

["*Serious injury* means any injury which: (1) Requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes or nose); (3) causes severe hemorrhages [or] nerve, muscle or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.

["*Substantial damage* means damage or failure which adversely affects the structural strength, performance or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component. Engine failure or damage limited to an engine if only one engine fails or is damaged, bent fairings or cowling, dented skin, small punctured holes in the skin or fabric, ground damage to rotor or propeller blades, and damage to landing gear, wheels, tires, flaps, engine accessories, brakes or wingtips are not considered 'substantial damage' for the purpose of this part."]

Eighty percent of the reports were from Part 121 primary air carriers, and 87 percent of the incidents occurred during passenger-carrying operations. Nearly all the incident reporters were flight crew members; only one report from a ground crew member was in the study set. Specific environmental factors were studied to determine to what extent they influenced the occurrence of ramp incidents. The time of day, the month of the year, the location (city and state) and the weather conditions referenced in the study set generally mirrored the distribution of those factors in the nearly 60,000 full-form records in the ASRS data base. Overall, environmental factors did not appear to be directly related to the reported ramp incidents.

The following ASRS report illustrates a typical ramp incident:

> *As I was approaching Gate XX, I shut down the #2 engine (per our Ops Manual). I was momentarily distracted inside the cockpit. … When I looked back outside, I saw about four ramp personnel around one of our gates, so I turned into that gate. One of the ramp personnel jumped up and crossed his arms, so I stopped the airplane. It was Gate XY, not XX. There was enough room to make a turn to the left to taxi over to Gate XX. I added power on the #1 engine. I did not notice the power setting, as I was clearing outside to my left. During the left turn, the jet blast from the #1 engine blew a mechanic off a maintenance stand. It also blew part of an engine cowling off the stand. Perhaps!û I had not been so focused outside, I would have been more aware of my power application. In future situations, I will … shut down and use a tug to reposition if there is any doubt about jet blast. (ASRS report no. 260480)*

The study found that ramp incidents were not evenly distributed between arriving and departing aircraft. The study found that the aircraft was arriving at the gate in 58 percent of the reports and departing the gate in 35 percent of the reports (another 7 percent involved miscellaneous events such as gate changes or power-outs). Different procedures — or lack of procedures — during arrival and departure may account for this disparity.

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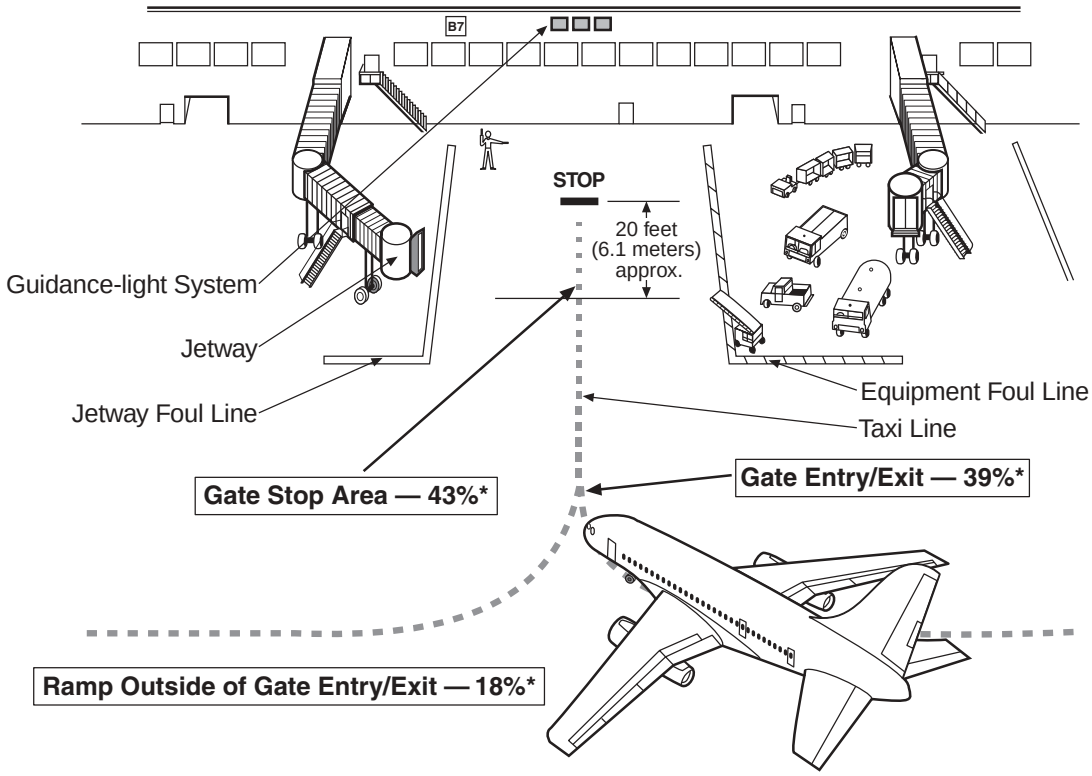
During arrivals, flight crews are often no longer in contact with air traffic control (ATC) or with company ramp-control agents after the aircraft is moved to the company gate area. In addition, the flight crew's communications with the ground crew are likely to be transmitted primarily through visual signals such as hand signals or guide-light systems.

