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SAFE PLACE VS SAFE PERSON: A DICHOTOMY, OR IS IT?

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ABSTRACT

Fully developed comprehensive safety management systems emphasise both engineering solutions and administrative controls in the mitigation of accidental injury or damage risk. Companies with immature safety systems will often make performance gains whether their emphasis is placed on engineering or administrative control measures. Those that rely on administrative controls alone may achieve some short term gains, whereas those who use administrative controls to enhance multi-faceted engineering preventive measures gain maximum benefit from their safety systems. However, there are some real-world examples of injury and/or damage potential, where engineering solutions are not yet available or are cost prohibitive. In these instances, the companies involved have no alternative than to rely on administrative controls and/or personal protective equipment (PPE) for protection. Safe Place versus Safe Person arguments are a distraction, since the issue should be on which controls are available, appropriate and cost effective. This paper suggests that immature safety systems probably attain greater benefit from available resource investment in engineering controls, but that highly sophisticated systems which have already invested significantly in safe place mechanisms, such as aviation safety, gain effective use of available resources by looking to additional safe person solutions.

INTRODUCTION

Aviation is commonly promoted as the safest form of transport. US airlines caused the deaths of 285 people in 1988 whereas in contrast, 46,730 persons died on US roads that same year (Cosgrove and Condit, 1990). In the period 1980 to 1990 scheduled US air carriers experienced an average of one fatal accident per million departures (a failure frequency of 10^{-6}). However, the machine aspects of the system were performing at a failure rate of around 10^{-7}, since less than 12% of accidents were the result of mechanical systems failures. Failure of the human elements of the aviation system accounted for 88% of fatal accidents (Boeing, 1990).

The proponents of safe place solutions would argue that design improvement should accommodate the error prone human and maintain a low risk operation despite those errors. However, unless the human is engineered entirely out of the system, aviation experience shows that a point may be reached where automation can erode operator skills. Figure 1 shows an example of a B747 aircraft touching down at Hong Kong's Kai Tak Airport where the pilot has all but lost control of the aircraft in the final stages of approach. Ironically, the skill erosion is a result of a lack of operational exposure due to the automated systems regularly performing the required tasks.

Even, or perhaps, particularly, in operations with highly refined safety systems, the need for emphasis on safe person issues, such as training, proficiency, supervision, procedures, and team management have significant value. Also, the need for training of operators in abnormal or emergency procedures takes on greater significance.

Figure 1 B747 Touchdown Kai Tak

ENGINEERING CONTROLS: THE COST BENEFIT BREAK

Hierarchy of Control theory (Department of Labour 1990) suggests that elimination, substitution and engineering solutions provide better risk reduction options than administrative and personal protective equipment solutions. Few would argue that removing a hazard entirely, or physically preventing its possible impact on people, is not an ideal objective. Some idealists would even say that such solutions should be applied at all cost.

