THE NEED FOR GREATER STANDARDIZATION OF CARGO HANDLING PROCEDURES

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1. Introduction:

Standardization of procedures is a cornerstone of safety in the aviation business and has proven over the years to be a consistently effective way to avoid risk and reduce accidents. Aviation professionals in the cockpit and on the ground rely on one another to do the same thing, the same way, every time, in order to ensure the safe and efficient operation of the transportation system. The Air Line Pilots Association, International (ALPA) believes that these same principles of consistent action and reaction, based on use of standard procedures, can be effectively applied to improve the safety and the efficiency of cargo handling. To ensure and improve the safety of cargo operations, it is necessary to identify safety-critical tasks being performed in cargo handling and develop standardized procedures for individuals performing these tasks.

For cargo to move safely and efficiently through the system, the actions of a host of organizations, many of which may not even know of the others' existence, must be carefully coordinated. Tasks by any single individual or organization are frequently done without any possibility of other persons or organizations being involved. Furthermore, there are few if any industry standard procedures being universally used by cargo carriers, their code share partners, or contractors. The combinations of shippers, packages, containers, and aircraft are virtually limitless, and can change constantly, even within one airline. This variety of processes, methods, individuals and organizations, in combination with the aforementioned lack of redundancy, increases the level of risk. Widespread implementation of cargo handling standards would decrease the risk of these operations. Standardization can provide the framework to make this coordination effective. There are many risk areas in the handing of cargo destined to be carried on aircraft. In the process of moving cargo from origin to destination, risk, and the opportunity to avoid or mitigate it, can be introduced long before the cargo gets anywhere near the aircraft. Failures, even small ones, in any step of the process can result in safety deficiencies, some of which may not be detected until the aircraft is in flight, and in some instances, until an incident or accident occurs. Many factors can influence the safety of cargo handling. These include: oversight and regulation of originating organizations, oversight and operational control of the loading/handling operations, outsourcing, turnover rate of qualified cargo personnel, improperly built-up pallets or loaded unit load devices (ULDs), operational constraints, schedule pressure, "cross-loading" operations, and faulty weighing equipment. The safety and efficiency of each of these can be enhanced through the use of standard procedures. We must ensure all the people and processes that touch the cargo conduct operations in a consistent, standardized manner.

NTSB investigations, as well as crew reports, suggest that personnel involved in cargo handling, particularly at the point of loading, do not always understand the operational impact of errors. In other words, the loading personnel may not know that if they improperly load the cargo and/or incorrectly list the weight of a pallet, a serious incident or accident could result. Factors characteristic of cargo operations, such as high cargo weight, outsized cargo, and the variety of containers available, can compound the complexity of required tasks and increase the possibility or severity of errors. It is of course not realistic to train each loader, handler, or even flight crewmembers in all the physical and aerodynamic relationships involved between size, weight and location of cargo and the way the airplane flies. It is, however, completely possible, to train personnel responsible for the tasks that comprise "cargo handling" to accomplish those tasks in accordance with industry-wide standardized procedures.

2. Discussion:

The potential for cargo to be handled, loaded and documented incorrectly is greater for an all-cargo aircraft airline operation than for a passenger airline operation. This is due to a greater exposure to the various types & sizes of cargo, the increased weights involved and different containers such as a ULD or pallet available to the cargo forwarder and operator. There is not a set of FAA-required standard operating procedures (SOPs) used throughout the industry by personnel performing critical cargo duties, nor a similar set of standards for certification of these personnel. Loadmasters or other employees certifying the accuracy of a cargo load and its placement on the aircraft need industry-wide standardized procedures.

Proper cargo loading of an aircraft involves a multitude of factors. One crucial factor is correct computation of the aircraft weight and balance. The "weight" portion of this is straightforward and relatively easy to understand. It is relatively easy to understand that if an airplane can carry 100,000 lbs, it is important to know what each piece of cargo weighs in order to avoid exceeding a limit. The significance of the "balance" portion, however, is more subtle, and arguably has a greater effect on the airplane's ability to perform properly. The location of individual pallets or containers has a direct bearing on center of gravity (CG) and thus the airplane's handling characteristics. If the actual center of gravity (as opposed one calculated based on incorrect figures), is forward of the allowable forward CG, the crew can experience reduced flight control response effectiveness resulting in a longer take off run and greatly reduced climb path once airborne. Similarly, if the CG is aft of the allowable aft limit, this condition could result in the nose of the aircraft leaving the runway earlier than anticipated and the aircraft attaining a higher pitch attitude than expected. If cargo is placed in the wrong location, the total weight obviously won't change, but the airplane operation may still have been dramatically impacted. If cargo weight is incorrectly determined or recorded, that can lead to incorrect placement of the pallet or container. In that event, both weight and balance will be in error. Without a standard procedure in place to ensure that the inevitable human error is prevented or at least detected, such errors can lead to a dangerous situation that can be, in some instances, beyond the capabilities of the aircraft and the crew.

