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Minimum Requirements for Future Wide-Body Aircraft Cargo Systems and Compartments (Intermodal)

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1. SCOPE:

The dedicated aircraft addressed herein is to be an uncompromised all-freighter aircraft developed primarily for use in the civil transport industry.

The requirements of this document are applicable but not limited to airborne equipment which is subject to the airworthiness directives of FAR Part 25 and which is designed to accommodate unitized cargo in the form of intermodal containers and other compatible unitized load devices. Intermodability in the context of this document encompasses the air-truck-rail-sea modes, and considers uncertificated as well as certificated unit load devices (ULDs). This document covers the fundamental prerequisites for the aircraft cargo compartment and the onboard cargo handling and restraining system. The cargo system and compartment considers primarily 96 in (2.44 m) wide, multiple bottom configuration ULDs. The cargo system and compartment should handle outsize cargo and should consider Civil Reserve Air Fleet (CRAF) requirement compatibility. The cargo system, compartment, and the cargo-related aircraft physical features should be sufficiently defined to establish specifications for ground interface mobile and/or fixed loading equipment and facilities with a goal of standardization thereof. This document is intended to assist air carriers in standardizing to the degree necessary to insure the smooth flow of cargo between ground and aircraft and between various aircraft in the future. This document is not intended to inhibit the development of new systems, but rather to establish a solid interface for the introduction of such systems.

1.1 Purpose:

This document specifies minimum performance, design, and test requirements for future civil wide-body dedicated freighter aircraft equipment identified as a main deck unitized cargo handling and restraint system. It further outlines the general design requirements for the cargo compartment and envelope.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this specification and references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP807	Flight Deck Interior Doors and Their Operation
ARP917	Stowage of Flight Crew's Survival Emergency, and Miscellaneous Equipment
ARP998	Crew Restraint System
ARP1150	Safety Considerations - Flight Deck Seats for Transport Aircraft
ARP1372	Minimum Requirements for Air Cargo Unit Load Device, Ground Handling and Transport Systems
ARP1409	Requirements for Aircraft On Board Weight and Balance System
ARP4101/9	Crew Safety Provisions for Cargo Aircraft

2.1.2 FAR Publications: Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591.

FAR Part 25

3. UNIT LOAD DEVICE (ULDs):

3.1 ULDs:

The following ULD specifications, standards, or applicable portions thereof, should be considered. Additional requirements may be obtained from equipment manufacturers' manuals, catalogs, and drawings.

3.1.1 CERTIFIED ULDs:

ANSI MH5.2-1976 Air Mode Containers

IATA 50/6 Main Deck 8 x 8 ft Container for High Capacity Aircraft

ISO 1496 Series 1 Freight Containers Part VII Air Mode Containers

NAS 3610-2F1, 2G1, 2H1, 2J1, 2M1, and 2R1 Cargo Unit Load Devices, Specification for (TSO/C90 and FAR Part 37.199)

SAE AS832 Air Land Demountable Cargo Containers

3.1.1 (Continued):

SAE AS1130 Air Land Demountable Cargo Pallets

SAE AS1131 Air Land Demountable Cargo Pallet Nets

SAE AS4041 Air Mode 8 x 8 ft Containers

TSO C90 FAA Technical Service Order for Certification of ULDs

3.1.2 UNCERTIFIED ULDs:

ANSI MH5.1-1975 Basic Requirements for Cargo Containers

ANSI MH5.4-1972 International (ISO) Freight Containers

ISO 1496 Series 1 Freight Containers

MIL-C-52661 Container, Cargo (MILVAN)

3.1.3 Optional ULDs: The following additional ULD specifications, or applicable portions thereof, may be considered for handling by optional system equipment:

MIL-P-27443 (USAF) Pallet, Cargo Aircraft (463L) (Type 1 Pallet Only)

MIL-N-27444 (USAF) Pallet Net, Cargo Aircraft (463L)

MIL-P-83037 (USAF) Platform, Cargo, Aerial Delivery (463L) (Considered for Logistic Purposes)

IATA 50/1B Interline Pallet for NAS 3610 Class II Restraint Systems

IATA 50/4 Certified Aircraft Container

IATA 50/8 Main Deck 3175 (125 in) Container for High Capacity Aircraft

3.2 General:

The following cargo-related airframe or aircraft equipment specifications, standards, handbooks, etc., or applicable portions thereof, should be considered. Additional applicable documents and/or requirements may be specified or forthcoming from customer and/or contracting agencies.

