PART 1

GENERAL TECHNICAL SPECIFICATIONS

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PART 1 - GENERAL TECHNICAL SPECIFICATIONS

1. PROJECT PARAMETERS

1.1 PROJECT SCOPE AND DESCRIPTION

1.1.1 GENERAL

The Material Handling System (MHS) to be designed, built and supplied by the Contractor shall be situated in a new Airfreight Terminal building to be built at KFIA Airport in Dammam. Primarily, the MHS shall provide mechanized capability for the Company to process unitized loads and loose freight.

1.1.2 SITE ACCESS

Due to the building construction requirements, the Contractor access shall only be available according to the building work schedule. Therefore, the Contractor shall coordinate closely with the Project Manager/Architect/Building Contractor in this regard. Access to the facility for the installation of the MHS need to be shared with other contractors.

1.1.3 BUILDING INTERFACES

Provisions for equipment trenches and cutouts, floor loading and electrical power distribution have been established in the proposed MHS layout required and incorporated into the building plans. The Contractor, however, retains responsibility for the Material Handling Systems, necessitating coordination of his detail design with the Final Architectural structural and with the "as built" condition of the facility, in close coordination with the Project Manager. (Should there be any additional building requirements or changes to what was reflected in this Contract Document, the Contractor is responsible to highlight in its tender submission. Otherwise, it shall be deemed that the building provisions indicated here are adequate for the MHS installation and operation by the Contractor).

1.1.4 COORDINATION

The Contractor shall be fully responsible for the coordination of his work with that of the Project Manager and other Building or Equipment Trades to ensure a smooth sequential installation in accordance with the Project time table. Phase 1 of the Building shall be handed over before the completion of the building for the installation of equipment for the international cargo.

1.1.5 LOCAL SITE CONDITIONS

Contractor shall deem to be fully aware of the local site conditions especially in terms of the use of local labour, power/water supply and the local weather conditions. The MHS shall be designed and install taking into consideration all the local factors. Cleanliness shall be maintained at all times throughout the entire project duration and the MHS shall be delivered in a broom-clean state for acceptance by the Company.

The handover for MHS installation shall come with a roof and a floor ready to take the

loadings from the MHS equipment. The Contractor may be required to start partial work prior to the roof being ready. However, permanent power supply may not be available until User Acceptance Testing (UAT). Therefore, Contractor is expected to provide its own temporary power to execute its work at no cost to Company up to the start of UAT.

1.1.6 SPECIFICATIONS

The Contracto shall be responsible for the design and build of a turn-key, functioning system, which complies with the foregoing and all other requirements contained within the specifications.

1.2 RESPONSIBILITIES OF THE CONTRACTOR

1.2.1 PRIMARY

The Contractor shall be responsible for designing, fabricating, finishing, marking, shipping, unloading, staging, installing, leveling, anchoring, wiring, touching-up, debugging, testing and turning over in good working order all components of the Material Handling Systems described herein.

1.2.2 SUPPORT

In the course of accomplishing the above, the Contractor shall be responsible for Insurance and Bonds, Authority submittal and approval, program management, scheduling, status reporting, drawing organization/submittal and approval, site supervision, security, coordination with other construction activity, housekeeping, delivery of maintenance and operating manuals, training, punch list recovery, commissioning date achievement, warranty servicing and spare parts availability.

1.2.3 FUNCTIONS

Ultimate responsibility for ensuring that the MHS and its components function as described herein shall reside with the Ec including ensuring that the equipment is compatible with the as-built condition of the building, and that the equipment is suited to the rough and abusive environment of a cargo handling operation. All material and equipment provided shall be able to withstand usage typical of an air cargo terminal environment, including use and abuse under circumstances which may be considered abnormal but not intentionally destructive.

1.2.4 AVAILABILITY

The Contractor shall endeavor wherever possible to utilize purchased components from locally available supply.

1.2.5 OTHER

1) All necessary protection against damages or loss to equipment (whether installed or brought on site) shall be carried out by the Contractor.

2) The Contractor must alter and adapt the protection carried out by them to accommodate and suit the Main Contractor’s sequence of works as and when required should the protection interfere with the Main Contractor’s work.

3) The Contractor shall be fully responsible to make good any damages caused by Contractor and/or reimburse the Company for any expenses incurred to rectify

any damages on his behalf.

