THE ECONOMICS OF AVIATION SAFETY

CHAPTER 1

INTRODUCTION

I started out in this business on the wrong foot. I assumed that the Director of Safety carried a fairly big stick and that all he had to do was to point out a safety problem and people would drop whatever they were doing and correct it.

Wrong! Not only did they not correct it; they didn't even pause in what they were doing to tell me they weren't going to correct it.

To make matters worse, I discovered that other managers who couldn't get one of their problems solved would claim that it was a safety problem in order to get a higher priority. Up at the top, where priorities were set, I found that my legitimate safety problems were lost in a sea of fake safety problems.

It took me a year or so to figure out what was wrong. Believe me, it was a tough lesson. If you'll stick with me here, I think I can save you some time.

Let's forget the emotional aspects of safety and look at some cold hard facts. Safety is not a moral problem or an ethical problem or a pain and suffering problem. It is an economic problem. Safety, by itself, generates a lot of sympathy, but very little action. Only the economics of safety generate action. In the entire history of safety, nothing good ever happened unless it was either economically beneficial or mandated by the government. Granted, we are sometimes forced to act on a safety problem for moral or ethical reasons. When that happens, though, it is frequently because we are confronted with a financial penalty if we do not act. Failure to anticipate that situation is usually the result of myopic vision on the part of management or, possibly, failure on the part of the Safety Director to adequately explain this to management. Sorry, but that's the way the system works. I learned that the hard way and there is no need for you to repeat my mistakes. This is one of those things that you don't have to like, but you do have to understand. Money talks. Sympathy doesn't.

As an example, consider how we got into the safety business in the first place. In the 1800s, the industrial revolution was in progress and there was no organized effort to reduce accidents or injuries. The worker injured on the job suddenly had no income and large medical expenses. In many cases he became an instant pauper. If the accident was the fault of the company and he wanted compensation, he had to hire a lawyer and take the company to court, which almost never worked. The company could simply outlast him.

In the late 1800s, an idea, called workers compensation, began brewing in Europe. Basically, it said that the employer should be responsible for on-the-job injuries and the injured worker should receive medical treatment and be compensated for loss of income until he was able to work again. This idea migrated to the United States and by 1930 all states had workers compensation laws on the books. The costs of the program were paid by the employer through a mandatory insurance scheme where the premiums were based on the company's accident record. Suddenly it became clear to the employer that it was a lot cheaper to not have the accident in the first place than it was to pay for the results of it. That economic incentive was the basis for the entire industrial safety movement. Prior to that, there was no incentive. All an accident cost the employer was some sympathy and perhaps a bouquet of flowers for the funeral.

Another example. A major automobile manufacturer got in trouble several years ago based on their calculation that it would cost more to correct a safety problem than it would to pay for the expected accidents. That news hit the street during litigation over some accidents and, as it turned out, the manufacturer had seriously underestimated how a jury would react to that line of reasoning. That miscalculation cost the manufacturer a substantial amount of money.

Nevertheless, there is nothing wrong with the manufacturer's logic. If a dollar spent on safety does not prevent at least a dollar's worth of accidents, he should spend his dollar somewhere else. That makes sense and that's exactly how many executives view aviation safety. "I have more things I could spend money for than I have money. If you want me to spend money on a safety project, you better show me why that's a better use of my money than any other project."

In other words, our entire industry is driven by economic forces; mainly money. Like it or not, you must put safety in those terms or nothing will happen.

Fair enough. Let's start with some basic business concepts.

COST OF RISK

In the business world, we pay others to assume certain risks for us. We call this "insurance" and we do it by either paying premiums to an insurance company who can spread the risk around a little or by being self-insured (government agencies, for example) and setting aside funds to be used to cover risk. Either way, risk has a cost and we are paying for it.

If we never have an aircraft accident, then our cost of risk is the minimum insurance premium that we can get. It never gets any lower and it is a fixed cost of doing business.

If, on the other hand, we do have an aircraft accident, then our cost of risk is the minimum insurance premium plus the excess premium (bad record, you know) plus uninsured costs or losses.

UNINSURED COSTS

The term "uninsured costs" deserves an explanation. Think of it this way. When you have a "fender-bender" in your automobile, you may eventually get it fixed and paid for by someone else's insurance company, but you'll never recover the costs of the time, inconvenience, and aggravation of doing so. Your time has some value as does your inability to use your car while it is in the shop. Also, if the accident turns out to be your fault and your insurance company pays, you can expect to lose your deductible and perhaps pay higher premiums next year. Those are uninsured costs and in the case of an aircraft accident, they can get really big.

Any textbook on safety will talk at some length about the uninsured costs of accidents. The reason is that uninsured costs are generally double or triple the insured costs. In the case of aircraft accidents, that may be conservative. One example is the situation where an airline executive discovered that the real cost of some minor ground damage to an aircraft was not the damage itself. It was the cost of aircraft downtime (loss of revenue) and system rescheduling costs which were nearly 70 times the damage costs. A ratio of 70 to 1 is probably a little high, but it can certainly happen. Accident costs are like icebergs. The direct costs are visible to everyone, but the hidden costs are bigger and underwater where they are not easily seen.

To give you some idea of the numbers involved, typical insurance payouts for a major aircraft accident (1995) were $120-200 million U.S. dollars for hull loss and an average liability of $2.8 million per passenger. One specific example involving a B737 resulted in $35 million for the hull and total liability of $375 million. Because of those costs, that particular airline's insurance premiums are about twice the average for the industry. That ought to be an incentive! (It should be noted that accidents generate insurance premium increases for the entire industry; although the companies having the accidents have by far the largest increases.)

On the other end of the scale, ground damage to aircraft (or "hangar rash" as it is sometimes called) is incredibly expensive. This type of damage is rarely classified as an aircraft accident and, unless someone was injured, it doesn't get reported as a ground accident either. Thus the numbers are not precisely accurate, but best estimates are that the airline industry in the United States pays about $850 million a year for this type of damage. You would think there would be some incentive there, too.

An understanding of these uninsured or indirect costs is fundamental to an understanding of the economics of aviation safety. Let's examine some basic ideas about costs.

We insure ourselves for hull damage and liability. For our own employees, we are already paying workers compensation premiums and we are covered for their injuries. When it is time to report the cost of the accident, we add up all those insurance payments and use that number. We almost never consider the uninsured costs because they are difficult to calculate and they do not necessarily occur with every accident. Furthermore, they are hidden to the extent that we cover them out of some other budgetary pocket and we don't really notice them. If we are going to correctly assess the cost of accidents, though, we have to understand them. Here are some typical uninsured costs of an aircraft accident.

INSURANCE DEDUCTIBLES. The insurance policy on your car requires you to pay the first $300 or $500 (whatever) of any accident. That's called the "deductible." In the aviation business, our insurance deductible tends to be quite high. This is money directly out of our pocket and it is not recoverable. In the airline business, a deductible of about one million on the hull is not unusual.

LOST TIME AND OVERTIME. When an aircraft accident occurs, the flying operation generally comes to an abrupt halt—at least until the dust settles and we are able to get back in business. During this time, though, we are still going to pay everybody who happens to be on duty. In industry, this cost is called "stand-around costs." The production line has stopped and everybody is just standing around—and getting paid for it. Furthermore, the accident is going to generate a lot of work for many of our managers and employees. We are either going to do this work at the expense of whatever we're supposed to be doing, or we are going to pay a lot of people overtime to get the job done. One corporate operator estimated that the aftermath of an aircraft accident consumed two full man-years each of two of their executives. That's an uninsured cost.

COST OF INVESTIGATION. This can get expensive. We are going to assign one or more of our employees full time to the investigation and we are going to pick up all of their travel and living expenses plus salary. We are going to use our copying machines (and time) to furnish any and all documents requested by the investigative team. We may provide some facilities for the investigators to lay out the wreckage or office space for them—all at a cost. If the wreckage is inaccessible, the costs really go up. The National Transportation Safety Board may pay for some of the recovery, but rarely all of it.

COST OF HIRING AND TRAINING REPLACEMENT PERSONNEL. If our employees have been injured or killed and we intend to stay in business, we are going to have to hire and train replacements. There is a cost to this. Ask any personnel director.

LOSS OF PRODUCTIVITY OF INJURED PERSONNEL. Let's suppose that we are a Fixed Base Operator (FBO) offering charter services and one of our pilots is injured in an aircraft accident. That pilot's services had some economic value to us and we lose the value of those services until we can find a replacement. Maybe the replacement will start as a copilot and not be upgraded to captain for several months. Then we also lose the difference in the value of the services of the copilot and the captain. Another example. Suppose we injure one of our aircraft maintenance technicians and we only had ten of them to begin with. Our choices are to do less maintenance, work the other nine longer hours, or hire temporary help. None of those are particularly attractive and there are some uninsured costs there.

Those are fairly simple examples of the hidden costs of injuries. What if we are a corporate operator and one (or several) of our passengers are senior officers in the corporation? Does their injury or loss represent an uninsured cost to the company? You bet!

COST OF CLEANUP AND RESTORATION OF ORDER. Someone has to clean up the mess. Let's suppose that during the aircraft accident, residual fuel was spilled and soaked into the ground. Cleaning that up may or may not be covered by insurance. In any case, cleanup is required by the Environmental Protection Agency (EPA) and it may include removal and treatment of soil, removal of fuel from public waterways, and a replanting of grassland and trees. See also Chapter 26. Within that same subject, suppose we have had fatalities among our passengers. We are probably going to provide travel and lodging for relatives and assist with funeral arrangements. How do we account for those costs? See Chapter 17 for a discussion of family assistance planning.

LOSS OF USE OF EQUIPMENT. This is a big one. If we have four airplanes and we break one, that's 25% of our revenue producing capability. Airlines have discovered that cost of damage is sometimes minor compared to loss of revenue. Actually, this category is almost a hidden problem within the industry. Ground damage to our aircraft costs us revenue in terms of aircraft down time, but we tend to ignore that loss if the damage does not qualify as an accident. See Chapter 23 on Flight Line Safety.

COST OF RENTAL OR LEASE OF REPLACEMENT EQUIPMENT. We may need to lease equipment just to stay in business.

INCREASED OPERATING COSTS ON REMAINING EQUIPMENT. Suppose we have four airplanes and we break one. Initially, we may try to maintain the same flying schedule with three planes instead of four. This is going to result in some unexpected maintenance and inspection costs on those planes. In addition, we may pick up some night and overtime maintenance costs.

LOSS OF SPARES OR SPECIALIZED EQUIPMENT. If we destroy a one-of-a-kind airplane, which is not unusual in this business, we also lose our stock of spare parts and specialized equipment for that airplane--minus, of course, the resale value of the parts.

FINES AND CITATIONS. It happens. The FAA, the Occupational Safety and Health Administration (OSHA), and the Environmental Protection Administration (EPA) are all empowered to impose financial penalties as a result of an accident. Also, as we now know, the FAA can shut an airline down if it feels that it is unsafe.

LEGAL FEES RESULTING FROM THE ACCIDENT. When an aircraft accident occurs, your legal counsel starts the meter running. Protecting your interests is likely to get expensive.

INCREASED INSURANCE PREMIUMS. They always go up after an accident.

LIABILITY CLAIMS IN EXCESS OF INSURANCE. The final settlement may exceed your insurance. Because of that possibility, you may have to put money into escrow now.

LOSS OF BUSINESS AND DAMAGE TO REPUTATION. What did this accident really cost you in terms of your business? It's hard to say. Some major oil companies will not charter aircraft from an operator with a bad accident record. Some passengers will absolutely not fly on certain airlines.

COST OF CORRECTIVE ACTION. This is hard to calculate as an uninsured cost. It is not unusual, though, to be in a situation where you previously had an opportunity to correct a problem at a reasonable cost. Now that you have had an accident, you are forced to take the same action at any cost. Prices are probably higher now and you are in no position to shop around or bargain. The loss is the difference between what you could have paid and what you are going to pay. Recently a Part 121 operator hired over 120 personnel to address flight safety issues *after* a fatal aircraft accident.

These are just a few of the uninsured and hidden costs that result from an aircraft accident. Calculating them is difficult, but it is worth doing occasionally, because it reminds management of what an accident really costs. An awareness of this concept of uninsured costs is essential to understanding the next step.

ACCOUNTING FOR ACCIDENT COSTS

In aviation, just like any other kind of business, managers deal with two types of costs; fixed and variable. Fixed costs are those costs that don't change regardless of how many airplanes we put in the air. In fact, fixed costs are those that we must pay whether or not our airplanes fly at all. We must pay them even if we do nothing to generate revenue. For example, each year we have to pay landing fees, licenses, interest, lease payments, rent on facilities, and so on, and we have to make these payments even if we have no passengers or cargo. We can't do anything about them. We can't make them go away whether we have less income or more income. On the other hand, variable costs are those costs that increase or decrease (i.e. vary) depending on the volume of business we do such as putting more or fewer planes in the air. An example of a variable cost is the cost of fuel. If we put more planes in the air, the total fuel costs increase, payroll for pilots increase, maintenance costs increase, and so on. If we put fewer planes in the air, fuel costs decrease, pilot payroll decreases, maintenance costs decrease, and so on. Variable costs increase or decrease as the volume of business. At some point, if the volume of business increases enough, we lease some more airplanes to accommodate the volume, and our "fixed costs" increase to a new level representing the new lease payments on the new aircraft. They remain "fixed" at that new level regardless of the volume of business. Similarly, if business drops off enough, we get rid of "surplus" airplanes to reduce the "fixed costs" of lease payments. The fixed costs then settle down at a lower level. Needless to say, managers are interested in total cost which is the sum of fixed and variable costs. The goal of top management is simple. Keep total costs below total revenue. Within this context, the cost of accidents is a variable cost if we assume that the more we fly, the more accidents we are likely to have even if our accident rate remains the same. See Chapters 2, 6, and 18 for additional discussion on this subject.

