SAFETY SCIENCE Monitor

ISSUE 3 1997 VOL 1

Article 3

# THE CAUSES AND PREVENTION OF BAGGAGE HANDLER BACK INJURIES:

# A SURVEY OF AIRLINE SAFETY PROFESSIONALS

**GEOFF DELL**
M.APP. SCI. (OH&S), GRAD. DIP. OHM, FSIA, MISASI

## ABSTRACT

Back injuries to baggage handlers collectively cost 15 airlines and a ground handling company an average of $US21 million per annum over the period 1992-1994. The annual Lost Time Injury Frequency Rates (per million hours worked) for the period exceeded 41.5 and 8.5 % of the baggage handler workforce suffered back injuries each year. This paper surveyed the Safety Professionals of 15 major airlines and a ground handling company, to identify the cost of baggage handler back injuries and the rates of occurrence of those injuries. The opinion of the Safety Professionals regarding back injury causation and prevention was also sought. The need for re-design of some aircraft baggage compartments, baggage handling systems, equipment and airport terminal facilities was identified.

## THE BACK INJURY PROBLEM

Of all types of occupational trauma, back injuries represent one of the largest groups. *Saraste (1993)*, in a study of Swedish male workers with back ailments, and *Stubbs (1986)* in a report of a study of the nursing profession in England, both suggested that 80% of workers experienced lower back ailments during their working life. In 1987 back injuries accounted for 27% of all lost time compensation claims in Ontario Canada (*WCB (1988)*), and a similar proportion of back injuries was reported more recently by *Workcover New South Wales (1996*), who reported back injuries to be 30% of all New South Wales workplace injuries in the period 1993 to1995 inclusive. Statistics published by the Victorian Health and Safety Organisation showed that 25.0% of all workers compensation claims lodged for the period July 1992 to June 1994, across all industries in Victoria, recorded back injuries as the most serious suffered by the claimants (*Health and Safety Organisation (1995)*). Furthermore, *NIOSH (1994[1])* reported that back injuries accounted for 20% of all injuries and illnesses in USA workplaces, costing in excess of 20 billion dollars per year.

Anecdotal evidence available in 1994 *(Dell 1994)*, indicated that back injuries to airline baggage handlers[1] also cost the aviation industry millions of dollars per annum and some airlines had over 20% of their baggage handler work force absent due to back injuries at any one time. Subsequently, in 1995 discussions were held by the writer with key engineering and safety staff of aircraft manufacturers Boeing, McDonnell Douglas, Avro, Airbus Industrie and Fokker. While all showed an interest in the back injury subject, the issue had not been raised with them before. All highlighted the need for accurate quantitative data on the cost of these injuries and the magnitude of the problem, if the issue was to be factored into manufacturers' aircraft design criteria in the future. At the time, the quantitative data was not readily available.

1 For the purpose of this study, a baggage handler is defined as a person who loads or unloads baggage and or cargo from commercial transport aircraft. It includes those persons who work within the airport terminal who handle baggage and those who consolidate baggage and cargo for particular flights.

This paper quantifies the magnitude of the back injury problem amongst airline industry baggage and cargo handlers. By canvassing safety professionals working in the industry, it also identifies the high risk baggage handling tasks and investigates some likely solutions. The paper is one in a series by the writer looking into various aspects of the baggage handler injury problem.

## METHODOLOGY

A questionnaire was developed and circulated to the occupational health and safety professionals of 32 major companies worldwide who employ baggage or cargo loading staff. Seventeen responded, however, one provided insufficient information to be included in the data set. The sixteen companies who provided useable data were: Sabena Belgian Airlines, Thai Airways International, Swissair, Qantas Airways, Air New Zealand, Canadian Regional Airlines, DHL Aviation, Canadian Airlines International, Hong Kong Air Terminal Services, Delta Airlines (Germany) , Ansett Australia, KLM, Ansett New Zealand, Eagle Airways, Delta Airlines (USA) and American Airlines.