4) The Contractor shall submit for approval, by the Company and/or the Project Manager/Architect, his proposed access route, sequence and method of work, and protection measures to the Main Contractors work, at least 2 months before the date of the equipment delivery to the site.

5) The Contractor shall work closely with the Project Manager to ensure that the delivery, installation, testing and commissioning suit the Main Building Contractor's program of work.

6) All attendance, e.g. power (excluding power for testing and commissioning), temporary light fixtures, wiring, water, hoisting facilities, covered storage, scaffolding, temporary staging/platforms, insurance for loss and damages, temporary protection, security, toilet facilities, etc, shall be the responsibility of the Contractor, including periodic cleaning and clearing off-site empty crates, debris, unwanted materials or waste.

1.2.6 MISCELLANEOUS

The Contractor shall (at its own costs):

1) Attend weekly site meeting for site coordination or when and as required.

2) Provide, check and verify the exact location, sizes, and allowable tolerances of all pits, trenches and floor openings required for MHS equipment prior to casting of concrete by Building Contractor and subsequently upon completion of casting.

3) Confirm and formally accept, in writing that the areas handed over for MHS equipment installation are in appropriate condition. This may include but is not limited to photographic recording of the area.

4) Submit project schedules and project status reports on a regular basis for review by the Company or the Project Manager (including photos to show the physical work done on and off-site wherever necessary).

5) Do all possible in order not to hinder, obstruct, or delay the Building Contractor in any way.

6) Report immediately any damage or loss done to the Building structures, services or finishes.

7) Carry out and take his own site survey, levels and dimensions at the site for the MHS installation purposes. Any setting out and survey information provided by any other source shall be used for information only.

8) Perform daily cleaning and housekeeping functions to the satisfaction of the Project Manager.

9) Submit calculations from the Contractor's own Registered Professional Engineer to verify the loading of MHS equipment, hoisting equipment scaffolding and staging, etc., on the existing structure to any relevant local authorities for certification, approval, licensing, etc, if necessary

10) Coordinate closely with the Project Manager and Building Contractor on all

building interface issues like casting in of electrical, control and hydraulic pipe conduits for pit equipment, pit trims and protectors, etc, as applicable.

11) The EC shall design a Engineering Change Request (ECR) form upon Contract Award. This form shall be used by the Contractor whenever he believes there is a requirement for engineering changes to the original Contract documents, specifications and/or the Tender's proposal. The ECR shall contain, at a minimum, the change requested, the reason for the change, the cost or saving involved, the functions/equipment and schedule affected by the change. The ECR must be approved by the Company before action is taken and in no case does such approval relieve the Contractor from his overall responsibilities for the performance of the system/equipment supplied.

The Contractor shall not:

11) Hack or drill any holes or openings in the building structure without approval from the Building Contractor. Any requests for hacking or drilling shall be submitted by the Contractors own Registered Professional Engineer, but subject to approval and/or change by the Company and/or his Engineer and the Project Manager.

12) Load any concrete structure, which has not achieved maximum strength without the Company's Engineer's approval.

13) Store materials on site in areas other than those allocated to the Contractor without prior approval by the Company.

2. GENERAL REQUIREMENTS

Unless otherwise specified, the following general and technical requirements shall apply to all elements, components, and subsystems comprising the MHS.

3. SERVICE CONDITIONS

3.1. GENERAL CONDITIONS

The elements, components, subsystems and systems included herein shall be designed to function in a warehouse/air cargo terminal environment. The nature of this type of operation demands rugged, impact-resistance hardware whose functions and controls shall be foolproof and failsafe, consistent with the anticipated level of unskilled labor (see also paragraph 1.2.3 above).

3.2. OPERATING ENVIRONMENT

The Design of the System, subsystems, assemblies and components shall consider the operational environment in which they are intended to function. Ease of operation and the level of supervision required to support the work force shall be considered. Control of powered components shall be consistent between elements to standardize their operation. Control elements shall employ nomenclature and symbols readily understandable by the potential operator in the job-site environment. best possible operational and maintenance access shall be ensured to optimize operating time and minimize the down time required to effect repairs.