Managers also talk about two other kinds of costs; direct and indirect. Direct costs are those costs directly associated with producing the product. In the case of airlines, those would be the costs directly associated with flying passengers and cargo. For the planes to fly, you must have planes, pilots, cabin crew, ground crew, fuel, and so on. A manager sitting back in an office somewhere is not a direct cost. Planes will fly with or without that person, but that person, nevertheless, generates costs. The dollars spent on people, buildings, light, heat, leases, insurance, training, planning, conferences, computers, telephones, photo copying, advertising, public relations, safety and so on, which don't directly contribute to flying planes are called indirect costs or "overhead." A certain amount of overhead is essential to running an airline or any other company, but these costs are not directly related to a product; they are indirectly related to it. In some cases, whether a cost is a direct cost or an indirect cost is a judgement call. That is why organizations hire accountants or lawyers, which are another example of overhead costs. In most cases, overhead costs are fixed costs and direct costs are variable costs.

In the aviation industry, the cost of excess premiums and uninsured losses runs about five percent of total costs—not an unmanageable amount. However, since most companies make a net profit (total revenues less total costs) of only five to ten percent, that's a number that should get the attention of most managers. When we talk aircraft accident prevention and aviation safety, we are talking about something that is a cost that we can reduce. It deserves, therefore, a large portion of our interest, time and energy. That's what we mean when we say safety is an economic issue.

TALKING WITH MANAGERS IN THEIR OWN ECONOMIC LANGUAGE

Most managers are too busy running a company to take the time to learn the language of safety even if they wanted to—and typically they don't. So safety managers have to learn how to talk to managers in an economic language that managers understand. This means you have to learn to talk in terms of revenue, direct costs, overhead, and profit. Managers call this talking in terms of earnings statements or "profit and loss" statements. This statement is a summary statement of how income and expenses compare or how revenues and costs compare. The format may vary somewhat, but a typical format might look like this:

Revenue (income from sales of product)

– Costs of Goods Sold (COGS, direct costs)

= Operating Profit (revenue minus direct costs)

– General and Administrative Costs (overhead, indirect costs)

= Net Profit or Loss (operating profit minus indirect costs)

Since managers are interested in "net profit" they constantly try to increase revenues and decrease direct and indirect costs. Even if your company is a government agency or a non-profit organization, management is still driven by a similar approach to finances. They just don't use the term Net Profit. The terms Budget Surplus or Deficit are used instead.

So where does safety come in?

If an aviation safety manager can approach top management and propose a safety program that can increase revenues, decrease direct costs, and decrease indirect costs, any sensible President or CEO should be eager to listen. Unfortunately, most safety managers don't talk that way, yet most aviation safety programs that are any good will do just that. They can help increase revenue because people will want to fly on a safer airline or they can prevent a decrease in anticipated revenue because people are worried about your airline's safety and decide to stop flying on it. Aviation safety programs can also decrease both direct and indirect costs. To compete with all the other demands on an organization's resources, such as marketing, public relations, training, and so on, safety managers must be able to talk about the financial impact of their proposals on the bottom line (net profit/loss or budget surplus/deficit.)

Let me illustrate that with an example. Suppose you are proposing a safety program that will cost $100,000 which would be an indirect cost. In the long run, though, it will prevent a loss of $500,000 in passenger ticket sales, cut direct costs by $500,000 and cut indirect costs by $300,000. If you can support those claims, it won't take a manager long to figure out that your proposal represents a net bottom line gain of $1.2 million. That's a substantial return on investment and it makes your aviation safety program competitive with all the other programs seeking funding.

Can you relate your aviation safety program to revenues, direct costs, and indirect costs? Yes. Your company is probably full of people who already know how to do that and you won't have to look far for help. Will this approach work in all cases? Of course not. It merely levels the playing field and allows you to compete for scarce company resources.

If you are sold on this approach, then one of the ways you could define safety is that it is a means of producing a return on investment. Not only does spending money eliminate the cost of doing something wrong; it eliminates the cost of doing something twice when it could have been done correctly in the first place. As long as what you save is larger than what you spend to achieve the savings—which is almost always true in aviation safety—you are in a good position to compete for pieces of the company's budget pie. That idea works out nicely with some ideas in later chapters about where safety fits in your company.

Beyond economics, there are some other good reasons for having an aviation safety program.

LITIGATION

These days, having an aviation safety program won't necessarily keep you out of court, although it ought to help. If you do get involved in litigation, consider that at some point the opposing attorney is going to ask about your company's attitude toward safety. You, naturally, are going to testify that safety has a high priority in your organization and that you are absolutely dedicated to a safe operation. OK so far, but how are you going to handle the next question? "Would you please show the jury exactly what your safety program is and how it is managed?" If you don't really have a safety program, that's a tough question.

PUBLIC RELATIONS

The existence of an aviation safety program ought to be marketable. Some companies are reluctant to mention the word "safety" for fear of scaring the passengers, but they are wrong. Thanks to our friends in the news media, the public already has a strong suspicion that airplanes are dangerous and they are naturally suspicious of any organization that tries to pretend that they aren't. The fact that you have a strong safety program and are genuinely concerned about your customers ought to get you more business, not less. In Profit and Loss Statement terms, you get more revenue.

If an accident does occur, you can expect your safety program to be put under a microscope; not only by the news media, but by the regulators and investigators.

MISSION

Maybe you are operating aircraft for a government agency and don't have to worry much about profit or litigation or customers. Try this.

During World War II, we (the United States) geared up our production capabilities and we were manufacturing airplanes at a rate that is unbelievable even today. We could build an airplane much faster and cheaper than we could train a pilot to fly it. Consequently, the loss of an airplane meant very little to us. There were plenty more where they came from and we had more of them than we could actually use in any theater of operations. Our ability to complete the mission seldom suffered from a lack of airplanes.

This attitude prevailed well into the 1950s and 60s and it is still alive and well today in many government organizations. The truth is that there is no bottomless barrel of airplanes and there hasn't been for some time. You were given X number of airplanes to perform a particular mission and if you destroy one, you are expected to perform the same mission with one less airplane. We only bought so many planes and there are no spares. If you break enough of them, you are out of business, because you can no longer perform your mission. In this respect, inability to perform the mission ought to have about the same effect that inability to produce revenue has on the commercial operator. The results are the same.

SO WHAT DO WE DO?

There are really only two choices. We either need an aviation safety program or we don't.

WE DON'T NEED AN AVIATION SAFETY PROGRAM. This used to be a common reaction, since aviation safety programs were not mandatory. One airline, for example, decided not to have a formal aviation safety program because, "In this airline, aviation safety is a fundamental part of everyone's job." To prove that, they changed all of the titles of their executives. Now we had the Vice President for Operations and Safety; the Vice President for Maintenance and Safety; the Vice President for Passenger Services and Safety; and so on. It was, to put it bluntly, all lip service. The airline's real interest in safety didn't go much beyond the titles on the offices and on the stationery. Everyone may have been involved, but no one was responsible. The Vice President for Ops and Safety, for example, didn't mind having safety as part of his title, but he had no plans for committing any portion of his workday to it. He had plenty of operations problems to keep him busy.

That's probably an extreme example, but it is easy to spot an organization that does not have a safety program. There is no internal reporting system; no deliberate selection of standards; no investigation or resolution of incidents or hazards; and (worst of all) no knowledge on the part of top management as to whether things are safe or unsafe. Since they haven't had any accidents recently, they assume that things are safe and they don't really need a safety program. As we shall see, that is not a good way to measure safety. If they do have an accident, it is not unusual for them to rush out and hire someone to become an instant vice president for safety. This doesn't hurt and might even help; but it's a little late.

The actual requirement for an aviation safety program in the United States is not well defined. If you are operating under FAR Part 121, you are required to have a Director of Safety (FAR Part 119.65), but it does not specifically say that you must also have an aviation safety program. Obviously, that was not the intent of the requirement and that oversight was, in some respects, corrected in 1999. A description of what the FAA expects to find in Part 121 operator's safety program is covered in Chapter 4. You may choose to argue that an aviation safety program is still not technically required because it is not specified by a Federal Air Regulation. Perhaps, but that is not going to be well-received as an explanation of why you don't have a safety program.

WE DO NEED AN AVIATION SAFETY PROGRAM. Good. You're convinced. That's probably why you are reading this book. Let's approach this logically.

HOW BIG A PROGRAM DO WE NEED? That depends on how big we are. How many planes do we have? How many different types? Do we operate out of one central location like a corporate flying operation or are we dispersed like a helicopter operator with several hospital EMS contracts? Do we fly locally, regionally, nationally or internationally? There are some fundamentals that go with any program, but there are some program elements that we may be

able to do without. Remember, we are going to build our program to meet the needs of our organization.

WHERE ARE WE GOING TO PUT IT? Interesting question. Good people can make any organizational structure work. Poor people will fail in the best of organizations. Some organizations, however, will work better than others and we are going to discuss that.

WHAT WILL IT DO? Another good question. We don't need an aviation safety program just for the sake of having one. That could be worse than no program at all. We ought to have some expectations, goals, or objectives for it. If we don't know where the program is supposed to go, how will we know when it gets there?

WHO WILL RUN IT? Do we need to go out and hire a full time Director of Safety? Maybe. If we are operating under FAR Part 121, that's exactly what we need. The rest of us are going to assign one of our pilots or maintenance supervisors to handle aviation safety as an additional or collateral duty. Does that work? Yes, it can work quite well. We'll discuss that. Can the program be combined with some other program such as security or workers compensation? This is discussed at some length in Chapter 4. The short answer is that safety does not combine well with ongoing activities that are likely to take precedence over it. If, for example, you were suddenly handed the job of Safety and Personnel Administration, which part of that do you think would consume most of your time?

HOW DO WE GET STARTED? Easy. Here's our first list of things to do.

1. Decide who's in charge. Where do we place responsibility and authority?

2. Determine the scope of our program. How big a program do we need? What will it include?

3. Agree on program policy, goals and objectives.

4. Get organized. Assign responsibility. Decide where in our organization we are going to fit the aviation safety program and who is going to run it.

5. Pick the elements that will make up our aviation safety program. Describe how the program elements will work. Write all this down and publish it as the company aviation safety program.

6. Determine how we are going to measure the success (or failure) of our program. How will we know if it is working?

Does all this sound like an exercise in management? It should, because it is. Good aviation safety programs are managed the same way any other successful business activities are managed. That's what the rest of this book is all about.

DISCUSSION QUESTIONS

1. Let's suppose that one of our airliners is parked at the gate and being serviced. The flight crew and passengers are not on board. The catering truck is mis-positioned and, as it is elevated, it damages the fuselage skin near the right rear door. There are no injuries, but the damage requires repair. Technically, this is not an aircraft accident (See Chapter 3) because there was no one on board intending to fly. It isn't even an industrial accident (OSHA) because there were no injuries. Suppose, though, that you are the Director of Safety for this airline.

   What, if anything, are you going to call this event?

   Will it be reported? Investigated? By who?

   What are the direct (insured) costs of this event?

   What are the possible indirect (uninsured) costs of this event?

2. You are the Director of Safety for an airline and you are recommending installation of a new piece of safety equipment on all of your aircraft. The FAA will probably not make it mandatory; at least not for several years. What arguments will you use in your recommendation?

3. The president of your organization has decided that there will be a full time Director of Safety and you're it! The president has not decided (or doesn't know) what a Director of Safety is supposed to do, so you have the opportunity to define your job for him. What are you going to tell him?

AVIATION SAFETY CONCEPTS

CHAPTER 2

SAFETY FIRST

The slogan "Safety First" has been around a long time and is probably the result of some long-forgotten safety manager's efforts to bring emphasis to the safety program. It sounds good, but, unfortunately, it isn't true and never has been. Belief in it has led many a safety manager down the wrong path. It implies that the mere mention of safety will make everyone drop what they are doing and focus exclusively on safety. Some managers who can't achieve an objective by any other means have been known to add the word "safety" to the objective in the hope of getting a little more attention. For the reasons stated in Chapter 1, it doesn't work that way.

All flying organizations were formed to achieve some goal or objective—and it wasn't safety. Perhaps we have a mission to perform or maybe we're hauling passengers or cargo and trying to make money for our stockholders. Whatever we're doing, our primary objective is not to just be safe. If it were, the obvious way to achieve that objective would be to chain the airplanes to the ramp and not let anyone fly them.

Safety certainly fits into our objectives somewhere, but its role is that of supporting the primary mission or objective and helping to get the job done-safely, but done! The old time industrial safety inspector (who really believed that safety was first) is often pictured running around with a handful of red tags and padlocks. By shutting down operations and taking equipment out of service, he was actively helping to not get the job done and he was at least partially responsible for the reputation safety people have among some managers.

In the aviation business, that approach just won't work. The first thing we have to do is to put safety in perspective and decide exactly where it fits in our organization and what level of safety we need. It clearly belongs somewhere above the lip service level where we have no intention of letting safety influence operations, but below the number one objective level where we let safety drive the operation.