During departures, flight crews are usually in radio contact with ATC or with company ramp-control agents before aircraft are moved from the gates. In addition, they are more likely to be verbally communicating with the ground crews during the early stages of a departure procedure. Despite this level of communication, a misunderstanding placed the following flight crew's Boeing 747 in the path of another B-747, damaging both aircraft:

> *We were cleared to push after Airline A taxied by. We began pushback after an Airline A [McDonnell Douglas] DC-10 passed by, but Ground Control said 'Not that one, the B-727 [Boeing 727].' They instructed the tug driver to pull us back into the gate [to let an Airline Y B-747 pass]. We started forward and … our right winglet was struck by the 747's left winglet. Ground Control had told Airline Y 'Caution for the aircraft pushed out from the gate.' Airline Y [acknowledged] just before he clipped us. Airline Y continued to the runway apparently unaware of the contact until Tower told him. (ASRS report no. 278114)*

Ramp Operations Areas and Incident Locations, Study of 182 ASRS Incident* Reports



* Although the events in the study set involved damage to equipment or injury to persons, they were classified by ASRS as "incidents" rather than "accidents" as defined by U.S. Federal Aviation Regulations Part 830.2.

** Percentage of total number of incidents in study data set.

Source: U. S. National Aeronautics and Space Administration Aviation Safety Reporting System

Figure 1

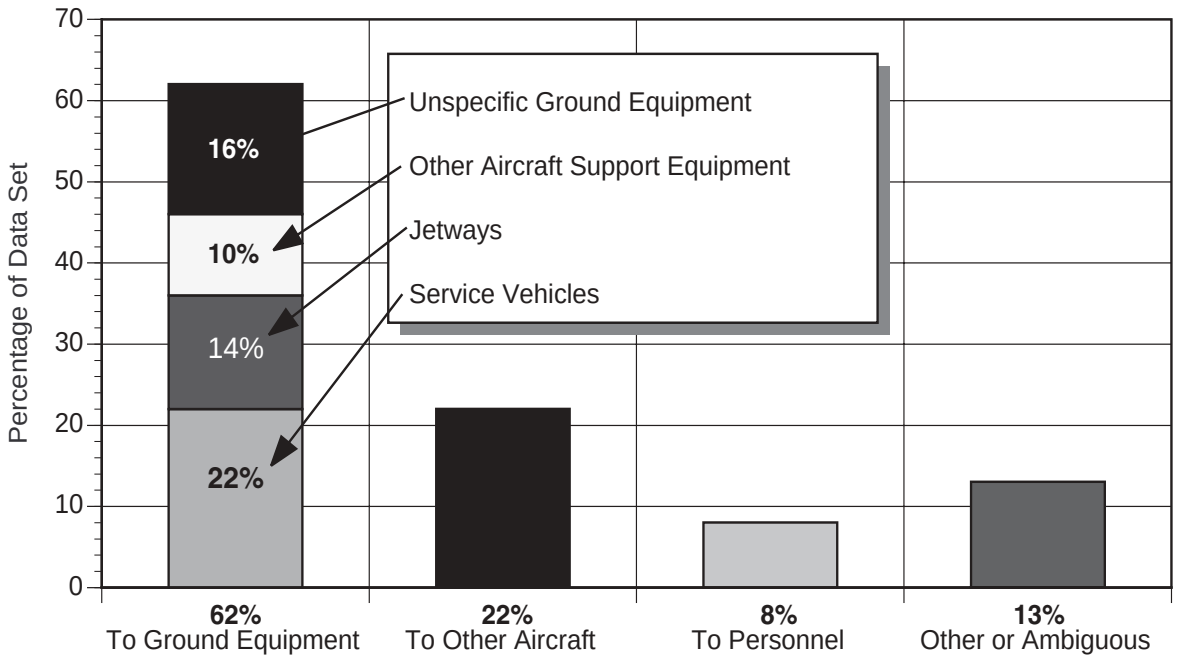
The ramp outside of the gate entry/exit area — adjacent to a taxiway and leading to or from a company ramp — was the site of the incidents in 18 percent of the study set (Figure 1). Aircraft operating in this area are usually in communication with, and under the control of, ATC. Another 39 percent of the incidents occurred at the gate entry/exit area, where taxi lines converge leading into or out of the gate area. In this area, an aircraft is less likely to be communicating with a controlling agency and may be relying on a company ramp-control procedure or ground crew input for guidance.