3.3. ENVIRONMENTAL REQUIREMENTS

Each element of the MHS system shall be designed, built and installed according the local operating environment it is subjected to.

3.4 RF INTERFERENCE

The use of any Radio Frequency devices and systems shall come with applicable approval from all the relevant. The use of such system shall in no way interfere with any MHS equipment or building facilities installed

3.5 IDENTIFICATION PLATES

Each equipment item/section shall be permanently labeled or marked for easy identification by operators and maintenance staff. Each conveyor number shall be carefully and neatly painted or stenciled in contrasting color, 100 mm in height, in a conspicuous location adjacent to the conveyor drive or in other locations approved by the Company and in a form and style approved by the Company before fabrication and installation.

3.5.1 SAFETY, MARKING & STRIPING

Black and yellow diagonal safety striping shall be applied to components that must visually warn operating personnel of potential danger. Warning (including both audio and visual forms where applicable or as specified in other parts of this specification) and caution signage and markings shall also be applied where potential danger exists including load units, high voltage, vehicle aisles, etc.

3.5.3 COMPONENT AND SUBSYSTEM NUMBERING

Any and all equipment numbering schemes shall be subject to approval by the Company. The Contractor shall propose a numbering scheme for the equipment, inclusive of diagrams, for review and approval by the Company prior to the finalization of equipment design.

3.6 ROLLER FINISHES

Conveyor rollers shall be adequately treated with anti-rust coatings and finished coats to meet the operating conditions of the equipment especially those which will be exposed to external conditions outside the warehouse

3.8 RELIABILITY AND LIFE EXPECTANCY

The required reliability of each subsystem and component is delineated in its respective specification. The following definitions of the principal terms used in these specifications shall apply:

3.8.1 MHS SYSTEM RELIABILITY

Reliability requirements of the MHS will be measured in terms of "Availability" (A) of MHS. Availability of the MHS is determined on a subsystem basis from the following definitions and formula:

3.8.1.1 Failure: A failure is defined as any malfunction of a MHS component, assembly, or subassembly which stops normal operations. A failure shall be charged against only the one subsystem which causes that failure. The following shall not be classified as failures:

- Malfunctions due to causes outside the MHS such as sabotage, general power outage, etc.
- Incipient failures, which are detected and repaired without affecting normal operation of the MHS.
- Malfunction of one of backup where the repair time does not affect normal operation of theMHS.

3.8.1.2 Scheduled Operating Time (ST): The scheduled time that the MHSis available for cargo processing (normal 24 hours per day).

3.8.1.3 Repair Time (RT): The interval of time between initiation of repairs and return of the MHSto operation.

3.8.1.4 MHS System Availability (A): MHS System availability is defined as follows:

$$A_S = ST\text{-}RT/ST$$

3.8.1.5 Each subsystem of the Material Handling System shall have an availability of not less than 0.99 for the first 30 days of full operation by the Company. After 30 days and within three months of completion, each and every subsystem in the MHS shall reach a system availability of not less than 0.995.

3.8.1.6 There will be liquidated in the amount below for failure to meet the above:
The penalty for not meeting the above will be 0.25% of the contract cost for each percentage point below the serviceability level standard up to a maximum 1.5% of the total contract cost.

3.9 MAINTAINABILITY

Maintainability shall take priority in the design of the MHS so as to minimize downtime in order to attain the above system reliability. Good maintenance provisions shall include but not limited to:

3.9.1 Provision of adequate maintenance access for maintenance personnel (e.g. removable covers, maintenance ladder/platform/railings). If the cover is too heavy to be removed by one person then hinged cover shall be provided;

3.9.2 Ease of replacement and trouble-shooting for all components requiring periodic change, maintenance without obstruction from fixed structures/frames or other non-related components, etc;

3.9.3 Convenient power sockets and plug-in type of electrical relays (with status indication) shall be provided inside all motor control panels;

