International Standard ISO 6833

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Air cargo — Minimum requirements for future wide-body aircraft cargo systems and compartments (intermodal)

Fret aérien — Caractéristiques minimales des futurs systèmes de chargement et des soutes à bord des aéronefs gros porteurs (transport intermodal)

First edition — 1983-06-01

UDC 629.7.045 : 621.869.8 **Ref. No. ISO 6833-1983 (E)**

Descriptors : aircraft industry, aircraft, cargo transportation, specifications.

Price based on 13 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 6833 was developed by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, and was circulated to the member bodies in July 1981.

It has been approved by the member bodies of the following countries :

Australia	France	South Africa, Rep. of
Austria	Germany, F. R.	Spain
Belgium	Ireland	United Kingdom
Brazil	Italy	USA
Czechoslovakia	Japan	USSR
Egypt, Arab Rep. of	Romania	

The member body of the following country expressed disapproval of the document on technical grounds :

Netherlands

Air cargo — Minimum requirements for future wide-body aircraft cargo-systems and compartments (intermodal)

1 Scope

This International Standard 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 Field of application

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 U.S. FAR Part 25 (or equivalent regional or national regulations) 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 International Standard covers the fundamental prerequisites for the aircraft cargo compartment and the onboard cargo handling and restraining system. The cargo system and compartment considers primarily 2,44 m (96 in) wide, multiple bottom configuration ULDs. The cargo system and compartment should handle outsize cargo. 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 International Standard is intended to assist air carriers in standardizing to the degree necessary to ensure the smooth flow of cargo between ground and aircraft and between various aircraft in the future. It is not intended to inhibit the development of new systems, but rather to establish a solid interface for the introduction of such systems.

3 Applicable documents

3.1 ULD's

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

a) Certified ULD's

ISO 1496/7, *Series 1 freight containers — Specifications and tests — Part 7 : Air mode containers.*

ISO 4115, *Air land cargo pallet nets — Specification and testing.*

ISO 4117, *Air land cargo pallets — Specification and testing.*

ISO 4128, *Air mode modular containers.*[1)]

ISO 8149, *Aircraft and space vehicles — Air cargo — Insulated air cargo containers.*[2)]

ISO 8150, *Aircraft and space vehicles — Air cargo — Main deck 3 175 mm (125 in) containers for high capacity aircraft.*

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

b) Uncertificated ULD's

ISO 1496/1, *Series 1 freight containers — Specifications and tests — Part 1 : General cargo containers.*

ISO 1496/2, *Series 1 freight containers — Specifications and tests — Part 2 : Thermal containers.*

ISO 1496/5, *Series 1 freight containers — Specification and testing — Part 5 : Platform containers.*

3.1.1 Optional (non-standard gauge) ULD's

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

ISO 4171, *Interline air cargo pallets.*

ISO 6895, *Aircraft — Structural igloo system.*[1)]

1) At present at the stage of draft.

2) In preparation.

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.

Government

U.S. FAR Part 25, *Airworthiness Standards : Transport Category Aircraft* (or equivalent regional or national regulations).

Industry

ISO 4116, *Ground equipment requirements for compatibility with aircraft ULD's.*

ISO 6702, *Requirements for aircraft on-board weight and balance systems.* [1)]

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 ULD's and outsize cargo in the aircraft.

4.1.2.1 Conveyance

The system should provide for the conveyance of the ULD's across the aircraft threshold and in and out of the aircraft cargo compartment.

4.1.2.2 Support and restraint

The system should provide for the structural support and restraint of the ULD's during flight and ground manoeuvre 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 U.S. FAR Part 25 (or equivalent regional or national regulations).

4.1.2.3 Guidance

The guidance features of the air vehicle cargo systems should assure that positive control will be maintained over moving ULD's and that ULD excursions will remain within the aircraft cargo envelope. Compatibility at the 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 ULD's.

4.1.2.5 Stick Loading

The system should provide for individual and/or multiple unit stick loading and unloading of ULD's.