Safety is actually a method of controlling costs (See Chapter 1). It allows us do whatever we're doing repetitively with minimum damage to our equipment or injury to our personnel. It assists management by developing the most efficient method of accomplishing a mission with the least risk. The aviation safety manager is in the business of actively helping to achieve the organization's objectives.

SAFETY VS MISSION

Isn't there an inherent contradiction between aviation safety and (say) a military combat mission?

It would certainly seem so and we have certainly treated it as a contradiction in the past. In World War II and Korea we literally threw away the safety manual with the attitude that, "This is combat. We don't have to be safe anymore." And we weren't. Our accidental losses exceeded our combat losses and not by just a little bit. In World War II we lost more pilots in training accidents in the United States than we did in combat in all theaters of operation. Many of us think that it was even worse. Combat losses were somewhat expected and acceptable while accidents generated a lot of unpleasant paperwork. There was a definite tendency to misclassify accidents as combat losses.

Along came Vietnam and this type of thinking started to change. It became obvious that we could not afford that volume of accidental losses and still have anything left to fight with. The war in Vietnam included a fairly strong aviation safety program, which didn't cure the problem by any means, but it took a pretty good cut at it. It did keep the accidents within the same general range as the combat losses. One lesson learned from that era is that whatever safety standards we impose upon ourselves in peacetime ought to work equally well in combat. If they don't, they will be ignored.

The war in the Persian Gulf was a significant improvement. United States aircraft accidents (non-operational losses) were less than the combat or operational losses—which were very few indeed. That is a remarkable achievement and one that contributed significantly to the outcome. If our aircraft accident rate had been anywhere near that of WWII, we would have been out of business in a few days and there is some doubt whether the American public would have supported continued involvement. It is clear that aviation safety was taken very seriously in the Persian Gulf. Since the Persian Gulf, military combat-related aircraft accidents have been few in number. Those that have occurred have been reported and investigated as accidents; not combat loses. In the opinion of the author, this was due primarily to significant changes in training as a direct result of lessons learned in the war in Southeast Asia. Training must closely match the realities of combat. It is further the author's opinion that basically dangerous activities can be done safely if the risks are correctly identified and minimized. A good example is inflight refueling. That's an obviously risky activity that is done routinely and safely. The procedures are well developed and they work equally well in peacetime training or combat operations.

This brings up a point that is applicable to any flying operation military or civil. Many of our processes and procedures in both operations and maintenance came about because of some form of risk management. They are really safety standards, although that's not what we call them. They were developed as a result of some safety problem or resulted from the recommendations of a safety manager. Regardless of what we call them, they have to be practical—or they'll be ignored in favor of getting the job done.

BLOOD PRIORITY

This term has been around for a long time in the aviation safety business and it is sometimes called, "Tombstone Safety." It is still used and it is still generally true. It refers to the idea that it is a lot easier to get something corrected if you have just had an accident that has killed someone—there is literally blood on the accident report. The corollary to this is that it is difficult to get something corrected if it has not caused an accident. This is the, "If it ain't broke, don't fix it," mentality. That's a cute saying, but we can't operate airplanes without maintaining them. We do a lot of aircraft maintenance that is purely preventive; not corrective. Likewise, we can't pretend that we have an accident prevention program if we are unwilling to correct hazardous situations that haven't (yet) produced an accident. To quote an old safety adage, "If you need an accident to prove that you have a problem, then you are part of the problem."

KNOWN PRECEDENT

This is another term that has been around a long time. This is the idea that there aren't too many new causes of accidents. There are new technologies, to be sure. Composite structures don't fail in the same manner as metal structures, for example. The root causes of the failures (overstress, maybe) tend to remain pretty much the same. Part of the aviation safety manager's stock in trade is in knowing, generally, what has caused accidents in the past. This provides the answer to the question, "Why correct it? It hasn't caused an accident yet." Answer: "Yes it has. It just hasn't caused one here—yet."

THE RANDOMNESS OF DAMAGE AND INJURY

When a hazardous situation occurs, we have no way of predicting the results of that situation. Take an engine failure. Maybe the fuel pump failed and the engine just quits. What happens next is strictly random and depends entirely on what we happen to be doing at the time and how badly we need that engine. The results can vary from a major aircraft accident if it occurs on takeoff to a mere nuisance if it occurs while taxiing. Keep in mind, now, that this is the same engine and in all cases it fails for the same reason. Question: Which failure was most important and deserves a full scale investigation and correction? Answer: What difference does it make? One failure did result in serious damage and injuries, but the other one certainly could have had the same result. Does the fact that it didn't mean that we don't have to worry about it? Of course not. Any engine failure should be treated seriously as it obviously could have had disastrous consequences under different circumstances. As an example, engine failures on landing roll-out may not be taken seriously—until someone needs that engine for a go-around. It doesn't make much sense to wait until the failure kills someone before we investigate it and correct it.

But isn't that exactly what we do? Our investigation and correction activities tend to be based on the amount of damage and injury—which is random. We don't really have accident prevention programs; we have accident correction programs.

The basic problem is that all of our definitions of an accident (Chapter 3) include some degree of damage or injury. If the event doesn't involve damage or injury, it may get some attention, but it most likely will not. Thus our efforts tend to be focused on the results (which are random) instead of on the event itself.

There are some strong feelings among aviation safety professionals that we should change that; and perhaps we will. Because of the excellent safety record, aviation, as an industry, could probably make this change more easily than any other industry.

Until that happens, though, the best approach is for aviation organizations to build strong incident and hazard reporting programs. That will work and those techniques are covered elsewhere in this book.

Let's summarize by making a few points about our present focus on damage and injury.

- There is very little correlation between any particular event (or hazard, if you prefer) and any resulting damage or injury. In aviation, as a matter of fact, an accident involving damage or injury is the least likely result of any event. The degree of damage or injury is a matter of chance and may be anything from severe to minimal.

- Concentrating our investigation and correction resources on a random and unlikely result is bound to be inefficient. In some cases we are going to spend our money foolishly trying to correct something that has a very low probability of ever happening again. Consider a Military KC-135 which had what should have been a very minor taxi accident involving a wing tip hitting the tower supporting a set of parking ramp lights. Unfortunately, the tower began swaying and, due to its design and the weight of the lights, it collapsed on top of the KC-135 doing an immense amount of damage. Because of the damage, the accident generated a large investigation and a thick report. Regardless of the amount of damage, it was still nothing more than a taxi accident and it should not have taken very long to figure out what happened and how to prevent it. In other cases, of course, we are going to miss the opportunity to fix something because we are generally unwilling to spend much of our time on things that don't produce damage or injury. In the case of the KC-135, we obviously could have straightened out our taxi procedures without waiting for a plane to hit something.

- In theory, any particular event has a certain built-in probability for disaster. In aviation, this probability is usually low, but it certainly exists. If we were able to calculate these probabilities with any accuracy, we should apply our preventive efforts to those with the highest likelihood of disaster regardless of whether that disaster has ever occurred. On the other hand, we should not waste our money trying to prevent something of very low probability even though we realize that a disaster is still technically possible. The pole could still fall on the airplane, but how often do we think that's going to happen?

- Aviation safety needs to be "event oriented" and not "result oriented". Aircraft accident investigations are a part, but only a small part, of the broader field of aviation safety.

ZERO ACCIDENT RATE

Is it possible to achieve a zero aircraft accident rate? Sure—theoretically. If each accident is individually preventable, then they are all collectively preventable. There are no (or almost no) accidents that can be truly termed, "Acts of God." Therefore, a zero accident rate is achievable. It's a good goal. In 1995, the Secretary of Transportation for the United States established that as a goal for commercial air transport. That was not a realistic goal and it has since been revised as discussed in subsequent chapters. There has been some progress, but we have a ways to go.

Back to the idea of a zero accident rate, there are two factors that we ought to recognize and accept. First, the risk in any operation is never zero. It may be very low, but it is always a positive number. Since the risk never goes to zero, neither does the accident rate. It just gets very low.

This would seem to argue that we could never achieve a zero accident rate. What actually happens is that we drive the rate down to such a low number that the mathematicians refer to it as "a number so small as to be indistinguishable from zero." Translated, that means that it should never happen.

Can we do that with all aircraft accidents? Not yet. We can probably do it with certain types of accidents and we should. We could, for example, drive runway incursion accidents down to one of those numbers "indistinguishable from zero." When we have a runway incursion accident, we seldom learn anything we didn't already know. We just haven't applied that knowledge to preventing them. We are in the process of reducing CFIT (Controlled Flight Into Terrain) accidents down to one of those low numbers. With the Enhanced Ground Proximity Warning Systems available, we can see daylight at the end of that tunnel.

Other types of accidents, landing accidents and loss of control accidents for example, will require more work.

The GPWS story is an interesting one. In Chapter 1 we stated that safety improvements only occur if they are economically beneficial or mandated by the government. The original GPWS had no apparent economic benefit and it took a lot of years before the FAA required it. Even then, it was only required for the type of aircraft which could show a positive benefit under our Cost-Benefit Analysis requirements. See Chapter 18. In actuality, there are some economic benefits to the GPWS, particularly the enhanced version. We should have been arguing those benefits instead of depending on the FAA to act.

The second factor affecting a zero accident rate involves economics. Preventing accidents involves some expense and the costs go up as the rate goes down. It takes money, time, and effort just to maintain a good rate. It takes even more to lower it. At some point, an additional dollar spent on prevention does not prevent a dollar's worth of damage or injury. At that point, an organization's enthusiasm for spending money on prevention starts to drop off. We should mention that no organization has yet reached that point or even come close. A dollar well spent on accident prevention is still one of the best investments a company can make.

Taking those two factors together (the fact that we cannot eliminate all risk and that prevention has a cost of its own), a zero accident rate does not seem likely. In 1996, a goal of reducing global hull loss and fatal accident rate by 50% by the year 2007 was established. That is much more realistic and, throughout the world, a lot of organizations are working to achieve that. It will be difficult, but well worth the effort.

THE CONCEPT OF CHANGE

If we are going to prevent something from happening, we are going to have to change something. Prevention requires change. If what we are presently doing is producing more accidents or incidents than we want, we are going to have to do it differently, or use different equipment, whatever. If we don't change something, we are going to continue to have those same accidents and incidents. To quote one anonymous bit of wisdom, "If you continue to do what you did, you are going to continue to get what you got!" Put another way, "If your tree is producing apples this year, don't expect peaches next year."

Now, that would seem self-evident; maybe even a little simplistic. It can't be too simplistic, though, because there are a lot of people out there who either don't understand it or don't believe it. That disbelief is what makes the whole science of accident prediction or accident rate projection work. It is very easy to take last year's accident rate and next year's projected flying hours and predict next year's accidents. This can be very accurate providing we are confident that nothing is going to change between now and the end of next year. That is usually a very good bet and we will look very smart.

We do things the way we are doing them because that's the way we've always done them and we like it that way. Aviation is full of activities that make no particular sense, but are extremely difficult to change. Consider, for example, the 360 degree overhead approach favored by military pilots. This approach was developed during World War II for safety reasons. The reciprocating engine was not particularly reliable (compared to today's jet engines) and we invented the 360 overhead to get the plane safely on the runway with or without the engine running. Now, with high performance jets, we still fly the pattern, but we have forgotten why. We fly it because it looks good and we've always done it that way. Even though it is not a particularly efficient pattern for either weather or fuel conservation and it no longer serves any emergency purpose, we have no intention of changing.

> **AUTHOR'S NOTE:** This still generates argument among the gray-haired pilots of my vintage. It is generally true that the 360 overhead is the most efficient way to recover a flight of aircraft in good weather if fuel is not a problem. Otherwise, the most efficient way to recover them is to have approach control split them up at altitude and bring them straight into the runway. That uses the least fuel and works in any weather. This controversy points out a problem common to the safety business. People who are emotionally attached to a procedure can always defeat someone who is merely armed with the facts.

Making predictions and identifying what must or should be changed is easy. Getting people to actually do things differently is difficult. Even good changes that benefit everyone and make life easier will be resisted. People like the way things are and they really don't want to change.

As an example of this, think what the business world must have been like before we had computers and word processing systems. If you were there (and I was) you almost had to hold a gun on people to get them to use the new technology. Even today there are probably some managers who still adamantly refuse to have anything to do with computers. They've always scribbled out their correspondence on a yellow pad or dictated it to a secretary and they like it that way.

Taking this idea one step further, if prevention requires change, the person responsible for prevention must be someone who can make changes. This answers the classic question of who is responsible for accident prevention in an organization. It is someone with line authority who can make changes. It is not someone with staff authority who cannot.

This concept should set the tone of the relationship between the aviation safety manager, who is a staff person, and any of the line managers. Here's how it goes.

> If the accident/incident situation within your organization is not acceptable to you (the line manager), then you are going to have to make some changes. Prevention always requires change. As a specialist in aviation safety, I am here to recommend what changes should be made and how they should be made, but the change orders have to come from you. This is your organization and your aviation safety program and prevention (change) is your responsibility. You always have the options of accepting my advice; modifying it; rejecting it and making some other change; or rejecting it completely and doing nothing. It's your call and whatever changes are made are going to involve your assets. Whatever happens, you are going to get the credit or the blame for the success or failure of the program, because you are the only one in a position to act—or not act.