3.9.4 Maintenance struts to provided for lifting equipment

3.9.5 Display of key schematics/diagrams on site to aid maintenance work;

3.9.6 Lifting and towing points and accessories, etc;

3.9.7 All components should be accessible and safe and easy to remove.

3.10 CODES AND SAFETY

3.10.1 MHS SYSTEM AND OPERATIONAL SAFETY

All control methods, circuitry, mechanical equipment and operating procedures shall be designed to provide maximum safety for operating personnel, minimum possibility of damage to ULD/cargo and convenient access to Emergency stops, etc. Designs shall incorporate for examples, failsafe principle and idiot-proof operating concept whenever possible, which could also handle equipment failure or improper equipment operation. Potential hazards to working personnel, resulting from moving equipment within manned or potentially manned areas of the warehouse shall have both audible and visual warning signals to warn personnel. In addition, the Contractor shall ensure that any potentially unsafe condition at MHS System/Building interfaces are rectified to the reasonable satisfaction of the Company, the cost of which shall be borne by the Contractor, regardless of whether such safety provisions are shown or mentioned in this tender document.

3.10.2 AUTHORITY REQUIREMENTS

All installed equipment shall meet all applicable safety requirements and other laws and regulations prevailing in India regardless whether these are described in this document. The costs of obtaining all such approval, licenses and certifications shall be the responsibility of the Contractor. This shall apply throughout the 24-month warranty period too.

3.10.3 MAINTENANCE SAFETY

The MHS design shall provide adequate means for ensuring the safety of maintenance personnel. Devices such as disconnect switches and lockouts shall be provided to prevent the accidental activation of those portions of the system shut down for maintenance.

3.11 INSTALLATION HARDWARE

The Contractor shall supply all the necessary equipment supports, chemical anchors, curb guards, pit frames, and rails, to permit the complete installation of the equipment and components.

3.12 GROUTING AND FINISHING

The Contractor shall be responsible for all finish grouting required by the installation of equipment or structures.

After anchoring, all building surfaces and elements shall be returned to their original finished conditions.

3.13 FACILITY INTERFACE

The Contractor shall be responsible for all interfaces between the MHS and the Facility. Special care shall be expended in the area of MHS system door penetrations and clearance from obstructing building structures like columns, ceilings and beams, etc, as well as M&E installations (e.g. fire sprinkles and lightings, etc). The Contractor shall ensure proper MHS system function and safety at these interfaces, while providing adequate clearance for full door closure and from adjacent columns, ceilings and beams as well as M&E installations. The Contractor shall ensure MHS system alignment and adequate equipment/ULD clearance when installed in the finished facility for safety and operational requirements. The Contractor shall be responsible for coordination of the MHS system design with the "as built" condition of the facility as identified in site visits prior to fabrication and/or installation (see also paragraph 3.4 and 3.10 above).

4.1 OTHER DESIGN REQUIREMENTS

4.1.6 STRUCTURES

All structures required be capable of supporting the total complement of elements, each filled to its maximum load capacity specified. The structure shall be stable and safe under maximum dynamic loading conditions. Individual element support connections shall be designed for a maximum load consisting of the element's weight plus full live load and an applicable safety factor.
In addition all structures shall be designed for dynamic loads, which include but not limited to equipment vibratory motion and side loads resulting from the transfer of cargo, contact with stops, stop retractors and friction drives, and the possible impact from ramp vehicles or material handling equipment (which include dollies, tractors and forklifts, etc).
The design of any structure shall comply with all local authority requirements, and in its absence, the applicable codes and practices in the industry.

4.1.7 LADDERS, STAIRS, PLATFORMS, AND HANDRAILS

Ladders (with back protection), stairs, platforms (with toe plates), and handrails shall be furnished by the Contractor wherever necessary to provide convenient access and good safety for both operational and maintenance purposes, even though this may not be specifically indicated on the attached layout drawing(s) or any part of this Contract Documents, and shall comply with all local authority requirements.

4.1.8 ELECTRICAL SYSTEM

4.1.9 POWER SUPPLY

The electrical system shall be designed in accordance with the local requirements on power supply and to cater to the expected voltage fluctuation (if any) that is experienced on site. The design shall provide standardization of components, function and maintenance procedures.
The Contractor shall provide all necessary conduits, fittings, wire, cabling/wiring, to tap power from the incoming power panels to be provided by others.

4.1.10 MOTOR CONTROL PANELS

4.1.10.1 The MCP shall be placed nearby or besides the group of equipment it is controlling. The MCPs shall be located with sufficient clearance from bypassing ULDs and

warehouse traffic and pose no danger to the personnel accessing the maintenance control panels mounted on the outside of the MCP doors.

