
# Equipment Damage and Human Injury on the Apron Is it a cost of doing business?

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*Over 37 years' experience in both fixed and rotary wing aviation, aviation safety, maintenance management, training and air traffic control. Holds a Bachelor of Science degree in management and a Master of Science degree in Psychology. Has flown all types of aircraft from small single-engine fixed wing aircraft and helicopters up to heavy jets.*

*Bob served in the U.S. Army in various aviation positions for 23 years before retiring in 1988. He spent four years in air traffic control work at the Federal Aviation Administration. He was director of technical projects for the Flight Safety Foundation for 10 years. In May 1999 he was elected Executive Vice President. During his tenure as director of technical projects he led studies on the use of on-board recorded data, safety aspects of precision approaches, wind shear training aid, fatigue and continuing airworthiness risk evaluation. He has organized, conducted and spoken at safety seminars and workshops all over the world. Bob was awarded the Aviation Week and Space Technology Laurels Award for his work with the Foundation's Controlled flight into terrain initiative.*

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The Flight Safety Foundation (FSF) estimates that losses from apron damage are costing the world's air carriers in the vicinity of US$4 billion every year. Add to this the costs of apron damage to the corporate and business aircraft fleet and the price tag goes up an additional US1billion per year. Some U.S. based operators suggest that for every dollar in apron damage they pay two dollars for human injury. Many assume that these losses are insured and so the financial risk has been mitigated or eliminated. This is in fact not the case.

Apron damage did not get to the $5 billion annual loss overnight. There has been a gradual increase in both the number of incidents and in their associated costs over the history of powered flight. According to the late Jerome Lederer, President Emeritus of the Flight Safety Foundation, the reason that Orville Wright flew the first flight as opposed to Wilber was because Wilber had damage the fabric on the wing of the Wright Flyer. In response to this damage, Wilbur made the repairs and Orville then flew the first flight. What is significant in this anecdote is the fact that we had damage to the first airplane which was inflicted on the ground and it occurred prior to the first powered flight. We, therefore, had apron damage before we got the first airplane airborne using its own power.

The problem of apron damage can be traced to the beginnings of aviation, through the era where aircraft were beginning to be flown on a commercial basis, right up to today where we have over 800 airlines globally and nearly 5,000 operators of corporate aircraft. It was during the early period that pioneers began to find barns or large structures to house the aircraft and to protect them from the elements. Movement of aircraft into and out of these structures, or what became known as 'hangars', sometimes inflicted minor damage to the aircraft. This damage was nicknamed "hangar rash" by the early aviation enthusiasts and that descriptor is still in use today.

Following the example of the Wright brothers, aircraft operators made repairs to their aircraft to correct the hangar rash in order to return them to flyable condition. This concept of repairing the minor damage to aircraft has continued for decades and today we are still following the example of the Wright Brothers by repairing damage as soon as possible thereby returning the aircraft back to service in the most expeditious manner. Wilbur made the repairs in the best manner that he knew and understood and in accordance with the aerodynamic principles as he knew them to be. Today we are making far greater repairs and doing so, in accordance with guidance from the regulatory authority and the

aircraft manufacturer's recommendations, but we are doing so at a greatly increased price.

As airlines began to form and increase in size they began to suffered hangar rash and at increased rates. In their attempts to remain competitive in the market place they repaired the aircraft damage and brought the airplanes back into service as soon as possible. This process was a natural extension of what probably started with the tear in the fabric on the Wright Flyer's wing and the need to repair it and get the attain flight on December 17, 1903. As airplanes became larger and more complex the repairs became more complex and the 'hangar rash' costs became more and more significant until today we are suffering $5 billion annually in what many refer to as apron damage. Today, as we work to reduce apron damage, we must extend the definition of apron damage to include not only the damage to aircraft but to include injury and death to ramp workers as well as the damage inflicted upon service vehicles and on airport structures.

It is appropriate to pause in the explanation of apron damage to describe how the Flight Safety Foundation became involved in this area. For the past 10 years the Foundation has focused its efforts on four primary areas where the greatest loss of life, equipment and resources have occurred. These four areas are controlled flight into terrain, approach and landing accidents, loss of aircraft control, and human error. The Foundation and the aviation industry have traditionally focused on safety of flight operations. We have utilized advanced training techniques in simulators; introduced CRM to cockpit, cabin and maintenance operations and this has brought about a level and stable safety rate in commercial aviation. We have also seen a maturing focus on safety in the maintenance arena. We now must shift the paradigm to address the emerging focus on ramp safety.

It is the contention of the Foundation that human error is involved in almost every accident and for this reason the Foundation has been a leading proponent of:

a) The use of flight operational quality assurance and collection and interpretation of ground damage data,
b) The implementation and use of non-punitive reporting systems both in the air and on the ground,
c) The awareness and reduction of fatigue in the aviation industry, and
d) The improvement in safety on the apron.

Safety must be viewed by looking at all the parts of the aviation system. Just as in other industries, human error is prevalent throughout. We find that human error can enter the system through design of the aircraft; through regulatory involvement and oversight; through management intervention; through the ATC system; through the flight crew; and we find human error impacting the system on the apron, in the hangar, through airports design and operation, and through

service providers. For these reasons we have taken the decision to lead an international effort for the reduction of apron damage.

The Flight Safety Foundation began this effort with the formation of a working committee whose charter was to plan the best path for success. The actual study began with data collection as we strongly believe that everything the Foundation does should be data driven in order to optimize the resources expended. This data effort is currently underway and once sufficient data are obtained the data elements will be closely analyzed to determine as closely as possible those things that are negatively impacting apron safety. The data team is also working to develop the actual cost related to apron damage. This will address both direct and indirect costs.

While the data collection effort is ongoing there are four other teams which are developing products designed to reduce or eliminate apron damage. These products will be used as interventions to stem the growing risk of apron damage and injury; to reverse the processes that are in place which allow or foster this dramatic loss. The FSF plan calls for implementation of the interventions on a limited basis to demonstrate the viability of the whole program. Once the limited implementation program is complete and any needed corrections have been applied the program will be implemented on a global scale by utilizing regional breakouts to focus the program.