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 ULD's

The system should be capable of handling and restraining uncertificated ULD's, 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 ULD's which would be detrimental to the function of the ULD's 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.

4.1.2.10 Optional ULD's

Provisions may be incorporated for the handling of optional ULD's. Aircraft cargo system equipment pertinent only to optional ULD's or to outsize cargo may be provided either as optional onboard equipment or as quickly removable kit-installed equipment.

1) At present at the stage of draft.

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 later 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 later 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, catalogues, and drawings. (See ISO 4116).

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 non-unitized cargo.

4.2.1.1 General cargo

General cargo unitized in containers or on suitable pallets will constitute the majority of the civil freighter domestic and international cargo in future air cargo operations. The ULD's 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 (see 4.2.1.1) but will be handled on suitable pallets within the dimensions and weights defined for general cargo. This cargo may include 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 ULD's listed (see 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 tiedown may be used depending upon the capability of the airframe and/or the design features desired by the buyer/user.

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 ULD's 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

The figure 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, and additional space may be required for access to floor tiedowns. 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 51 mm (2 in) 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 multi-stick arrangements should be not less than 102 mm (4 in) in a mechanical or automated system but could be much greater in a manual (floor tiedown) 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 manoeuvre 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 kilograms (pounds) 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.

4.2.4 Cargo aperture

Cargo doors have the basic function of closing the loading access opening of the cargo compartment. No constraints should be placed on the operation of the cargo doors. The aperture should consider external cargo handling operations such as winching or hoisting of outsized cargo. Hinging, latching, actuation and sealing of the door should not interfere with the basic function or loadability of the cargo compartment.

4.2.4.1 *Door location*

Cargo door locations may be considered to be at the discretion of the aircraft designers. However, the location should be selected and the path of cargo movement (i.e., straight-in, Y, 90° turn) should be directed by the ability of the system to meet such performance parameters as turn-around times and the handling of all ULD sizes. Consideration should be given to a location which will enable suitable ground loading equipment to manoeuvre easily into position. The door opening should be such that it provides maximum clearance with the cargo envelope, and the full open position should be the maximum allowed by the aircraft structure.

4.2.4.2 Ground equipment clearances

Cargo door (including visors) opening criteria should be compatible with the requirements for clearance of ground interface loading equipment at the aircraft loading interface.

4.2.4.3 Operating times

Cargo door opening and closing times should be as short as possible commensurate with safety and the unlocking, actuation, and locking operations. These times, however, should not exceed 90 s.

4.2.5 Cargo floor height

This document does not purport to specify a discrete cargo floor height. However, a range of cargo floor heights is desirable to provide the ground system equipment designers some finite parameters. The most important decision in this process is the determination of whether the cargo floor is above or below the aircraft wing (unless the aircraft is to be a distributed-load aircraft). This decision, when made, dictates whether the aircraft is high wing or low wing. In making this determination, it is important to evaluate the time effect of lift height on cyclic lift devices. There is no way to kit or add-on a capability to effect a substantial floor height change. Integral and/or removable kit loading ramps may be provided as requirements dictate for special ground loading operations. The cargo floor height of the aircraft to be developed should fall between a minimum of 1,37 m (4.5 ft) and a maximum of 5,49 m (18 ft).

4.2.6 Aircraft stabilization

The cargo floor of the future all-freighter aircraft can be expected, under changing cargo and fuel loads during the loading/unloading operation, to incur (unless restrained) substantial changes in height and deck angle. This floor height/angle excursion is detrimental to the loading process, especially at the threshold floor sill location. Also, during the loading and discharge of cargo, tip-over of the aircraft must be prevented. The aircraft should be capable of being stabilized to provide a relatively constant floor height and deck angle during cargo handling. The degree to which change in height and attitude should be controlled is a function of the specifics of the cargo handling system and the tolerances to which it can accept cargo in transit at and across the threshold interface.