In its report of a 1997 fatal cargo aircraft accident, the NTSB determined that the accident resulted from the aircraft being loaded incorrectly, which produced a more aft CG that precipitated an extreme pitch-up at rotation. The Board further found that the airline failed to

exercise operational control over the cargo loading process and that the loading organization failed to load the airplane properly.[1]

The potential for significant weight errors is greater for all-cargo aircraft than for passenger aircraft. Although freight is carried on passenger flights, passenger aircraft payloads consist largely of passengers and their baggage, the weights of which all tend to exist in a relatively small range (compared to the range of possible cargo weights). Passenger operations use actual cargo weight and a "standard" passenger weight to determine aircraft gross weight and CG. Cargo aircraft payloads are, of course, cargo of every shape, size, and weight. Cargo operations rely exclusively on knowing exact weights of the entire contents of the aircraft to arrive at the aircraft's CG. In passenger operations, if the number of passengers is significantly different than the actual count, that is easily discovered. If a significant error exists in the calculations of how much the "passenger load" weighs, it is relatively easy to spot because there is a relatively small range of "reasonable" values for a given number of passengers. However, a 1000 lb pallet and a 10,000 lb pallet may well look exactly the same once they are built up. Thus, if the weight of a pallet is not correct the error is not as obvious. Reports of cargo found on aircraft that did not have the proper weight listed on the load manifest are not uncommon. Such errors are normally suspected by the flight crew during flight when the aircraft handling or performance is not as expected and then confirmed after landing when the cargo is weighed again. The reweigh can result in discovery of errors from a few hundred to thousands of pounds different than initially reported.

Another concern involves the documentation of weight, even if it is accurately determined. The documentation used to identify size, weight, and nature of cargo containers varies from shipper to shipper and operator to operator. Much of the data on these documents is manually entered, leading to the very real possibility of errors that may not be obvious. The cargo weight figures being transferred onto the document could be transposed; 2,100 pounds could become 1,200 pounds. Dropping a single digit can mean 11,000 lbs. becomes 1,000 lbs. The resulting difference can be significant when computing the aircraft's weight and CG. Misidentification of a specific ULD/pallet and logging the wrong weight can also easily occur. Even if the actual weight is correct but is recorded wrong or attributed to the wrong pallet or ULD, the result is the same. Opportunities for these types of mistakes happen when the information on the load manifest is being transferred from one operator's form to another and the load personnel are unfamiliar with the other operator's form. The location of critical information should be standardized to reduce the potential of the load personnel identifying, marking or logging a number that does not refer to the weight of the cargo being loaded.

Incorrect recording of cargo weight is not the only way for weight errors to occur. The process of determining the actual weight of an empty or loaded pallet or unit load device (ULD) is also an area where standardized industry procedures must be developed further. A weigh scale is the equipment used to determine the weight of the cargo, ULD, pallet and other load devices. A recommended tolerance for scale accuracy of $\pm$ 1% has been established by the International Air Transport Association (IATA). Some domestic and international carriers use the IATA tolerance, others use a different tolerance, and still others do not address the issue at all. This

[1] NTSB/AAR-98/02, DCA97MA059

situation exists because no requirement exists for the IATA recommendation or any other standard value to be used. The FAA makes reference to the IATA tolerance in its draft Advisory Circular (AC) "Air Cargo Operations", but does not require its use. Moreover, there is no rule or other standard for frequency with which a scale must be checked to ensure its accuracy. Thus, the value used for "weight" of a given item of cargo can vary as that cargo moves from one operator to another within the system. Weigh scale errors can be cumulative and could extend beyond the safety limitations aircraft manufacturers have listed in their manuals. ALPA believes that the tolerance should be required to be no greater than ±1%. This should be established as the standard and adhered to for weighing cargo that is transported on all aircraft but specifically for all-cargo aircraft. The FAA recommends that periodic calibration of the weigh scale be accomplished, but standards need to be developed to provide guidance on how often a calibration should occur. ALPA believes these periodic calibrations are an important function and their frequency critical in preventing the scale to exceed its tolerance. This frequency may vary based on the age and electromechanical characteristics of each scale, but scale owners and operators need to be provided with guidance from scale manufacturers to enable them to ensure the accuracy of the weight being measured.