The questionnaire was in two parts, those questions intended to quantify the costs and magnitude of the back injury problem (Part A) and those intended to investigate the causes and any preventive measures their organisations had attempted (Part B), as follows:

PART A

In order to validate the anecdotal information on the magnitude of the baggage handler back injury problem, the industry safety professionals were asked, for the years 1992, 1993 and 1994, to provide the following information related to their operation:

- The number of baggage handlers employed per annum.
- The average number of hours worked per week per baggage handler
- The number of lost time back injuries[2] per annum
- The annual cost of those injuries.[3]

Response data obtained was used to calculate annual lost time injury frequency rates per million hours worked (LTFRs) for the total baggage handler population and the average cost per injury per annum.

PART B

The questionnaire also canvassed the following information from the safety professionals:

- Whether baggage handlers in their organisation were required to lift baggage and cargo exceeding 32Kg (70lb) weight? 32Kg is a pre-existing notional industry limit on passenger baggage weight.
- From a list of twelve manual handling tasks routinely carried out by baggage handlers, which did they consider to be the five (5) most likely to cause baggage handler back injuries?
- What back injury control measures had been applied in their companies? In particular, information was sought on use of back support belts, back care training, use of ground equipment, use of narrow body aircraft in-plane baggage stacking systems and details of any attempts at building re-design to reduce the instance of baggage handler manual handling injuries.
- What measures did they believe would be necessary in future to reduce the instance of back injuries to baggage handlers?

2 Lost Time Back Injury was defined as the failure, following the injury, to report for duty at commencement of the next work shift.
3 Cost was defined as including workers compensation, medical and rehabilitation expenses.

**RESULTS**

The reported cost of back injuries in the baggage handler work force of the respondent organisations collectively rose from $US 17,639,857 in 1992 to $US 23,697,170 in 1993 and dropped slightly to $US 21,710,953 in 1994. The total number of lost time back injuries rose from 1570 in 1992 to 2408 in 1993 and then remain almost unchanged at 2405 in 1994. Figure 1 summarises the responses to the questions in Part A, as well as the LTFRs and average back injury costs calculated from those responses. LTFRs calculated from the respondent data were 42.5 for 1992, 41.5 for 1993 and 43.5 for 1994. Average cost per back injury reduced over the period from $US 11,236 in 1992 to $US 9,841 in 1993 and $US 9027 in 1994.

**Figure 1 The Back Injury Problem Quantified**

| | 1992 | 1993 | 1994 |
|---|---|---|---|
| No of Baggage Handlers | 19430 | 30257 | 29099 |
| Av. Hours Worked/ Person/Week | 38.0 | 38.4 | 38.4 |
| No of Lost Time Back Injuries | 1570 | 2408 | 2405 |
| Annual Cost ($US) | $17,639,857 | $23,697,170 | $21,710,953 |
| Lost Time Injury Frequency (per $10^6$ hours worked) | 42.5 | 41.5 | 43.5 |
| Average Cost Per Back Injury ($US) | $11,236 | $9841 | $9027 |

In addition to the questions concerning costs and injury frequency, the Safety Professionals were asked to rank the following workplaces in order from that which they considered were most likely to be the site of a back injury, to those which were least likely. The work places were: Baggage check-in; Baggage make-up room; Inside narrow body aircraft; Inside wide body aircraft bulk hold, and; Outside aircraft on the ramp. Figure 2 shows that 10 of the 16 respondents felt that the highest injury risk location to be "Inside Narrow Body Aircraft

**Figure 2 Manual Handling Locations Ranked MOST Likely to Cause Injury**

| | f (n=16) |
|---|---|
| Baggage Check-in | 1 |
| Baggage Make-up Room | 2 |
| Inside Narrow Body Aircraft Baggage Compartments | 10 |
| Inside Wide Body Aircraft Bulk Hold | 0 |
| Outside Aircraft On the Tarmac | 3 |

With regard to which baggage handling tasks were considered most likely to cause back injury, 14 of the 16 respondents selected "Stacking Baggage inside the Baggage Compartment of Narrow Body Aircraft" as one of their top 5 high risk tasks (see Figure 3). This was closely followed by "Pushing Baggage from the Doorway into the Baggage Compartment of Narrow Body Aircraft" and "Transferring Baggage from a Trailer directly into a Narrow Body Aircraft" (11 responses each) and "Pushing and Pulling Containers and Pallets inside Wide Body Aircraft", which only occurs when the aircraft's built in equipment is broken, was ranked as the fourth most likely injury causation task (9 responses).