The first step for the Flight Safety Foundation was to create a working definition to add scope to the apron damage and human injury initiative and at the same time to establish a common point of reference. The working definition:

> *"An incident that occurs on the airport movement area or in the hangar that results in either the loss of use of a piece of equipment (aircraft, vehicle, and/or facilities) for any period of time or a lost work day case that occurs when an individual is injured."*

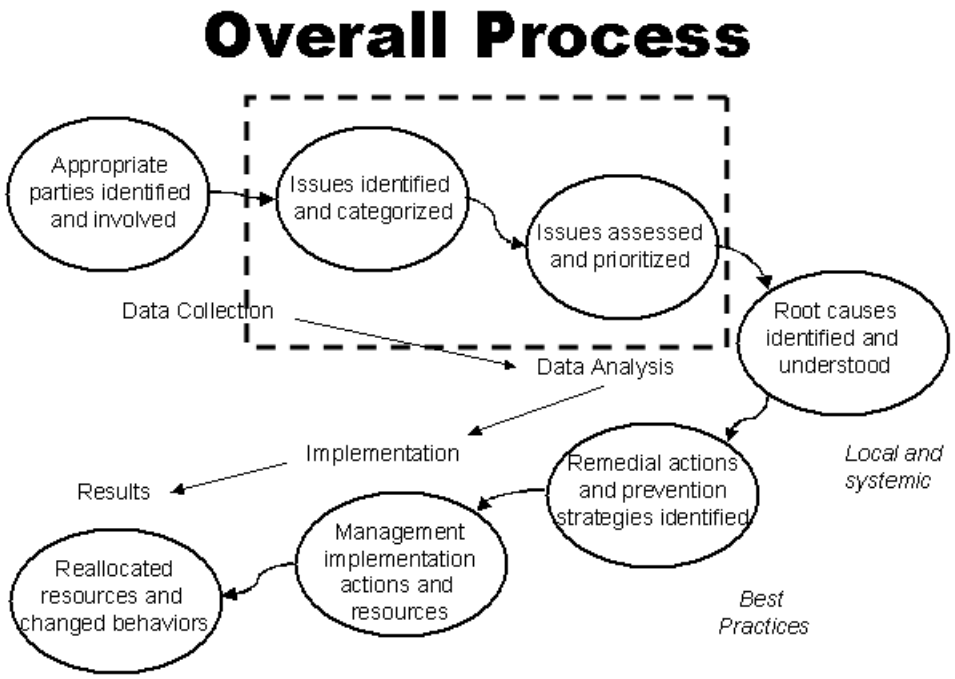
The Foundation believes the primary cause of apron damage is human error and this belief ties directly into our fourth primary area of emphasis, the reduction of accidents and incidents caused by human error. In 1993/1995 a study commissioned by the IATA Airside Safety Group into the causes and costs of apron damage concluded that the major cause of apron damage (92%) was 'operator error'. The survey concluded that the operator error included inadequate training, inadequate supervision, failure to follow standard procedures, pressure of work, inappropriate equipment and inclement weather conditions.

We need to remember though that human error is quite normal. We all make mistakes and hopefully we learn from them. Someone once said that mistakes are the down side of having a brain. Mistakes are not only a result of our being human but there is benefit gained by learning from our errors. The fact that

human errors are normal is not a reason to dismiss them as an unmanageable problem. Quite the contrary, if human error can be identified, causes determined, interventions designed, we can implement the science of human factors and we can defeat the identified problems.

We must begin our assault on apron damage and human injury not only by obtaining data but by looking at such things as management oversight, training deficiencies, language difficulties and fatigue as areas where we can begin this effort. By accepting the premise that human error is the primary cause of apron damage, it mandates that we specifically identify an error taxonomy that has identifiable and measurable parameters. Once we have accomplished this step and understand the problem we can design appropriate resolution strategies. This design will necessarily encompass error tolerance in procedure and equipment. Identification of the solution is not the ending point of this strategy. To truly combat apron damage and get the reduction that we are looking for we need to modify behavior. This modification of behavior will occur in the implementation phase of the apron damage and human injury reduction effort.

**Figure 1**



As we began our research to identify possible solutions, logic dictated that we include as many organizations as possible that are stake holders. The following is a partial listing of stakeholders in the reduction or elimination losses on the apron.

- Airlines
- Cargo/Package carriers
- Corporate operators
- Military
- Airport operators
- Insurers
- Fixed base operators
- Ground handlers
- Fuel & oil suppliers
- Caterers
- Manufacturers
- Maintenance, repair and overhaul facilities
- Airport designers
- International Civil Aviation Organization
- Airports Council International
- Flight Safety Foundation
- International Air Transport Association
- National Business Aviation Association
- Regulatory agencies
  - Aviation authorities
  - Occupational safety and health authorities
  - Customs authorities
- Labor organizations
- Security organizations

Although the availability of data is limited, the Flight Safety Foundation (FSF) has sufficient information from a variety of air carriers to estimate the magnitude of the problem from both the airline and the corporate aircraft industry perspective. We estimate that the loss exceeds US$4 billion dollars on an annual basis for the air carriers alone. This figure is a combination of the direct costs and the associated indirect costs which typically run from 3 to 5 times the direct costs.

A quick example will provide some perspective as to the direct costs associated with apron damage to a Boeing 737.

**Figure 2.**


This slide does not depict the cost to the interior of the aircraft in the cargo compartments. Primarily damage to cargo compartments occurs to sidewall lining panels, ceiling panels, blow-out panels, and floor panels. These are typically caused by:

- Damaged sidewall and ceiling panels due to incorrectly assembled pallet load, or cargo operators leaning on sidewall panels to manually maneuver unit load devices (ULD).
- Damage to floor panels from crowbars when used to manually maneuver ULD's.
- Damaged or manually operated blow-out panels caused by strikes from ULD's or customs staff looking for illegal substances.
- Damage to door seals from incorrectly assembled or misaligned pallets.

The indirect costs for an airline or an airport might include:

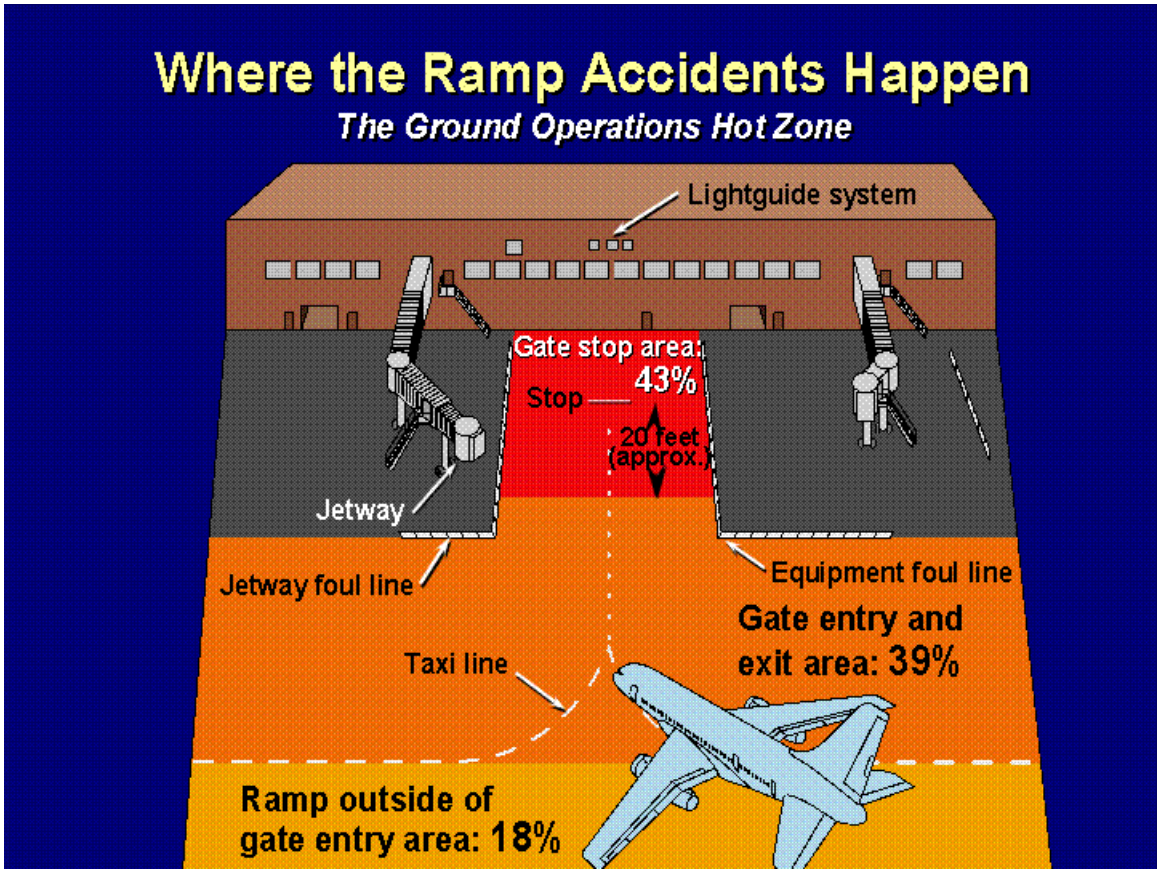
- Lost direct revenue (ticket sales and cargo revenue)
- Aircraft diversions (replacements)
- Flight cancellations
- Passenger food and lodging
- Replacement labor and overtime
- Damage to public image
- Management and supervision time
- Incident investigations
- Purchasing seats on another airline to accommodate passengers
- Pain and suffering for those injured and their families
- Adverse impact on operations
    - Productivity and schedule efficiency
    - Quality
    - Costs
- Employee relations/overall company morale
- Regulatory agency reactions
- Total costs of workplace injuries
- Public perceptions