The following actual report, retrieved from the Safety Information Exchange system, containing worldwide event data and maintained by British Airways, describes a complete breakdown in the procedures within an operator's system. The report involves a 747-400 parked on the ramp. The primary concern described is the lack of knowledge and understanding of basic cargo loading procedures and the associated problems that can be encountered regarding the contents of the load sheet, cargo weights or positioning the cargo on the aircraft. Emphasis is added for purposes of illustration.

Report Synopsis:

> During the pre flight, a review of the load sheet revealed a **9-ton discrepancy** with the aircraft weight and balance system (out of limits). The following problems were encountered when attempting to reconcile the L/S [load sheet] with the main deck pallets:
>
> 1) **Some pallets were listed on the L/S using net weights**.
> 2) **Some were listed using gross weights**.
> 3) **Several had incorrect weights.**
> 4) **Several pallets had no tags at all**. **[Airport x] load control advised us to use gross weights to reconcile the L/S**. **The [airport y] staff produced a telex from [airport z] Cargo advising us to use the net weight**. Since the weight and balance system was indicating a heavier ZFW [Zero fuel weight], I uplifted extra fuel to account for this weight.

Clearly, there was confusion over whether to use gross or net weights on the parts of several people or organizations in the process of the above load being on an airplane. The example provides a graphic illustration of how, especially when such confusion exists in combination with outright errors in weights and the absence of any information at all on some cargo, errors can be introduced that can lead to catastrophe. Just as clearly, if all the people and organizations

that "touched" the cargo all used the same standard for weighing the load, recording the weight, and communicating that information to the next party, the hazard would have been eliminated.

The loading and handling of cargo involves processes that can damage the cargo, ULD, pallet and the aircraft itself if performed improperly. The operator and those contracted by the operator should use safety procedures that are uniform throughout the system and equally understood by all parties. To prevent mishandling at the aircraft those procedures should include ensuring a clear understanding of the type and model of aircraft and the same understanding of the ground equipment that can and cannot be used for loading and unloading. Forklifts, belt loaders, lift trucks, and other equipment have all been involved in causing damage to cargo, cargo components and the aircraft. When mishandling of cargo occurs the potential for seen or unseen damage exists. Damage to a package, container or pallet may not immediately be observable (e.g. a leaking container inside a larger container). This latent risk may not manifest itself until after the aircraft is airborne. The flight crew relies on the presumption that all cargo has been appropriately handled. To ensure, with a high degree of confidence, that such a presumption is warranted, it is necessary that handling and loading, from the time cargo is first packaged, be a well known, well documented, well understood process. Oversight of such processes, whether by a regulator or a company, necessarily relies on the ability to identify procedural errors. Standardizing such procedures across the industry enhances that capability to detect and correct problems before they become critical safety deficiencies.

NTSB records provide an excellent illustration of the hazards that can result from the mishandling of cargo. On April 28, 1999, the Board investigated a fire that destroyed freight loaded on an aircraft pallet. According to the report, the pallet had been offloaded from an inbound flight. The flight arrived about 1020 local time.

> "At 1120, a company equipment operator picked up a pallet loaded with lithium batteries from a dolly and tried to set it on the ground near the cargo facility. To get the pallet to slide off the forklift blades, the operator stopped his vehicle quickly. As the pallet came off the blades, it rolled onto its side against a pallet from another shipment. The pallet was left resting against the second pallet until 1233, when two equipment operators separated the pallets and righted the pallet with the batteries by placing the forklift blades under the boxes. The operator who righted the pallet said that the pallet seemed to be "top-heavy" and difficult to maneuver. Another equipment operator, who was in the area shortly after the pallet was righted, stated that several batteries were on the ground near the area where the pallets had been separated, indicating that some of the boxes of batteries may have been damaged. … At 1457, the pallet that had overturned was picked up again and moved next to another pallet containing lithium batteries, along with other types of batteries and cargo. Three minutes later, at 1500, a company equipment operator noticed smoke, followed quickly by a small fire on the back of the previously overturned pallet. Another equipment operator on a forklift moved that pallet away from the rest of the pallets to prevent the fire from spreading. While the pallet was being moved, the fire spread to the adjoining pallet containing lithium batteries. Both pallets then erupted in flames."