4.1.10.2 The MCP door shall have a manual over ride provision to permit opening of door by qualified personnel with the power on. In addition, all live cables/wires shall be protected to prevent accidents.

4.1.10.3 The interior of the MCP shall be well lighted upon opening of door(s) (lights off when door closed) and the interior temperature shall be maintained at suitable level for prolonged and lasting operation of the MCP components enclosed inside via adequate cooling fan(s) with removable filter(s). Cooling fan(s) shall be turned off when door is opened. Lighting and power socket requirement should also apply to Operator and Maintenance cabinet.

4.1.10.4 AC and DC components/live cables shall be clearly labeled and separated. Preferably wire color used inside the MCP for AC and DC should be different.

4.1.10.5 Each Motor Control Panel shall be clearly and prominently identified to indicate the group of equipment belong to it.

4.1.10.6 Standards: Ensure that all Motor control equipment complies with applicable standards and codes. Where such codes and standards are not available, the following U.S. codes and standards (or their latest revision) shall apply: NEMA Standard ICS-1, ICS-2, UL publication 845 and other applicable standards of NEMA, UL, IEEE, ANSI, NEC and National Electrical Safety Code.

4.1.10.7 The isolator for the MCP should come with provision for padlock to lock out the panel in case it is required to ensure power is not available to the equipment.

4.1.10.8 Pockets shall be provided on MCP doors for the placement of electrical manuals and a swing table for placing the drawings.

4.1.10.9 MCP electrical drawings should include earthing points as well as looping wires.

4.1.10.10 The wiring for electrical outlet and lighting should be separated from the other circuits. electrical isolation of the other circuits should not affect this circuit. When the MCP isolator is off the lighting and power outlets should still be available.

4.1.11 FIELD WIRING

The Contractor shall supply all the necessary metal trunkings, conduits, fittings, wires and wiring from power distribution points provided by building contractors to the equipment and shall be responsible for all electrical and communication interconnections within the equipment.

Electrical supply lines shall be provided with disconnects that can be locked in the 'OFF' position with a single padlock.

All field run wiring shall be encased in standard rigid metal conduit. Final connection to motors, interlocks, limit switches, photosensors and other type of control sensors requiring periodic adjustment shall be in armored flexible conduits. All exterior wiring shall enclosed in waterproof casings There shall be 20% spare wires for all electrical multicore cables. The cores in the cable should come ready numbered from the supplier so that ends of the cable can be identified easily.

Wiring circuits for Emergency stops should not be looping. Each Emergency stop should

have its own wiring.

All cables gorups shall be labelled and each individual wire labelled with the terminal/component connection number or alphablet.

4.1.12 WIRING AND ELECTRICAL/CONTROL COMPONENT IDENTIFICATION

Component and Console wiring shall employ a uniform wire marking system throughout, indentifying wiring terminations (e.g. via cable sleeves) and all electrical/control components to permit rapid and effective tracing and trouble shooting. Furthermore, all wiring used for field devices shall be identified with a two letter prefix code on the wire marking identification, indicating field device type (i.e., PE-Photoelectric cell, LS-Limit Switch, PS-Proximity Switch, etc.). The wire markings in junction boxes shall indicate the terminal numbers to which the wires are to be connected. Similarly for all connections to sensors, motors etc. Maintenance Manuals shall fully reflect same markings to minimize maintenance time and effort.

In addition within the operator control panels and main control panels each individual wire shall be lableed with the terminal number it is connected to wither terminal bock of device/component.

4.2 ELECTRICAL HARDWARE AND SOFTWARE TECHNICAL SPECIFICATIONS

4.2.1 FUNCTIONAL AND OPERATIONAL REQUIREMENTS

4.2.1.1 The Programmable Logic Controller (PLC) shall have individual power supplies with built-in indication. It should be of modular design with a basic rack. Furthermore, expansion should allow for the use of an extension rack. The input and output modules shall be of the slot in type, which can be slot in and out of rack easily. All other add on modules shall also be of the slot in type.

4.2.1.2 The PLC shall have all the basic functions and shall include:

- Programming port
- Serial Link

4.2.1.3 The input and output modules shall be equipped with isolation from external source.

4.2.2 HARDWARE

4.2.2.1 The PLC shall be able to operate in a temperature of up to 60 degrees C (min) and relative humidity up to 98% or the highest local temperature and humidity, whichever is highest.