An actual incident of apron damage that involved a catering truck hitting an airplane showed that the direct costs were $17,000 however the indirect cost of $230,000 for a grand total of $247,000. In another incident a jet way operator hit an aircraft with the jet way. The airplane suffered $50,000 damage in direct costs and $600,000 in indirect costs.

The first argument put forward is that this loss is insured so the airlines are not loosing a significant dollar amount. FSF recently reviewed data from one US based airline which indicated that in a one-year period the airline had 274 reported cases of apron damage. When reviewing the insurance coverage it was determined that the deductible was $500,000 for an older-generation single-isle aircraft, $750,000 for a modern single-isle aircraft and $1,000,000 for wide body aircraft. It was determined that the average event cost was $250,000. When this deductible of each incident was compared to reported apron damage case, the result was that 273 of the reported cases were below the deductible limit. The only conclusion that one can come to is that the vast majority apron damage is self-insured and therefore these cost of repairs come directly off the bottom line of the airline's balance sheet. This same airline's management indicated that they believe there are a number of unreported cases of apron damage.

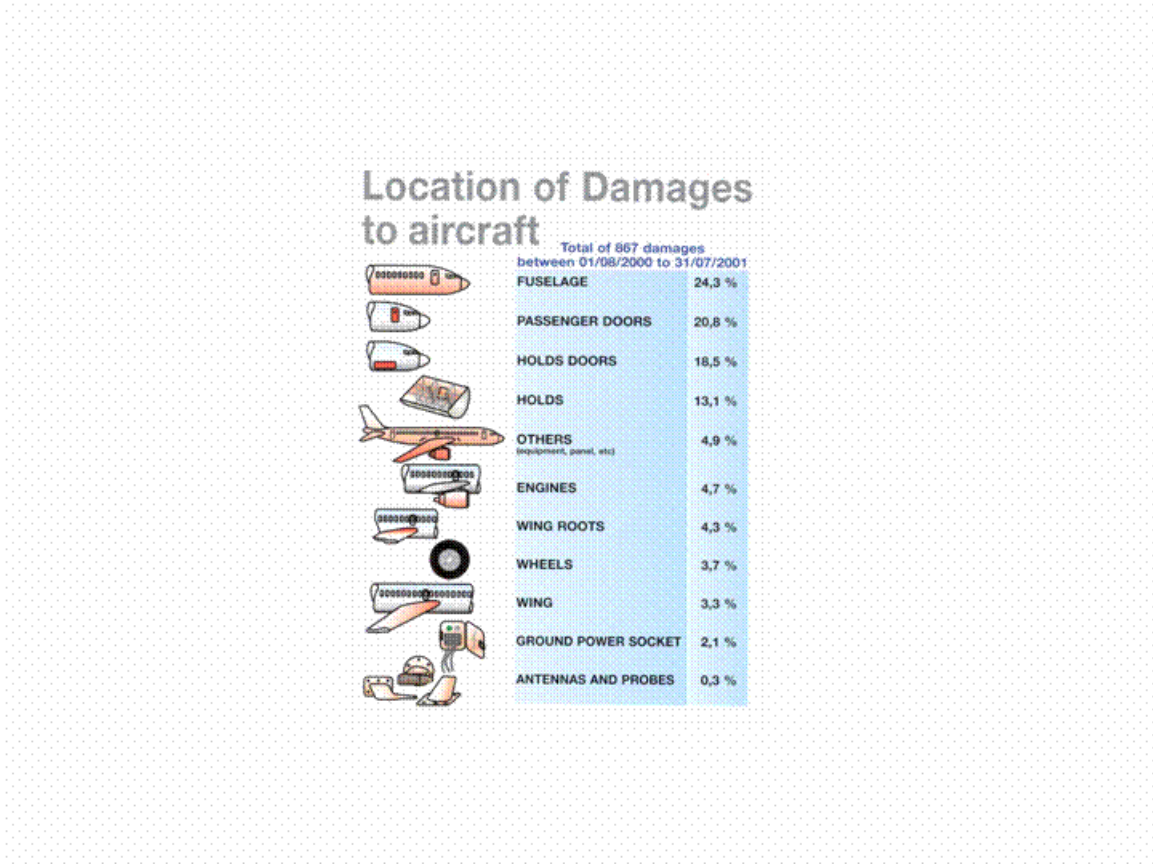
To begin combating apron damage to aircraft, we need to determine where the loss is occurring. We currently have limited data which indicate both where the majority of the damage is occurring on the aircraft and also where on the movement area the damage is happening. These data were supplied by Boeing and suggest that the largest number of apron accidents occur in the gate stop area.