There. That's a little blunt, but it is absolutely true. If you can get all of your line managers to nod their heads and agree with that, you have made monumental progress. You have established the basic idea of whose program this is and who is responsible for it. You have also established the idea that you are here to help them with their program and objectives; not the other way around. It is the only really satisfactory relationship a staff safety specialist can have with line management.

SAFETY AND MANAGEMENT

Early in the aviation safety business, we spent about a third of our time exhorting and cajoling people to be safe; another third wandering around with a clipboard trying to catch them not being safe; and the other third investigating accidents. That kept us busy, but we didn't seem to be making a lot of progress. Eventually, we realized that safety was very much a function of management and it was time to start treating it that way. Current thinking holds that accidents are indications of a failure somewhere in the management system.

If you agree that accident prevention requires change, then you must agree that the key player is not the aviation safety manager. It is some other manager with the power and authority to direct change. This is absolutely true and it puts the burden of accident prevention right where it belongs; in the line manager's office; not the safety office. Once we get by that hurdle, it is easy to see that safety programs can be managed just like any other program. Basic management principles work just fine.

ACCIDENT CAUSES

Here is a useful definition of accident causes.

> Causes are those factors, events, acts or conditions which singly or in combination with other causes resulted in the damage or injury that occurred and, if corrected, eliminated or avoided, would likely have prevented or reduced the damage or injury.

Any cause of an accident should be able to pass what lawyers refer to as the "but for" test. "But for this event, omission, action, whatever, this accident would not have occurred." In other words, that cause was essential to the accident. It had to be there or we wouldn't have had an accident.

Any cause should also have some element of correctability in it. It does absolutely no good to talk about causes that are uncorrectable. "Pilot Error" is an uncorrectable cause. On the other hand, "Pilot Error Due to Lack of Instrument Training," is correctable. We can do something about that. Another way to look at it is to consider "proximate" and "root" causes. Pilot error is a proximate cause. You get to the root cause by continually asking, "Why?" When that question can no longer be answered, you have arrived at the root cause.

Causes may be categorized as either unsafe acts or unsafe conditions. These categorizations go back to the 1930s and they still work. An unsafe condition refers to the equipment. An unsafe act refers to the way we use the equipment. Anyone who has been in aviation for a while would agree that the equipment we fly really isn't that bad. It's the way we fly it that gets us in trouble. Best estimates are that between eighty and ninety percent of all accident causes are unsafe acts; not unsafe conditions. If you agree with that, then you must agree that aviation safety is more of a "people" problem than a "thing" problem.

We should point out that this idea of human error being involved in a large percentage of our accidents is not new; nor is it unique to aviation. William Heinrich (see bibliography) figured that out back in 1931 when he wrote his classic book on industrial accident prevention.

MULTIPLE CAUSE VS SINGLE CAUSE

Back in the 1930s, safety theory held that each accident had one and only one cause. That was the single cause theory and it has taken us a long time to abandon it. Some haven't abandoned it yet and will go to their grave arguing about "PRIMARY CAUSE" or some such terminology.

Actually, there are very few accidents that have just a single cause. This is particularly true in aviation where we have built a system that is supposed to tolerate the single failure or single mistake. As it turns out, almost all aircraft accidents are composed of several causal factors each of which had to occur or the accident wouldn't have happened. Remember the "but for" test. Each cause has to be essential to the accident. If that is true, then each cause is infinitely important. There is no such thing as "primary", "main", or "most important" cause. The inevitable result of attempting to make those categorizations is that the "minor" causes (which are still essential) are ignored. They do not get the attention they deserve and therefore are not corrected. Today, safety professionals are solidly in agreement with the theory of multiple causation. This theory holds that all accidents result from multiple factors combined together in random fashion. If we fail to identify all of those factors as causes, we miss the opportunity to correct them.

The evidence is overwhelming. Attempting to explain an aircraft accident with only a single cause is an exercise in futility.

Looking ahead, there are some theorists in the aviation safety business who argue that causes serve no purpose. All that counts are the factors significant to the accident and the recommendations to prevent it. They are probably right. Australia has been doing it that way for several years. In the United States, though, it will be a while before we give up causes. Even if we did, our news media can be counted on to helpfully supply a single cause for each accident.

DISCUSSION QUESTIONS

1. Consider the following accident sequence.

A. Single engine aircraft.

B. Engine fails on takeoff.

C. High speed abort (RTO).

D. Heavy braking.

E. Tire fails on main landing gear.

F. Aircraft departs runway.

G. Aircraft hits cement base of runway marker.

H. Landing gear is sheared - substantial damage.

How many causes are there in that sequence? Which is the primary cause? What additional information do you want before you make recommendations?

2. Which of the following would you categorize as "Act of God" accidents? Why? Why not?

   A. Birdstrike. Substantial damage.

   B. Lightning Strike. Aircraft destroyed.

   C. Windshear encounter. Aircraft destroyed.

   D. Flight through volcanic ash. Substantial damage.

3. What is the role of safety within an organization?

4. Discuss two methods by which safety controls costs.

5. What is the relationship between safety and the every day practicality of getting the job done?

6. Discuss the concept that, "An accident involving damage or injury is the least likely result of any event."

7. Discuss the concept that, "Aviation safety needs to be event oriented and not result oriented."

8. Assume an organization had an accident. Under what circumstance might the "safety staff" be considered "responsible?" Under what circumstances should they not be considered "responsible?"

CHAPTER 3

AVIATION SAFETY TERMS DEFINED

The title of this chapter may be a little optimistic. It implies that I have some magic insight that allows me to wipe away all controversy and give you the firm and final definitions of all safety terms. Wrong. I can give you the choices and suggest areas where you might want to develop your own definitions to suit your organization.

As an example, the word "accident" can generate a lot of discussion. Technically, it is an unplanned and unwanted event that results in damage or injury caused by unknown and totally random factors. There is an implication that it was "accidental" and therefore easily forgiven and of little importance. It was, after all, only an "accident."

That, obviously, is not the way we use the term. Granted, an accident is an unplanned and unwanted event, but it is certainly not caused by unknown or random factors. It could have been prevented if we had been smart enough to do so. That is the basis for all safety programs.

The definitions in ICAO Annex 13, "Aircraft Accident and Incident Investigation," (see bibliography) are accepted by the vast majority of the ICAO members, or "contracting states" as they are called. We should mention that the Convention on International Civil Aviation and its Annexes do, in some cases, represent international law. In other cases they are International Standards and Recommended Practices (STARPS) and they do not supercede the laws of any individual contracting state. The latest version of Annex 13 is the Ninth edition dated July 2001. Contracting states are obligated to file a Notice of Differences between their laws and the ICAO STARPS. As these are received, they are published as amendments to the Annex. With each new edition, it usually takes a few years before these notices are received and published. As a practical matter, it becomes obvious to anyone engaged in international civil aviation that there are huge advantages to having everyone adhere to the same STARPS whenever possible.

Thus if we want to make sure that we all mean the same thing when we talk about safety, we should agree to use the ICAO definitions for Accident, Serious Injury, Incident, and Serious Incident. These are presented below with comments where appropriate. For comparison, United States definitions are included and identified as such.

We should note that in some contracting states, the wording or editorial presentation differs somewhat from that of ICAO, but the substance remains the same. This, as we will see, is true of the United States.

AIRPORT CERTIFICATION MANUAL

If the airport is located in the United States and serves air carriers, it must have an Airport Operating Certificate granted under FAR Part 139 and it must maintain an Airport Certification Manual. Even if the airport is not a Part 139 airport, it should still have an airport operations manual. Although a manual is not technically required in this case, it is difficult to imagine how a busy airport can be safely operated without one. Understanding how the airport operates starts with understanding the manual. Listed below (paraphrased) are the general manual contents derived from FAR Part 139.

AIRPORT CERTIFICATION MANUAL CONTENTS

1. Airport operational responsibility.
2. Current exemptions to FAR Part 139.
3. Limitations imposed by FAA Administrator.
4. Airport grid map.
5. System of runway and taxiway identification.
6. Location of lighted or marked obstructions.
7. Description of aircraft movement areas.
8. Procedures for:
    - Avoidance of interruption during construction work.
    - Maintenance of paved and unpaved areas.
    - Maintenance of safety areas.
    - Maintenance of marking and lighting systems.
    - Maintenance of traffic and wind indicators.
    - Complying with hazardous materials requirements.
    - Conducting a self-inspection program.
    - Controlling ground vehicles.

    - Protection of navaids.
    - Airport condition reporting.
    - Identifying, marking and reporting unserviceable areas.
9. Rescue and fire fighting equipment and procedures.
10. Snow and ice control plan.
11. Public protection.
12. Wildlife hazard management plan.
13. Airport Emergency Plan (see below).

AIRPORT EMERGENCY PLAN

The Airport Emergency Plan is part of the Airport Certification Manual although the plan is sometimes published and distributed separately. Each tenant or regular user of the airport should have a copy of the Airport Emergency Plan incorporated into its own pre-accident plan. Here, paraphrased, are the general contents of an Airport Emergency Plan as listed in FAR Part 139.

AIRPORT EMERGENCY PLAN CONTENTS

1. Instructions for response to:
    - Aircraft incidents and accidents.
    - Bomb incidents.
    - Structural fires.
    - Natural disasters.
    - Radiological incidents.
    - Sabotage and hijack incidents.
    - Power failure in movement area.
    - Water rescue situations.

2. Available medical and rescue services including:
   - Ambulances and other transportation.
   - Hospitals and medical facilities.
   - Rescue squads.
   - Available surface vehicles and aircraft.
   - Hangars or buildings for injured or deceased.
3. Crowd control.
4. Removal of disabled aircraft.
5. Alarm systems.
6. Coordination of airport and control tower functions.
7. Notification procedures.
8. Rescue from significant bodies of water.
9. Coordination with law enforcement, fire and medical organizations.
10. Participation in plan development and review.
11. Training of airport personnel having emergency duties.
12. Review of plan every 12 months.
13. Full scale emergency plan exercise every 3 years.
14. Inclusion of appropriate FAA Advisory Circulars.

AIRPORT/HELIPORT CRITERIA

The rules and regulations on what standards the airport or heliport should meet can be found in several places. The easiest to understand are found in ICAO publications and airport service manuals. If you operate internationally, it is worthwhile maintaining a set of these.

The ICAO manuals, of course, are not the definitive standards for any one country. In the United States, you would need to consult the Federal Aviation Regulations and the numerous Advisory Circulars in the 150 series dealing with airports and heliports. In the United States military, the Department of Defense has published airfield criteria used by all services. The differences between the DOD criteria and the FAR criteria are minor.

The problem is that few if any airports meet all aspects of the applicable criteria. Some airports were built before we had criteria and long before we had large jet aircraft. Some airports have been encroached on by civilization and they have no room for unrestricted approach paths and the like. Almost all airports operate under several deviations or exemptions of criteria. Some of the problems can be corrected, but some of them will never be corrected.

From an aviation safety point of view, we need to know what those deviations are. We should be pushing for the correction of those that can be corrected and we should be adjusting our flying operations to cope with those that can't be corrected.

Airport criteria is generally found under two major headings; airfield criteria and airspace criteria.

AIRFIELD CRITERIA

This refers to things that obstruct aircraft operations on the ground. Here is where you find information such as the minimum distance from a runway, taxiway, or parking ramp to an obstruction. You should also find a list of obstructions that we tolerate because we need them. These include radar reflectors, glide slope and localizer antennas, ceiling and visibility measuring equipment, and so on. Even though these are "approved" obstructions, there are still rules on how they are to be constructed and located to represent the least possible hazard to an aircraft.

AIRSPACE CRITERIA

This refers to things that obstruct airplanes or helicopters in flight. Here you will find information on clearance planes and height criteria that will allow you to determine whether something is an obstruction or not. That tree off the end of the runway keeps growing. When do we require it to be trimmed?

INSPECTIONS

Someone has to inspect the airport or helipad at least once every day and more often during severe weather or when something unusual has occurred. Things change. Lights fail. Parts fall off vehicles and airplanes. Airport maintenance is a full time job and it starts with a program of regular inspection to determine the need for maintenance.

Airfield inspections are part of the job of whichever line manager runs the airport. It is not an aviation safety job. The aviation safety manager should be interested in how the inspections are done and how well they are done, but the safety manager should not take on the burden of doing it. It is a line manager responsibility.

Ideally, the airport should be inspected by someone who is experienced in airport management. As a practical matter, the inspections can be done by anyone who can follow an inspection checklist and has been trained on inspection procedures. In some cases, the inspections are done very well by fire department or security personnel.

FOREIGN OBJECT DEBRIS (FOD) CONTROL

Foreign objects are a never-ending problem on airports and heliports. Some FOD is generated by the aircraft and by maintenance activities, but some is generated by the airport itself. Sealant between the cracks in the pavement deteriorates over time and this becomes FOD. In some cases, the pavement starts to deteriorate, possibly due to cold weather damage, and it creates FOD. Snowplows knock over taxiway lights which are now FOD. High winds blow debris onto the airport from other locations. Jet blast sprays rocks from unpaved areas. There must be a method of identifying these problems and responding to them before they start damaging aircraft.

BIRD HAZARDS

Many airports have bird problems. In some cases, the runways and taxiways are attractive to birds because they retain heat. In other cases, the airport is poorly located with respect to something the birds really like; a garbage dump or feeding area, for example. The problem is not completely hopeless. There are a lot of methods available for making the airport area unattractive to birds and some of them are very effective. In some cases, regular bird patrols and warnings to pilots are the best solutions. Additional information is available in the 150 series FAA Advisory Circulars.

