eGSE America: Electric Aircraft Cargo Conveyor (EACC) Technical Specifications

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Electric Transportation Applications

1.0 SCOPE:

This document outlines the design and performance requirements for a battery-powered, self propelled belt conveyor for handling baggage and cargo at aircraft bulk cargo holds. The use of “shall” in this document indicates a mandatory requirement. The use of “should” indicates a recommendation or that which is advised but not required.

2.0 APPLICABLE DOCUMENTS:

Portions of the following documents to the extent specified herein are a part of this Recommended Practice.

ASME/ANSI B56.9-1992 (Reaffirmed 2000)	Safety Standard for Operator Controlled Industrial Tow Tractors
ANSI/NEMA No. 250-1997 (AUG01)	Enclosures for Electrical Equipment (1000 Volts Maximum)
CiA Draft Standard Proposal 418 (OCT02)	CANOpen: Device Profile for Battery Modules
CiA Draft Standard Proposal 419 (JAN03)	CANOpen: Device Profile for Battery Charger
IWC Report Final Draft (APR02)	National Infrastructure Working Council (IWC) Non-road Fast Charging & Connectors Sub-Committee Report: Electric Ground Equipment Conductive Fast Charge Specification
MIL-STD-461E (AUG99)	Electromagnetic Interference Characteristic Requirements for Equipment
NFPA No. 505 (AUG02)	Standard for Use, Maintenance and Operation of Industrial Trucks. Fire Safety for Powered Industrial Trucks
SAE ARP1247 Rev. C (DEC98)	General Requirements for Aerospace Powered Mobile Ground Support Equipment
SAE ARP1328 Rev. A (DEC97)	Aircraft Ground Support Equipment Vehicle Wind Stability Analysis
SAE AIR 1375 (JUN00)	Minimum Safety Requirements for Special Purpose Airline Ground Support Equipment
SAE AIR 1558 (SEP97)	Interface Protective Devices – Ground Equipment to Aircraft
SAE ARP1817 Rev. A (MAR98)	Batteries for Battery Powered Ground Support Equipment
SAE ARP 1836 (REV.A, DEC94)	Aircraft Cargo Conveyor – Battery Powered

SAE AIR 1838 (DEC99)	Pictograms for Ground Support Equipment
SAE ARP 1892 Rev. C (TBD05)	Electrical Connectors for Use in Battery Powered Ground Support Equipment
SAE AIR1898 Rev. A (DEC98)	Maintenance of Batteries and Battery Charging and Servicing Facilities
SAE AS4828 (JUN02)	Technical Manual Development for Ground Support Equipment
SAE J163 (JAN01)	Low Tension Wiring and Cable Terminals and Splice Clips
SAE J377 (FEB87)	Performance of Vehicles Traffic Horns
SAE J551-1 (JUN96)	Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles and Devices (60 HZ to 18 GHZ)
SAE J551-12 (SEP96)	Vehicle Electromagnetic Immunity – On-board Transmitter Simulation
SAE J561 (JUN93)	Electrical Terminals – Eyelet and Spade Type
SAE J858a (AUG69)	Electrical Terminals Blade Type
SAE J1127 (MAY00)	Battery Cable
SAE J1128 (MAY00)	Low Tension Cable
SAE J1654 (MAY00)	High Voltage Cable
SAE J1673 (JUL96)	High Voltage Automotive Wiring Assembly Design
SAE J1690 (AUG96)	Flashers
SAE J1742 (MAR98)	Connections for High Voltage On-Board Road Vehicle Electrical Wiring Harnesses Test Methods and General Performance Requirements
UL 583 (9^{th} Edition, JUN96) (Including Revisions through JUL99)	Electric-Battery-Powered Industrial Trucks

3.0 DESIGN REQUIREMENTS

3.1 General Requirements

3.1.1 The cargo conveyor shall comply with all performance requirements over the full range of environmental factors specified in SAE ARP 1247, Paragraph 3.6.