3.2.1 GOVERNMENT:

FAR Part 25 Airworthiness Standards: Transport Category Aircraft (or equivalent airworthiness regulations)

3.2.2 MILITARY (Optional):

AFSC DH1-11 Design Handbook - Air Transportability

AFSC DH2-1 Design Handbook - Airframe

MIL-A-8421 General Specification for Air Transportability

3.2.3 INDUSTRY:

ARP1372 Minimum Requirements for Air Cargo ULD Ground Handling and Transport Systems

ARP1409 Minimum Requirements for Aircraft Onboard Weight and Balance Systems

4. REQUIREMENTS:

4.1 Interface:

Cargo system and compartment compatibility with unitized cargo, other cargo, ground equipment, facilities, and pertinent cargo-related aircraft physical and environmental features, including capacities and limitations, should be clearly and completely defined herein and by reference to appropriate documentation.

4.1.1 Cargo: The ULD specifications and standards or applicable portions thereof as listed in 3.1, and the cargo types as described in 4.2.1, should be considered as the cargo for the future dedicated freighter aircraft.

4.1.2 Air Vehicle Cargo System: The air vehicle cargo system should provide for the handling and restraint of specified ULDs and outsized cargo in the aircraft.

4.1.2.1 Conveyance: The system should provide for the conveyance of the ULDs across the aircraft threshold and throughout the aircraft cargo compartment.

4.1.2.2 Support and Restraint: The system should provide for the structural support and restraint of the ULDs during flight and ground maneuver in a manner which will assure the cargo will not present a hazard to the aircraft or its crew, and shall be in accordance with the requirements of FAR Part 25.

4.1.2.3 Guidance: The guidance features of the air vehicle cargo systems should assure that positive control will be maintained over moving ULDs and that ULD excursions will remain within the aircraft cargo envelope. Compatibility at interface with ground loading equipment should be provided to assure guidance continuity.

4.1.2.4 Powered Movement: The system equipment should provide for powered movement and control of ULDs.

- 4.1.2.5 Stick Loading: The system should provide for both individual and multiple unit stick loading and unloading of ULDs.
- 4.1.2.6 Outsize Cargo: The system should provide for the handling and restraint of outsize cargo within the limits of the aircraft.
- 4.1.2.7 Uncertificated ULDs: The system should be capable of handling and restraining uncertificated ULDs, including standard containers which do not have continuous flat bottom surfaces. This capability may be provided directly by the cargo system or through the use of adapters installed in the cargo system or on/under the ULD.
- 4.1.2.8 Containers: The system should not impose unusual or peculiar requirements upon the ULDs which would be detrimental to the function of the ULDs in other transport modes.
- 4.1.2.9 Component Application: Some system components applicable to the loading/unloading function may be introduced into the aircraft for that function but remain with the ground equipment. Compatibility with military ground loading equipment for CRAF type missions should be considered.
- 4.1.2.10 Optional ULDs: Provisions may be incorporated for the handling of optional ULDs. Aircraft cargo system equipment pertinent only to optional ULDs or to outsize cargo may be provided either as optional onboard equipment or as quickly removable kit-installed equipment.
- 4.1.3 Aircraft Physical and Environmental Features: The aircraft cargo system and compartment should be thoroughly compatible and integrated with those aircraft physical, functional, and environmental features which impact the system and the compartment.
 - 4.1.3.1 Physical and Functional Features: Example aircraft physical and functional features are: door opening size, shape and location, cargo envelope and clearances, cargo movement paths, sill height, cargo floor attitude and excursion, aircraft stabilization characteristics, crew location with respect to cargo compartment, cargo floor and fuselage structural characteristics. These features are further covered in this document.
 - 4.1.3.2 Environmental Features: Example aircraft environmental features are: temperature, pressure, atmosphere, venting, vibration/shock, noise, and lighting. These features are further covered in this document.
- 4.1.4 Ground Equipment: The following specifications, standards, and recommendations should be considered. Additional requirements may be obtained from equipment manufacturers' manuals, catalogs, and drawings.
 - a. ARP1372
- 4.1.4.1 Compatibility: The ground equipment should be fully compatible with the aircraft cargo handling system.

- 4.1.4.2 Cargo Alignment: The combination of the aircraft cargo system, aircraft interfacing ground equipment, and aircraft physical features should minimize the criticality of cargo positioning and aligning during loading/unloading.
- 4.1.4.3 Facility: With respect to interface of the aircraft and/or unitized cargo to the facility, the facility and the ground equipment can be considered as synonymous when only the function of loading and unloading the aircraft is considered.