4.2.3 SOFTWARE

4.2.3.1 Software must be fully documented and all Input/Output, Timer, Memory variable, etc., must be identified.

4.2.3.2 Each software module must be accompanied by a short description on the functions of the software. Functions of I/O Points, Timer, Memory variable must be provided.

4.2.3.3 Clear and meaningful comment line(s) in English are required in the program.

4.2.3.4 All software must also be accompanied by detail Software flow-chart.

4.2.3.5 The software should be stored into a EPROM.

4.3 MECHANICAL HARDWARE

4.3.1 Please note that only AC motors shall be provided, which could give smooth acceleration and deceleration (adjustable) throughout the speed ranges.

4.3.2 Every electric motor shall be equipped with an isolation device.

4.3.3 All electric motors shall be provided with ring-bolts attached to the motor to facilitate maintenance.

4.10.4 All electric motors shall be equipped with provision to release its brake by a lever. EC to supply 10 levers for use with all its powered roller deck motors, whereas for bigger motors, each shall have its brake release levers attached (clipped) directly onto the motor itself. For big motors indication of brake release is required.

4.4 MOVEMENT

4.4.1 All equipment speeds shall conform to the requirements specified in other parts of this specifications. Acceleration and deceleration shall be smooth without jerkiness. The transfer of a load between two powered elements shall occur at the same linear speed to prevent scuffing and/or skewing. Moving parts reaching the end of their travel shall cut off automatically to prevent impact with frame of stop. The design of all drives, guides and stops shall minimize wear and damage to the Unit Load Devices (ULD).

4.4.2 CLEARANCES

4.4.2.1 The Contractor shall be responsible to ensure all structure and component designs shall allow for providing adequate clearance for the smooth, safe and efficient operation of the MHS by locating each element in its necessary position within location and level tolerances required for system function. The attached MHS layout plan serves as a reference for the Contractor's consideration in this respect. Equipment Structural framing shall not encumber unitized load flow; shall provide adequate clearance for the passage and flow of each specified load; and shall not inhibit access for personnel, should an operational or maintenance problem arise requiring such access. The Contractor is ultimately responsible to determine the right clearance for safe operation regardless of whether such clearance has been indicated in the Contract Document.

4.4.2.2 Sufficient clearances shall be provided for all equipment conveying ULDs to prevent hitting of stoppers and collision with other ULDs. Sufficient tolerance shall be provided for small protrusion ULDs due to cargo or plastic sheets.

4.5 SENSORS

4.5.1 Sensors shall be of the photocell, proximity or limit switch type (unless specified otherwise) and shall indicate a reliable life of over 10 million cycles, and be repetitive and unaffected by environmental conditions such as rain, ice, cold, heat, dust, mist, fog and sunlight. Provisions shall be made to effectively accomplish the sensing of a required

edge or surface of any of the specified ULD including surfaces of cargo shipments, which project beyond the pallet base. Sensor installation shall provide protection for both the sensor and its associated wiring. Care shall be exhibited in the mounting of the sensor and its control wiring to minimize the damage due to moving of loads, contact with associated components or by personnel working on or in the vicinity of the MHS. Sensors on roller decks to sense ULDs shall be slot-in type with a clearly visible status indicator for ease of maintenance.

4.5.2 All roller deck sensors shall come with dust (protective) covers.

4.5.3 The Contractor shall be responsible to design, supply and install adequate sensors with the appropriate functions to ensure the smooth, reliable and accurate tracking of ULD movements in the MHS system as well as to maximize the storage/queuing of ULDs (e.g. on the airside & landside powered conveyors).

4.5.4 Where photoelectric sensors used for ULD sensing are mounted on the walkways, the area immediately surrounding each cut-out shall be painted with yellow paint (for short-range sensors) and blue paint (for long-range sensors) to enable operational staff to identify sensor range.

4.6 STOPS

4.13.1 The Contractor shall be responsible to design, supply and install adequate stoppers besides those specified herein, if necessary, to ensure operator safety and shall minimize the risk of interference with ULD movement (including pallet nets, etc), while at the same time ensure the MHS can function as intended.