Fifteen of the Safety Professionals surveyed in this study indicated that baggage handlers in their organisations were required to lift baggage weighing in excess of 32kgs(70lbs). Ten of the Respondents in this survey also felt enforced limitations were necessary.

Since a number of airline baggage handlers around the world were reported to be using various types of back support belts, the Safety Professionals were asked to indicate whether their organisations had used such belts as a measure to control back injuries in baggage handlers. However, there was no conclusive outcome. Only 2 respondents reported that a back support belts were used in their airlines. One of these

indicated that introduction of the belts had made no difference to the instance of baggage handler back injuries, while the other claimed a 60% improvement in injury occurrence.

**Figure 3 Manual Handling Tasks Ranked MOST Likely to Cause Injury**

| | f (n=80) |
|---|---|
| Lifting Baggage on or off Scales at Check-in | 2 |
| Loading Baggage onto Trailers in the Baggage Make-up Room | 8 |
| Loading Containers in the Baggage Room | 6 |
| Unloading Baggage Trailers in the Baggage Room | 3 |
| Unloading Containers in the Baggage Room | 1 |
| Pushing and Pulling Loaded Baggage Trailers, Containers and Pallet Dollies | 7 |
| Transferring Baggage from a Trailer to Mobile Belt Positioned at the Aircraft | 2 |
| Transferring Baggage from a Trailer Directly Into an Aircraft through the Cargo Door | 11 |
| Pushing Baggage from the Doorway into the Baggage Compartment of Narrow Body Aircraft | 11 |
| Stacking Baggage Inside the Baggage Compartment of Narrow Body Aircraft | 14 |
| Pushing and Pulling Containers and pallets Inside Wide Body Aircraft | 9 |
| Stacking Baggage in the Bulk Hold of Wide Body Aircraft | 6 |

The industry Safety Professionals were also asked whether Back Care Training was used as an injury control measure in their airlines, and if so, what impact had the training had on the instance or severity of back injuries. It is significant that while 12 of the 16 respondents reported that Back Care Training was provided to staff, only 2 reported that the training had any effect on their back injury rates. 10 of the Respondents in this study felt better training was a viable option.

Eleven respondents reported that their airlines used ground equipment to reduce the manual handling risk to baggage handlers. However, only 1 reported that use of ground equipment had resulted in an improvement in injury occurrence (10%).

Nine of the 16 Safety Professionals indicated that manual handling tasks associated with pushing and pulling baggage containers and pallets were a significant injury risk when equipment was broken or otherwise unserviceable.

Only 6 respondents reported their organisations' having reviewed the design of buildings, and just one was able to suggest that an injury rate reduction occurred. None had provided mechanical lifting aids to assist with baggage handling tasks.

**DISCUSSION**

The Figure 1 data removes any doubt about the industry's need to take positive back injury prevention steps. These LTFRs for baggage handler back injuries can only be described as abysmal. Worlds best practice organisations, for example Du Pont *(Brock 1996)* and ICI Australia *(ICI Australia 1996)* consistently experience LTFRs below 1.0.

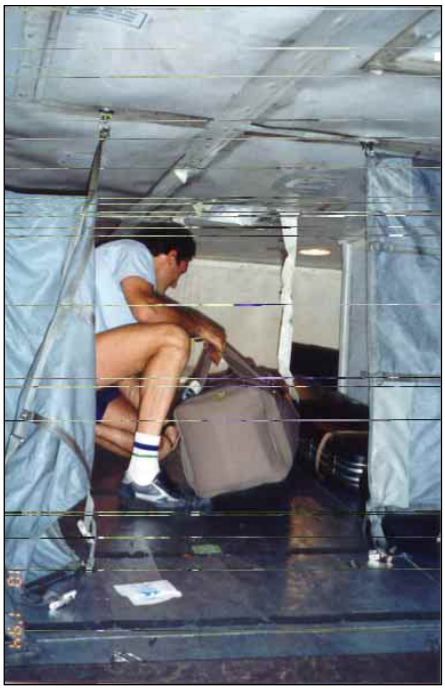
While the average cost per injury reduced over the 3 year period by 19.6%, the LTFR fluctuated above 41.5 indicating that over 8% of the baggage handler work force experienced lost time back injuries each year.[4]

The consistent poor performance over the three year period would also suggest any pre-existing injury prevention programs had been ineffective at reducing the instance of lost time baggage handler back injuries to an acceptable standard.