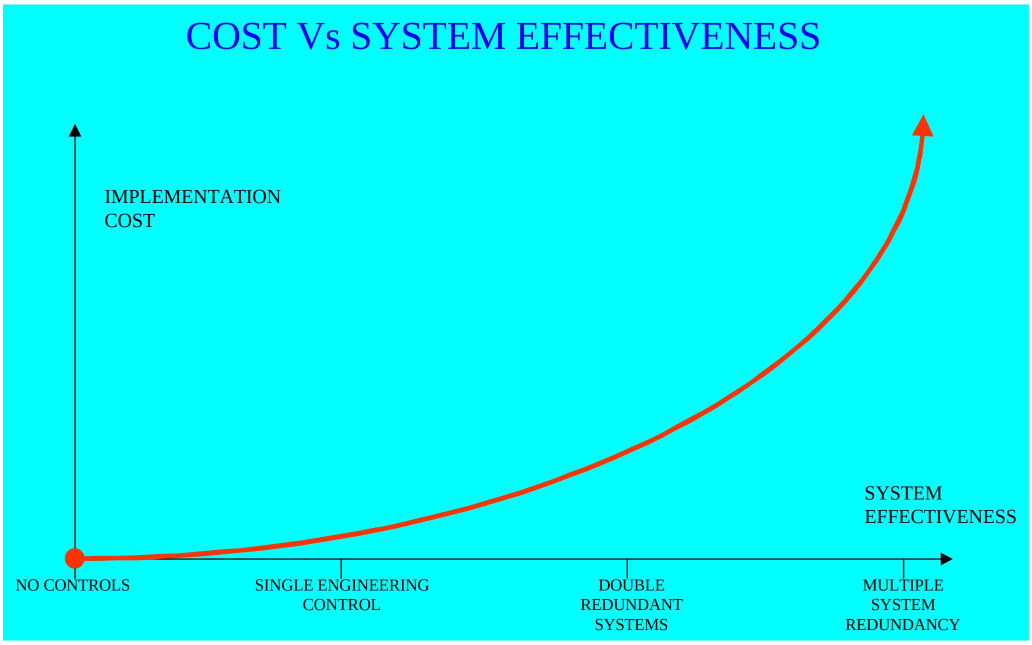

Figure 2

However, in the business world in which our precious OH&S principles are applied, the issue of cost, or rather cost effectiveness, becomes the driving force in decision making. Even in the most cash flush companies, senior management desire to maximise investor or shareholder returns, places finite limits on the funds available for any business undertaking. Unfortunately, the injury and damage prevention effort of most organisations are no different, finite OH&S budgets are struck and enlightened management are looking for the best risk reduction return with the funds available.

Figure 2 is a model of the relationship of cost to effectiveness of implementing risk control measures. Poor OH&S performers, with little or no systems in place, can and do, make significant performance improvements without much effort or resource commitment. However, those organisations who wish to reduce potentially high risk operations, such as aviation, to become acceptable low risk endeavours, must invest considerable resources to achieve that end.

Increases in engineering control protection are achieved by incorporation of control system redundancy. In simplistic engineering systems, people are protected from a hazard by a single control measure, such as a pressure valve, machine guard or electrical isolating switch. However, to protect against exposure should that single control fail, it is necessary to provide a second control - a double redundant protection system. Many organisations use this technique to protect workers in hazardous working environments.

However, if the reliability of the control measure is low, or the consequences of loss of hazard control are great enough, there may be a need to incorporate additional parallel controls to achieve 3 or even 4 levels of control system redundancy, as is the case with the Boeing B747 flight control system.

However, in many industries, quadruple system redundancy is not often a reality. Organisations with advanced OH&S systems seldom incorporate more than double redundant hazard control measures, and those with rudimentary hazard control systems would incorporate single level protection systems. Sadly, many organisations do not implement any engineering controls at all (see Figure 3).