3.1.2 The cargo conveyor shall comply with the requirements of SAE ARP1328.

3.1.3 The cargo conveyor should comply with the requirements of NFPA 505 and UL 583 for Type E, ES, EE or EX vehicles. Manufacturer shall specify whether the cargo conveyor meets the requirements of Type E, ES, EE or EX.

3.2 Electrical System

The electrical system shall consist of an appropriate size and type traction battery pack powering a compatible electric motor(s) through an electronic controller(s) to produce smooth acceleration and operation. Traction battery voltage should reflect the best design for duty cycle, vehicle speed, tractive effort and minimum current losses. The traction battery charger shall be appropriately selected to properly charge the traction battery and meet the requirements of the particular application.

3.2.1 Traction Battery

3.2.1.1 The traction battery should comply with the requirements of SAE ARP1817. A single battery should be provided of size and capacity to satisfy performance and accessory requirements. Operational characteristics should also be considered when selecting the proper battery, such as the average amp-hour draw, any non-gassing requirements, available maintenance personnel and facilities. The vehicle manufacturer shall provide the battery manufacturers specifications including the one hour and three hour discharge rating of the traction battery (in ampere-hours) and shall specify the operating time (in hours) which the battery will support based on the conditions as specified in section 4.8a & b.

3.2.1.2 Means of restraining the traction battery in the lateral and longitudinal directions shall be provided.

3.2.1.3 Vehicle manufacturer should supply battery manufacturers recommended traction battery charging algorithm

3.2.1.4 Vehicle Manufacturer should supply traction battery maintenance requirements

3.2.1.5 Vehicle Manufacturer shall indicate the depth of discharge below which the traction battery should not be discharged.

3.2.1.6 The traction battery shall be protected by a cover, which shall support at least 12 lbs/sq ft.

3.2.1.7 The traction battery and traction battery compartment shall be designed such that electrolyte from the battery is captured in an auxiliary tray or the battery tray and not allowed to drain onto the ground, corrode parts of the cargo conveyor, or create acid paths for current to flow to the chassis.

3.2.1.8 Battery cable connectors shall be located such that they create no danger of igniting gases expelled during battery charging. The location should also be convenient for charging while not subject to damage during battery removal or installation.

3.2.1.9 Manufacturer shall supply an MSDS for the battery and any materials used in the cargo conveyor that would not typically be found in an automotive shop.

3.2.2 Propulsion System

3.2.2.1 The electronic controller(s) and motor(s) shall be sized for the application and shall limit maximum battery discharge as specified in Section 3.2.1.5 to prevent degradation of battery life and abrupt loss of cargo conveyor operability. Such limit shall be adjustable, repeatable, and accurate within 10% battery state of charge.

3.2.2.2 All wiring and components used in the high voltage propulsion system shall be of a "two-wire" design using an insulated return wire rather than the vehicle chassis as ground and sized in compliance with SAE J1673.

3.2.2.3 Vehicles shall not contain exposed conductors, terminals, contact blocks or devices of any type that create the potential for personnel to be exposed to 60 volts (nominal battery voltage) or greater (the distinction between low voltage and high voltage, as specified in SAE J1127). Access to any high voltage components shall require the removal of at least one bolt, screw, cover, or latch. Devices considered to be high voltage components shall be clearly marked as HIGH VOLTAGE. These markings should be installed at any point the voltage can be accessed by the end user. Additionally, cable and wire marking shall consist of orange wire and/or orange sleeves as required by SAE-J1127.

3.2.2.4 All HIGH VOLTAGE cable shall comply with the requirements of SAE-J1654. All low voltage cable shall comply with the requirements of SAE-J1127 or SAE-J1128 as applicable.

3.2.2.5 HIGH VOLTAGE connectors (except charger power supply to vehicle) should utilize latching devices to prevent inadvertent disconnection, shall be keyed to prevent mis-connection and should be moisture proof. HIGH VOLTAGE connectors should comply with the requirements of SAE-J1742.