4 LTFR of 41.5 equates to 8.3%. For every 500 baggage handlers employed in the study group organisations in 1993, 41.5 (8.3%) experienced lost time back injuries (assumes a 40 hour working week and a 50 week working year [ie $10^6$ hours worked = 500 people x 40 hours x 50 weeks]).

There is no doubt that the back injury problem is exacerbated by the poor lifting postures which baggage handlers must adopt in some cases, particularly those inside aircraft baggage compartments (see Figure 4).

**Figure 4 Loading Inside Aircraft Baggage Compartments**



*Hogwood (1996)* suggested that aircraft cargo compartments are ergonomic disaster areas. Of this there is little doubt. While most, if not all, modern passenger aircraft have the latest technology systems installed in the cockpit and passenger cabins, there is no similar situation below the cabin floor. The baggage compartment, particularly in narrow body aircraft such as the Boeing B737, McDonnell Douglas DC9, British Aerospace BAe146 and Fokker F100, is little more than a space left for the purpose of stacking baggage and cargo. Manual handling is usually the only option available to load and unload the aircraft.

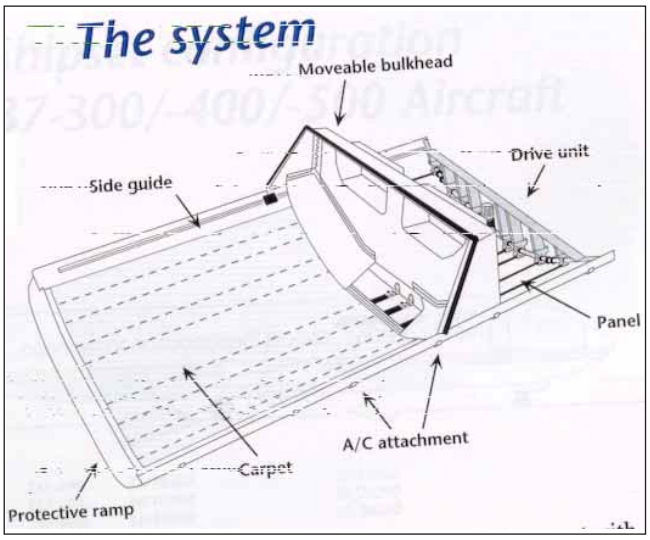
Consistent with earlier studies of this matter *(ARTEX (1980) , Dell (1994) & Hogwood (1996)*), the majority of respondents in this study felt the narrow body aircraft baggage compartment represented a high injury risk. However, it is of interest to note that none of the respondents felt that working inside the bulk hold of wide-bodied aircraft presented a greater risk of injury than working in the baggage make-up room, outside the aircraft on the ramp, or in the baggage check-in area. Yet the dimensions of the bulk hold of wide body aircraft are smaller in many cases, than those of narrow body aircraft cargo compartments and as such, are more restrictive on baggage handler working posture.

There is clearly a need to address these aircraft design shortcomings. However, as *Briggs (1997)* stressed, *"there will have to be airline industry consensus before the aircraft manufacturers will carry out design changes to their aircraft".* This suggests the manufacturers will only react to market demand. So why have the airlines not demanded such changes long before now? The answer is simple. In the past, aircraft were designed to satisfy three criteria required by the airlines: range, payload and low operating cost, especially low fuel burn. Accordingly, only those systems essential for the airliner's operation were considered in the design. Thus, keeping the weight of the aircraft as low as possible, directly reduced the resultant fuel burn and maximised the potential payload capabilities of the design. The cost of injuries to baggage handlers was never factored into the equation.