The largest percentage of the incidents, 43 percent, occurred in the gate stop area within 6.1 meters (20 feet) of the nosewheel parking line. At this point, the flight crews usually rely entirely on ground crew guidance for clearance from obstacles and for final taxi instructions. This guidance is often given in the form of hand signals from ground crews or signals from a parking- or guidance-light system mounted on the terminal building.

There were more incidents in the gate stop area during arrival (48 percent of gate stop–area incidents) than during departure (31 percent), possibly because there are more obstacles for aircraft to avoid as they enter the congested areas next to gates and terminal buildings. Ground crews are sometimes not in position during arrival, increasing the possibility that ground equipment might remain outside the foul line. But there were fewer incidents on the ramp outside of the gate entry/exit during arrivals (13 percent of the outside-gate-entry/exit incidents) than during departures (30 percent). [In both sets of percentages, the remaining percentage was not categorized in the ASRS study because of unclear or missing information in the incident reports.] This may be related to the large number of pushback, power-out and power-turn procedures that occur during departure operations.

Ground equipment and other aircraft appear to be most vulnerable to damage or injury in ramp incidents (Figure 2, page 4). Damage to ground equipment occurred most often in the gate stop area, less often in the gate entry/exit area and rarely on the ramp outside of the gate entry/exit.

Aircraft-to-aircraft damage usually occurred on the ramp outside of the gate entry/exit and in the gate entry/exit area, where taxiing aircraft were sharing a common maneuvering area and were likely to be in radio contact with a controlling



* Although the events in the study set involved damage to equipment or injury to persons, they were classified by ASRS as "incidents" rather than "accidents" as defined by U.S. Federal Aviation Regulations Part 830.2.

Note: Multiple citations are possible in this category; thus, the combined percentage of types of damage is more than 100 percent.

Source: U. S. National Aeronautics and Space Administration Aviation Safety Reporting System

Figure 2

agency. Damage to aircraft at the gate stop area was less common in Part 121 operations than in Part 135 operations.

There were 15 reports of injury to personnel in the study set, and two-thirds of those injured were ground crew members. Although this figure indicates that only about 8 percent of the incidents studied involved personal injury, those injuries represent large financial losses in the form of flight delays, lost employee time and insurance, medical and other associated costs.

Incident reporters stated that they were provided with ground personnel for ramp guidance in 64 percent of the incidents. The marshaler is the "chief" of the ground crew and has primary responsibility for the signals given to the flight crew. The marshaler is often a senior ground crew member who has received specific training for this position. Other ground crew members have varying degrees of training and experience. These positions include:

