"B-767-300ER Variant Lower Lobe Cargo ULD Restraint System"

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Slides 1 and 2: Aloha, we are Marc Kup and Mont Smith from Hawaiian Airlines. Our presentation is entitled "B-767-300ER Variant Lower Lobe Cargo ULD Restraint System."

Slide 3: Hawaiian Airlines operates 14 B-767-300ER aircraft. We have discovered that many other experienced operators are familiar with nuisance movements of containers in the lower lobe cargo compartment owing to the restraint system configuration.

When Boeing started building these aircraft some 15-20 years ago, the first model was the B-767-200, having 6 cargo positions in the forward hold and a small cargo door. A simple restraint system focused on standard loads of ULD containers. No provision was made for pallet loading. When the B-767-300ER was introduced, a variant restraint system was designed to accomodate "multi-mix" loads.

Almost immediately after Hawaiian took delivery of its first B-767-300ER in October 2001, pilots and cabin crew began reporting noises on takeoff, at top of descent, during configuration for landing, and on touchdown/rollout. The noises were reported as "very loud" and seemed to be coming from right behind and below the cockpit. At first, we had incorrectly surmised this might be due to galley carts shifting in the service center directly behind the aft cockpit bulkhead on aircraft right (First Officer's side).

We developed an exhaustive reporting protocol for suspected load shifts that required the Captain to alert Maintenance Control and Dispatch when inbound with a suspected load shift. Because many line personnel were more familiar with Hawaiian Airlines' predecessor DC-10-10 and DC-10-30 load systems than the B-767, we required Ramp Managers (or ourselves) to meet the aircraft and carefully document the download, position-by-position.

Slides 4 and 5: Eventually we learned that the origin of these noises seemed to be associated with the configuration of certain aircraft. Noises only occurred on B-767-300ER variants equipped with the large Forward Cargo Compartment door (134" X 69" "clear door" dimensions) and almost exclusively in the forward compartment. As we reviewed the manufacturer's Cargo Loading Manual, we realized this could possibly be due to the location of specialized restraint hardware intended for use with either standard ULDs (e.g., LD-2, LD-3, LD-7, or LD-8) or pallets (125 X 96, 125 X 88, half pallets, etc.)

Slide 6: We began to realize that many opinions varied among load agents in our system, both Hawaiian employees and vendors, regarding proper restraint of ULDs and pallets. Some Hawaiian personnel thought they could apply their DC-10 knowledge to this aircraft. Vendor personnel often mistakenly believed all B-767 were configured the same, whether B-767-200s or even B-767-300s with different cargo handling systems! The fact that we were operating 3 former German LTU aircraft in our fleet equipped with the small forward cargo doors meant they often would often see one configuration on one day and another the next!

Slide 7: We learned that our B-767-300ER variant was designed to be "stack loaded." In other words, each container, in each load position, was not intended to be individually restrained. Instead, the forward cargo compartment on "large door" aircraft is divided into several "zones," enabling containers (or pallets) in each zone to be "married together" and restrained collectively, with some allowance for reasonable distortion of the containers due to "wear and tear" and for slight thermal expansion/contraction.

Slides 8 and 9: The manufacturer had, in fact, alerted operators to the fact that up to 5.5" of "gap" in a stack would NOT exceed structural design limitations.

Slide 10: The problem arises with the fact than an LD-8 container, designed to span an entire load position, can weigh in at 5400 lbs. including tare (empty) weight. This means that if you have a "stack" of as many as 5 LD-8 containers, as you could very likely have in IATA positions 14 and 21 through 24, with a permissible gap of 5.5", you could have 27,000 lbs. of cargo moving with an energy equal to $\frac{1}{2}mv^2$ whenever the pitch or velocity of the aircraft changed appreciably. Passengers and crewmembers can hear and feel the movement in the cabin apart from the slipstream and engine noise.

125" X 88" PAG pallets require the use of Auxiliary Side Guide Rails, which need to be carefully extended in anticipation of this type of freight. FQA-type pallets require close scrutiny and vertical tiedowns. Because of the near-square geometry (60.4" X 61.5") of certain PKN pallets that have the footprint of an LD-3 when they are not clearly mark ed for appropriate loading, we do not permit interline acceptance of these pallets.

We've made it a company policy to discourage Load Planners from developing "blind partial loads," or "buried cans," wherein a Loadmaster standing at the open doorway cannot visually confirm the restraint of all cans in a particular stack, and would have to depend on the load agent's assertion that all cans loaded sequentially were properly restrained. Visualize an LD-8 in IATA position 24, followed by an LD-3 in IATA position 23, and then another LD-8 in IATA position 22. If IATA positions 21 and 14 were empty, as is sometimes the case, the load agent may exercise the option of restraining positions 7 and 8 as a stack, using pallet locks in lieu of *non-existent partial load stops at the interface of positions 22 and 23*, and then erecting partial load stops forward of position 22. This results in a permissible longitudinal gap of 4.40" for containers 23 and 24, and a gap of 0.3" for container 22, but there is no way for the Loadmaster to

verify the Auxiliary Guides are erected adjacent to the LD-3 in position 23.

Another option for the Loadmaster (if the load in position 23 were 2 LD-2s or an LD-8) would be to consider all 3 positions as a stack and accept a permissible overall 5.5" gap after erecting only partial load stops forward of position 22. Obviously this choice is sub-optimal for movement (potentially 16,200 lbs. through 5.5").