In the manufacturers' defence, the actual costs of those injuries were not well known, until now. Consolidated for the first time in this study, baggage handler injury costs should be factored into all future aircraft design specifications. If the manufacturers will not react without the airlines' consensus, then it becomes the role of the airlines' safety professionals to ensure their airlines firstly address the issue internally, then begin to put pressure on the manufacturers for design solutions to the back injury problem.

Some airlines have retro-fitted semi automated systems in baggage compartments in narrow body aircraft. These systems provide a moveable wall which can be positioned near the cargo compartment door and eliminate the need for baggage to be shifted manually down the length of the cargo compartment. However, these systems still require the baggage handler to stack the baggage in the baggage compartment. Figure 5 depicts the Scandinavian Belly Loading Company "Sliding Carpet" system

**Figure 5 Scandinavian Belly Loading Company Sliding Carpet Loading System**




Although not yet in wide spread use, systems such as *Sliding Carpet* have been installed by some airlines and information available to date is encouraging. For example, *Johansen (1995)* reported a 25% reduction in baggage handler sick leave rates, 50% reduction in the occurrence of damage to baggage and the lining of the baggage compartments and a 3% reduction in the number of baggage handlers required in the operation. *Johansen (1995)* also claimed a $US 2 million saving over the first 3 years of operation of 17 B737 aircraft with the system installed. If these results are what can be expected, the slow rate of adoption of these systems by the industry may change. One would hope that as more airlines do introduce these systems, they will also publish their experience.

There is also little doubt that the weight of the baggage required to be lifted by baggage handlers is a major factor in injury causation. Some previous authors (eg *ARTEX (1980), Dell (1994) and Bérubé (1996)*) have identified this and urged that industry limitations on baggage weight need to be enforced. It is of interest that the majority of respondents in this study also felt there was a need to enforce the pre-existing industry limits.

Unfortunately, commercial pressure in this area of airline operations often far out weighs the injury prevention considerations. At a meeting of the Ergonomics Sub-committee of the International Air Transport Executive of the National Safety Council of America at Brussels Belgium on May 5, 1995, which was chaired by the writer, the majority of attendees felt that many airline commercial department managers and supervisors would turn a blind eye to the increased injury risk to baggage handlers exposed to heavy baggage, rather than refuse to uplift a passenger's heavy bag or put the passenger to the inconvenience of re-packing their bag to reduce the weight.

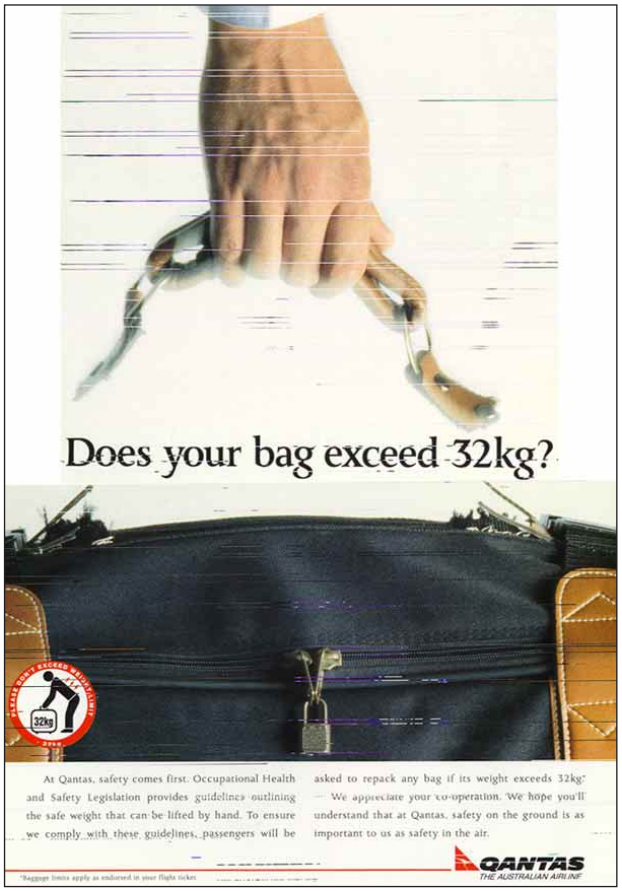
Few airlines have attempted to address this difficult matter. Among those who have are Qantas, Air New Zealand, Ansett Australia and Ansett New Zealand. These airlines have procedures in place intended to limit baggage weight below 32kg, the pre-existing notional industry weight limit.