SNOW AND ICE REMOVAL

While the snow and ice control plan is part of the Airport Certification Manual, it is sometimes published and distributed as a separate document. In general a good plan prioritizes the airport areas for snow removal, establishes timely commencement of removal operations, notifies tenants and air carriers of removal operations, and specifies where snow is to be piled or dumped.

AIRPORT MAINTENANCE AND CONSTRUCTION

It is safe to say that at any given time, any airport has one or more ongoing maintenance or construction projects. In almost all cases, we attempt to continue flying operations in spite of the construction. We rarely close the airport.

The problem is that the people doing the work don't necessarily appreciate the hazard they may be creating to the aircraft. The contractor digging a new light vault near the runway may not know how far his dirt pile and equipment should be kept from the runway when he quits for the night. He may not appreciate that his normal method of marking an obstruction may be a hazard all by itself. Will the wing of your plane fit over a 55 gallon drum with a blinking light on it? Furthermore, the contractor has to get his equipment back and forth across the taxiway. This can make a mess of the taxiway with dirt and rocks. Keeping it clean has to be part of the contract.

Aviation safety managers can appreciate this very well. If possible, someone from the safety department should participate in the development of the project before the contract is even awarded. After it is awarded, someone has to examine it daily to make sure that nothing has happened that is hazardous to the aircraft.

FUEL HANDLING

There are some excellent publications on how to handle fuel safely in an airport environment. Most bulk fuel suppliers have this information available. One of the best sources is the FAA Advisory Circular on fuel handling and dispensing on an airport. This reflects National Fire Protection Association standards. Basically, your two concerns are contamination and safety.

CONTAMINATION. Fuel should be checked for quality at least twice. You should never permit fuel to be pumped into your bulk storage facility without verifying that it is the correct type of fuel and free of contaminants. Next, you should check the fuel for quality on a daily basis as it comes from the truck, but before it goes into the aircraft. These tests are reasonably simple and are covered in the referenced Advisory Circular.

SAFETY. The tendency of a fuel to ignite is related to its flash point. Flash point is the minimum temperature at which the fuel will vaporize to form an ignitable mixture above the surface of the fuel. Avgas has a low flash point and is fairly volatile. JP-4, which has been widely used in military jets, also has a low flash point and is difficult to handle safely. At this writing, the United States Air Force has converted from JP-4 to JP-8, a much safer fuel to handle. Jet A, the commercial jet fuel, has characteristics comparable to JP-8 and is much safer to handle. This gives us problems as we have a tendency to mishandle it and take unnecessary risks.

As an example, static electricity is a common source of ignition in a fuel handling accident. We cannot stop static electricity from being created. The act of moving fuel through a hose creates it. The electrical potential created is somewhat related to temperature and humidity. The cold dry air of Alaska breeds a lot of static electricity while it is not much of a problem in the damp heat of Florida. To do it right, we should ground both the fuel truck and the aircraft and we should bond them together. Finally, we should have good metal-to-metal contact (or a bonding device) between the nozzle and the tank filler neck. We are still going to create static electricity, but with everything at the same electrical potential, there should be no ignition.

If we are handling Jet A, we know from experience that we can skip some of these procedures and get away with it because of the high flash point of the fuel. This is an unnecessary risk, though, and one in which the penalty far outweighs the convenience. Our procedures for handling fuel should be the same ones we would use all the time any place in the world.

HELIPORTS

Because of the unique capabilities of the helicopter, the whole question of adequacy of heliports or helipads is one of controversy. There are plenty of standards available on what the minimum criteria for a helipad should be. The problem is that the helicopter in the hands of a good pilot is capable of operating from a pad that doesn't meet the standard criteria in any parameter.

Consider Hospital EMS operations. Most hospitals were not built with a helipad in mind and many of the existing hospital helipads are, to put it kindly, at variance with the recommended criteria. Helicopter contractors, though, have a tendency to accept these pads because they want the contract. In the long run, this is not good business. It really goes back to some ideas mentioned in chapter 21. The customer furnished landing area has to meet our standards. If it doesn't, we should not risk putting a helicopter worth several million dollars into it. The rebuttal to this argument is that we will lose the contract if we don't accept the helipad "as is." Perhaps. On the other hand, our insistence on adherence to our minimum helipad standards should be part of our total "safety" package. We are offering the hospital a safe operation because we have high standards and we are not going to bend them. If that is not satisfactory, maybe we are better off without that contract. We can't let the customer determine our level of safety.

AIRPORT AND HELIPORT SAFETY INSPECTIONS

The development of an inspection checklist for an airport or heliport is the same as described in Chapter 14. Listed here are three sets of guides for subjects that might be examined. The first could be used by the aviation safety manager to construct an overall airport inspection checklist. The second is an adjunct to this guide, but deals strictly with the way fuel is stored, handled and dispensed. This is provided as a separate guide because some organizations store and handle fuel; but do not have responsibility for the airport itself. The third guide could be used to develop a program where any pilot transiting the airport conducts a mini-inspection and notes current deficiencies and hazards. As stated earlier, this is a useful method of extending the reach of the aviation safety manager and obtaining pilot participation in the aviation safety program.

AIRPORT AND HELIPORT SAFETY INSPECTION SUBJECTS

1. **AIRPORT MANAGEMENT AND SAFETY PROGRAM**
   - Management organization
   - Staffing
   - Adequacy
   - Designated safety officer
   - Airport safety committee
     - Tenant participation
     - Effectiveness
2. **AIRPORT CERTIFICATION MANUAL**
   - Airport certification
   - Operating procedures
   - Responsibilities
   - Limitations
   - Obstructions
   - Maintenance
   - Lighting systems
   - Snow and ice control plan
   - ARFF Equipment and procedures
   - Hazardous materials plan
   - Traffic and wind direction indicators
   - Emergency plan
   - Self-inspection program

- Control of ground vehicles
- Obstruction marking
- Navaid protection
- Public protection
- Wildlife hazard management
- Airfield condition reporting

3. **AIRFIELD INSPECTION AND FIELD CONDITION REPORTING**

- Inspection frequency
- Qualifications of inspectors
- Checklists
- Follow-up action
- Friction measurement method
- Condition determination
- Dissemination of information

4. **AIRFIELD MAINTENANCE**

- Organization
- Equipment
- Responsiveness

5. **PAVED AREAS**

- Condition
- Rubber deposits on runway
- Weed and vegetation control
- FOD control

- Painting/marking
- Shoulder and overrun condition
- Bird control
- Directional signs
- Drainage
- Edges and drop offs

6. **AIRFIELD/AIRSPACE CRITERIA**

- Runway/taxiway/ramp obstructions
- Grading, gradients
- Sight distance, runway humps
- Condition of non-paved areas
- Safety areas
- Size (helipads)
- Approach/departure obstructions
- Landing area obstructions
- Airport equipment (markers, antennas, Vasi, etc.)
  - Properly Located
  - Frangible construction where appropriate
- Waivers and exemptions to criteria

7. **AIRFIELD EQUIPMENT**

- Lighting systems
  - Approach

    - Runway
    - Taxiway
    - Parking ramp
    - Lighting controls
- Wind indicators
- Traffic direction indicators
- Directional signs
- Distance markers
- Navaids
- Landing aids
- Emergency power supply
    - Coverage
    - Testing

8. AIRCRAFT PARKING AREA

- Condition
- Painting and marking
    - Lead-in lines
    - Stop marks
- Tie-downs and chocks
- Grounding points
- Condition of fuel pits and covers
- Condition of power receptacles

- Ground support equipment parking
- Control of vehicles
- FOD control
- Fire extinguishers
- Fire department notification system

9. AIRFIELD EMERGENCY PLAN

- Response
- Aircraft accidents and incidents
- Bomb threats
- Structural fires
- Natural disasters
- Sabotage/hijacking
- Power failure
- Medical assistance
- Transportation
- Equipment
- Facilities
- Crowd control
- Removal of disabled aircraft
- Mutual support agreements
- Plan review (12 months)
- Airport emergency exercise (3 years)

10. AIRFIELD RESCUE AND FIRE FIGHTING

- Airport category
- Equipment required
- Equipment available
- ARFF rating
- Fire department organization
- Manning
- Facilities
- Condition of equipment
- Training
- Agents and supplies
- Alarm system
- Response times
- Knowledge of hazardous materials on airport
- Exercises

11. AIR TRAFFIC CONTROL FACILITIES

- Control tower
- Tracon
- Flight Service Station
- Weather support

12. PASSENGER HANDLING

- Equipment (boarding stairs, jetways)
- Control
- Emplaning/deplaning procedures

13. SECURITY

- Airport
  - Condition of fence
  - Control of access points
  - Fuel bulk storage security
- Security personnel organization/availability
- Aircraft security
- Cargo/baggage area security

FUEL STORAGE AND HANDLING SAFETY INSPECTION SUBJECTS

1. GENERAL

- Types of fuels used
- Major supplier
- Bulk delivery method
  - Truck
  - Tank car
  - Pipeline
- Transfer system
- Truck
  - Bottom fill
  - Top fill
- Hydrant

- Fuel pit/fill stand
- Fuel quality control
  - From supplier
  - To aircraft
- Contaminants
  - Solids
  - Water
  - Surfactants
  - Micro-organisms
  - Misc. contaminants
- Fuel identification
- Filtration
- Testing records
- Training of fueling personnel
  - Contents of training program
  - Frequency
  - Records
- Fueling safety program
- Procedures to prevent mis-fueling aircraft
- Procedures for segregation of contaminated fuel
- Written procedures for normal fueling
- Written procedures for defueling

- Fuel Spills
  - Procedures
  - Equipment
  - Disposal

2. BULK STORAGE

- Fenced
- Marked with warning signs
- Fire extinguishers
- Fire plan
- Notification of fire department
- General housekeeping
- Safe distance from other structures
- Emergency system shutoff
- Grounding of fueling vehicles
- Restriction of non-fueling vehicles
- Control of ignition sources
- Drop spout reaches bottom of tank
- Underground leak detection system
- Fuel spill containment

3. FUEL TRUCKS

- Loading
- Written procedures
- Top fill

    - Drop spout to bottom of tank
    - Deadman control
- Bottom fill
    - Loading hoses marked/coded
    - Coupler secure
    - Self-sealing truck valve
    - Deadman control
- Truck Markings
    - Type of fuel
    - Hazardous cargo markings
    - No smoking
- Two fire extinguishers on truck—20-BC Rating
- Bonding and grounding wire connectors
- Emergency shutoff system
- Air filter and spark arrestor
- Fuel filter and filter separator
- Nozzle bonding device
- Nozzle dust cap
- Deadman control on nozzle
- Hose condition

4. **FUELING OPERATIONS**

- Fueling procedures/checklist

- Control of smoking
- Truck properly positioned
- Grounding points available
- Truck grounded
- Aircraft grounded
- Truck and aircraft bonded
- Nozzle bonded to receptacle
- Deadman control
- No other maintenance operations during fueling
- Fire extinguishers

AIRPORT AND HELIPORT SAFETY SUBJECTS FOR PILOTS

1. **GENERAL**

- Current Notams
- Accuracy of airport documents
    - Approach plates
    - Departure plates
    - Airfield diagrams
    - Airport directory
    - Gate parking layout

2. **CONDITION OF AIRPORT FACILITIES**

- Runways
- Taxiways

- Parking ramp
- Approach/departure obstructions
- Navaids
- Wind indicators
- Runway/taxiway paint condition
- Runway/taxiway identification
- FOD control
- Wildlife control
- Airfield construction projects

3. **AIR TRAFFIC CONTROL FACILITIES**

- Tracon
- Control tower
- Flight service station
- Weather service

4. **RAMP/GATE OPERATIONS**

- Lead-in lines
- Stop marks
- Marshalling
- Gate numbers visible
- Parking system
- Ramp surface
- Positioning of ground equipment
- Communications with ramp personnel
- Pushback/powerback procedures

- Fueling procedures
- Deicing procedures

5. **DISPATCH/FLIGHT PLANNING AREA**

- Weather information
- Notams
- Communications facilities
- Planning facilities
- Planning documents
- Lounge

6. **SECURITY**

- Aircraft security
- Identification of personnel
- Screening of passengers
- Screening of baggage
- Screening of cargo

7. **LOADING OF AIRCRAFT**

- Passengers
- Cargo

8. **DEPARTURE**

- Communications with ramp personnel
- Push back/power back procedures
- Marshalling
- Tower/ATC procedures
- Noise abatement restrictions

9. OTHER SAFETY ITEMS NOT OTHERWISE COVERED

SUMMARY

Airports and heliports demand constant attention and the criteria can get a little complicated. Fortunately, there is plenty of reference material available. In addition to the references listed, the Federal Aviation Administration has other airport information including a video tape on airport self-inspection.

DISCUSSION QUESTIONS

1. Your airport is inspected daily by a member of the airport manager's staff. What methods can you use to determine the adequacy of these inspections?

2. You have received several hazard reports from control tower personnel. They deal primarily with vehicle safety violations such as entering a taxiway or runway without permission, failing to yield to moving aircraft and so on. What are you going to do about this?

CHAPTER 25

OTHER APPROACHES TO AVIATION SAFETY

INTRODUCTION

I do not believe that aviation safety has to be complicated. There are many different approaches to aviation safety and some of them are very good. There are, however, certain basic items that are important no matter what method is selected. These are best described in Chapters 4 and 5. If, for example, you have not correctly established responsibilities for accident prevention, it really doesn't matter what program you use. It is unlikely to work.