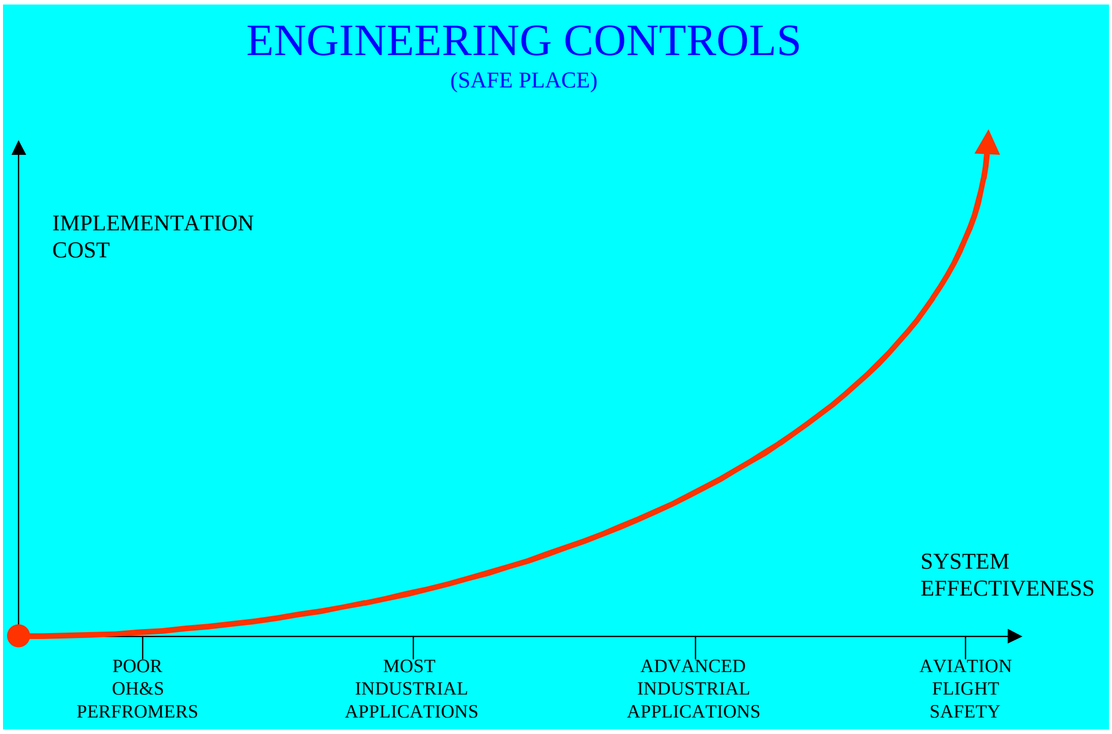

Figure 3

As Figure 4 shows, advancing a hazard protection system by a single level of protection has a significant effect on complete system failure probability, since the failure probabilities of the individual controls are multiplied to arrive at the overall systems theoretical failure probability. Transport aircraft are designed to a theoretical failure rate in critical systems of a minimum of 10^{-9}. All critical systems have at least 3 back-up systems. Even twin engine transport aircraft achieve this level of protection by providing a third power supply to critical systems from an auxiliary power unit.

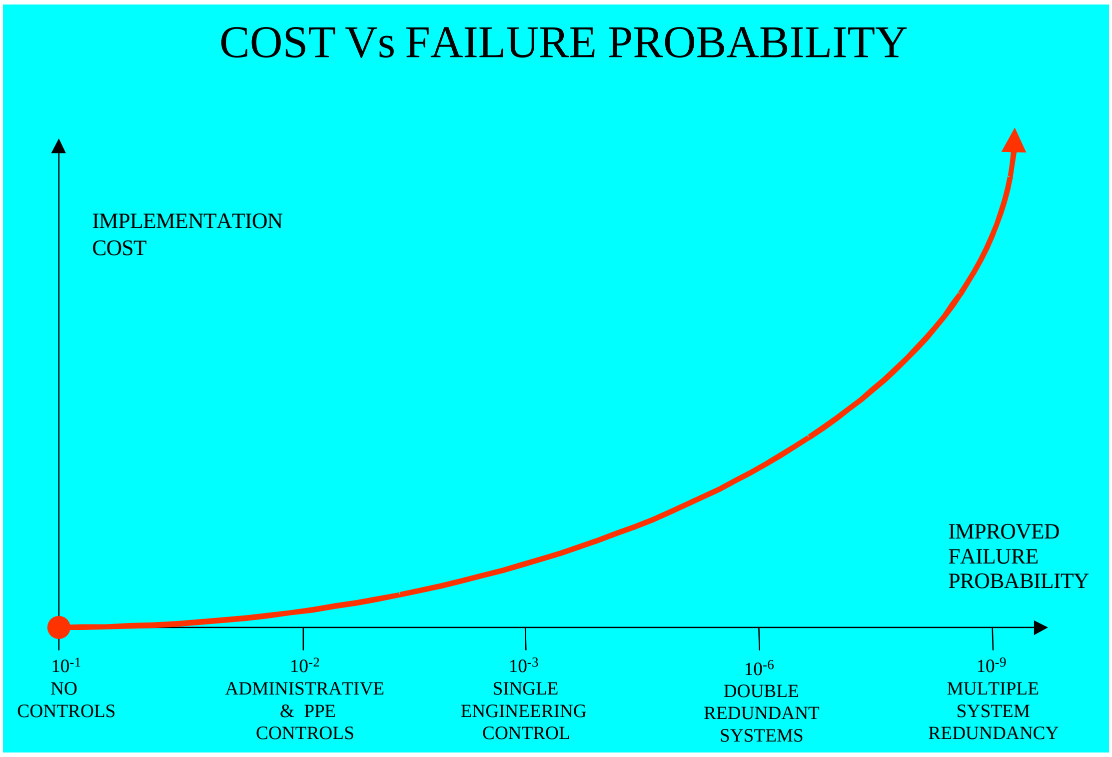

Figure 4

Unfortunately the cost of moving up each level of protection increases dramatically. There is not only the compounding cost of installation but also of ongoing running and maintenance costs. It is clearly these compounding cost factors that are the reason machine operating systems are not engineered with five or six levels of protection. While such redundancy would reduce failure probability to such an extent as to virtually erase the risk of total system failure, to do so would likely render the machine so expensive to construct and operate as to make it financially untenable.

ADMINISTRATIVE CONTROLS, WHEN ARE THEY APPROPRIATE?