However, this Australasian attempt at using passenger education programs to tackle the heavy baggage issue has been one of mixed success. Posters and warning material at check-in locations (see Figure 6) have certainly elevated the profile of the issue, but has had little or no impact on the frequency of heavy

baggage being presented to the airlines for uplift. Control of the heavy baggage risk continues to rely on compliance with baggage acceptance procedures at check-in locations to ensure baggage over 32Kg is re-packed prior to check-in.

Also, it must be recognised that if an industry limit was to be set based on injury prevention criteria alone, then that standard would probably be closer to 16 to 20Kg, above which the risk of back injury increases significantly (see for example *Occupational Health and Safety Authority (1988)*). Doubtless, the industry would have extreme difficulty introducing such a limit since worldwide agreement would be very difficult to achieve. Also, any country or airline who attempted to introduce a limit ahead of the rest of the world would be placed at a considerable commercial disadvantage.

**Figure 6 Heavy Baggage Advertisement to Passengers of Qantas Airways**




It is doubtful that heavy baggage in the airline industry will be removed as an injury causation factor without complete redesign of the existing manual handling tasks, or without the combined positive intervention of the various OH&S Regulators worldwide.

The juxtaposed responses to the question on use of back belts in this study is consistent with the findings of *Perkins and Bloswick (1995)*, who concluded that "*The impact of back belts on the prevention of back injuries due to manual material handling remains unclear*" and "*There is no clear evidence that back belts reduce the incidence or severity of back injuries*". Similar conclusions were also made by *NIOSH (1994[2])* who criticised the unscientific methodologies of many earlier studies into back support belts as a possible injury prevention tool.

There is a clear bias of some authors *(eg Congleton J. et al (1993) and McGill S. (1993))* away from use of back support belts in the prevention role. This is no doubt due to the emphasis in modern OH&S teaching of application of the hierarchy of hazard controls *(Dept. of Labour (1990))*. This author believes that until adequate permanent engineering controls are developed in the baggage handler back injury area, any

control measure, even one on the low end of the hierarchy, is better than no control measure. Accordingly, it is a pity that researchers in the back support area have been unable or unwilling to undertake studies with sufficient scientific rigour to prove one way or the other, if back support belts could be used as a prevention tool, even as a short term solution. The baggage handler back injury problem is begging for a short, as well as long term solution.

In an operation relying heavily on manual handling such as airline baggage handling, it is not unexpected that many airlines have placed considerable emphasis in the past on back care training, as was found in this study. However, this author believes that if back care training has been in use in the airlines, as the Respondents indicate, and the back injury rates have not appreciably altered during the 3 years of this study, then additional back care training is unlikely to have a positive effect on injury occurrence. Not withstanding, 10 of the Respondents in this study felt better training was a viable option, although there would clearly be the need to find different training solutions to those applied in the past.

There may be several reasons for the apparently low success rate with use of ground equipment. As *Dell (1994)* suggested, existing airline ground equipment was designed to solve the volumetric problems associated with moving large amounts of passenger baggage to and from the passenger jet aircraft. Unfortunately, nearly all current airport baggage handling systems and ground equipment still require manual stacking and transfer of baggage from one part of the system to the next (see Figure 7). Another reason existing ground equipment may not contribute to injury prevention, is its generally poor level of maintenance in many airlines. Manual handling tasks associated with pushing and pulling baggage containers and pallets were a significant injury risk when equipment was broken or otherwise unserviceable. "*There is no doubt the industry needs to make wholesale improvements to baggage transfer systems maintenance. Airlines need to ensure that similar priority is given to maintenance of loading equipment as is afforded to other aircraft systems" (Dell (1994)).*

The design of airport terminal facilities provided for baggage handling functions is another factor in injury causation. There is no doubt that state of the art baggage sortation systems today, do not take manual handling injury risk into consideration other than by a very rudimentary ergonomic compromise. Hi-tech computerised systems deliver baggage to the location where the load for particular flights are being handled, but leave the actual loading and stacking tasks to manual handling. The new systems at Denver Stapleton, Sydney International, Brisbane International, Melbourne International and Wellington are examples. With these systems, the design of conveyor belts at the worker interface uses average worker heights and reach distances to try to cope with the ergonomic problems presented.