Nevertheless, there is some innovative thinking out there and we should not ignore it. As I said in the beginning, you build your safety program to suit the needs of your organization. There are always different ways to achieve the same result.

In the remainder of this chapter, we'll cover some other safety programs or techniques which show a lot of promise.

SAFETY MANAGEMENT SYSTEMS (AVIATION)

The Canadian equivalent of our Federal Aviation Administration (FAA) is Transport Canada (TC). Unlike the FAA, TC is a multi-modal organization in that it deals with all forms of transportation. It has always had a very proactive approach to aviation safety and has developed a number of innovative programs that go all the way down to the general aviation level. Their Safety Management System (SMS) was developed with some assistance from Professor James Reason of the University of Manchester in England and the Civil Aviation Safety Authority of Australia. SMS is also widely used in England.

A safety management system is a systematic, explicit, and comprehensive process for the management of safety risks. It integrates operations and technical systems with financial and human resources management for all activities. In short, it is a business-like approach to safety. Like most management systems, it provides for goal setting, planning, and performance measurement.

A safety management system is characterized by these features.

- A comprehensive systematic approach to the management of aviation safety within the company and including the interfaces between the company and its suppliers, sub-contractors, and business partners.

Cylinders separated and marked by type of gas

Cylinders protected from heat

Suitable trucks, carts used to move cylinders

Regulators, hoses, fittings—condition

Separate plumbing for oxygen cylinders

Oxygen cylinders separated from POL products

Chemicals

Hazard communications procedures

Storage, separation, security

Personnel awareness (Material Safety Data Sheets)

Reactive chemicals separated

Deluge shower and eyewash fountains available

Ventilation of storage area

Control of smoking

Radioactive materials identification

Control of hazardous waste

Procedures

Equipment

Disposal

SUMMARY

Aircraft maintenance is an important part of aviation safety. The Director of Safety should make every effort to include it in the overall aviation safety program.

DISCUSSION QUESTIONS

1. In this chapter, the author stated that any aircraft maintenance operation should have two safety programs. Why? What are their different areas of responsibility?

2. Some of the pilots in your organization have complained that some of their safety-related aircraft write-ups were not properly corrected. How are you going to handle this situation?

AIRCRAFT GROUND OPERATIONS

CHAPTER 23

BACKGROUND

In aviation, we separate accidents into "flight" and "ground." Those occurring in flight are well reported and investigated. Those occurring on the ground are seldom reported outside of the company unless they involve serious injury or death. They may or may not be investigated.

Regardless, they represent a serious problem to the aviation industry. Estimates of the costs of aviation ground accidents run from several million to well over a billion dollars per year. Worse, they are almost chronic. While flight accidents are rare events, ground accidents are not. They occur daily and they represent a substantial cost to any aircraft operator. Flight line safety is an effort to control these costs by reducing both accidents and injuries that occur during aircraft ground operations.

As discussed in Chapter 4 under the scope of the safety program, flight line safety (also called ramp safety or ground operations safety) may not be part of the program. It is my opinion that it should be. This chapter is included to support that opinion.

THE PROBLEM

An aircraft parking ramp is a high risk area. It is full of high energy sources that can produce disaster if uncontrolled. Some of these energy sources include propellers, tail rotors, jet blast, fuels, oxygen, chemicals, electricity, high pressure air, pressurized containers, jet bridges, carts, tugs, belt loaders, maintenance trucks, and crew busses.

If airplanes were designed to be worked on safely, they probably would not include things like sharp static discharge wicks, blade antennas, pitot tubes, and propellers. They would come equipped with hand rails and non-skid surfaces on the wings and a fuselage high enough to walk under without bumping your head. They would be nice to work on, but no one would care because they would never fly.

All things considered, the potential for accidents and injuries in the flight line environment is very high and reducing that potential requires the efforts of everyone out there.

THE CAUSES

Based on a lot of accumulated experience with both industrial safety and aviation safety, we can make some general statements about the causes of flight line accidents.

THE MAIN PROBLEM IS NOT WITH THE EQUIPMENT; IT'S THE WAY WE USE THE EQUIPMENT. In other words, this is mainly a "people" problem, not a "thing" problem. Granted, the propeller of an airplane is inherently dangerous, but we know that and we can't do much about it. We can, however, avoid becoming personally involved with it. Another aspect of the problem is the overall organization and management of the aircraft parking ramp. A large number of the people working around the airplanes are not employees of the operator of the aircraft. This is a supervision and accountability problem.

THE FLIGHT LINE IS A DYNAMIC ENVIRONMENT WHERE MANY THINGS ARE IN CONSTANT MOTION. Aircraft are moving. Vehicles and equipment are moving. People are moving. Unlike the industrial environment where the machinery doesn't move much, the place on the flight line where it was safe to walk five minutes ago has suddenly become a very bad place to be.

FLIGHT LINE OPERATIONS ARE AFFECTED BY THE WEATHER. Most of what we do to an airplane takes place outdoors. This means that we do it in heat, cold, rain, snow, ice, and wind; not to mention darkness. This not only increases the difficulty of the task, but it increases our exposure to injury.

SAFETY TRAINING AND EXPOSURE TO HAZARDS ARE NOT ALWAYS RELATED. There is sometimes, in fact, an inverse relationship between training given and training needed. We tend to provide the best training to the people most technically qualified to work on the airplanes. They, after all, are our most valued employees. Unfortunately, the people most often exposed to the hazards and in a position to create the most damage tend to be the least technically qualified and (sometimes) the least trained. They drive the trucks, park the planes, fuel them, and handle the baggage. They are on the front end of this problem and it is their activities that give us the most trouble.

ALL FLIGHT LINE ACCIDENTS INVOLVE HUMAN FACTORS. These can cover the entire range of human factors including stress, distraction, pressure (time or peer), haste, physical condition, complacency, ignorance, and fatigue.

THE SOLUTIONS

THE LAYOUT OF THE FLIGHT LINE MUST BE DESIGNED WITH SAFETY IN MIND. Our basic scheme for painting lines on the pavement should aid us in separating incompatible vehicles, equipment, and aircraft.

WE NEED A PLAN FOR CONTROLLING THE MOVEMENT OF BOTH AIRCRAFT AND VEHICLES. Our plan must reduce movement hazards as much as possible and still allow us to get the job done.

PERSONNEL WHO WORK IN THE FLIGHT LINE ENVIRONMENT MUST BE FULLY TRAINED IN BOTH THEIR JOB AND IN THE SAFETY PRECAUTIONS NECESSARY FOR THEIR JOB. There is no job on the flight line that does not require some level of safety training.

OUR FIRE PREVENTION PROGRAM SHOULD BE AIMED AT REDUCING FIRE HAZARDS. There is more to fire prevention than just having a fire department and an alarm system.

ALL PERSONNEL ON THE FLIGHT LINE SHOULD HAVE A BASIC UNDERSTANDING OF PERSONAL SAFETY PRACTICES AND THE USE OF PROTECTIVE EQUIPMENT. Noise, for example, is both ubiquitous and non-discriminatory. None of us are immune to its effects.

FLIGHT LINE VEHICLE OPERATIONS

In any aircraft flight line operation, we need vehicles. The bigger the flight line and the bigger the aircraft, the more vehicles we need. We can't do the job without them.

Unfortunately, aircraft and vehicles are a poor mix. They can get in each other's way and do enormous damage to each other if they collide. In one classic case, a lavatory servicing vehicle was being backed toward a jet aircraft. For some reason, the accelerator stuck and the vehicle hit the aircraft and penetrated about a foot into the fuselage. The total tab was $375,000 for damage to the aircraft; $474,000 for lease of a replacement aircraft while repairs were made; and $1,300,000 for loss of revenue until a leased aircraft could be obtained and permanent loss of value to the damaged aircraft. Grand total: $2,149,000. The risk of something like that happening is always present on any flight line.

The basic problem is that the flight line is designed for aircraft; not vehicles. Most of the signs and markings are for the airplanes. The needs of the vehicle are given, at best, a low priority and on some flight lines, none at all. If there is no organized control of the vehicle traffic, a large flight line is a confusing place to drive regardless of driver qualifications. Let's bring some order to this confusion and discuss some proven methods of vehicle control.

GENERAL PROCEDURES

The general approach to flight line vehicle safety involves five steps.

1. **VEHICLE CONTROL PLAN.** This plan is usually developed by the airport authority and applies to all flight line areas and all vehicles operated on them. All airport tenants are expected to know and follow this plan.

2. **VEHICLE OPERATING STANDARDS.** These are the basic ground rules for how vehicles will be operated on that airport. They are normally developed by the airport authority, perhaps with the advice and assistance of the major tenants.

3. **VEHICLE LIMITATIONS.** A basic rule is to limit the number of vehicles on the flight

line to the minimum number needed to do the job. Each vehicle has to be justified. All vehicles should be company-owned; no privately owned vehicles.

4. **VEHICLE OPERATOR TRAINING.** Another basic rule is that drivers must have some sort of training before they are allowed to operate vehicles on the flight line. This program may be administered by the airport authority or by the major tenants using airport authority guidelines. Such training may also be required by OSHA's Powered Industrial Truck (PIT) program. This program includes tugs, deicing vehicles, and pushback vehicles.

5. **ENFORCEMENT.** Obviously, none of this will work unless the tenants and the drivers comply with the plan and the standards.

VEHICLE CONTROL PLAN

The vehicle control plan establishes vehicle flow, designates areas where vehicles are or are not permitted, and specifies pavement markings and control devices for vehicles.

VEHICLE FLOW. Ideally, the majority of vehicles are kept to the perimeter of the aircraft parking area. This is done through a system of marked roadways. Most maintenance vehicles, supervisory vehicles and personnel vehicles can be confined to these roadways. If this is done, then the only points of conflict are where the roadways cross a taxiway.

Some vehicles, such as catering trucks or fuel trucks, must be permitted to operate outside of these roadways in the vicinity of the aircraft. This should be kept to a minimum and they should use the roadways most of the time.

Some emergency vehicles must also be permitted to operate outside the roadways if an emergency is in progress. If so, they should be equipped with distinctive flashing lights to use during an emergency.

Vehicles permitted to operate outside of the roadways on the taxiway and runway complex should be radio-equipped, have a flashing light, and have a specific reason to be there. Some of our runway incursion problems are vehicle-related.

No vehicles, except possibly fire trucks responding to an emergency, should be permitted to operate off the paved surfaces. This will reduce foreign object damage (FOD) problems.

MARKINGS. It is always best to mark roadways using the same markings the drivers have become familiar with in that community. This includes lane edges, lane dividers, turn arrows, stop lines and so on. This is really a problem in traffic engineering and a large airport should have one available for consultation. Like all other pavement markings, these need to be repainted occasionally and this should be part of the regular airfield maintenance program.

CONTROL DEVICES. Vehicles can be controlled by the same signs and traffic lights used in the community. If lights are used, they are usually controlled from the control tower or from the ground movement control tower if there is one. One possible problem is that signs and lights must either be far enough from the aircraft movement area or close enough to the ground so that they are not obstructions to taxiing aircraft.

Other methods involve radios and control tower light gun signals. The use of radios for control should be limited to emergency vehicles and vehicles requiring access to the taxiways and runways. Light gun signals are not particularly reliable as the vehicle driver is seldom looking directly at the control tower. Vehicles subject to control by light signals should have a decal on their dashboard listing the signals and their meaning.

STANDARDS

The Vehicle Control Plan should establish the general standards for all vehicles. The following are suggested standards.

SPEED LIMITS. On designated vehicle roadways, the speed limit should be appropriate for the conditions. The posted speed limits could vary depending on proximity to the aircraft movement area.

- Aircraft parking area. Normally 15 mph and 5 mph within 25 feet of an aircraft.
- Vehicle parking area. 5 mph.
- Taxiways and Runways. As appropriate for conditions.
- Congested areas. 15 mph.
- Towing speeds:
  - Aircraft - 5 mph
  - Equipment - Single-towed - 10 mph
  - Equipment - Multiple-towed - 5 mph
  - Baggage trains - Normally 10 mph
  - Ground power equipment - 15 mph

To provide a frame of reference, 5 mph is equivalent to a brisk walk.

PROXIMITY TO AIRCRAFT. Some special purpose vehicles are specifically designed to operate close to, against, or under aircraft. Other vehicles should adhere to these safety standards.

- Do not operate the vehicle closer than 25 feet to any part of the aircraft.

- Do not approach the aircraft from such an angle that if the brakes failed or the accelerator stuck, the vehicle would hit the aircraft.
- Do not permit vehicles to park in such a manner that the emergency movement of the aircraft would be impeded.
- Do not operate a vehicle closer than 200 feet behind a turbine-powered aircraft with the engines running. Jet blast can flip a vehicle over.

VEHICLE MARKINGS. In addition to their identification, vehicles should be marked with reflective tape so they can be seen at night with their lights out. It is generally desirable to limit flashing or rotating lights to emergency vehicles as flashing lights are both blinding and confusing to pilots.

All vehicles should be identified by company logo and, if possible, a number readable through binoculars from the control tower or an observation point.

VEHICLE PARKING. Vehicles should be parked only in designated areas with the engine off and the brakes set. Vehicles parked temporarily in close proximity to an aircraft should have the brakes set, the engine off and the key in the ignition. This would permit rapid movement of the vehicle in an emergency. If the vehicle must be parked in a way that it could roll into an aircraft (catering trucks, for example), the vehicle should be chocked.