4.13.2 Stops shall be capable of restraining a 6800 kg ULD traveling at 18 or at speed of rollers mpm in a slightly skewed condition with no permanent deformation or loss of function. The stop's sections shall be no less than 13 mm thick and provide a minimum restraining height of 60 mm above the support surface.

4.13.3 ULD stops must be strong and rugged and able to restraint slightly warped ULD bases, which is the norm in any airfreight terminal.

4.13.4 All stops shall be painted with safety yellow paint for ease of identification by operators.

4.13.5 Stoppers shall be equipped for manual release by means of lever. (lever to be provided by Contractor)

4.13.6 SPRING RETURN

All stops defined as having spring return shall have this action imparted through gas cylinder springs, which shall be capable of independently returning the stop. Mechanical spring is not allowed to be used.

4.14 FULL WIDTH ROLLERS

4.14.1 GEOMETRY

Full width rollers shall be a minimum of 127 mm (5 inches) diameter, spaced 305 mm (12 inches) maximum on centers.

4.14.2 BEARINGS

Full width rollers shall be mounted using sealed for life, unit bearing assemblies to minimize rolling resistance and simplify installation and replacement. Bearings shall have a minimum rated capacity of 450 kg (1000 pounds) each and shall be sealed.

4.14.3 SIZE

Roller wall thickness of standard rollers shall be adequate to support the intended functions while the roller thickness of lead rollers shall be greater than that of standard rollers. The roller wall thickness shall provide adequate stiffness and strength to withstand normal wear and tear as well as to prevent permanent deformation and eccentricity over its lifespan of at least 15 years.

4.14.4 AXIAL LOADS

Wherever rollers are subject to significant axial loads such as on vehicles and right angle decks, roller shafts shall be positively retained against inner races by locking collars or equivalent. Bearings shall be rated for such axial loading, and the use of pressed steel bearing retainer plates shall be prohibited.

4.14.5 CHAIN CONNECTIONS

Roller decks either self powered or friction driven shall have every roller chain coupled. Chain coupling shall allow for tension adjustment at lowerable workstations. Chains and sprockets shall be rated for maximum drive forces.

4.15 MAINTENANCE AND PROTECTION

All unitized load drive components including motors, reducers, brakes, clutches, sprockets and chains shall be easily accessible by maintenance personnel for inspection, troubleshoot, lubrication and replacement tasks by employment of removable covers (able to be handled by one person) and include use of “chuck-key” locks so as to facilitate easy disengagement of motors/brakes, etc. from chains to free rollers for maintenance purposes. Wherever possible, motor/electrical terminal boxes shall be externally located to facilitate ease of maintenance. Protection of such elements from impact, tampering, dirt, debris and for personnel safety shall be provided. At places where maintenance access is difficult due to height or space constraints,

4.16 FUNCTIONAL SURFACE WALKWAYS

4.16.1 All walkway/functional surfaces shall contain non-skid walk surfaces and be flat and continuous, whenever possible.

4.16.2 No oil-can effect shall be allowed under normal personnel traffic.

4.16.3 Gaps, catching or pinching points, if any, shall be eliminated.

4.16.4 In the event that walkway covers are used to protected components within, these shall be rugged, non-skid and easily removable to provide convenient maintenance access.

4.17 BUMPERS & OTHER FORM OF PROTECTION

Bumpers or other forms of protection shall be furnished on the elements of the MHS as required

by the system, subsystem, and component specifications or by required function. Rubber bumpers or other forms shall protect equipment, cargo, ULDs and personnel from the impact loads, and excessive noise, which may result from normal MHSoperation. Design shall not require replacement of rubber bumpers or such protective devices at intervals of less than three (3) years.

5.0 DESIGN REVIEW PROCESS

5.1 Upon tender award, the Contractor shall immediately commence its design activities in order to start the design review process with Company soonest possible.

5.2 The Equipment shall schedule a series of design review meetings to complete the design review of all equipment subgroups and obtain Company's approval prior to fabrication.

5.3 The Contractor shall submit its detailed design drawings and specifications at 2.5 weeks prior to each design review meeting. Any late submission by Contractor shall postpone the design review meeting dates by the corresponding number of days at the cost of the Contractor and without any extension of the completion/acceptance dates for the MHS.