3.2.2.6 The cargo conveyor should utilize a single speed, multi-speed automatic, hydrostatic or continuously variable transmission.

3.2.2.7 A propulsion power system operating at greater than 60 volts shall be isolated from the vehicle chassis such that leakage current does not exceed 20mA with the battery connected.

3.2.2.8 An arrangement for the controller to increase braking by changing motor field current (called "plugging" or "regenerative braking") shall be offered. Maximum regenerative braking settings shall be adjustable such that maximum current returning to the traction battery pack can be set to avoid potential damage to traction battery pack or electrical components.

3.2.2.9 If a DC traction motor is used, the motor should be accessible for brush inspection without having to remove the battery.

3.2.3 Accessory Power System

3.2.3.1 A 12 volt DC accessory power system shall be used to power the following:

a. Two sealed beam headlights on front of cargo conveyor (one each side).
b. Two tail lights on rear of cargo conveyor (one each side).
c. Two brake lights on rear of cargo conveyor (one each side).
d. Backup light(s) activated through reverse position of the directly control switch.

e. Two adjustable floodlights, one forward and one rear, shall be installed with switch on dash panel.

A combination assembly may be used to accommodate the brake and tail lights. A horn shall be supplied and should comply with the requirements of SAE J377.

3.2.3.2 The 12-volt system should incorporate a “2-wire” design using an insulated return wire rather than the vehicle chassis as ground for isolation purposes. If chassis ground is used for the 12 volt negative it shall be isolated from the traction system by at least 500,000 ohms resistance. The 12-volt system shall be powered from the main traction battery by an electronic DC-to-DC converter.

3.2.3.3 Low voltage connectors should comply with the applicable requirements of SAE J163, J561, and J858.

3.2.3.4 Low voltage wire shall meet the requirements of SAE J1128.

3.2.3.5 All electronic components shall be protected by an enclosure meeting the requirements of ANSI/NEMA 250-1997, Type 4 Enclosure.

3.2.3.6 The electrical/electronic systems shall incorporate proper shielding and filtering, to assure electromagnetic compatibility of the vehicle with any and all communication and navigation frequencies in and around the airport ramp areas in accordance with MIL-STD-461. The cargo conveyor shall not be susceptible to externally generated electromagnetic fields and shall comply with the applicable sections of SAE J551-1. Additionally, vehicles shall not be susceptible to electric magnetic fields from an on-board radio transmitter and shall comply with the requirements of SAE J551-12.

3.2.4 Battery Charging

3.2.4.1 It shall not be possible to drive the cargo conveyor when the cargo conveyor is connected to the charger.

3.2.4.2 Charging circuits shall be isolated from the vehicle chassis such that ground current from the grounded chassis does not exceed 20 mA at any time the vehicle is connected to an off-board charger.

3.2.4.3 Charge connector shall be prevented from being inadvertently connected to the controller or motor rather than the battery.

3.2.5 Electrical Systems

3.2.5.1 Electric Systems shall comply with the requirements of SAE ARP1247 Paragraphs 3.13.1.2.5, 3.13.1.2.6, 3.13.1.2.9, 3.13.1.2.10, 3.13.1.2.12, 3.13.1.2.20, and 3.13.1.2.23.

3.3 Mechanical and Hydraulic Systems

3.3.1 Design requirements as delineated in 3.13.1.1 and 3.13.1.3 of ARP1247 in particular shall be followed.

3.3.1 The cargo conveyor shall be a four wheel vehicle. Excessive steering effort shall not be required to maneuver.

3.3.2 Tires shall be heavy duty pneumatic or equivalent and selected for rated loads and speeds. Single piece rims should be provided.

3.3.3 Service brakes shall be of a dual system hydraulic design with split master cylinder and indicator light on dash to warn the operator if one system fails.

3.3.4 The unit shall be equipped with an adjustable over-center manual type hand brake with a pulling motion toward the operator engaging the brake.