So if in most cases costs prohibits design elimination of system failure risk, how else can cost effective improvements in hazard control performance be achieved. The Figure 5 model depicts a similar relationship between levels of redundancy in administrative controls and cost. Effective administrative control systems have double redundancy as an intrinsic part of procedures. For example, all aviation engineering functions are carried out using dual inspection and certification processes. That is one qualified person carries out the work and before being considered complete, the work is inspected and signed off by another qualified individual who was not involved in the original work.

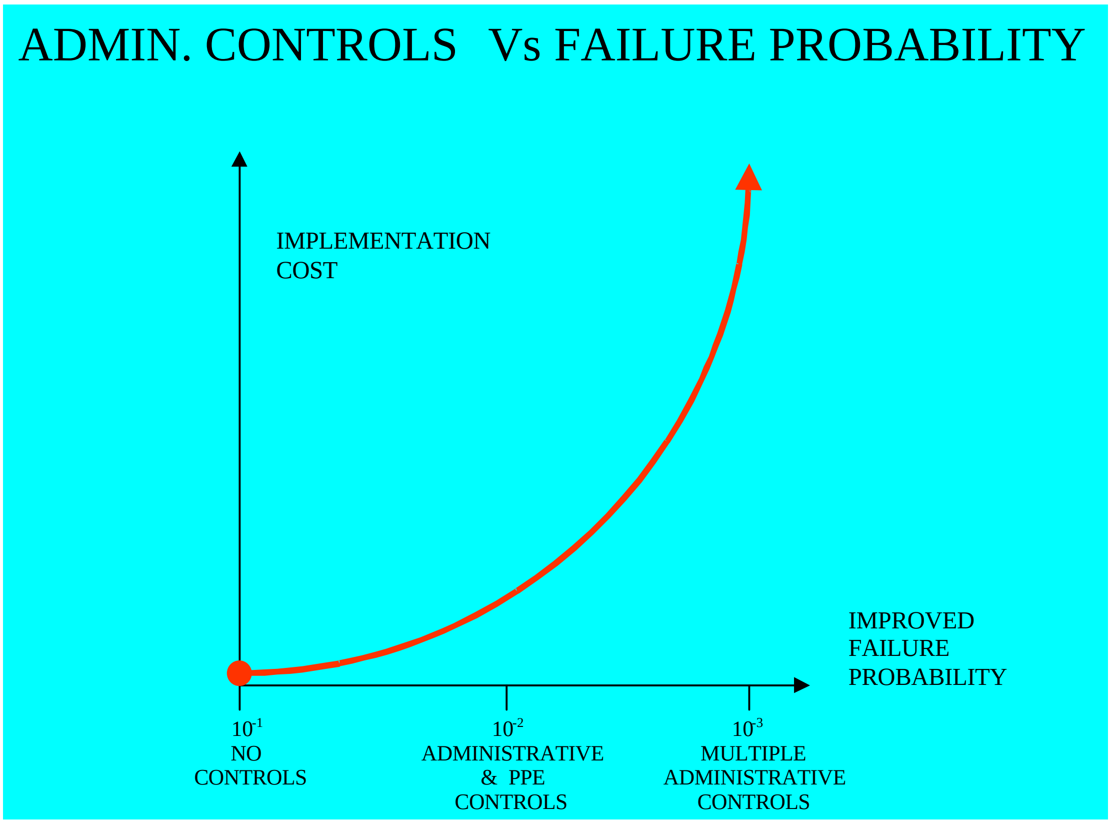

Figure 5

Perhaps a good aviation example is the checks carried out to ensure there is no critical water contamination of an aircraft's fuel. Fuel quality in the airfield supply system is checked daily by the fuel company. Incoming fuel by tanker is checked in the tanker prior to delivery into the airfield system, and the airfield system is checked after each such transfer. Further, each aircraft's fuel system is checked by an engineer after each refuelling operation and the fuel drain samples are inspected by the pilot during the aircraft pre-flight inspection.

Since no aircraft are designed with duplicate fuel systems, total reliance on administrative controls to protect against fuel contamination is required. Four levels of redundancy in administrative controls are routinely employed to minimise the risk of system failure to an acceptable level. There is little doubt that without such administrative control redundancy, fuel contamination would be a significantly greater threat to flight safety.

Unfortunately most industrial environments rarely lift administrative controls above a single level of protection. Even the notion of supervision of those carrying out critical processes is diminishing as business downsizing is reducing the number of persons available to add such value to the safety system.

There are still many industrial applications where higher order controls are as yet unavailable and/or remain cost prohibitive. Figures 6 and 7 depict two such applications- loading passenger baggage on aircraft and sheep shearing.