**Figure 3**



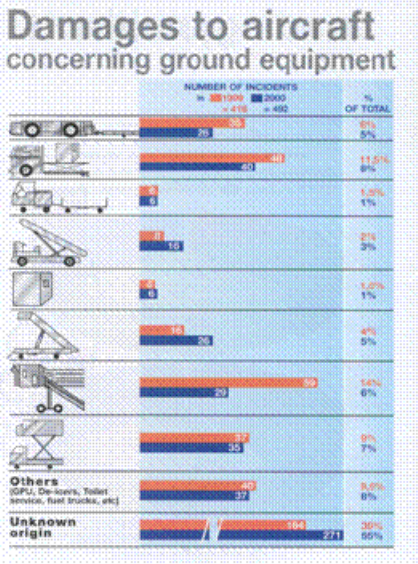

By reviewing the chart below we begin to see where the majority of damage is occurring relative to the airframe itself. We see that it is occurring at the primary locations of servicing on the fuselage, near the passenger doors, near the hold doors and in the holds themselves. We have a basic understanding of what happened. We can see that over 75% of the damage is in fuselage, passenger doors, holds doors, and holds. This gives us a good indication of where on the aircraft we need to focus.

**Figure 4**



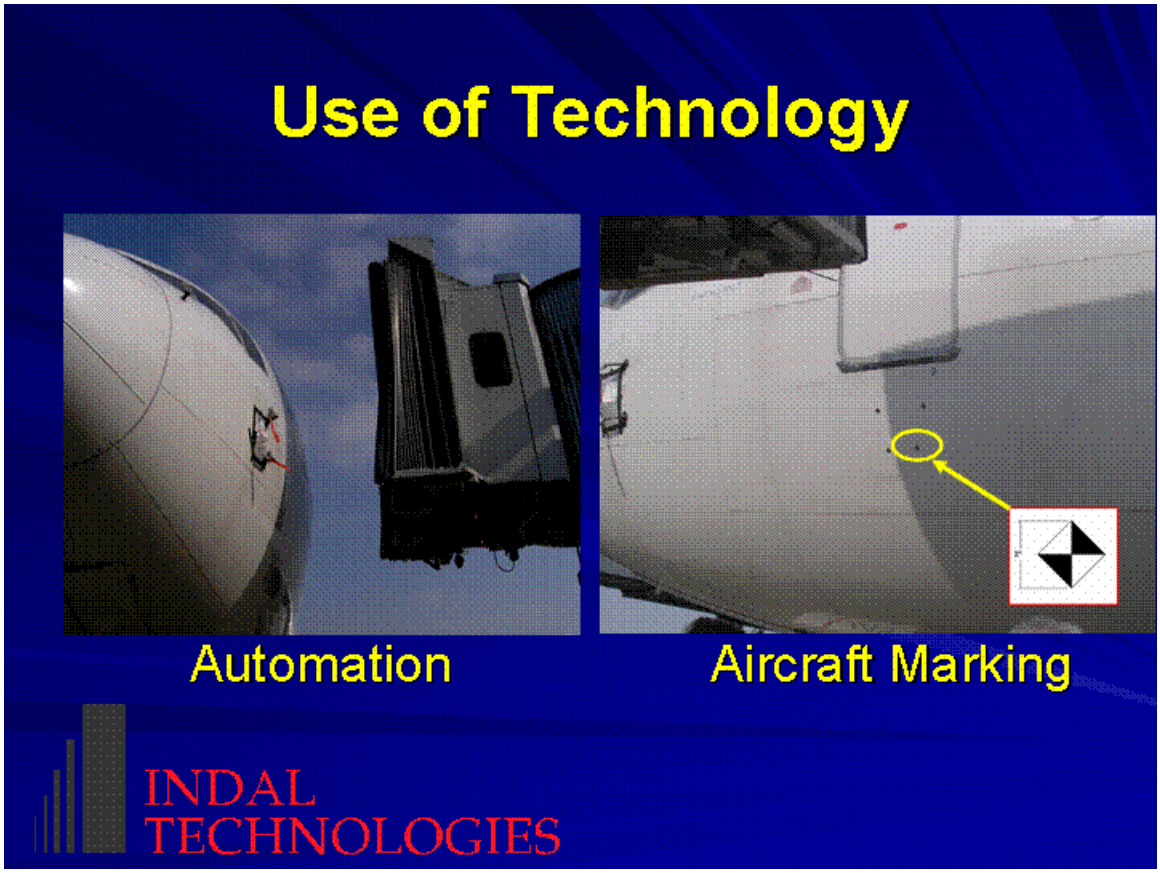

If we were to look at the limited data available on ground equipment we see that tugs, cargo positioning equipment, jet ways, and food service vehicles seem to be the most common culprits. One item that stands out is that in the “others” and “Unknown origin” categories we have almost 2/3 of the damage. We as an industry must explore this area much more closely. This will be one of the tasks for the data collection working group which was chartered under the Flight Safety Foundation’s new initiative to reduce damage and injury on the apron.

**Figure 5**



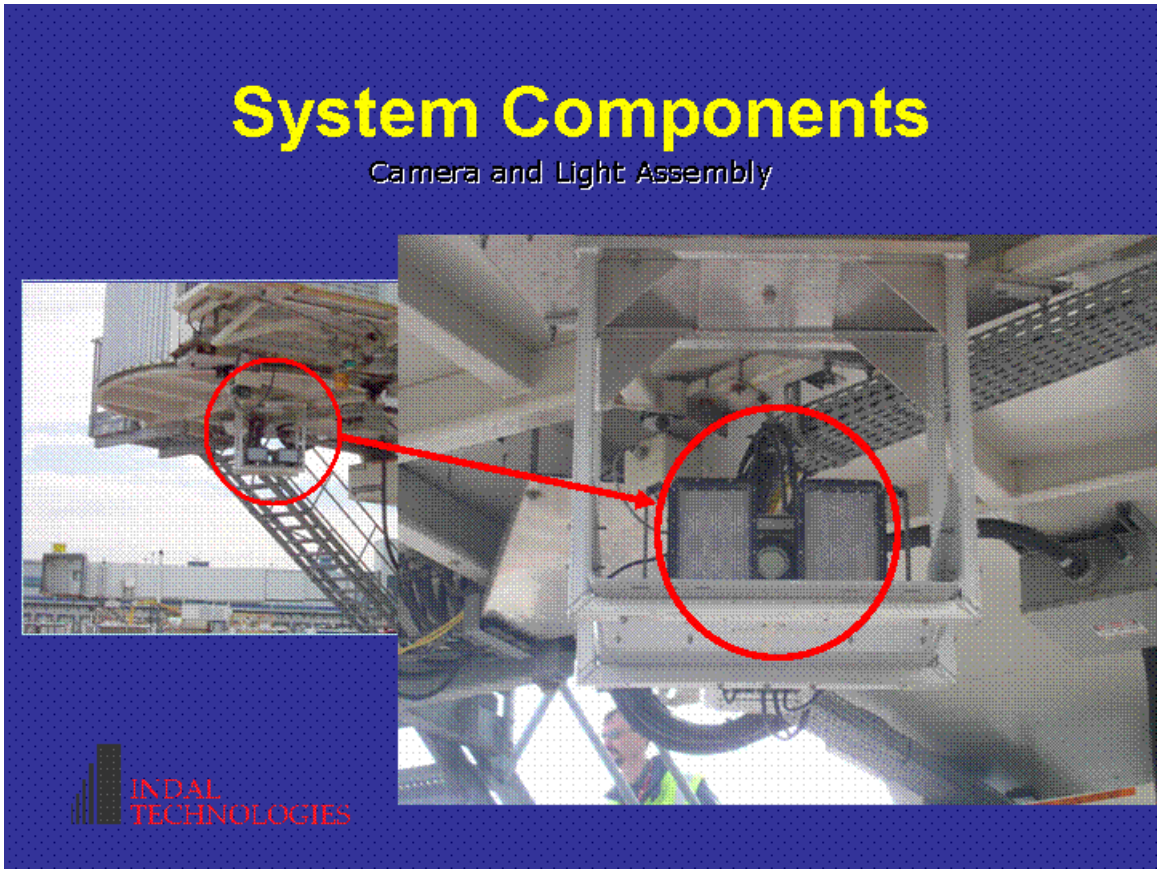

If we were to combine the information contained on these two charts we would see that there is a common link which can be challenged to reduce the overall cost of apron damage. Indol industries has developed an automated passenger bridge system which can dramatically reduce damage due to human error.