Unfortunately, this is not likely to be an easy matter to resolve. Not only is there the difficulty of designing adequate mechanical assistance devices to load baggage containers and barrows, there is a definite reluctance of airport designers and builders to give the matter the credence it deserves.

**Figure 7 Loading of Containers from the Delivery Belt in the Baggage Room**

At an Australian airline industry meeting with project officers of an airport authority in 1996, specifically to discuss design aspects of the then new Melbourne International baggage sortation system, project engineers were bemused even at the concept of making the geometry of delivery belts and container heights fully adjustable to optimise the ergonomic advantage for all individuals. The idea of providing mechanical lifting aids or automating the manual handling tasks was treated as if in the realms of science fiction. There are some systems available, however. Figure 8 shows one such device available from European manufacturer AirGro. Unfortunately, their adoption by airport designers is few and far between.

**Figure 8 The AirGro "ErGoBag" Mechanical Assistance Device**

Airline safety professionals clearly have a difficult task ahead to make in-roads into this problem. However, unless design engineers are convinced of the seriousness of the baggage handling injury issue, they will continue to construct these critical manual handling workplaces from concrete and ignore the basic ergonomic needs of all but the average proportioned individual baggage handler.

One area of concern highlighted during the study was the difficulty some safety professionals had in quantifying the costs of back injuries and measuring the benefits of some of the supposed injury control measures. In fact, four airline safety professionals who did not complete the questionnaire, subsequently advised that their airlines had no idea of the extent of the problem and could not even identify what back injury costs were being incurred. In future, if safety professionals cannot support their efforts with basic business measures, such as cost, then it is highly unlikely that any effort to eliminate injuries in airline ground operations will be taken seriously.

## CONCLUSION

LTFRs calculated from the data from the survey of safety professionals suggest that the instance of baggage handler back injuries was almost constant over the 3 years 1992 to 1994. Little comfort may be taken in the fact that there does not appear to have been a worsening trend, since neither was the trend improving and the back injury rates revealed in this study of airline industry baggage handlers were over 40 times worse than world's best practise.

The survey showed that on average, over $US 21.0 million was lost per annum due to baggage handler back injuries in only 16 organisations. Also, approximately 8.5% of baggage handlers suffered back injuries each year of the study period.

Accordingly, there is little doubt that the industry must find real and long term solutions to the causation of baggage handler back injuries.

The key injury prevention findings of this study were:

**1.** The need for re-design of baggage handling systems, including aircraft cargo compartments, ground equipment and airport terminal facilities to reduce or eliminate manual handling risks. A design solution must be developed for each and every manual handling task currently required to be carried out by baggage handlers.

**2.** Airlines need to ensure the serviceability of ground equipment and aircraft loading systems are maintained to a high standard, since the risk of injury to baggage handlers increases significantly when required to manually handle the heavier loads that were intended to be moved by the failed equipment.

**3.** As an interim, until design solutions are available, the need for limitation to be placed on baggage and cargo weights accepted by airlines, and a means to enforce such limits.

The support and commitment of the aircraft and ground equipment manufacturers, who will be required to take much of the remedial design action in the long term, will surely be jeopardised without accurate injury cost data from a broad airline industry base. Industry safety professionals must apply pressure to their organisations, to ensure that the real costs of injuries are recorded. Without such information, it is unlikely the manufacturers will take any further action.

Airlines who have introduced narrow body in-plane systems, such as *"Sliding Carpet"*, should make the results of their experience available to others in the industry.

There needs to be some unbiased research into whether back support belts may, or may not, provide a part solution. While no comprehensive design solutions exist, back support belts may be a useful short term measure. Presently, there is insufficient reliable scientific data for the industry to make a positive decision in this area.