3.3.5 The directional control switch shall have three positions: forward, neutral and reverse. The reverse position shall be to the front, neutral in the middle and forward to the rear. Operation shall be located to the right of the steering wheel.

3.3.6 No portion of the cargo conveyor shall contact the ground with any combination of flat tires (ref. SAE ARP1247 Paragraph 3.13.1.7.1.9).

3.3.7 The suspension system shall be adequate to prevent chassis bottoming under normal operating conditions with a full rated load (ref. SAE ARP1247, Paragraph 3.13.1.7.1.10).

3.3.8 Drive wheels shall have at least a 2.0-inch (5.08 centimetres) clearance under rated load to permit the installation of tire chains.

3.3.9 Manufacturer shall specify recommended and maximum allowable battery weight (full rated load).

3.3.10 Beginning at full charge, vehicles should be capable of operating and charging after being out of service in an ambient temperature between 40˚F and 120˚F and off charge for 16 days. No operator action should be required during this period.

3.3.11 Provisions for adjusting belt tension and alignment shall be made.

3.4 Physical Characteristics

3.4.1 Overall dimensions of the cargo conveyor shall be within 347 in (8.81 m) long and 80 in (2.03 m) wide. The cargo conveyor shall have a minimum front to rear wheel base of 110 in (2.8 m)

3.4.2 Overall height should be kept as low as possible consistent with good operation, safety, and ground clearance.

3.4.3 The manufacturer shall specify which aircraft the cargo conveyor shall be capable of servicing.

3.4.4 The turning radius as measured from the outside corner of the vehicle shall not be greater than 25 ft (7.6 m)

3.4.5 The following characteristics shall be met under normal operating conditions and loads:

a. Approach angle: 16 deg (0.28 rad) minimum
b. Ramp Breakover angle: 10 deg (0.18 rad) minimum
c. Departure angle: 10 deg (0.18 rad) minimum

3.4.6 The conveying belt shall be 24 in (0.61 m) wide. Usable conveyor bed width shall be a minimum of 32 in (0.81 m) with guides and a maximum of 40 in (1.02 m) overall.

3.4.7 The belt conveyor shall have tire tread suitable for outdoor use and all performance requirements as specified in this document.

3.4.8 The minimum ground clearance shall be at least 5 in (0.13 m).

3.4.9 The loader chassis shall have rub rails on both sides for protection against damage.

3.4.10 To minimize aircraft damage the forward end of the conveyor support structure shall be protected with a type of rubber bumper. (ref. SAE AIR1558)

3.4.10.1 First Bumper Alternative: Bumper does not extend across the front of the conveyor bed, but is mounted to the support structure on either side of the conveyor bed, reducing finger pinching hazard.

3.4.10.2 Second Bumper Alternative: Bumper is full width, 5 in (0.13 m) ID x 7 in (0.18 m) OD

3.4.11 The operator's control area shall meet the requirements as shown in Figure 1 and Table 1 of SAE ARP1836.

4.0 PERFORMANCE REQUIREMENTS:

4.1 The following performance requirements apply to dry level concrete (co-efficient of friction of 0.7 or better), with an outdoor ambient and traction battery temperature of 77°F (25°C), unless otherwise specified.

4.2. The maximum speed of the vehicle with no load shall be approximately 15 mph (24.1 km/h)

4.3 The manufacturer shall report the total distributed load capacity for conveyor angles up to 15 deg (0.26 rad), and at the maximum conveyor angle of the loader.

4.4 The manufacturer shall report the load density rating of the cargo conveyor.

4.5 Conveyor belt speed shall be manually controllable within a range of 40 to 100 ft/min (12.2 to 30.5 m/min) with any loads up to those in 4.3 and 4.4, and the controller, motor and battery shall be capable of continuous operation at the maximum speed and loads as specified in 4.3 and 4.4.