**Figure 6**




If this system were implemented globally we could realize a 14% overall reduction in damage to air carrier airplanes. This system is adaptable to all existing and planned passenger bridges and requires only minimal adaptation to the aircraft. All one needs to do is place 4 small decals on the aircraft under the passenger loading doors and the Indal system does the rest automatically. This not only reduces the repair costs associated with passenger bridges but it allows for the repositioning of the passenger bridge operator to other duties on the airport.

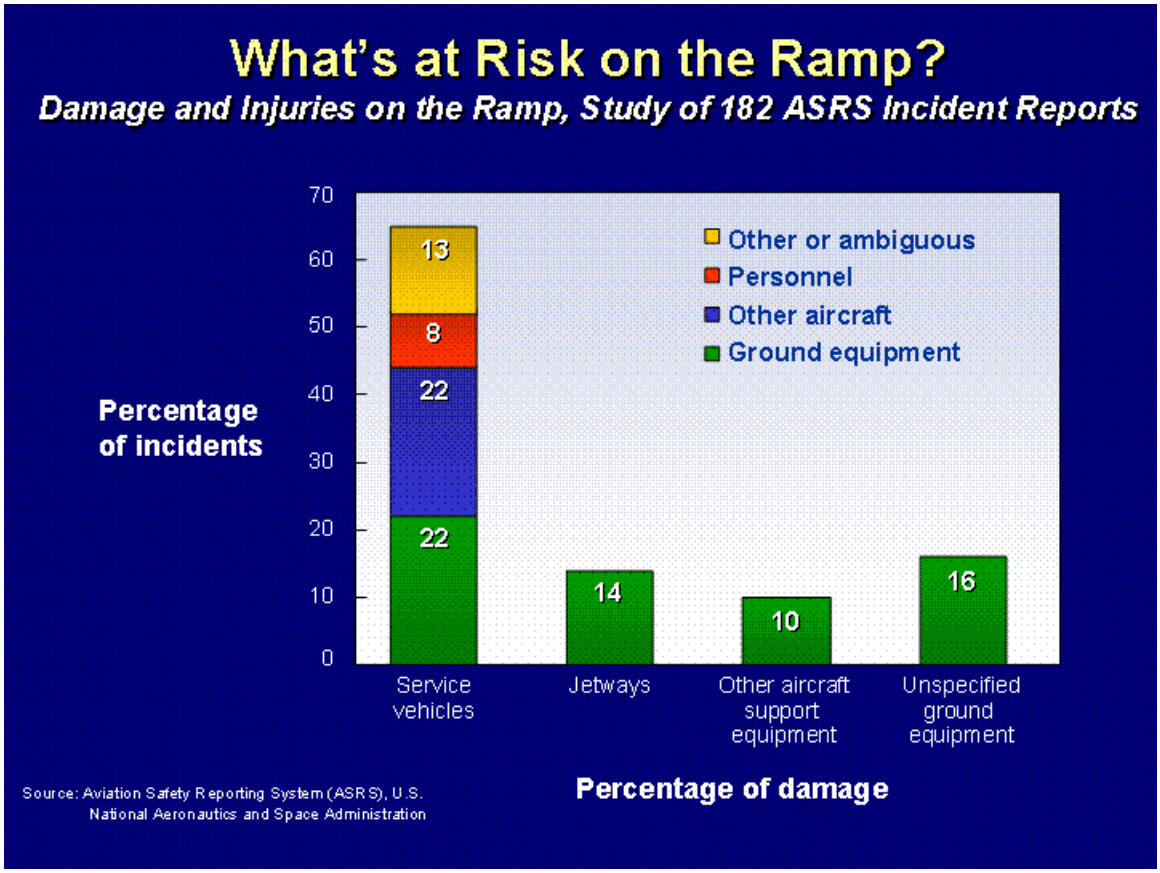
**Figure 7**




This system uses two sensors that are located underneath the passenger bridge. Through the application of infra-red technology the system is able to make the bridge to the aircraft and not be affected by weather. There exists the possibility of saving the air carrier industry $560 million annually through this one piece of technology. If we added this type technology to ramp vehicles such as catering trucks, jetways and cargo loaders we could then have the potential for saving upwards of $1.3 billion annually.

Another study conducted under the auspices of the Aviation Safety Reporting System (ASRS) shows a different picture.