VEHICLE PASSENGERS. Passengers should only be permitted to ride on vehicles equipped with seats specifically designed for passengers. Passengers should not ride on any part of the vehicle not intended for passengers.

MOTORCYCLES AND BICYCLES. These vehicles should follow the same general rules as other vehicles. They should be equipped with lights, brakes and reflective tape markings.

RIGHT OF WAY. Regardless of the vehicle control plan, an aircraft taxiing or under tow has the right of way over any vehicle.

VEHICLE LIMITATIONS

The airport authority should exercise control over how many vehicles are operated on the flight line and who owns them. Tenants wishing to use a vehicle on the flight line should file an application stating the identification of the vehicle, its purpose and the justification for permitting it on the flight line. If approved, the vehicle should be issued a numbered decal which not only identifies the vehicle but aids in security access control. The vehicle owner should be advised of any special marking requirements such as reflectorized tape.

VEHICLE OPERATOR TRAINING

Airport tenants should apply for training and certification of the drivers they need to operate vehicles on the flight line. Application should include verification of driver's license and review of driving record. A sample lesson plan for flight line driver training is shown here.

SAMPLE VEHICLE DRIVER TRAINING LESSON PLAN

- Airport Vehicle Flow Plan
- Authorized Driving Routes
- Areas not Authorized for Vehicles
- Vehicle Control
  - Pavement Markings
  - Control Signs and Lights
  - Radios
  - Control Tower Light Signals
- Vehicle Operating Standards
  - Speed Limits
  - Right of Way of Aircraft
  - Operating in Proximity to Aircraft
- Vehicle Parking
- Passengers
- Towing Operations
- Actions if an Accident Occurs
- Local Hazards
- Local Driving Regulations
- Examination

LICENSE. The license to operate a vehicle on the flight line should be a controlled document. One way to do this is to annotate the employee's security access credentials with information on driving privileges.

REVIEW. As a general rule, review or recertification should not be necessary as long as the employee maintains a state driving license and has a good driving record both on the flight line and on municipal roadways.

ENFORCEMENT

The principal enforcement of flight line driving standards must be through the supervision provided by the individual tenants. They, after all, have a high stake in the safety of flight line operations. If one tenant is consistently violating the standards, the quality of that supervision must be questioned.

Beyond that, it is not realistic to expect airport security police to run traffic patrols of the flight line. They have other things to do. Since the flight line and the vehicle roadways are not public roads, it is usually possible to assign enforcement responsibility to the airport manager and the airport staff. They can be authorized to identify violators and issue citations. Acceptance of this arrangement should be part of the tenant's application to drive out there in the first place.

Some major airports have established a schedule of fines for driving violations which is almost beyond the financial capability of the individual driver. This, in effect, charges the tenant for the drivers' violations. This puts the supervisory and enforcement burden where it belongs.

The ultimate penalty, of course, is revocation of flight line driving privileges. In some cases, that would cost the employee a job and in the extreme case would put the tenant or the contractor out of business.

Control of vehicle traffic on the flight line is an administrative procedure belonging to the airport authority; not a criminal procedure belonging to the local police or court system. Because of this, there are some powerful incentives available to the airport authority that should ensure compliance with vehicle operating standards.

AIRCRAFT TAXIING, TOWING, AND PARKING

This is a general discussion of basic taxiing, towing, and parking safety procedures. Where there is a conflict with the aircraft manufacturer's taxiing or towing instructions, the manufacturer's instructions should prevail.

Good taxiing and towing safety practices start with the layout of the flight line and the manner in which the lines are painted. Ideally, aircraft of the same general size are always parked in exactly the same position on the flight line or at the gate. Taxi lines should keep taxiing aircraft on exactly the same route. Clearance lines at the wingtips mark areas where parked vehicles and equipment are not allowed.

If the flight line is laid out in this manner, then it should only be necessary to ensure that no equipment or vehicles are within the clearance lines and the aircraft is on the taxi line. If this is done, it is difficult to see how an accident could ever occur.

They do occur, of course. Other aircraft, vehicles, and equipment are not always parked where they should be. When we push back an aircraft, we don't always push it back on the taxi line. Considering the size of the aircraft involved, darkness, weather, and time pressure, it is easy to

overlook some simple parking or towing procedure that leads to an accident. The safety practices suggested in this chapter were all born from accident experiences.

TAXIING

PERSONNEL QUALIFIED TO TAXI AIRCRAFT. Pilots are obviously qualified to taxi aircraft although some of them have been known to taxi a wee bit fast. Almost all aircraft flight manuals specify a maximum speed of 5 mph or less in congested areas. That's brisk walking speed.

In some organizations, maintenance personnel are allowed to taxi aircraft. There is nothing wrong with this providing they have received the same training and use the same checklists that the pilots use. If the airplane requires two people to fly it, then it also requires two people to taxi it.

COMMUNICATIONS. As a rule, aircraft do not move on the airport complex without radio contact with and permission from the control tower. Even in situations where radio contact is not required, the radio should be in use as it is the fastest method of obtaining emergency response in the event of an accident. Thus the people taxiing the aircraft must also know how to use the radios.

ENGINE POWER. All taxiing should be done with full consideration of what is behind the aircraft. The engine power used should be the absolute minimum necessary to move the plane.

WING WALKERS. If the taxi path is obstructed (vehicles or equipment within the clearance lines) wing walkers should be used. They should also be used anytime the aircraft is to be taxied within 25 feet of an obstruction. An exception to this is when the aircraft is on the taxi line and there are no obstructions within the clearance lines even though they may be closer than 25 feet to the wingtips. If the obstruction is within 10 feet of the wingtip, wing walkers should always be used.

MARSHALLING SIGNALS. Final parking of the aircraft is usually done with marshalling signals. It is important that everyone use the internationally accepted marshalling signals.

PREPARATION FOR TAXIING. Windows and windshields should be clean and doors and hatches should be closed. Aircraft navigation lights should be on. Strobe lights, rotating beacons, and landing lights should be off. Taxi lights may be used if installed.

AIRCRAFT TOWING

QUALIFIED PERSONNEL. The safe towing of a large aircraft in a congested area may require as many as six people. They should all be trained on towing procedures.

TOWING SUPERVISOR/CREW CHIEF. The towing supervisor is in complete command of the operation. The supervisor (or crew chief) has a checklist covering all towing procedures and is in a position, usually at the nose, to see the towing team members at the wingtips and tail and signal directly to the tow vehicle operator. If possible, the supervisor is in direct radio or interphone contact with the tow vehicle operator and the brakeman in the cockpit.

TOW VEHICLE OPERATOR. The tow vehicle operator is qualified to operate that vehicle. The operator is in direct interphone contact with the brakeman in the cockpit and can see the signals of the towing supervisor.

WING AND TAIL WALKERS. These individuals are positioned at the wingtips and tail and are responsible for the vertical and horizontal clearance of the wings and tail from any obstruction. Ideally, they are in radio contact with the towing supervisor. Clearances may be very critical when hangaring an aircraft and the towing operation should be stopped when there is any doubt.

BRAKEMAN IN COCKPIT. A person should be in the pilot's seat with the seat properly adjusted to reach the brake pedals. The brakeman should be in direct interphone contact with the tow vehicle operator and should be able to see the signals of the towing supervisor. The brakeman should know how to maintain hydraulic brake pressure and should notify the tow vehicle operator if hydraulic pressure drops below safe operating limits. If the aircraft has a steerable nose gear, the brakeman should be cautioned not to use it while under tow. Finally, the brakeman should know how to use the aircraft parking brake and the emergency braking system if one is installed.

PERSONNEL NEEDED. Obviously, the number of tow team personnel actually needed depends on the aircraft and the route. Wing walkers are not needed if there are no obstructions within 25 feet of the aircraft. There will be cases where only one wing walker is needed as only one wing is vulnerable to obstructions. Except for hangaring, the tail walker is only needed if the plane is being moved backwards. In the case of small general aviation aircraft, a brakeman in the cockpit is probably not necessary as the tow vehicle can stop the aircraft. These are all decisions to be made by the towing supervisor. If some members of the team are temporarily not needed, they should not ride on any part of the aircraft or on the tow vehicle unless seats are provided for that purpose.

CHOCKS. The tow team should always have a set of chocks available. The chocks should be the correct size for the aircraft and should be used on the main landing gear.

RADIO CONTACT. If the tow is to use the taxiways, radio contact with the control tower will be necessary. Ideally, the towing supervisor should have the contact. If this is not practical, the brakeman in the cockpit should maintain contact using the aircraft radios.

TOWING SPEEDS. 5 mph maximum.

TOWING SIGNALS. Ideally, all tow team members should be in radio or interphone contact, particularly when towing a large aircraft. Visual signals have not proved to be entirely

effective. The problem is that a large plane has a certain amount of inertia and it cannot be stopped in an instant. When a wing walker (say) realizes that clearance is in doubt, the wingtip is already within a few feet of the obstruction. By the time the wing walker's hand signal gets to the towing supervisor and is relayed to the tow vehicle operator and the brakeman, the accident has already occurred. If visual signals must be used, the standard luminous or fluorescent wands are probably best. In some non-noisy environments, whistles or horns powered by air pressure have been used successfully.

TOWING PREPARATION. Consult aircraft handbooks for specific instructions.

PARKING

Specific aircraft parking procedures should be covered in the aircraft handbook. The following procedures are generally applicable, although not to all aircraft.

CHOCKS. Installed fore and aft on both main gear. Leave a small amount of space between the chock and the tire to permit the aircraft to settle during refueling without binding the chocks.

AIRCRAFT BRAKES. Released.

TIE-DOWNS AND MOORING LINES. If the aircraft has tie-down points, the tail and both wings should be tied down using standard mooring procedures.

TAIL STANDS. If the aircraft has a tail stand to keep it from tipping backwards onto its tail, it should be installed.

WING SPOILERS. This applies primarily to general aviation aircraft. If high winds are anticipated, spoilers should be installed on the top surface of the wings.

GROUNDING WIRE. Although not required in all cases, the aircraft should be grounded if there is a grounding point available.

DOORS AND HATCHES. Closed.

INTAKE COVERS AND PITOT COVERS. Installed.

LANDING GEAR SAFETY PINS. Installed if available.

REMOVE BEFORE FLIGHT STREAMERS. If wing spoilers, intake covers, landing gear pins or pitot covers are installed, they should be clearly marked REMOVE BEFORE FLIGHT with streamers or some other warning device.

SUMMARY

As mentioned at the beginning of this chapter, a well organized flight line with properly painted taxi lines, clearance lines, and vehicle roadways can solve a lot of safety problems. If everything is where it is supposed to be, the chances of an accident are significantly reduced.

DISCUSSION QUESTIONS

1. Ground vehicles, when used around aircraft, are a common source of hazards on the flight line. How can the potential for accidents involving ground vehicles be reduced?

2. Imagine that you as the Director of Safety for an airline observe the driver of a contract fuel truck driving at excessive speed on the flight line. How do you handle this situation?

3. You are operating a regional or commuter airline using aircraft that do not normally use terminal gates or passenger bridges. Your passengers walk to or from the airplane to the terminal and use the stairs built into the cabin door. At most of the airports you serve there are several parking spots for your type of aircraft in the same location. What safety problems can you foresee and what company procedures would you recommend to reduce or eliminate them?

AIRPORTS AND HELIPORTS

CHAPTER 24

INTRODUCTION

There are three situations that commonly occur in aviation safety that involve airports or heliports.

1. You are a tenant on someone else's airport. The management structure of the airport depends on whether it is an FAR Part 139 airport serving air carriers. Most airports are not, but the larger ones should still have about the same management structure as a Part 139 airport. There is (or there should be) an airport safety committee. If there is, you, the aviation safety manager for your organization, are a logical member. In this case, you need to be familiar with the airport certification manual and emergency plan. As a tenant, you are in a position to recommend or influence change.

2. It's your airport (or heliport). All of its safety problems are your safety problems. Here, the airport operations manual is prepared by your organization and you are very interested in its contents. Furthermore, your organization is responsible for regular inspections of the airport and knowledge of airfield criteria is essential.

3. You use a lot of different airports (or heliports) belonging to other agencies. Part of your aviation safety program is a regular survey of these facilities so that you can warn your flight crews of hazards and, in the extreme case, decide whether you want to continue using those facilities. Among major airlines, this is usually a two step process. Prior to using an airport (and regularly thereafter) a team including someone from the aviation safety department examines the airport and documents its hazards. On a regular basis, flight crews using the airport are asked to fill out checklists designed to update current airport information and identify new hazards. This process can work quite well. It extends the reach of the aviation safety department and secures flight crew participation in the program.

In any case, the aviation safety manager tends to learn a lot about airports and heliports regardless of who actually owns them. What follows are some basic ideas about how to approach common airport and heliport safety problems.

AIRCRAFT ACCIDENT (ICAO)

An occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight until such time as all such persons have disembarked, in which:

a. a person is fatally or seriously injured as a result of:
   - being in the aircraft, or
   - direct contact with any part of the aircraft, including parts which have become detached from the aircraft, or
   - direct exposure to jet blast,
   - EXCEPT when the injuries are from natural causes, self inflicted or inflicted by other persons, or when the injuries are to stowaways hiding outside the areas normally available to the passengers and crew; or

b. the aircraft sustains damage or structural failure which:
   - adversely affects the structural strength, performance or flight characteristics of the aircraft and
   - would normally require major repair or replacement of the affected component,
   - EXCEPT for engine failure or damage, when the damage is limited to the engine, its cowlings or accessories; or for damage limited to propellers, wing tips, antennas, tires, brakes, fairings, small dents or puncture holes in the aircraft skin; or

c. the aircraft is missing or is completely inaccessible.