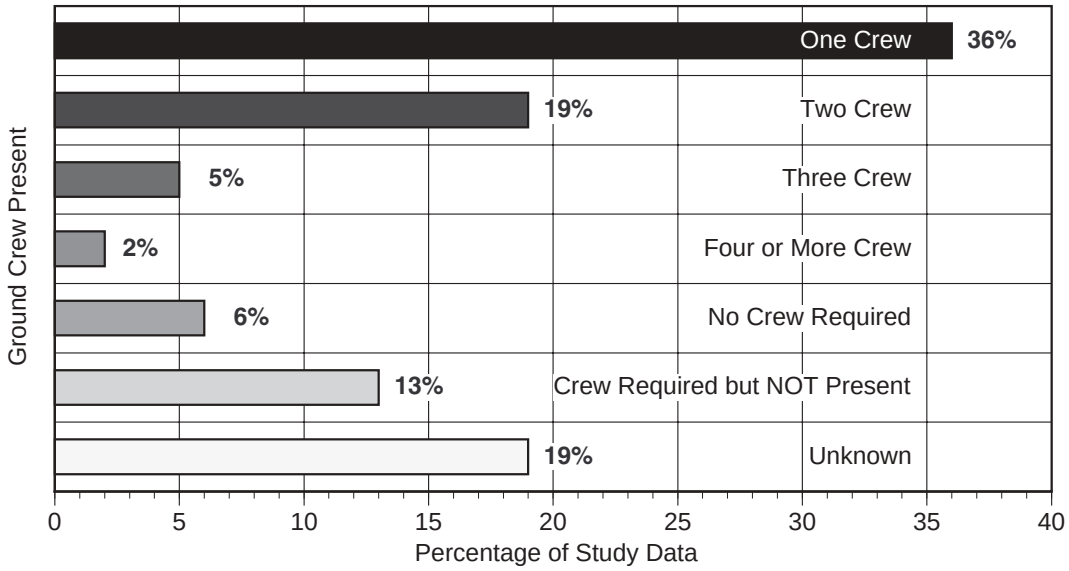
- One or more wingwalkers, who are often baggage handlers or other ground crew members;
- A tug driver, who must watch both the aircraft and the other ground personnel during tow and pushback operations; and,
- A chock handler, whose position may be covered by a marshaler or a tug driver.

Marshalers were present during 56 percent of the incidents, and one or more wingwalkers were present during 17 percent of the incidents. According to incident reporters, marshalers should have been present, but were not, in 12 percent of the incidents.

Figure 3 (page 5) shows the number of ground crew personnel present at the time of the reported incidents. These numbers appear to suggest that "more is better." A small four- or six-passenger Part 135 aircraft on a spacious ramp might have little need for a large ground crew. Nevertheless, a B-747 making its way into a crowded gate may require three, four or more ground personnel to navigate safely. In practice, many companies assign only one or two ground crew members to an aircraft. The number and functions of ground personnel assigned to an aircraft may be gate-specific, depending on gate location or the presence of aircraft parked at an adjacent gate. The study set contained few reports of incidents in which three or more ground crew members were present.

Flight crews reported that the presence of a marshaler might have had a positive effect in some of the incidents in which no ground crew member was present, 13 percent of the total. Incident reporters also concluded that wingwalkers should have been present in 26 percent of the incidents. In hindsight, many incident reporters, like the following captain, clearly recognized the value of having a wingwalker:

Ground Crew Present at Time of Ramp Incidents, Study of 182 ASRS Incident* Reports



* Although the events in the study set involved damage to equipment or injury to persons, they were classified by ASRS as "incidents" rather than "accidents" as defined by U.S. Federal Aviation Regulations Part 830.2.

Source: U. S. National Aeronautics and Space Administration Aviation Safety Reporting System

Figure 3

My aircraft made contact with another company aircraft. There was only one marshaler directing me and no one watching the wing. [The marshaler later] stated that he did not even see that the wings had collided. Had there been a wingwalker in the congested parking area, this incident would not have occurred. (ASRS report no. 260065)

Incident reporters attributed errors to ground crew members in more than one-half of the reports, and they acknowledged errors of their own almost as frequently. The flight crews defined their own errors in two ways: specific tasks or actions that they failed to perform or performed incorrectly (usually a failure to follow procedures); and incorrect or inappropriate responses to ground crew actions or instructions (usually faulty decision making about the hazards involved in following those instructions) (Figure 4, page 6).