**Figure 8**

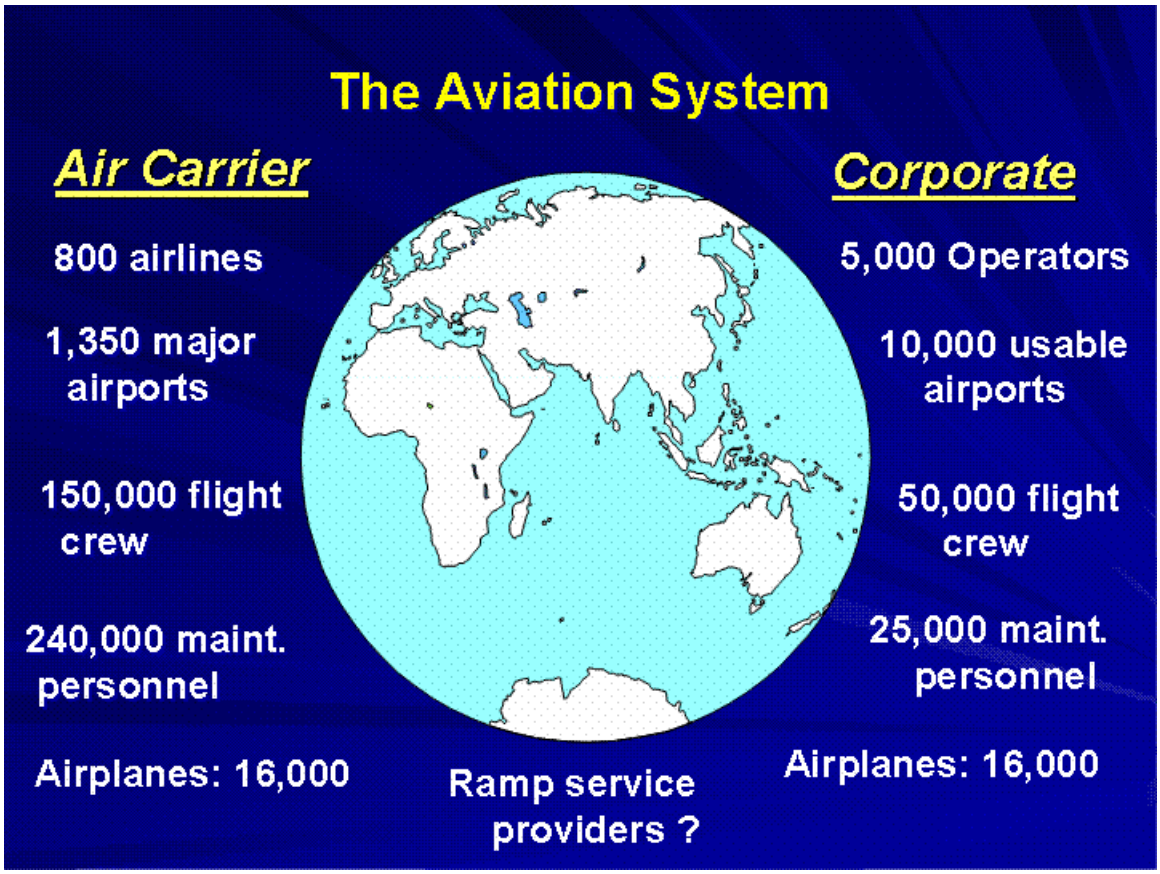



If we were to break out the corporate and business aircraft we might see a slightly different picture which we would expect as these aircraft are normally serviced differently. It is routinely the case that the flight and cabin crew load baggage and meals into the airplane and that FBO's accomplish the ground handling. For corporate aircraft we now believe the phase of apron operations where the highest percentage of damage incidents occurs is in the towing phase while the highest percentage of personal injury occurs during the loading of the aircraft. We see that in the ground handling phase of the operation approximately 40% of the incidents occur to wing tips with a comparable number to the wing's trailing edge. It is postulated that these occur as the result of the aircraft being pushed into a congested hangar area without the use of ground guides or wing walkers. The other major category is damage to the leading edge of the wing. It has been postulated that the damage to the wing tips occurs because today's tug operators do not have the spatial recognition skills that their predecessors possessed.

How do we reduce apron damage? The process is obviously multifaceted. We must look to all stake holders to manage the issue in their sphere of influence.

When we look closely at the system the air carriers operate in it gives a fairly good idea of the complexity of the global forces impacting them.

**Figure 9**



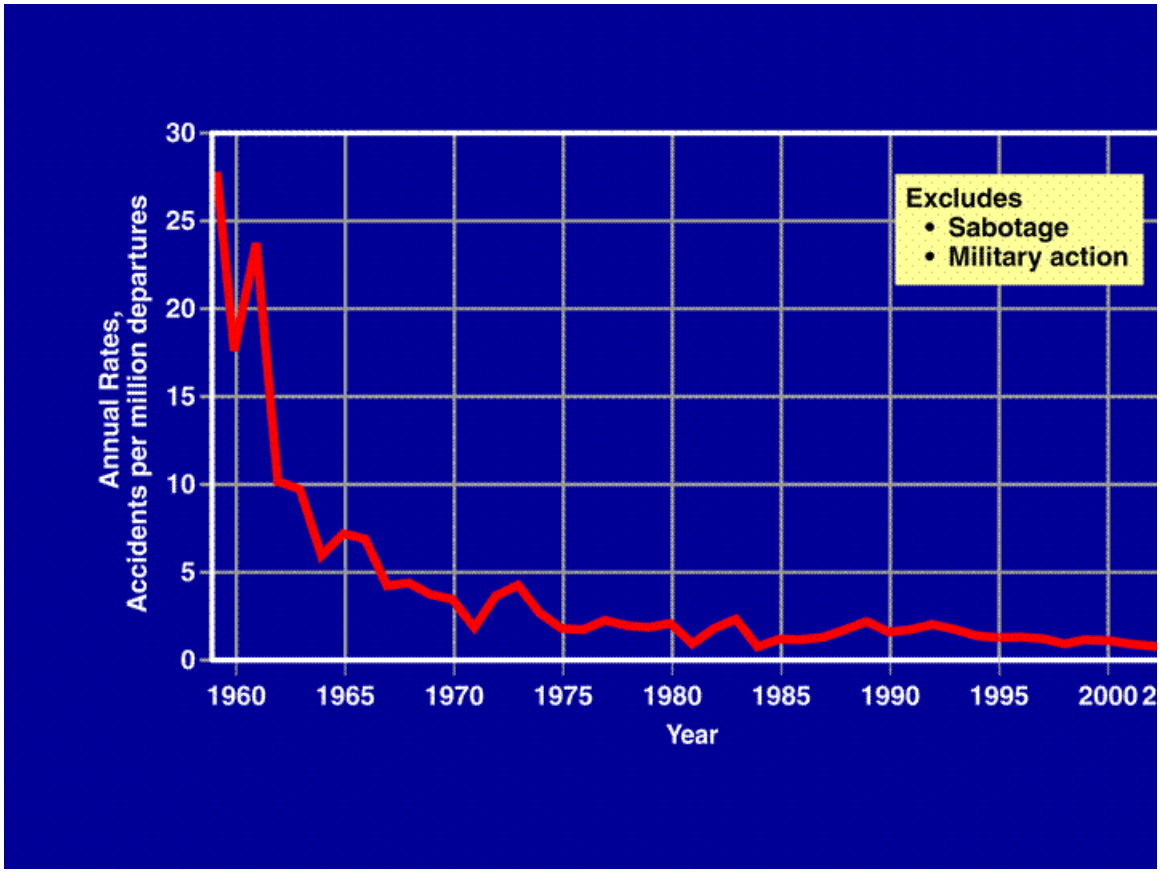

The picture for corporate operator is slightly different. These aircraft have many more operators than the air carrier system and they fly to many more airports. Their inclusion expands the number of airports that will be included in the solutions to the apron damage and personal injury initiative.

Some of the Foundation's solutions will be specific for each of the many stake holders while some will cut diagonally across the aviation industry. For those that cut across the industry there are basic principles that should be applied to all. The Flight Safety Foundation maintains that safety begins at the top and therefore it follows that apron safety begins at the top. The CEO, whether at the airport, airline, ground handling company or the corporate entity, sets company safety culture. He must walk the walk and talk the talk. It is a time proven adage that the workers do well what the boss checks. If the CEO puts safety high on his corporate agenda and checks the results then his managers who set safety policy will conform to the CEO's lead. Finally, the management team must

assume responsible for safety. If the organization has this basic structure in place they are on your way to developing a strong safety culture within their organization which will greatly assist in reducing human error on the apron.

While the solutions will differ depending upon whether one is operating an airline, a corporate aircraft, an airport, or an air traffic control system, safety will fit into the production objectives. It will not be the prime objective as that will be to produce or sell at a profit but it must be openly recognized that apron safety supports the prime objective. It conserves resources and costs, prevents damage and injury and reduces risk. Safety must be a core business value.