Slide 11: We began to realize there are certain anomalies in the load system. For example, between IATA positions 22L&R and 23L&R, there are no partial load stops…only pallet locks. Therefore, if you are attempting to restrain a stack consisting of 2 LD-8s, 2 LD-3s, or any combination of LD-8s, LD-3s, and LD-2s in IATA positions 23L&R and 24L&R, you will have to rely on the pallet locks and accept a 4.4" gap.

Slide 12: We also recognized that many times we were feeling and hearing a "pile driver" effect. If Center of Gravity considerations dictated carrying a full LD-8 can in IATA position 24 and riding a series of, say, 4 empty LD-8 cans ahead of it in a legal 5-can stack, the movement of these cans slamming against the partial load stops forward of IATA position 22 would create a huge booming noise that we believe is transmitted through a large sub-floor vent under the stack leading forward, and dividing near the door to provide heat or air conditioning to the forward cabin and cockpit. This likely explains why the pilots could hear and feel the movement as if it was occurring directly below and behind them.

Slides 13, 14 and 15: Loadmasters have some limited choices available to them when faced with a large stack that can be broken down into several smaller ones. The slides show the optimal manner in which to deal with 3, 4 and 5 ULD container-widths in the IATA zone from 14L&R through 24L&R

Slide 16: After a while, we began to see a possibility for some omissions and errors that could be generated by load agents misunderstanding what the restraint system is designed to do. (We call these assumptions "urban legends" in loadmaster re-certification class!)

Slide 17: We noted other misconceptions. We heard an opinion voiced that the Center Guides need not be extended when loading two LD-2 containers side-by-side. The source said that the two cans will ride perfectly well without the separation this device provides. Not so. First of all, LD-2s are uploaded using a technique the manufacturer calls "bumping." This technique employs a movement of the joystick to allow the two cans to separate and follow distinct paths as the Power Drive Units convey them fore or aft into the stack. Center Guides take up the slack that originates because the lateral dimension of each can's footprint is about 1" less (47.0") than half of the available floorspace (48.0"). This allows the outer edge of the LD-2 to ride under the side guide rail, while the inner edge is restrained by the "butterfly" feature of the Center Guide.

It goes without saying that the Auxiliary Guides used to laterally restrain LD-3 containers, if not raised, would cause considerable lateral motion.

Slide 18: We frequently hear it said that with a "full fit" compartment there can be no excessive movement. This is untrue. More importantly, the movable, electro-mechanically operated Lateral Guides may incur a side impact load that can cause premature failure. On rare occasions, agents may forget to extend the Lateral Guides prior to close-up. This can have the consequence of allowing a ULD that was intended to be restrained in IATA position 21L&R to move forward or aft.

Slides 19 and 20: At the junction of IATA positions 12L&R and 13L&R, for example, there are 3 sets of restraints commonly used for different purposes. The simplest are the 4 partial load stops. These are designed to restrain a group of standard ULDs (2 LD-8s, 2 LD-3s or 4 LD-2s, for example). Since the footprint of these containers is 96" X 60.4" in each load position, for a total length overall of 121.3" with distortion, the position of the partial load stops at 121.8" would allow 0.5" of gap between 2 "stacked" containers and the "fixed pallet end stops" at the forward end of the compartment, and the partial load stops. If a load agent omits raising these restraints, the 10,800 lb. potential load can move aft to contact the three raised Lateral Guides intended to restrain a single container in the IATA 21L&R(door)position. Since this gap is on the order of 6" a rather load and discernible noise and vibration will be heard and felt in the cockpit/forward service area directly above. This is what we call a "classic" error of omission.

Note that if a load agent errs by raising the 4 forward pallet locks instead of the partial load stops to restrain this previously-described load, a similar, but slightly less egregious gap will result. Now, in effect the ULDs are riding in a space designed top accomodate a full sized 125" X 88" or 125" X 96" pallet. Since the stack, with distortion, is calculated at 121.3" there is 125.25" - 121.3" or roughly 4.05" of gap between the stack and either the fixed pallet end stops or forward pallet locks.

Slide 21: The only way to put "urban legends" to rest is by adherence to S.O.P.

Slide 22: "The possibility of *cargo containers shifting during flight*, within the limits shown in the attachment, is *normal*?" Perhaps, but this does little to assuage our passengers.

Slide 23: In summary, our experience suggested that we develop a "Loadmaster Re-Certification Course" for our people. Starting with Station Managers, the course has been taught to all Hawaiian and vendor Load Agents, Loadmasters, Load Planners, Line Supervisors, and Ramp Managers. The course requires 8 hours of classroom instruction and features a comprehensive workbook on our experience with the B-767-300ER variant we operate. We teach a thorough "pre-flight" and "through flight" of the cargo compartments, with emphasis on prompt reporting of load handling equipment discrepancies to the mechanic. We have seen our frequency of reported "suspected load shifts" greatly diminish, but, of course, not disappear. We believe inadvertent employment of the 5.5" maximum permissible gap option has generated a number of these situations.

Slides 24 and 25: As a result of the training and Loadmaster feedback, we have developed a pocket-sized "Job Aid" that Loadmasters and Load Agents can wear on their arm badges or carry in their pocket. When a combination of containers allows for re-organization in a stack, the restraint arrangement can be optimized by reference to the card. On the obverse side, we have a "Close-up Procedure," consisting of a final set of checks to be carried out by the Loadmaster in his capacity to QA the Load Agent's work.