4.2.7 Cargo handling

The cargo handling system provides the interface between the cargo and the airframe. It also provides an interface with the ground interface loading equipment. Although certain types of cargo may be loaded manually, the basic cargo handling system should be mechanical with powered drive for movement of cargo. The system should have growth potential for operation by automated means. Aircraft systems design should allow for simultaneous cargo handling and refueling or line maintenance operations. Specific system recommendations are covered elsewhere in this document.

4.2.8 Ground system facility

The ground system should interface both the aircraft onboard cargo handling system and the ground transportation system.

The ground system should have the capability to load/unload the aircraft within the minimum load/unload times of the aircraft cargo handling system. This interface provides the intermodal aspect for the air-truck link of the air-sea-truck-rail overall intermodal transportation system. The facility should provide the necessary ramp, equipment, and building spaces to accommodate the ULD staging/storage requirements and the cargo loading/unloading and aircraft servicing operations.

4.2.9 Loading access inspection verification

Loading access/inspection/verification to the exterior of all ULD's should be provided to assure the security and integrity of the cargo when restrained in the cargo department. This may include a combination of direct and/or remote means such as direct access, compartment lighting, fibre and/or reflective optics, micro-switches or other applicable means to make such determinations. Consideration should be given for access to cargo handling equipment in case of malfunction with cargo in place. Considerations may be extended to in-flight cargo monitoring functions.

4.3 System performance

The system should be designed with total consideration for all functions to be performed. The cargo system and compartment should provide a capability for a maximum payload of unitized cargo with minimum loss of loadable volume.

4.3.1 Performance standards

The aircraft onboard cargo system should be designed to provide the capability for minimal turn-around times with high reliability, minimal cargo handling costs and the damage-free handling of cargo.

4.3.1.1 Load unload cycles

With appropriate aircraft/ground interface equipment available, the cargo handling system should be capable of discharging a full unitized cargo load in 15 min, and completely reloading the aircraft in 15 min. Five additional minutes should be allowed for a changeover from unloading to loading. Aircraft positioning and door opening/closing times are not to be charged to the load/unload cycle times.

4.3.1.2 Manloading

Onboard manloading requirements should not exceed 1 man per stick of cargo during normal ULD loading/unloading operations. This requirement is not necessarily applicable to optional ULD's or outsize cargo.

4.3.1.3 Force

If an onboard power system is provided, the frictional rolling or other force requirements should not exceed 3 % of the gross load weight when moving the load on a level surface, and the system should further be capable of moving the load on the inclined surfaces of 4.3.1.4.

4.3.1.4 Loading system alignments

The system at the interface between the aircraft and the ground loader/dock equipment should function properly if the aircraft moves through a range from 2° nose down to 2° nose up and plus or minus 2° in roll attitude during loading/unloading operations unless the aircraft is positioned and restrained. Relative crest or valley angle during load/offload should not exceed 2°. A step of 9 mm (0.38 in) up and 13 mm (0.50 in) down should be transversable by ULD's in transit.

4.3.2 Functional characteristics

The system should consist of a low-friction load-bearing surface or device for conveyance of ULD's to and from their loaded position within the aircraft, powered ULD movement equipment, directional control equipment, and restraint devices.

4.3.2.1 All-seasons operation

All loading/unloading, power and restraint operations should be capable of being accomplished by personnel encumbered with special clothing such as winter gloves.

4.3.2.2 Special tools

System equipment should be designed to accommodate ULD's of one standard width and varying lengths, heights, and configurations. Optional capabilities may be provided to accommodate ULD's of varying width. When this capability is provided, the adjustment should be accomplished without special tools and should be operable by personnel wearing winter clothing.

4.3.2.3 System capabilities

The system should be capable of accommodating the maximum load for which each ULD is designed. The system should also accommodate heavier than specification ULD loads to the extent that the airframe can accept heavier local loadings. Aircraft structural capabilities may limit the final positioning locations of maximum weight loads within the aircraft.

4.3.2.4 System growth

This system should consider growth to full automation with respect to the movement and restraint of ULD's.