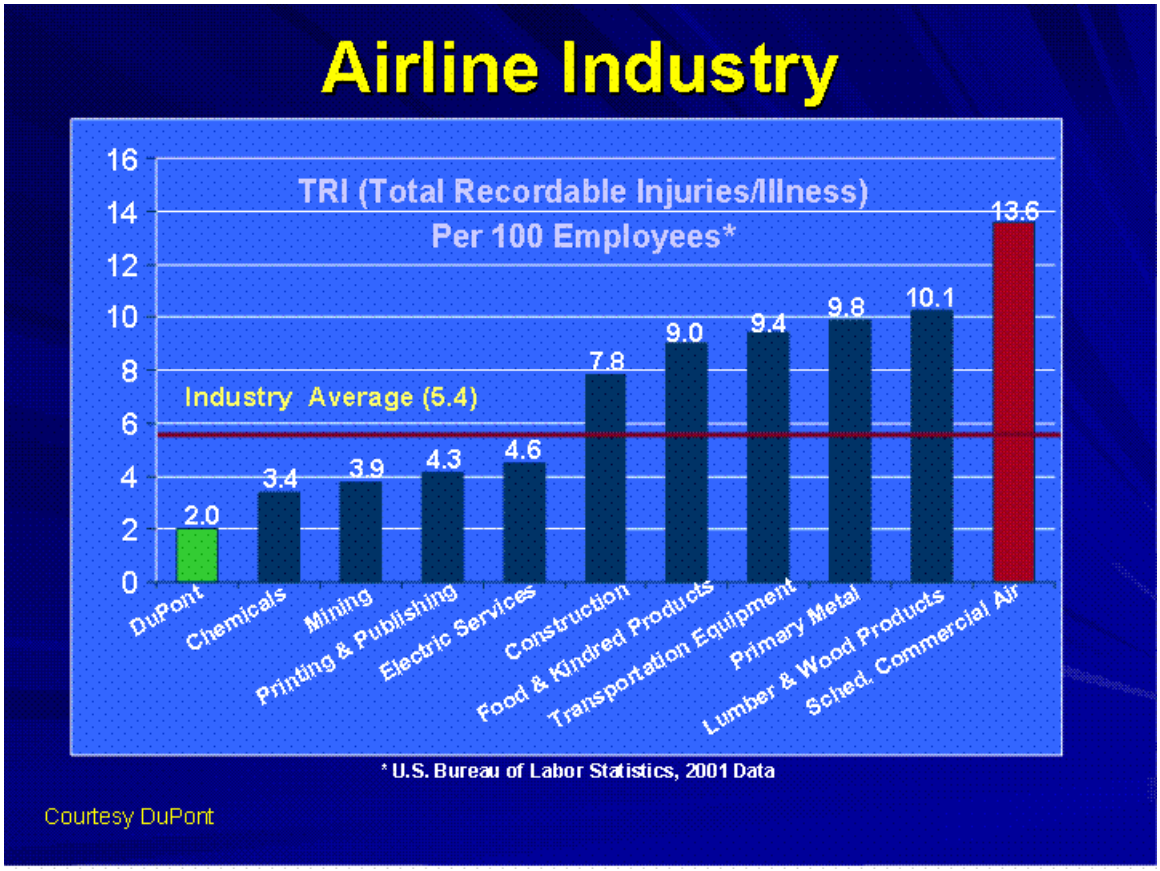
**Figure 10**




This chart shows how we have driven hull losses down over the last half century. The accident rate has been stable at approximately 1 hull loss for every million departures for the past 25 plus years. We need to continue our efforts in this area but at the same time we are calling for a paradigm shift. We need to look at the safety of the apron worker.

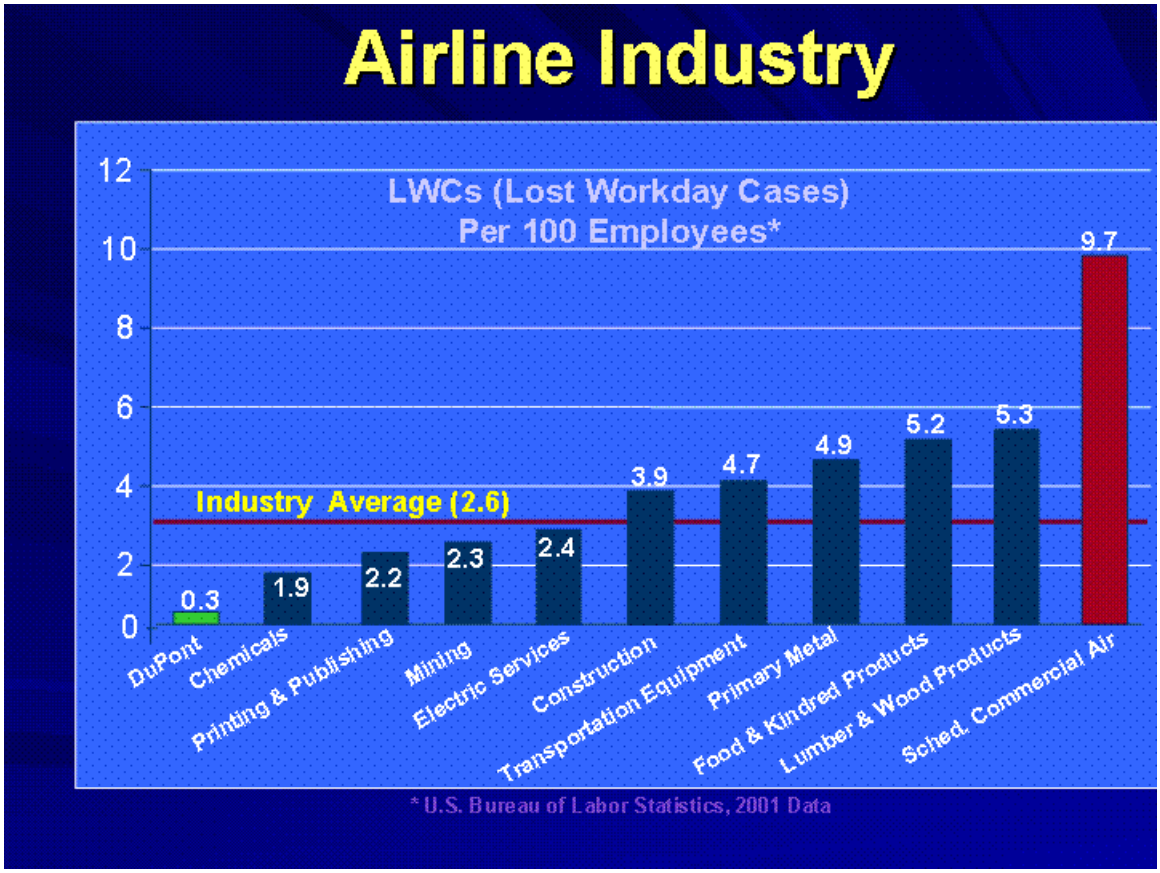
What about the actual line employees? Advocates have maintained for many years that aviation is the safest form of mass transportation and the statistics firmly support this. However, when we compare how employee injuries in the total aviation industry compare to that of other industries we find a different picture. The following graph was developed by DuPont Safety Resources from U.S. Bureau of Labor Statistics and shows data for the United States.