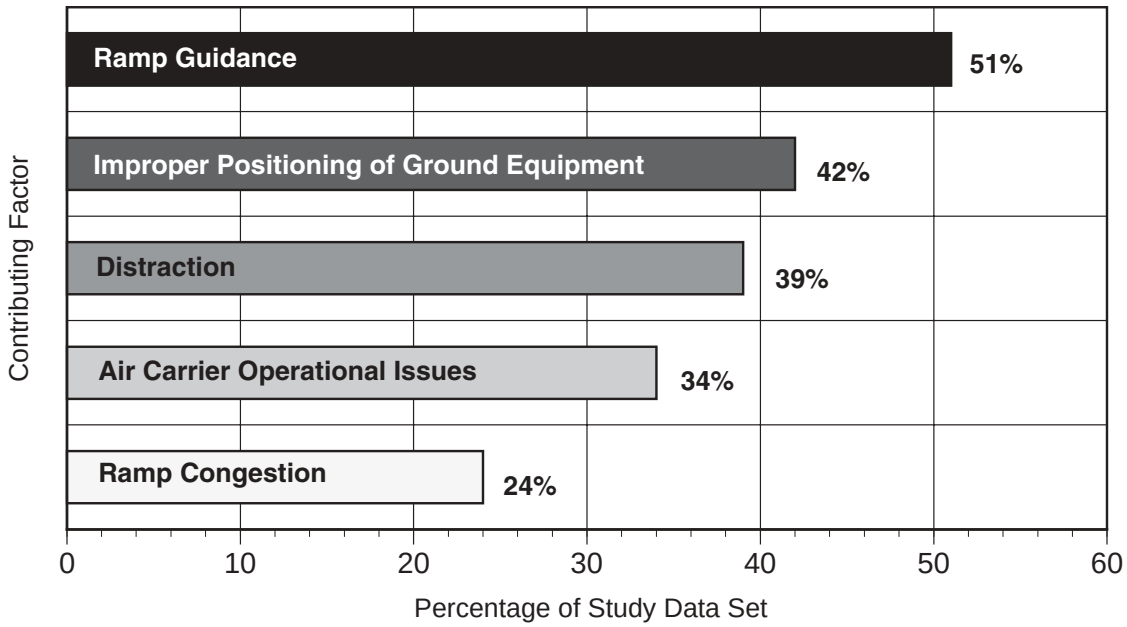
Ramp-guidance issues included incorrect or inappropriate gate assignments; inadequate ground crew staffing during aircraft movement, especially during night or bad-weather operations; and improper taxiing or parking instructions from ATC, a company ramp-control agent or ground personnel. Mechanical guidance systems were also criticized. Marginally visible taxi paint lines, poorly placed lead-in lights and building-mounted light systems were also cited as contributing factors to incidents. Some incident reporters recommended requiring wingwalkers during all ramp operations, to augment mechanical systems.

Communication is an integral part of ramp guidance. Incident reporters were communicating — verbally, visually or both — with the ramp-guidance personnel in 79 percent of the incidents. Nevertheless, 52 percent of the incident reporters said that the communication with the guidance personnel was poor. One particular communication technique, the nearly universal "all-clear" salute, was notably absent in many of the reported incidents. Ineffective communication was a factor in the following towing incident that resulted in aircraft damage:

The Captain had interphone communications with ground personnel, and no communication ever indicated that ground personnel were going to [push] the aircraft. They thought we were aware of the … pushback, even though no signals or verbal communication indicated [that] this would happen. (ASRS report no. 247677)

The study showed that 85 percent of the incidents involved moving aircraft and that 80 percent of these movements were considered "normal." In almost half of these incidents, the flight crew reported that a ground crew member was signaling "come ahead," even after the aircraft had contacted ground equipment. This type of miscommunication is illustrated in the following report excerpt written by a Part 135 captain:

… Taxiing to the right of the taxi line, marshaler was on First Officer's side. Lighting was poor. A commissary truck was adjacent to another truck. I felt I had at least 3 feet of wingtip clearance … [then] I looked to see the wingtip coming off the back of the truck. All the time, the marshaler was still giving me straight ahead. (ASRS report no. 258353)



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Source: U. S. National Aeronautics and Space Administration Aviation Safety Reporting System

Figure 4

The increasing number of flights, stringent aircraft scheduling requirements and efforts to squeeze large jets into gates designed for much smaller aircraft require precise maneuvering and contribute to traffic jams on the ramp. The combination of ramp congestion and a lack of staffing was a factor in the following captain's report on a collision with a cargo loader:

> *[Returning to the gate], we had a single marshaler guiding us in. After just passing through some congested areas on the other side of the airport, I figured we had had practice at judging how close things were to the wingtip. Misplaced confidence … . (ASRS report no. 201610)*

Improper or premature positioning of ground equipment was another major factor contributing to incidents. Incident reporters said that ground equipment was sometimes parked outside the marked areas, thus encroaching on aircraft movement areas. Some incident reporters said that flight crew members are usually unable to determine when ground equipment is parked in the aircraft movement area and must rely on vehicle drivers and jetway operators to keep equipment within the equipment foul lines.

Other incident reporters noted that aircraft-support vehicles and jetways were moved toward the aircraft before their aircraft had stopped at the designated stop point and before the crew had given an "all-clear" signal (usually by turning off the aircraft's rotating beacon). The following report illustrates this:

> *… Ground taxi director directed a stop using a light signal, [1.2 meters to 1.8 meters (four feet to six feet)] short of normal gate position. Very shortly thereafter, a green light indicated continue taxi. After moving about one foot, the aircraft contacted something. A fuel truck had moved forward of the right wing when the aircraft stopped the first time. (ASRS report no. 222895)*

Incident reporters often mentioned distractions caused by cockpit duties, ATC or company communication, checklists and fatigue. Some incident reporters had continued an operation even when something appeared wrong or was blatantly wrong. Flight crews also admitted failing to request a tug to get into or out of tight parking places. The latter two problems may have been the result of schedule pressure or the demand for on-time performance, which were also mentioned by many flight crew members as underlying causes of incidents.