   NOTE. A fatal injury is an injury resulting in death within thirty days of the date of the accident.

SERIOUS INJURY (ICAO)

An injury sustained by a person in an accident and which:

a. requires hospitalization for more than 48 hours, commencing within seven days from the date the injury was received; or

b. results in a fracture of any bone (except simple fractures of fingers, toes, or nose); or

c. involves lacerations which cause severe hemorrhage, nerve, muscle or tendon damage; or

d. involves injury to any internal organ; or

e. involves second or third degree burns, or any burns affecting more than 5 percent of the body surface.

f. involves verified exposure to infectious substances or injurious radiation. (This was added in the July 2001 edition.)

AIRCRAFT ACCIDENT (NTSB)

An aircraft accident is an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage.

SUBSTANTIAL DAMAGE (NTSB)

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."

FATAL INJURY (NTSB)

A fatal injury is any injury which results in death within 30 days of the accident.

SERIOUS INJURY (NTSB)

This is any injury which:

a. requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received;

b. results in a fracture of any bone (except simple fractures of fingers, toes or nose);

c. causes severe hemorrhages, nerve, muscle, or tendon damage;

d. involves any internal organ; or

e. involves second or third degree burns, or any burns affecting more than 5 percent of the body surface.

AUTHOR'S NOTE: Except for the recently added ICAO injury definition involving infectious substances or radiation, this definition keeps the United States in conformance with ICAO. It is slightly at variance with the injury definitions established by the Department of Labor under the Occupational Safety and Health Act (OSHA). In some situations, either definition could apply.

ACCIDENT CATEGORIES (NTSB)

In 1997, the NTSB created accident sub-categories based on severity. These are primarily for analysis and do not affect the basic definition of an aircraft accident or its reportability. The NTSB accident categories are listed below.

MAJOR ACCIDENT. One that results in the destruction of an aircraft operated under FAR Part 121, or in which there were multiple fatalities, or that an aircraft operated under Part 121 is substantially damaged and at least one fatality occurs.

SEVERE ACCIDENT. One that results in only one fatality and an aircraft operated under Part 121 is not substantially damaged, or there was at least one serious injury and the aircraft was substantially damaged.

INJURY ACCIDENT. A non-fatal accident having at least one serious injury but without substantial damage to an aircraft.

DAMAGE ACCIDENT. An accident in which there are no fatalities or serious injuries, but an aircraft is substantially damaged.

AIRCRAFT MISHAP

This is a term used primarily by the United States military services to describe any safety-related reportable occurrence involving aircraft. The military definition of injury (fatal, permanent total, permanent partial) follows those established by the Department of Labor and the Occupational Safety and Health Administration (OSHA).

Whereas the ICAO and NTSB definitions of damage are somewhat subjective, the military classifies damage in terms of dollar costs. This has some advantages in that it is fairly simple to establish the accident (mishap) classification and the use of dollar amounts provides an index of mishap severity by requiring calculation of the direct costs of the mishap. Its disadvantages are that the dollar amounts need to be regularly adjusted for inflation and there is no way to accurately determine the real value or cost of a destroyed military aircraft. The figure reported for a destroyed aircraft is acquisition cost, which is convenient and consistent, but is probably low in terms of the aircraft's actual value.

The U.S. military also defines "aircraft operation" slightly differently. Where the ICAO definition involves people on or off the airplane, the military definition runs from start of takeoff roll until the aircraft has cleared the runway after landing. (The military has other mishap categories to cover other times the aircraft is in operation.)

Outside of the military, the term "mishap" is not defined. It is perhaps a convenient way to describe both accidents and incidents, but it is not widely used. ICAO and many of its contracting states, use the term "occurrence," although you will occasionally catch them using, "condition," or "circumstance." Personally, I have trouble spelling "occurrence" and I prefer the word "event" to describe a happening that we have not yet categorized. It could be anything. Throughout this book, you'll find that the words, mishap, occurrence and event all have about the same meaning.

INCIDENT (ICAO)

An occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation.

SERIOUS INCIDENT (ICAO)

An incident involving circumstances indicating that an accident nearly occurred. Note: The difference between an accident and a serious incident lies only in the result. (Examples of ICAO Serious Incidents are listed in Chapter 11.)

> **AUTHOR'S NOTE:** Why distinguish between an "Incident" and a "Serious Incident?" Some background may help. The 1992 ICAO Investigation Divisional Meeting laid the foundation for the Eighth Edition of Annex 13. A main concern of the meeting was to find ways to get more prevention activity from the incidents that were obviously occurring. With tens of thousands of incidents occurring every year, some priorities needed to be set. Thus the "everyday" incidents would be recorded in the various data collection systems of the world while the serious ones would be investigated as if they had been accidents.

This was a major step forward for the ICAO contracting states. Previous editions of Annex 13 carried a note: "Nothing in this Annex is intended to impose an obligation on States to conduct an investigation into an incident." Now, Annex 13 recommends that Serious Incidents be investigated wherever they occur in the world. That may not seem like a big deal in the United States, but it represents real progress internationally.

INCIDENT (NTSB)

The NTSB definition of an incident is identical to the ICAO definition. The NTSB does not use the term, "Serious Incident." Events that the NTSB considers to be reportable incidents are listed in Chapter 11.

The United States Military does not use the term "Incident" and the closest analogy would be a "Class E Mishap." A list of these (for the United States Air Force) is included in Chapter 11.

HAZARD

This term is not defined in ICAO Annex 13, although the ICAO Accident Prevention Manual defines a hazard as, "Any condition, event or circumstance which could induce an accident."

There is clearly an overlap with the term, "Incident." Some would define a hazard as an event not involving damage or injury, but with the potential for damage or injury to occur. This is convenient and it can be argued that a hazard must exist in order for an accident or incident to occur. We could say that all accidents and incidents involve hazards, but not all hazards result in accidents or incidents.

One way to keep hazards and incidents separate is to think of "incident" as a defined event that requires a report. A hazard, on the other hand, is an undefined event that is reported only at the discretion of the person noticing or encountering it. See also Chapter 11.

In the United States, the Occupational Safety and Health Administration (OSHA) has pretty much taken over the term "hazard" and requires employers to maintain a hazard reporting program wherein employees can bring hazards to the attention of management. The USAF has a program called the Hazardous Air Traffic Report (HATR) where narrowly defined hazards including Near Mid Air Collisions (NMAC) can be reported and investigated. The U.S. Navy's "Anymouse" program is probably one of the oldest and most successful hazard reporting systems. Many countries have initiated anonymous reporting programs which are essentially hazard reporting systems. These include the Aviation Safety Reporting System (ASRS, United States) and several similar systems throughout the world.

SAFETY

There are many definitions of safety—some too long and involved to quote here. The simplest one is that safety is freedom from hazard; the absence of risk. Another is that safety is the preservation of resources including people, material, money, and time. A similar one was suggested in Chapter 1. Safety is a method of controlling costs.

One very workable definition is based on the acceptability of risk. If a particular risk is acceptable, then we consider that thing or operation to be safe. Conversely, when we say something is unsafe, we are really saying that its risks are unacceptable. This is consistent with the idea that there is no such thing as absolute safety, because there is no such thing as zero risk. It also suggests that the Safety Director is primarily in the business of identifying and determining the magnitude of the risks.

RISK

Risk is simply the probability that an event will occur. Mathematically, it is the number of undesirable outcomes divided by the number of possible outcomes. For our purposes, we usually modify our risk calculations by the number of times we intend to expose ourselves to that outcome, which is usually a function of how often or how long we intend to fly our planes. Then we factor in the severity of the undesirable outcome if it does occur. This leaves us with a numerical assessment of that risk compared to other risks. Correctly measured, there are varying degrees of risk and the task confronting us is to weigh those risks against the potential benefits of taking them (risk management or risk-benefit analysis) and deciding whether the

risks are acceptable or not. In this manner, we also decide whether something is safe or unsafe. This is consistent with the last definition of "safety" stated above and is discussed at greater length in Chapters 6 and 18.

The question of who is in charge of identifying risk and determining its acceptability deserves comment. This was discussed in Chapter 2. Basically, the Safety Director (or Aviation Safety Manager) is in the business of identifying risks and providing some guidance as to their magnitude. The decision to accept or not accept a risk is always a management decision.

It is sometimes useful to sub-define risk in four categories:

INFORMED RISK. This is the risk correctly identified and assessed as described above.

UNINFORMED RISK. This is the risk we don't know we are taking. We have either not identified it or we have incorrectly measured it.

POINTLESS RISK. This is the risk we take without reason. There is no possible benefit. This describes the pilot who flies under the bridge or does an aileron roll on takeoff.

BENEFIT-DRIVEN RISK. This is the risk we take because the perceived benefits are so great that it is worth the risk. If, for example, we put a pilot in a position where he must (or thinks he must) accept a particular risk or lose his job, we have created a benefit-driven risk. Not all benefit-driven risks are necessarily bad. Sometimes, we have a choice and the benefit-driven risk may be the best one.

Obviously, we would like all our risks to be "informed risks."

PUBLIC AND CIVIL AIRCRAFT

These definitions are peculiar to the United States and are included because the status of the aircraft determines which of the Federal Air Regulations (FARs) apply and who has investigative authority if there is an accident.

In our skies, there are only two types of aircraft; public or civil. Although everyone (including the FAA and the NTSB) uses the term "military aircraft" it is not defined anywhere. Technically, a military aircraft is a public aircraft.

In general, public aircraft need only comply with Subpart B of FAR Part 91, which are the traffic rules of the air. The NTSB investigates civil aircraft accidents and has acquired authority to investigate public aircraft accidents except those involving military aircraft or aircraft operated by intelligence services.

This mess goes all the way back to the Air Commerce Act of 1926 and the first serious attempt to straighten it out didn't come until 1995. That removed many aircraft from the "public" category, but it muddied the water somewhat. Now, any aircraft (except military or intelligence aircraft) could be a "public aircraft" depending on how it is being operated at the time. Thus Safety Directors of companies who occasionally do business with the Federal Government, States, Counties, or Cities need a working knowledge of the definition or at least knowledge of where to find it in a hurry. If you are not in that situation, you might want to skip the rest of this chapter.

PUBLIC AIRCRAFT (NTSB)

A Public Aircraft is an aircraft used only for the Unites States Government, or an aircraft owned and operated (except for commercial purposes) or exclusively leased for at least 90 continuous days by a government other than the Unites States Government, including a State, the District of Columbia, a territory or possession of the United States, or a political subdivision of that government. "Public Aircraft" does not include a government-owned aircraft transporting property for commercial purposes and does not include a government-owned aircraft transporting passengers other than: transporting (for other than commercial purposes) crewmembers or other persons aboard the aircraft whose presence is required to perform, or is associated with the performance of, a governmental function such as firefighting, search and rescue, law enforcement, aeronautical research, or biological or geological resource management; or transporting (for other than commercial purposes) persons aboard the aircraft if the aircraft is operated by the Armed Forces or an intelligence agency of the United States. Notwithstanding any limitation relating to use of the aircraft for commercial purposes, an aircraft shall be considered to be a public aircraft without regard to whether it is operated by a unit of government on behalf of another unit of government pursuant to a cost reimbursement agreement, if the unit of government on whose behalf the operation is conducted certifies to the Administrator of the Federal Aviation Administration that the operation was necessary to respond to a significant and imminent threat to life or property (including natural resources) and that no service by a private operator was reasonably available to meet the threat.

CIVIL AIRCRAFT

Civil Aircraft means any aircraft other than a public aircraft.

> **AUTHOR'S NOTE:** That last sentence sounds like a facetious definition, but that's exactly what the law says. This subject is discussed further in Chapter 17.

SUMMARY

All definitions of an aircraft accident require some degree of damage or injury and they all differentiate between an airplane that was acting like an airplane and one that was just an aluminum structure sitting in a hangar. If there was no damage or injury, or if the plane was not acting like a plane, it may have been a serious event, but it wasn't an aircraft accident.

All aircraft accidents (as defined by whatever system you are using) are reportable. That does not mean that within your own organization, you cannot define some other event as an aircraft accident. Of course you can. If it suits the needs of your safety program, you should.

Incidents are fairly serious events, but they are not well defined. Hazards exist in all accidents and incidents, but they can also exist by themselves. As a practical matter, an incident is reportable and (therefore) should be defined. The decision to report a hazard is generally left to the person who notices it and determines that it is, in fact, a hazard. Reporting systems are discussed in Chapter 11.

Safety is really a function of risk acceptability. That will be discussed in several chapters.

DISCUSSION QUESTIONS

1. Construct scenarios where the same identical event could be an aircraft accident (ICAO or NTSB), a lost-time accident (OSHA) or a "nothing" depending on the results and the people involved.

2. Inflight, a compressor blade of a turbine engine fails severely damaging the engine and requiring shutdown. The blade itself penetrates the compressor case and cowling and punctures the aircraft fuselage. There is no other damage and no injury. Would you classify this as an aircraft accident? Why?

3. Construct accident scenarios in which the risk was: informed, uninformed, pointless and benefit-driven.