4.6 The belt drive system shall not permit a load to move more than 0 in/min in the unpowered (belt motor off) state. This condition applies to any loads up to those specified in 4.3 and 4.4.

4.7 Conveyor lift speed with no load shall be at least 25 ft/min (7.62 m/min). Conveyor lowering speed at no load shall be within 50% of lift speed; i.e., within a range of 12.5 to 37.5 ft/min (3.81 to 11.43 m/min).

4.8 The manufacturer shall report the actual operating time of the cargo conveyor prior to requiring recharging based on an operating time ratio of 1 to 3, vehicle operation to cargo operation respectively and the following conditions:

a. Vehicle Operation:

(1) Vehicle traveling with no load (except operator) at various speeds
(2) 15 full stops and starts
(3) 45 full turns per mile at various speeds
(4) Rest period of 20 min for every hour of driving

b. Conveyor/Belt Operation:

(1) Belt operating with 750 lb (340 kg) load
(2) 15 deg conveyor angle (with respect to horizontal)
(3) 75 ft/min (22.9 m/min) constant belt speed
(4) 6 full stops and starts per each simulated 20 min aircraft loading, demonstrating the service capabilities established in 3.4.3

4.9 The cargo conveyor shall maneuver at full speed without under steer or over steer. Steering effort shall not be excessive. The manufacturer shall report the turning radius as measured from the furthest protrusion at the front of the cargo conveyor. While maneuvering at minimum turning radius, the cargo conveyor shall not produce excessive tire scrubbing.

4.10 Vehicles shall be capable of completing the eGSE America Rough Road Test GTP-005 including (1) driving through two (2) inches of standing water at a speed of 12 mph without damage and without battery to chassis leakage current exceeding 20mA, and (2) standing for extended periods in extreme temperatures without damage to or failure of the vehicle or its systems. Vehicles should be capable of completing the eGSE America Rough Road Test GTP-005 without becoming inoperable. Vehicle shall be capable of completing all eGSE America tests without repairs exceeding a cumulative total of 72 hours.

5.0 BRAKING

5.1 Braking shall require a brake pedal force of not more than 100 pounds (445 Newtons).

5.2 The manufacturer shall report the service brakes stopping distance from 12 mph without load.

5.3 The manufacture shall report the service brakes stopping distance of the cargo conveyor from 6.2 mph (10 kilometers per hour) with a towed load of 25,000 pounds (11,340 kilograms) on level ground with no swerving of the cargo conveyor or jack-knifing of the load.

5.4 The cargo conveyor and towed load of 25,000 pounds (11,340 kilograms) shall be held on an incline of at least 10% (5.8°) by either the service brake or the hand brake.

5.5 Regenerative braking shall not adversely impact the cargo conveyor's braking stability, particularly on varying road surfaces.

5.6 In its most unstable condition, the cargo conveyor shall be stable in operation at inclines up to 17.5% (10°) fore and aft and 8.7% (5˚) sideways. (Ref. SAE ARP 1247, Paragraph 3.2.2.)

5.7 The cargo conveyor shall conform to the reliability requirements of SAE ARP 1247, Paragraph 3.3

6.0 OPERATOR CONSIDERATIONS:

6.1 Instruments and Controls

6.1.1 Instruments and Controls shall comply with the requirements of SAE ARP1247, Paragraphs 3.13.1.8 and 3.13.12.

6.1.2 Instrumentation shall include as a minimum a battery state of charge indicator and an hourmeter. The hourmeter shall register the operating time of the vehicle during travel

time and belt conveyor function. An indicator light for the brake system as per Paragraph 3.3.3 is required on the dash.

6.1.3 The vehicle should include a state of charge indicator for the propulsion battery. The battery discharge indicator shall include a warning device that alarms when conditions are reached as specified in 3.2.2.1. Indications should be repeatable and accurate to +/- 10% of full scale.