There was no reason other than chance that this pallet had not been loaded onto an outbound aircraft during the approximate 2 hours it was at the cargo facility after the damage had been done. Had that been the case, the fire would have been inside a cargo aircraft in flight. During

its investigation, the NTSB also found that, according to employees interviewed, it is not uncommon to accidentally overturn a pallet and that other loads of batteries had been damaged. One of the equipment operators who helped right the pallet involved in the fire stated that this was the third pallet that he had righted this year. Another operator stated that he had witnessed a pallet full of batteries turn completely upside down when it accidentally rolled off a dolly. A third operator reported seeing four crushed boxes of batteries on the bottom half of a pallet and "thousands" of small batteries spilling out as the pallet was taken off an international flight.

The above example, in addition to being an illustration of the dangers of improperly loaded or handled cargo, points to another beneficial use of standard procedures. Note the number of times that cargo handling personnel observed damage, and in particular the one cargo handler who had seen the same problem reoccur three times. Use of standard procedures has the advantage of providing a common benchmark against which to measure conformity with, and hence deviations from, established safety practices. This, in turn, allows such safety problems to be more easily identified, corrected, and that information shared with others who can use it. This is particularly critical in the air cargo industry. The ease with which an individual consumer can ship a package by air is, in large part, due to the number of different organizations involved in the process. Individual packaging stores, subcontracted pickup and delivery services, surface transportation elements, and finally an air cargo company can all be involved. The FAA has no jurisdiction over many of these organizations involved in the preparation, movement, and loading of cargo. Multiple government agencies are responsible for portions of the regulations intended to ensure the safety of the operation. Furthermore, there is no current industry standard method or process for cataloguing, reporting and tracking errors or deficiencies that are identified in any cargo loading or handling operations. Therefore, even if a carrier or one of its "feeder" organizations identifies a safety problem with its own operation or with another (e.g. a freight forwarder), there is no mechanism to share that information and avoid the problem at other carriers. The risk may be well mitigated at one point and remain present at another.

Cargo restraint systems and their proper use in securing the cargo load in the aircraft to prevent movement or shifting during all phases of the flight continues to be a concern. As discussed above, a load shift can change the CG of the aircraft to the point where it is outside the manufacturer-defined flight envelope, eroding the intended safety margins and possibly rendering the aircraft incapable of flight. When these shifts occur, and particularly if they occur during critical phases of flight, the results can be deadly. Cargo aircraft incident and accident reports highlighting improperly secured loads frequently note the movement and a change in the aircraft CG. A search of the SIE data previously described identified 139 reports during a recent 24-month period that dealt with cargo issues. A review of the reports revealed the continued problem of incorrect loading and securing of ULDs and pallets. Representative instances included:

- Cargo not being properly tied down
- ULD not locked into position
- Pallet moved due to cargo crash net not properly installed (the report stated: "the ground handling staff was unable to open the door of the forward hold")
- Pallet not properly locked, no center locks on left side (which left uncorrected would have allowed the pallet to move laterally into another pallet)
- Pallet had moved more than three feet during the flight

- Load shifted during flight

Some of these reports also noted a failure to maintain serviceable equipment. They also contained narratives that indicated some of the cargo mentioned had not been secured by any means, indicating that loading personnel had not locked them into position before the flight.

Another issue in securing cargo concerns improper "build up" of pallets. An unsafe situation can exist when the built up pallet has a high center of gravity (i.e. it is "top heavy"). The previously mentioned NTSB investigation made reference to this as presenting problems for the ground handling personnel. Pallets or other containers loaded in this manner are physically unstable and much more likely to tip over that properly configured ones. They become a serious problem during the acceleration for take off, turbulence while in-flight or deceleration during landing. The cargo restraint system is designed based on an assumption that the cargo is properly packaged and loaded and the pallet remains in the same basic form as loaded. The improperly loaded or configured pallet may have an unstable CG. This, in turn, can cause the form to change, the net restraint system to become ineffective, and the cargo to move from its intended position. That movement can affect the aircraft's CG or cause damage to the aircraft.