This author believes that if the legislative requirements to provide safe work places, or the moral duty of care to protect the well being of employees, are not incentive enough, then the ongoing high costs of back injuries should alone dictate the need for change.

Occupational Health and Safety Professionals in the aviation industry, aircraft and ground equipment manufacturers, aviation industry associations and even the OH&S Regulators, all have an obligation to take up the challenge to address the baggage handler injury issue. There is a need to seek real solutions to the problem, address aircraft and ground equipment design and serviceability, and develop more realistic international baggage and cargo weight and size standards. If the industry doesn't achieve a satisfactory result, the labour force will likely impose sanctions which will be far less palatable and more expensive than any solutions the engineers and/or safety professionals may consider, however complex and hi-tech they may be *(Dell 1994)*.

REFERENCES


ARTEX (1980), "*Airline Baggage handling Back Injury Survey*", International Air Transport Section (ARTEX), National Safety Council of America, Itasca.

Bérubé D. (1996), *"Ergonomic Assessment of Bulk Loading Aircraft by Ramp Operators"*, Occupational Health Clinics for Ontario Workers Inc, Toronto.

Briggs D. (1997), *"A Strategic Approach for Addressing Baggage Handling Injuries"*, Presentation to the National Safety Council of America, International Air Transport Section Conference Atlanta, National Safety Council of America, Itasca.

Brock J. (1996), *"Achieving a World Class Aviation Safety Culture",* Presentation to the International Air Safety Seminar Dubai, Flight Safety Foundation, Washington.

Congleton J et al (1993), *"Brief Summary of Lifting Belt Research Conducted at Texas A&M University"*, Dept. of Industrial Engineering, Texas A&M University, College Station.

Dell G. (1994), "*Baggage Handler Back Injuries: Our Prevention Obligations*", Presentation to the National Safety Council of America, International Air Transport Section Conference Memphis, National Safety Council of America, Itasca.

Department of Labour (1990), "*Hazard Control*", Victorian Department of Labour Share Program, Melbourne.

Health and Safety Organisation (1995), *"A Statistical Profile of Occupational Health and Safety in Victoria",* Department of Business and Employment, Government of Victoria, Melbourne.

Hogwood N. (1996), *"Aircraft Holds-Ergonomic Disaster Areas"*, Presentation to the National Safety Council of America, International Air Transport Section Conference Sydney, National Safety Council of America, Itasca.

ICI Australia (1996), *"No Injuries to Anyone, Ever",* Briefing to the Management of Australian Paper Ltd, ICI Australia, Melbourne.

Johansen T. (1995), *"Evaluation Report - Sliding Carpet Loading System Servicing Braathens SAFE's 17 B737-500",* Braathens SAFE, Oslo.

McGill S. (1993), *"Abdominal Belts in Industry: A Position Paper on their Assets, Liabilities and Use",* American Industrial Hygiene Association Journal, Issue 54 pp752-754 December 1993.

NIOSH (1994[1]), *"Do They Prevent Injury",* Publication No. US Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH), Cincinatti

NIOSH (1994[2]), "*Workplace Use of Backbelts: Review and Recommendations*", US Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH), Cincinatti.

Occupational Health and Safety Authority (1988), *"Regulations and Code of Practice for Manual Handling",* Government of Victoria, Melbourne.

Perkins M. & Bloswick D. (1995), "*The use of Back Belts to Increase Intra-abdominal Pressure as a means of Preventing Low Back Injuries: A survey of the Literature*", Occupational and Environmental Health Vol. 1 No. 4 Oct-Dec 1995.

Sareste H (1993), *"The healthy Back, Its Environment and Characteristics",* Karolinska Hospital Orthopaedic Clinic, Stockholm.

Stubbs D (1986), *"Back Pain and Its Relationship to Manual Handling",* Proceedings of the 26th Annual Conference of the Ergonomics Society of Australia and New Zealand, Melbourne.

WCB (1988), *"Backfacts",* Workers Compensation Board of Ontario, Statistical Services Summary Sheet April 6 1988, Toronto.

Workcover New South Wales (1996), *"Back Injuries Statistical Profile 1994/1995",* New South Wales Workers Compensation Statistics, Workcover New South Wales, Sydney.