6.1.4 All control switches and levers except for vehicle movement shall be in the direction of motion and comply with 3.6 of AIR1375. Proper placarding shall clearly illustrate the function and direction of each control. Pictograms shall be used for this purpose and shall comply with SAE ARP1838.

6.1.5 Weatherproof electrical switches at each end of the conveyor shall be provided to control belt movement and emergency stop.

6.1.6 The belt speed control shall be provided at the aft end of the conveyor or at the operator's compartment. An emergency stop control shall be provided at the forward end of the conveyor bed.

6.1.7 The conveyor bed raise/lower controls shall be located at the operator's compartment.

6.1.8 All controls shall be protected from inadvertent operation caused by cargo falling off the conveyor platform.

6.2 Entry and exit to the operator's seat shall require minimum effort and be without obstructions.

6.3 The cargo conveyor shall be designed with operator visibility as a primary consideration.

6.4 A riding type cargo conveyor should be equipped with a full seat including backrest. The cargo conveyor seat, supporting structure and suspension system shall not transmit excessive shock or vibration to the operator.

6.5 Safety Requirements

6.5.1 Safety requirements shall comply with SAE ARP 1247, Paragraphs 3.8, 3.9 and 3.10, SAE AIR 1375 and ANSI B56.9-1992.

6.5.2 Brake pedals and all work surfaces shall be equipped with non-slip material and/or painted with durable non-skid paint.

6.5.3 Lamps, accessories and other surface mounted equipment should be protected by guards to minimize the likelihood of damage.

6.5.4 All components and systems shall fail in a safe state.

6.5.4.1 A deadman type seat switch shall be supplied with an interlock that de-activates the traction circuit whenever the operator is not on the seat. The switch and its installation shall be designed to prevent false tripping due to driving over bumps or the operator leaning in any direction on the seat.

6.5.4.2 The controller shall incorporate a "static return to off" feature. This is another interlock that requires the operator to set the directional control to neutral before cargo conveyor movement is possible once the seat switch has been opened.

6.5.4.3 A handbrake interlock shall also be provided to prevent traction system operation unless the handbrake is disengaged.

6.5.4.4 Vehicles using HIGH VOLTAGE traction systems shall be equipped with a “master” switch that shall interlock controller propulsion functions and battery contactor(s), if any, to render the propulsion system inoperative. Contactors(s) used in conjunction with the master switch shall be capable of interrupting maximum rated controller/inverter current.

A manual service disconnect for vehicles using a HIGH VOLTAGE traction system shall also be required. It shall have the following characteristics:

- Manual action is required to break the connection,
- The disconnection is physically verifiable,
- The disconnection does not create exposed conductors capable of becoming energized while exposed, and
- The service disconnect is clearly marked and is accessible without the use of tools.

6.5.5 The cargo conveyor shall be designed for easy access to those areas that require frequent checks and/or servicing.

6.5.6 Proper placarding of permanent design shall be used for all controls, instrumentation and cautionary information.

6.5.7 Information regarding maximum towing speed shall be properly placarded on the dash and at the tow points if potential damage exists to the traction motor during maintenance towing at higher than recommended speeds.

6.5.8 Tire inflation pressures shall be placarded or stenciled above the wheel well on the cargo conveyors.

6.5.9 Jack points shall be placarded on the cargo conveyor at all locations.

6.6 Permanently installed supports or other methods for locking the conveyor bed at a convenient raised height for maintenance or inspection shall be furnished.

7.0 MAINTENANCE REQUIREMENTS:

7.1 Service access shall comply with the requirements of SAE ARP1247, Paragraph 3.4.3.

7.2 Every effort should be made to facilitate maintenance access according to required check frequency or probability of failure of each system or component. In particular, the electrical compartments shall be located and laid out such that checks and troubleshooting can be accomplished easily and rapidly.

7.3 Requirements of SAE ARP1247, Paragraph 3.12.5 shall be followed where applicable. Systems and components requiring expertise not normally found with ground equipment mechanics shall have adequate troubleshooting charts and procedures. Simplified and/or automatic test equipment is encouraged.

