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AEROSPACE INFORMATION REPORT

SAE AIR4364

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UTILIZATION OF BATTERY-POWERED GROUND SUPPORT EQUIPMENT

1. SCOPE:

This Aerospace Information Report (AIR) covers, and is restricted to, selecting appropriate applications for electric powered ground support equipment (GSE) at airports.

2. PURPOSE:

This AIR is intended to provide basic information and procedures for determining applications and developing cost comparisons that are appropriate for the use of electric powered GSE. Adherence to the guidelines herein will minimize the possibility of using electric powered GSE in unsuitable applications.

3. REFERENCES:

3.1 Applicable Documents:

The following published documents were utilized in the preparation of this AIR:

- a. SAE Paper #880972, Electric Tractors for Airports
- b. Battery Powered Industrial Trucks - The Lead Industries Association, Inc.
- c. Unpublished proprietary industry surveys and reports were also used as data sources.

4. LIMITATIONS:

This AIR is intended as a basic guideline for selecting appropriate applications for electric powered GSE. It does not cover the performance of, or service/design deficiencies in specific pieces of equipment.

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5. BACKGROUND:

Historically, GSE has been powered largely by gasoline or diesel engines. More recently, electric powered GSE is being used in varying degrees by major passenger airlines, regional carriers, fixed base operators, air cargo lines, airport authorities, and the military.

The most frequently found types of electric GSE on airport ramps are baggage tractors, push back tractors, belt loaders, and cargo transporters. In off ramp cargo/baggage areas, electric forklifts are widely used. The original motivating factor behind the introduction of electric GSE was the price and availability of fossil fuel during and after the energy crisis of 1979. Subsequent experience with this equipment has proven a number of other advantages, which can be more significant than the original energy considerations.

Applications for electric GSE must be selected carefully to ensure that the equipment will operate satisfactorily.

6. INDUSTRY EXPERIENCE:

Industry experience has generally been positive, except where inappropriate applications were selected for GSE. Electric baggage tractors and push back tractors are now widely accepted, and baggage conveyors are steadily gaining acceptance.

A recent survey of four major North American users of electric GSE (baggage tractors, push back tractors, and belt loaders) indicated the following:

- a. Energy Costs: For the same work performed, electric energy costs range from 2 to 7% of the gasoline or diesel fuel costs.
- b. Annual Maintenance Costs: Either on a cost per operating hour or an annual maintenance cost basis, electric GSE costs are approximately 20 to 45% of equivalent diesel or gasoline powered GSE.
- c. Fuel Consumption Rates: The diesel powered baggage tractor's average fuel consumption rate was 1.0 gph while gasoline was 1.5 gph, and idle time is approximately 75 to 80% of total operating time. One study reported that 3.5 kW·h of electric energy were used by an electric baggage tractor per actual operating hour. Based on these data, on an energy equivalency basis, 1 gal of diesel would be equal to 3.5 kW·h, whereas 1 gal of gasoline would equate to 2.3 kW·h.

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7. ADVANTAGES/DISADVANTAGES OF ELECTRIC GSE:

Provided that applications are selected where the electric GSE meets all of the performance criteria and has sufficient storage (battery) capacity to perform at least 1.5 shifts of duty without charging, electric GSE will normally exhibit the following advantages in comparison to similar diesel or gasoline powered GSE:

- a. Energy costs are considerably less. Depending on the design of the equipment and the relative cost of fuel compared to electricity, the electric vehicle energy costs are less than 10% of similar gas or diesel equipment. This great difference is due to two factors:
 - (1) Electric vehicles are inherently more efficient in converting the chemical energy of the battery into shaft horsepower.
 - (2) There is no "idle time" for electric GSE. Energy is used only when the vehicle is working; driving at speed, moving a load, etc. Typically, electric vehicles will accumulate 20 to 25% of the operating hours of gasoline or diesel equipment performing the same mission.
- b. Maintenance costs are considerably less, typically ranging from 20 to 45% of diesel or gas powered equipment.
- c. Lower susceptibility to operator abuse due to the design of the equipment.
- d. Operator/environmental impact is less than gasoline or diesel equipment due to the reduced noise level on nonexistent exhaust emissions.
- e. Lower out-of-service rates for electric GSE due to enhanced reliability.

Conversely, the following disadvantages of electric GSE have been exhibited:

- a. Difficulty in obtaining sufficient electric power at gate locations to operate the chargers.
- b. Difficulty in disciplining operations staff to plug vehicles into chargers during periods of inactivity.
- c. Higher capital cost considering the vehicle, battery, charger, and charger installation costs.
- d. Extreme low temperature conditions will reduce battery performance somewhat, although recent battery improvements have significantly improved this factor. Conversely, gasoline and diesel engines are very difficult to start under these conditions and they are normally left running even during long periods of inactivity.

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8. EVALUATION OF APPLICATION:

In evaluating the feasibility of an application, it is necessary to compare the equipment mission profile with the equipment manufacturer's performance specifications.

The prime factors in defining the equipment mission profile are as follows:

- a. The length of time the equipment must operate without recharging (the shift).
- b. The work that must be performed during the shift. Typical types of work are as follows:
 - (1) Movement on horizontal surfaces with or without towed loads.
 - (2) Movement on inclined surfaces with or without towed loads.
 - (3) Specific work functions are as follows:
 - (a) Lifting loads
 - (b) Operating conveyors

This work must be defined in terms of duration and loads lifted/towed/moved during the shift.

Using the definitions of the equipment mission profile over a complete shift, and making certain assumptions regarding the conversion of electrical power to work, it is possible to compute the total number of kilowatt-hours required from the vehicle battery during a shift. A comparison of this total value with the energy available from the battery (kilowatt-hours) will indicate if a sufficient margin of safety (50%) exists for the application, to accommodate battery deterioration, unusually heavy work cycles, etc.

In many operations, it is difficult to obtain sufficient data to use the quantitative approach. If data are available, the GSE manufacturer will be able to confirm the ability of the equipment to operate satisfactorily.

An alternative method, using more readily available data from existing gasoline or diesel powered equipment, can be utilized to evaluate potential electric GSE applications.

Daily fuel consumption records for gasoline or diesel powered GSE of similar design, performing similar work, would be evaluated to derive an average fuel consumption figure for the shift. Each gallon of fuel consumed is then converted into equivalent electric energy in battery kilowatt-hours. Typically, 1 gal of gasoline translates into 1 kW·h of battery energy. The required ampere-hour rating to the battery is then calculated by dividing the kilowatt-hour requirement by the average discharge voltage of the battery (normally 95% of rated battery voltage).

As a final check, other users of similar or identical airport equipment with similar climate and duty cycles should be contacted to evaluate their relevant data. All of the above data can be utilized in confirming the viability of a proposed electric GSE application for a specific piece of equipment in a given location.