4.2 Loadability:

The chosen spectrum of cargo should be readily loadable if the aircraft is to perform efficiently. The cargo compartment should be sized to receive and contain the cargo utilizing most effectively the volume determined to meet the performance requirements. The cargo aperture and envelope should be located and sized, respectively, to meet the needs of the cargo and the handling system, which, in turn, should perform to meet the requirements of aircraft turn-around and unloading. There should be no constraints on methods to load or unload the cargo compartment of the aircraft.

- 4.2.1 Types of Cargo: The cargo compartment should accept various types of unitized and nonunitized cargo including cargo suitable to CRAF missions, when such is taken into consideration.
 - 4.2.1.1 General Cargo: General cargo unitized in dry van containers or on suitable pallets will constitute the majority of the civil freighter domestic and international cargo in future air cargo operations. The ULDs listed in 3.1 will encompass the ULD spectrum which must be handled through the cargo aperture and in the cargo compartment.
 - 4.2.1.2 Special Cargo: Special cargo is generally defined as cargo which may not be environmentally or physically compatible with the containers used for general cargo (4.2.1.1) but will be handled on suitable pallets within the dimensions and weights defined for general cargo. This cargo may include refrigerated or frozen items, liquids, autos, live animals, etc. Preservation of compatibility with ground transportation should be considered a requirement.
 - 4.2.1.3 Outsize Cargo: Outsize cargo are those items incapable of being contained or restrained by the various ULDs listed (3.1), but that will fit with adequate clearance, the cargo envelope of the aircraft being developed. Bulk loading, special pallets or containers, dollies, or other means of entry and tie-down may be used depending upon the capability of the airframe and/or the design features desired by the buyer/user.
 - 4.2.1.4 Military Cargo: Military (CRAF mission) cargo, when taken into consideration, may have considerable impact on the cargo compartment depending on the type, size, range, and payload under consideration for the aircraft being developed. Future development of the CRAF requirements for ULD types and sizes, for wheeled and tracked vehicles, and for outsize military cargo should be monitored and considered in the basic design and/or add-on capability of the aircraft.

- 4.2.2 Cargo Envelope: The size and shape of the cargo compartment and access thereto should have no constraints for receiving and restraining the specified spectrum of cargo. Criteria for applicable existing and proposed ULDs and for applicable military cargo proposed/negotiated for the future cargo aircraft should constitute the items used to determine the cargo envelope and, in turn, the fuselage contour. An efficient use of the volume should be achievable under maximum payload operations.
- 4.2.2.1 Loading Method Effects: Cargo compartment envelope sizing may be affected by loading methods. Proper positioning of the cargo within the compartment may also require design consideration for both the compartment and the loading equipment.
- 4.2.2.2 Sizing Factors: Figure 1 shows the various cargo envelope development sizing factors. A space allowance should be provided for guidance and restraint equipment. This space may or may not fall within the clearance space provided between the payload and structure. If required for outsize or other cargo, an additional space may be required for access to floor tie-downs. A space allowance should be provided for personnel ingress along the inboard or outboard sides of the cargo sticks. In addition to the basic clearance dimension of 2.00 in (50.8 mm) between payload and structure during both the loading/unloading and restraint modes, there may be an additional localized clearance dimension requirement in threshold areas for the gyration (i.e., teetering, valleying, articulating) of the load in transit at the interface. A space allowance should be made for the loading (conveyance) system equipment whether it be below or above the payload. Load separation in multistick arrangements should be not less than 4.00 in (101.6 mm) in a mechanical or automated system but could be much greater in a manual (floor tie-down) system. The largest factor in envelope development is the payload cross section. The composite payload cross section, which forms the basis onto which the above clearances and space allowance are additive, should be carefully considered. Where growth is probable in ULD gauge or height during the life of the aircraft, the growth dimensions should also be considered.
- 4.2.2.3 Crew Location: The flight station should be located in a manner to both facilitate the movement of cargo in/out of the aircraft and to maximize usable volume of the cargo compartment. Additionally, advantage should be taken of applicable reduced restraint criteria accorded aircraft whose cargo is not projected to pass through the flight station during an emergency/crash landing condition.
- 4.2.3 Cargo Compartment: The cargo compartment accommodates the cargo during loading/unloading modes and contains and restrains it during ground maneuver and flight. The number of cargo sticks and the stick length determinations go beyond the scope of this document. However, the sizing of the compartment with respect to a selected aircraft gross payload in pounds (kilograms) is basically determined by the value set for the onboard unitized cargo design density. Sufficient trade-offs should be evaluated utilizing cargo envelopes, payloads, ULD volumes, and tare weights to achieve the needed cargo compartment dimensional sizing.