7.4 The cargo conveyor shall be supplied with a manual, which complies with the requirements of SAE AS4828.

7.4.1 The manual shall include a complete electrical schematic, wiring diagram and component location chart.

7.4.2 Jacking instructions and pad locations shall be adequately illustrated in the manual.

7.5 Any special tools or test equipment shall be identified in the manual and drawings or source of procurement documented.

8.0 OPTIONS:

8.1 A passenger seat should be offered with a hip restraint located to the outside of the vehicle.

8.2 A cargo conveyor with a fully enclosed cab should be offered. The specifications given shall comply with SAE ARP 1247, Paragraph 3.13.1.7.3.

8.2.1 The overall height of the cab shall not be more than 78 inches (198.1 centimeters).

8.2.2 Corner posts shall be made as small as possible within structural requirements to increase front and side vision.

8.2.3 Optional Cab accessories should include a windshield wiper, window heater/defroster, dome light, hazard light, turn signals, and provisions for a ramp two-way radio

8.3 An indicator light on the dash to caution the operator of motor brush wear should be offered where applicable.

8.4 A guarded, recessed inching switch at the rear of the cargo conveyor with adequate safety interlocks should be offered.

8.5 A means of securing the main power battery on the cargo conveyor in the event of accidental overturning should be offered.

8.6 Turn signals on the rear of the cargo conveyor should be offered.

8.7 Cold weather option for the battery should be offered.

8.8 Hazard lights should be offered which are capable of at least one hour of continuous operation in the event of shutdown or isolation of the propulsion battery pack or failure of the DC/DC converter system as required by SAE J1690.

8.9 Universal chargers which communicate with the vehicle battery pack and capable of automatically charging a wide range of battery packs should be offered with the options in section 8.9.

8.9.1 A vehicle charge receptacle meeting the requirements of the IWC Electric Ground Equipment Conductive Fast Charge Specification should be offered.

8.9.2 The vehicle shall incorporate a method to ensure the receptacle high-voltage pins are not energized when exposed to human contact and during normal vehicle operation, and the vehicle shall be immobilized to prevent a “drive-off” scenario when the charge plug is engaged in the vehicle receptacle.

8.9.3 The charge receptacle shall be located on the vehicle in such a way as to minimize incidental connector snags after the operator removes the charge connector from the vehicle charge receptacle.

8.9.4 The battery module should comply with the requirements of “CiA Draft Standard Proposal 418.”

8.9.5 The vehicle-charger communication protocol should meet the requirements of “CiA Work Draft Proposal 419.”

8.10 An automatic timer and sensing device that stops the belt if there is no load placed on it. The timer shall have a manually adjustable range.

8.11 Alternate operator positions such as toward the middle or at right front.

8.12 A backup alarm that is fully audible in the airport ramp environment.

8.13 Accessories operating at battery voltage.

8.14 The foldable or retractable 6 in (0.15 m) package guide to prevent packages and bags from falling off the left side of the belt boom.

8.15 Emergency stop switches provided at each end of the conveyor opposite from the normal controls for belt movement and emergency stop.

8.16 A foldable or retractable three position handrail a minimum of 30 in (0.76 m) high shall be installed on the right side of the conveyor, as viewed from the rear, for protection when walking up the conveyor to enter the aircraft cargo hold and providing a package guide when loading.

8.16.1 In the intermediate position the handrail will lock 6 in (0.15 m) above the surface of the conveyor to act as a package guide.

8.16.2 The handrail must be self-locking and operated from a single point with one hand.

8.16.3 The forward end of the handrail must be capable of extension/retraction with variable lock points and rubber bumper to eliminate any clearances caused by variance in fuselage contours between aircraft.

8.17 Guards, shields, or interlocks shall be installed to protect personnel operating the equipment or performing maintenance on it against accidental contact with the exposed parts which are subject to high voltage, high operating temperatures, or any other hazardous condition.