Figure 6 Stacking Baggage
Within Aircraft Baggage Compartments

Figure 7 Sheep Sheering

ENGINEERING AND ADMINISTRATIVE CONTROLS: A COMPLIMENTARY SAFETY PARTNERSHIP

Since financial constraints limit organisations' ability to engineer effectively risk free environments, there will always be a need to combinations of engineering and administrative measure to control hazard exposure. However, due to the fallibility of the human element of the workplace operational system, as Hierarchy of Control theory suggests, organisations should first assess the possibility of elimination, substitution and engineering measures to reduce injury risk.

Administrative controls should be considered when no higher order controls are available, or when engineering control introduction or enhancement would be cost prohibitive. Figure 8 depicts the improvements in safety system effectiveness when a refined engineering control system is enhanced by a multiple redundancy administrative control system. Cost effective gains in overall system effectiveness can be made, as is the case with the aviation examples above.

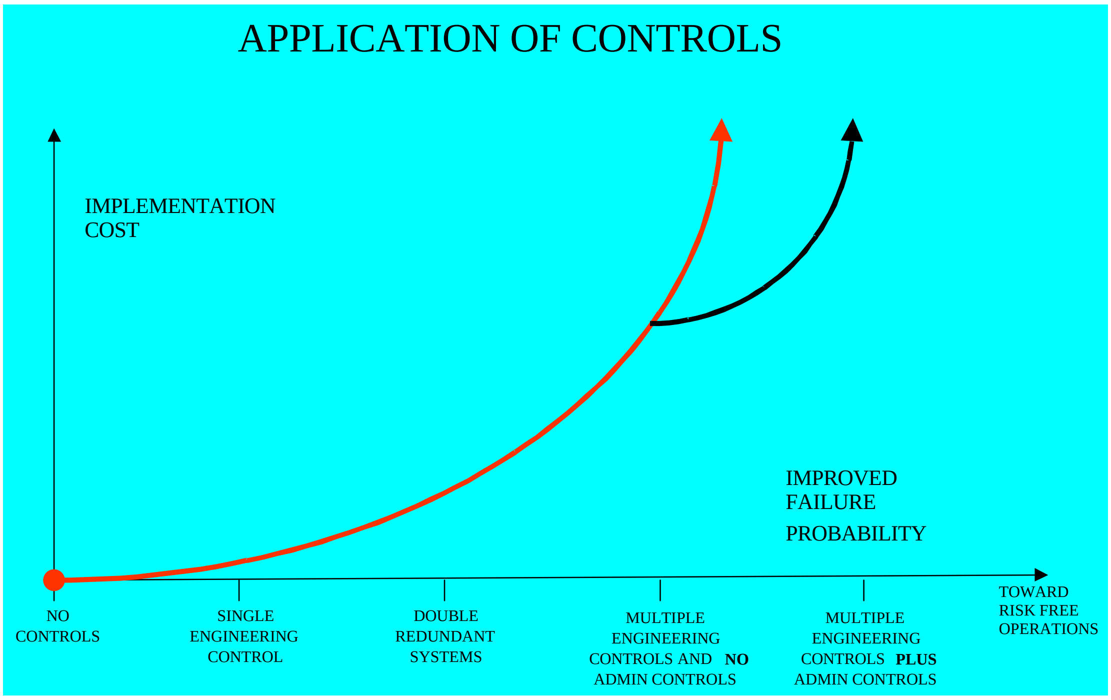

Figure 8

It is an unfortunate fact that many organisations turn first to an administrative control to protect individuals from a hazard, and this is solely a function of ease and speed of implementation. It is rarely the result of critical assessment of that control's likely effectiveness. Also, as suggested above, few organisations build any redundancy into their administrative control systems. Accordingly, their actual level of protection against hazard exposure is significantly lower than they expect or believe.