In many instances, cargo arrives at a destination and, if it is not delivered to the ultimate recipient, placed in a cargo facility where it is intended to be properly tracked, stored, repackaged or otherwise processed. Sometimes, however, cargo bypasses that type of facility and it "cross loaded." A cross load operation is when cargo is offloaded from an arriving aircraft and left on the ramp waiting to be loaded onto another aircraft. This type operation can be error-prone. If the cargo is going from one aircraft to another of the same type, there may be no problem (assuming no mishandling or incorrect weighing has already occurred). However, the aircraft receiving the cargo can be an entirely different type from the same operator, an interline partner or other contracted operator. During such operation, the cargo does not return to any formal processing facility. The lack of standardized forms and document procedures used by various operators, loading contractors and cargo facilities can easily result in the weight and/or contents may not be properly conveyed. In some instances, if the cargo cannot be simply transferred from one aircraft to another, a pallet or container may need to be opened, the contents rearranged, and a new pallet or container built up. Ideally, the cargo should be removed from the ramp and taken to a cargo facility for proper build up and weighing. However, operational pressures, inadequate training, or the absence of a good set of standard operating procedures may result in such a tear-down and build-up operation taking place right on the ramp, or may result in attempts to "force fit" a pallet or ULD not suited for the outbound airplane.

Operational pressures are a significant concern. Reliability of moving cargo in a timely manner drives the industry and in turn commands the flight schedules, work schedules, the work place and ancillary duties of load personnel, supervisors, ramp workers and other responsible individuals. Companies are trying to accomplish more movements with fewer people, which leads to assignment of additional duties to people in safety critical positions. Under these conditions, supervisors responsible for surveillance and oversight may also have additional duties, which can reduces his or her effectiveness. This increased tempo can manifest itself in errors that occur when personnel are distracted from the performance of their assigned. "Habit pattern interference" is a well-known cause of errors in aviation operations. Even highly

experience, skilled professionals make mistakes when the "normal" routine is interrupted and there is no reliable way to resume that routine exactly where they stopped. The ability to return to the task at exactly the right place can mitigate interruption of a critical task. Flight crews and mechanics have checklists to ensure that tasks are performed in a specific order, even if distractions occur. Loaders, supervisors, and others with safety-critical tasks to perform must be provided a means to know that each step of their task has been performed correctly and in the proper order. That means is typically a robust standard operating procedure.

Ground personnel operate from different sets of manuals and company directives than other groups. For example, pilots use the Flight Operations Manual developed by the Flight Operations Department while cargo/ground personnel work from a Cargo Manual developed by the Ground Handing Department. Because these manuals are generated from separate departments within a company and cover different areas, the directives many times do not incorporate or make reference to the safety items in the other manuals. In some instances, flight crews have been tasked to perform functions that should be accomplished by individuals specifically trained in handling and loading cargo. Pilots do not receive sufficient training concerning the use and functions of cargo restraint system and their components used in securing cargo loads on pallets and onto the floor of freighters to be the final authority on the security of the load.

3. Conclusions:

We have identified several areas relating to cargo handling that need to be addressed to increase the safety of moving cargo from origin to destination. We believe that standardized procedures and actions should be implemented by operators, carriers, and cargo facilities to prevent cargo with inaccurate weights being improperly loaded onto pallets that have incorrect documentation and are not properly secured on a cargo aircraft. We further believe it is in the best interest of the air cargo industry to use this consistent set of procedures to safely move cargo even if that cargo changes containers, aircraft, and/or operators. Operators should provide adequate staffing to safely perform the duties and functions required and their supervisory personnel should maintain surveillance and oversight of their operations, including those provided by contractors and at their outstations.

4. Recommendations:

- Develop standardized forms to contain specific, safety-critical information in load documentation, load manifests, and other forms used in the loading or cross loading of an aircraft. Design and use of such forms should minimize the potential of incorrectly reporting weight and location information pertinent to the cargo loaded and operation of an aircraft.

- Develop a uniform weigh scale tolerance and frequency of calibration for scales used in air cargo operations. ALPA recommends a tolerance of plus or minus one percent (±1%) and a frequency of calibration of the weigh scale sufficient to maintain the tolerance.

- Develop standard procedures and guidance material to allow personnel performing or supervising safety-critical tasks to verify that all task steps are completed in the proper sequence. This process would be enhanced by efforts to ensure that supervisory personnel

are not overloaded in their responsibilities such that it would prevent them from properly exercising safety responsibility to ensure the integrity of the load documentation and the cargo on the aircraft.

- Ensure training programs for cargo supervisors, loaders and ramp personnel include familiarization with the safety implications of aircraft being loaded incorrectly. This curriculum should contain modules that include operational information used by the flight crew and awareness of the potential problems that incorrectly loaded, unsecured or damaged cargo placed in a ULD or on a pallet may have on ground personnel, occupants of the aircraft when in flight, and the aircraft fuselage and structure.

- Develop a non-punitive reporting process to allow identification and correction of observed hazards by anyone involved in the cargo loading, packaging, or transport process. Such a program should include a means to disseminate such information to all parties performing, supervising, or having operational control over similar functions.