**Figure 11**



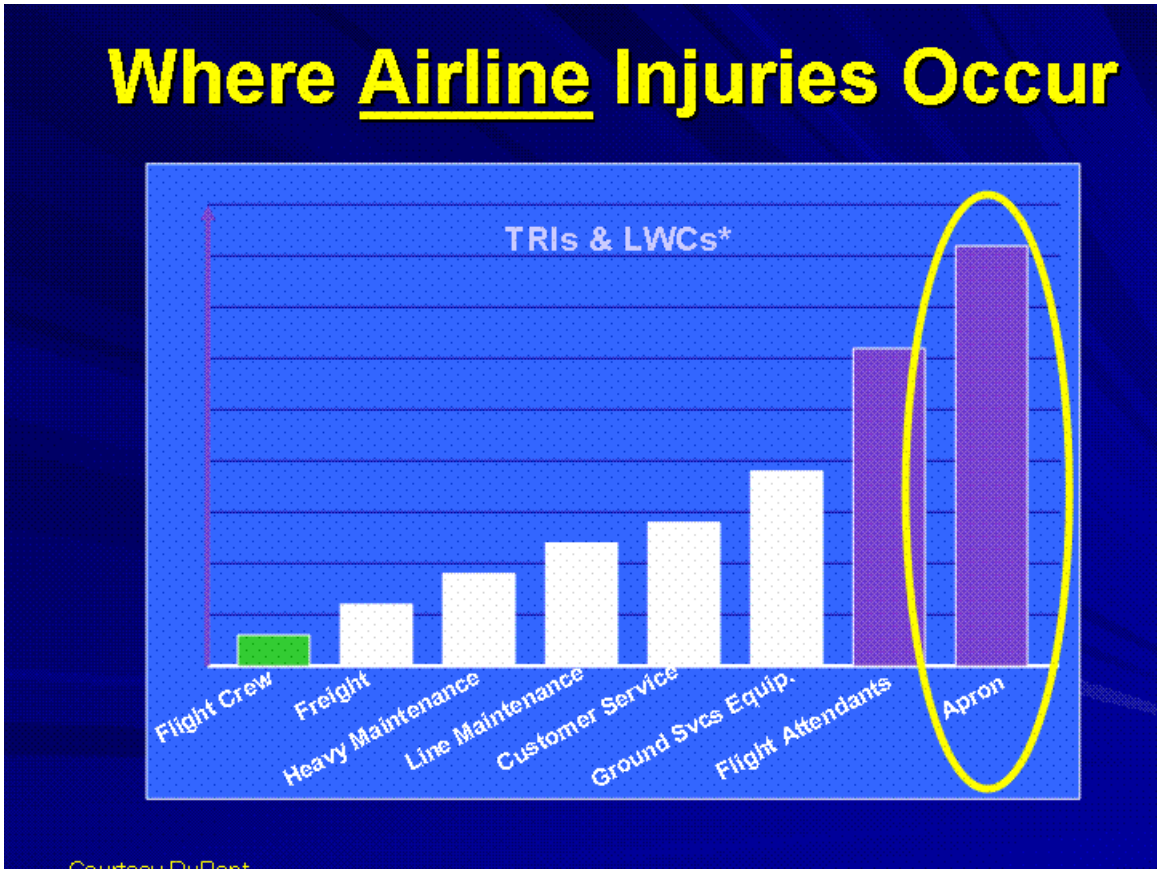

These data clearly show that with an industry average of 5.4 total recordable injuries (TRI) per 100 employees on an annual basis and that transportation by air for scheduled air carriers the rate is 13.6. When we look at the DuPont average we see that aviation experience over 7 times more lost work days per 100 employees than DuPont on an annual basis. It is obvious to the Flight Safety Foundation that DuPont has developed a method of developing a safety culture which is worthy of emulation.

**Figure 12**




This graph shows that in 2001 the aviation industry suffered 10 lost work days per 100 employees. This cost was significant in both terms of dollars and productivity. If this is somewhere near the average it tells us we must move to change the situation. This is lost workday cases. As you can see again our industry is not in good shape. You might also find it interesting to note that companies that are in what is perceived as higher danger industries actually have lower workplace injury rates because they have focused on improvements.

**Figure 13**




Combining the TRI and LWC we get a more complete picture of where the risk is for the air carrier worker. You can see from this graph that the apron is the area where most injuries occur.

There will be both technological and human centered approaches to the apron damage issue. Technology can not only assist us in the measurement of what is actually happening on the apron, it can assist us in numerous ways to eliminate certain categories of apron damage. One of the human centered methods to help us obtain a clearer picture of what is happening on the apron is to develop and institute a confidential non-punitive reporting system. We cannot be certain that we are fixing the correct problem unless we know what is happening and obtain an insight into why it is occurring. Initiation of a non-punitive incident reporting system will be a major step in understanding the "why" as it relates to the incident's cause.

We must find a change agent and that is what the Foundation's apron damage and human injury reduction initiative is about. This Foundation program began as a collaborative effort. We have enlisted participants across the aviation industry which embraces the inclusion of work already accomplished by the

International Air Transportation Association, the Regional Airline Association, the National Business Aviation Association, the U.S. Air Transportation Association and the European Regions Airlines Association.

We have identified over 100 initial issues which are being addressed by volunteers who populate the five working groups. The working groups have been generally divided into:

- Data collection and analysis
- Education and training
- Apron facilities, equipment and operations
- Management Processes
- Industry Awareness Working Team

The data team will work to define the metrics for the initiative and the objective targets. They will also be tasked to redefine the magnitude of the problem. They will conduct the basic data collection, analyses and support the various working teams. In addition they will develop cost models which will include both direct and indirect costs.

The education and training team is working to understand and base-line present day industry practices regarding ground handling and recommend improvements to education and training.

The apron facilities, equipment and operations working team will identify apron facilities, equipment & operational practices that improve safety. They will also assess and develop enhancements to design, installation and operations that will reduce ground accidents.

We have asked the management processes team to identify management and leadership practices (culture) that impact safety. They are also tasked with assessing and developing enhancements to management practices designed to reduce ground accidents.

The final team is the industry awareness team and they are charged with keeping the industry aware of what is being developed. Specifically, this team will generate a multi-tiered and multi-media communications plan with long-term strategies and near-term tactics to communicate issues and to market results to stakeholders.

The entire process will is expected to take approximately three years before we begin putting products and solutions in place. We are using the model that the Flight Safety Foundation used in its award-winning effort to reduce both controlled flight into terrain and approach and landing accidents. In addition we will utilize the same management team and are very optimistic about the results.

It is our firm belief that equipment damage and human injury on the apron need not be a cost of doing business.