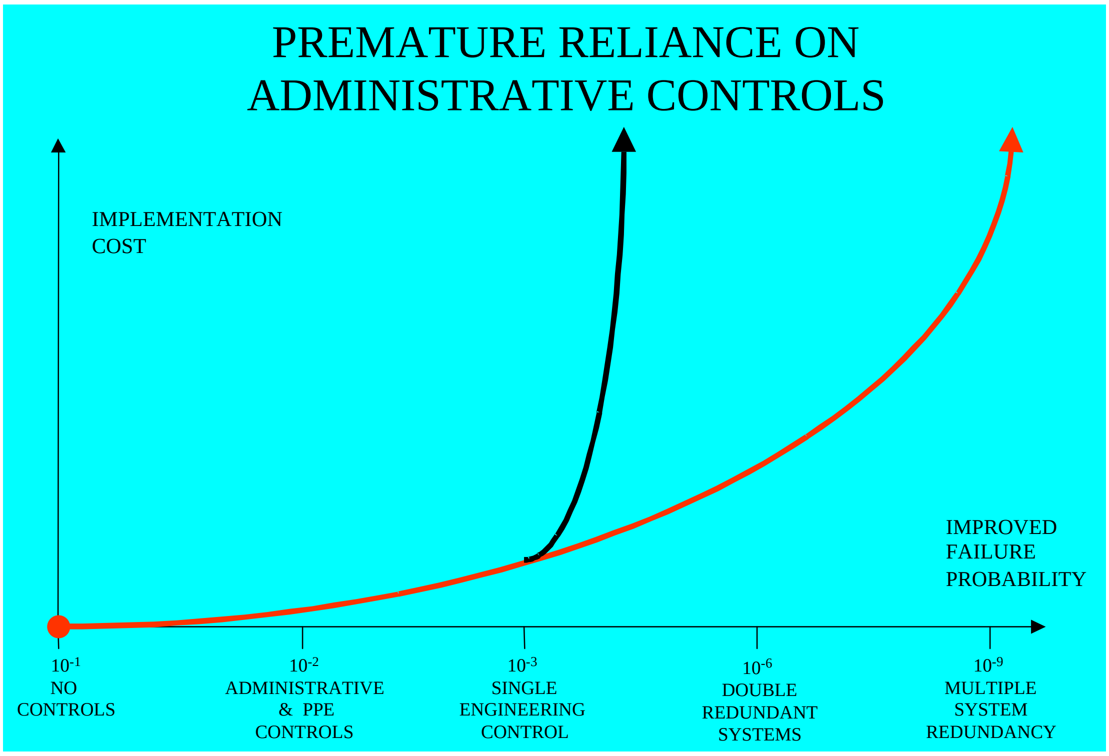

Figure 9

Figure 9 depicts the lower effectiveness of systems which use administrative controls to enhance only rudimentary engineering control systems and Figure 10 shows one example where this fallible approach was adopted.

Figure 10 Aircraft Pushback Tug Driver Introducing "Mickey Mouse" Control (Umbrella)

The aviation statistics from Boeing quoted at the beginning of this paper suggests that it is the administrative control elements of the aviation safety system which are failing most often. Figures 10 and 11 show two similar examples. The clear message is that where ever there is a reliance on administrative controls, significant effort must be expended in ensuring those controls work. Redundancy of administrative procedures is necessary and must be applied or the control system will fail.

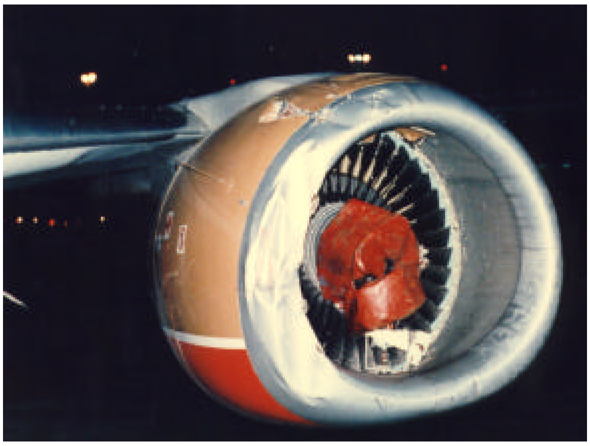

Figure 11 100 Litre Oil Drum Ingested into B737 Aircraft CFM 56 Engine

Figure 12 Catering Vehicle Overturned in Impact by Aircraft Under Tow

CONCLUSIONS

As OH&S professionals, we should acknowledge that there is a need for both Safe Place and Safe Person solutions. Limits on cost and engineering capability prevent total elimination of risk. The issue for effective risk control, is actually a selection of the appropriate controls, dependent on their availability, appropriateness and in particular their cost effectiveness.

Aviation safety professionals do not argue between safe place or safe person solutions, since the industry requires both to maintain a level of safety acceptable to the air travelling public. OH&S professionals should strive for risk control systems which address the need. In many instances, engineering solutions will be available, cost effective and should be adopted. However, integration of effective administrative controls into the working environment will also be necessary.

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