These and other sources of distraction caused a marked reduction of cockpit coordination and crew resource management (CRM) skills. An aircraft's rear airstairs, for example, were damaged when the flight crew became distracted by multiple demands and failed to perform as a team:

> *[This incident was caused by] distractions in the cockpit, plus a desire to operate on schedule. There were several conversations going on … inside and outside the aircraft. Raising the airstairs is a checklist item. … Backup is*

another checklist item which requires the Second Officer to check a warning light. No one noticed the light. The pushback crew consisted of two wing observers plus the individual in the tug … all failed to observe the rear stairs. (ASRS report no. 264692)

Incident reporters identified two types of air-carrier operations management issues. Some cited instances of a crew's failure to follow an established policy or procedure; others referred to a lack of established procedure. In the following report, the crew followed one company procedure — requesting a tow-in on an icy ramp. Nevertheless, misunderstandings about a new towing procedure led to a ramp incident:

Tow crew did not follow their checklist (unknown to us that they even had one for that situation) and did not challenge us to switch off hydraulic pressure to nosewheel. We overlooked it — new situation, no checklist or SOP [standard operating procedure] for it. They hooked up and called for brake release a little sooner than I expected. Result was a broken tow bar connection on the nosewheel. I should have retained command of the aircraft until I was satisfied we were all ready for tow-in. (ASRS report no. 264610)

Incident reporters offered suggestions for reducing the number of procedural errors. They suggested, for example, that pilots be given simulator training in ramp operations and pushback procedures and that flight crews and ground crews receive parallel training (that is, the two groups each get the same information and training). Parallel training would promote a clearer understanding of flight crew and ground crew responsibilities and expectations during ramp and gate operations, some incident reporters said.

Air-carrier managers can help reduce ramp accidents/incidents. The following recommendations are based on this study's findings and on suggestions from a panel of ASRS analysts:

- Require certification for the marshaler and wingwalker positions;
- Provide scenario-based training for ground crews, using ramp-incident reports from the ASRS data base;
- Increase the use of radio communication between flight and ground crews;
- Maintain paint lines, taxiway markings and guidance-light systems in highly visible condition; and,
- Establish and enforce speed restrictions and communication procedures for vehicle drivers.

Ultimately, however, the responsibility for safe operation of the aircraft rests with the flight crew. Regardless of any actual or assumed inadequacy of management or the ground crew, the flight crew must prevent incidents. Flight crews can employ the following preventive actions:

- Perform a flight crew briefing of the gate entry or exit procedure. Follow the established procedure for operation at that gate. Reaffirm cockpit coordination and CRM techniques;
- Maintain situational awareness during aircraft movement. Exercise care when judging ground-equipment clearance;
- Be wary of faded or painted-over foul lines, the use of orange cones to mark foul lines or taxi lanes, and reflections on guidance-light systems;
- If no taxi guidance is provided, consider that a no-taxi situation exists. Wait for an "all-clear" salute or other specific guidance from the person marshaling the aircraft. Similarly, if the marshaler is lost from sight, a no-taxi situation exists;
- Use wingwalkers if ramp congestion is a possibility. One wingwalker is good; two are better. Nevertheless, consider that the marshaler may be focusing on the nosewheel position rather than watching the wingwalkers;
- Be aware that the marshaler may be unable to see the wingwalker(s); and,
- Recognize that ground crews may be unable to communicate verbally with each other or with vehicle drivers.♦

Editorial note: This article was adapted from a report in the June 1996 issue of *ASRS Directline*, which is distributed worldwide by ASRS to identify current operational safety issues.

Reference

1. "ASRS Database Statistics." *ASRS Directline* Issue no. 8 (June 1996).

Additional Reading from FSF Publications

Dell, G. "Pushback Accidents Reviewed to Identify Causes and Prevention." *Airport Operations* Volume 20 (May–June/July–August 1994).

Enders, J.H. "Ramp Operations Hold Key to Overall Flight Safety Level." *Airport Operations* Volume 19 (March–April 1993).

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