4.3.3 Structural compatibility

The cargo compartment envelope basically defines the inside of its surrounding structural airframe shell. Because of inherently different flexure characteristics existent between airframe and ULD's, it is necessary to consider the level of structural compatibility and possible limiting conditions.

4.3.3.1 Loads

The airframe shell and cargo support structure should be capable, throught the cargo restraint system, of adequately restraining the cargo for both ground manoeuvre and flight

loads as defined in U.S. FAR Part 25 (or equivalent regional or national regulations). This should be accomplished without damage to the aircraft or the cargo. Also, loads introduced during cargo loading/unloading should be accommodated without damage. Consideration should be given to zone loading restrictions normally associated with airframe structures. Load capabilities should be provided in the distributed (force/area) and running (force/unit of length) manner. Additional capabilities (such as concentrated, puncture, axle) may also be specified.

4.3.3.2 Deflections

The cargo support structure working with the cargo restraint system should accommodate the range of deflections imposed by ground manoeuvres and flight loads as defined in U.S. FAR Part 25 (or equivalent regional or national regulations). This should be accomplished without damage to the aircraft or the cargo. Since aircraft structures in the interest of weight saving are relatively flexible, and since many container types of ULD's are relatively rigid, the introduction of highly concentrated loads of a crippling nature must always be of prime consideration. Thus, cargo support structures should be designed for such concentrated loads or alternative methods employed for distributing the loads.

4.3.3.3 Restraint

Cargo restraint should be provided through the interface system such that the ground manoeuvre and flight loads as defined in U.S. FAR Part 25 (or equivalent regional or national regulations) will not damage the aircraft or the cargo. The restraint interface is a function of the cargo interface and is further described in 3.2, 4.1.2, 4.2.4 and 4.7.3.

4.3.3.4 Weight and balance

Cargo placement (location) in the cargo compartment is dictated by a combination of factors including foremost, the proper distribution of ULD's or other cargo of widely divergent gross weights to effect a proper aircraft centre-of-gravity. Secondarily, zone loading capabilities must not be exceeded, and thirdly, placement for offloading at enroute stops must be considered.

4.3.4 Crash conditions

The structural provisions and other features peculiar to the containment or control of cargo and the protection of crew and personnel during emergency landing operations shall be designed to meet the requirements of U.S. FAR — Part 25 (or equivalent regional or national regulations).

4.3.4.1 Barriers

Cargo compartment bulkheads or barrier nets designed, when required, for crew and personnel protection during emergency landing operations shall incorporate means for access between compartments. Such access provisions during normal operations shall be operable by one man and the time for opening or closing shall not exceed one minute. If bulkheads, barrier nets, or other restraint barriers are employed in conjunction with the restraint of uncertificated ULD's, similar ingress/egress features should be provided. This requirement may not apply to fixed structural bulkheads.

4.3.4.2 Structural fuses

If structural fuses are employed, the fuse support structure should be designed for 1,5 more than the fuse.

4.3.4.3 Crew safety

Careful consideration for all aspects of regulatory requirements for crew safety shall be made. For SAE publications relative to this subject, ARP 807, ARP 808, ARP 917, ARP 998, ARP 1139 and ARP 1150 should be referred to.

4.3.4.4 Hazardous cargo

Provisions should be made for the carriage of hazardous cargo in compliance with appropriate hazardous cargo regulatory requirements. Positive provisions shall be made for in-flight inspection and/or monitoring.

4.3.5 Environmental compatibility

The cargo compartment should provide an environment compatible with the requirements of the cargo for the time the cargo is aboard the aircraft. Additionally, the cargo compartment should provide an environment compatible with the needs of personnel whether they are loading and/or maintenance personnel or flight personnel. Most functional equipment provided environmental requirements apply only to the cargo compartment when the aircraft is closed up and prepared for flight or in flight.

4.3.5.1 Temperature

The aircraft environmental system should provide a cargo compartment temperature above freezing (0 °C or 32 °F) when measured in any part of the loadable volume.

4.3.5.2 Pressure

The aircraft and its environmental system should be capable of providing a pressure altitude for the cargo compartment of 5 486 m (18 000 ft) when the aircraft is at maximum cruise altitude. Customer requirements may, however, specify a lower cargo compartment pressure altitude suitable to the carriage of a greater spectrum of cargo/commodity types, and the flight station may be separated from the cargo compartment for pressurization.

4.3.5.3 Venting and circulation

Ventilation and circulation requirements should be determined by the spectrum of cargo to be carried; for instance, inert cargo requires no ventilation whereas live animal cargo (if a customer requirement) requires a ventilation rate of up to one air change every three minutes. The circulation capability should assure that there are no static air pockets in the cargo compartment.

4.3.5.4 Vibration/Shock

The cargo compartment and equipment should be designed to withstand vibration levels of 4 mm (0.15 in) from 5 Hz to 1 000 Hz with a maximum acceleration of 20 m/sec^2 (2 g).

4.3.5.5 Noise

The cargo compartment should have sufficient soundproofing to provide adequate noise protection for the types of cargo to be transported for a given length of flight time.

4.4 Reliability/maintainability

System reliability and maintainability should provide for high equipment availability.

4.4.1 Replacement times

When a failure occurs, the replacement time for repetitive high usage items including components per 4.1.2.9 should not be more than 10 min. Major low usage items should be capable of replacement in 30 min.

4.4.2 Service life

The major onboard components of the system, based on expected operational usage, should have a service life equivalent to the aircraft airframe service life. Service components including components per 4.1.2.9 having a high frequency of use and exposure to fatiguing impacts, such as latching devices, restraint fittings, guide rails, etc., should have a design life expectancy of five years.

4.4.3 Maintenance tools

Assembly, disassembly, and maintenance (including servicing) should be accomplished with general purpose tools and equipment normally and commercially available.

4.5 Convertibility

Equipment provided to handle and restrain optional ULD's and/or outsize cargo should be capable of quick erection/installation. Where applicable, this equipment may be kit installed. Auxiliary equipment in place should not limit handling and restraint of basic ULD sizes. If a non-standard gauge option is exercised, the system should be able to accommodate a stick composed of a mixture of basic and optional ULD sizes.

4.6 Safety

Safety of personnel, the aircraft, and the cargo must be given prime consideration in the layout, design, and operation of all cargo handling and cargo compartment features and equipment.

4.6.1 Personnel

Provisions for the safety of personnel should be incorporated with regard to anticipated operating conditions and the capabilities of the operating personnel. Especial care should be exercised to make safe the performance of necessary tasks by personnel working at or across the threshold area(s) and at the interface with ground loading equipment. Applicable current personnel safety regulatory standards shall be met.

4.6.2 Cargo monitoring

The capability to monitor the security of cargo at all times when onboard the aircraft should be a basic provision. Sub-clause 4.2.9 covers the access, inspection, and verification of the integrity of the cargo with respect to its restraint and containment. The monitoring of the security of the cargo should also encompass, by direct or remote means, a surveillance of its well being with respect to environmental and other conditions.

4.7 Detail design

The following design guidance provides further product definition in those areas where sufficient knowledge exists to offer same.

4.7.1 General design considerations

The following design parameters should apply to all onboard cargo handling equipment components.

4.7.1.1 System components

The system components should be minimum weight, simple, rugged, and low cost.

4.7.1.2 Environment

The system should be capable of operating under the following conditions :

a) temperature range from −32 °C* to +60 °C (−25 °F to + 140 °F);

b) relative humidity up to 95 %;

c) exposure to salt-sea atmosphere;

d) vibration incident to service use;

e) sand and dust particles as encountered in desert areas;

f) exposure to rain in cargo door area.

g) ice and snow in cargo door area.

4.7.1.3 Impact loads

System components should be capable of withstanding impact loads resulting from rough handling. ULD's moving at speeds up to 18 m (60 ft) per minute should be considered unless speed limiting devices are used.

* Where application includes an arctic environment, this figure should be changed to −54 °C (−65 °F)