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JACK R. GILSTRAP
GENERAL MANAGER

64-856

February 27, 1976

To: Members of Board Rapid Transit Committee

From: Jack R. Gilstrap

Subject: INFORMATION ON GARRETT CORPORATION's ENERGY STORAGE SYSTEM FOR RAPID TRANSIT CARS

Attached for your information find a photocopy of the Introduction to a Technical Report on subject systems. Mr. Gallagher and Mr. Gardner first reported to you about a year ago on this inspection of their system at the DOT Pueblo Test Track.

This is one of the alternatives to the "profile grading" of transit lines. According to the Garrett report the use of this equipment results in appreciable dollar savings in propulsion power and substations, probably in the range of 20-25%.

Two cars so equipped are now in regular service in New York City.

Respectfully,

Jack R. Gilstrap

Jack R. Gilstrap

By: Richard Gallagher

Richard Gallagher
Manager, Rapid Transit Dept.

Attachment

cc: All Board Members

Introduction

Background:

During the 1960's the demand for electric power in the United States grew at a much higher rate than did the ability of electric utility companies to supply additional generating capacity. As a result, the Country experienced periodic blackouts and "brownouts" (voltage reductions). Because these difficulties were particularly severe in New York City, there was especially strong motivation to reduce the high power demand on the local electric utility. Since the subway system in New York City is the largest single user of electric power and, most importantly, because the peak demand for subway power coincides with the city-wide peak demand period, there was a great need to reduce energy consumption by the subways. This reduction in consumption would also be beneficial to the subway operation, itself, by lowering power costs by a modest, yet significant amount.

In the 1970's, however, the power problem changed drastically from a shortage of generating capacity to a shortage of the energy sources, themselves. It thus became greatly important to conserve energy so that:

1) Large operating cost savings could be made.
2) As little as possible of scarce energy resources would be expended.
3) A favorable effect on the U.S. balance of trade with foreign countries would be achieved through reduced petroleum imports.

With regard to the first item above, it should be noted that the total cost for electric power used for operating subway cars in New York rose from $36 million in 1971 to $78 million in fiscal 1975.

It was in 1970, between the two stages of the energy shortage problem, that plans were made to develop, test and demonstrate a new transit car propulsion system that held promise for sizable energy savings. The system, called Energy Storage, uses a set of rotating discs (flywheels) to store on-board the transit car that energy which conventional cars waste during braking cycles. The stored energy is re-used during the next acceleration of the car.

Benefits:

The primary result of equipping a car with the Energy Storage (ES) propulsion system is that the car uses less energy in its operation than a conventional car does. Moreover, since it uses less energy it also generates less waste heat energy. Furthermore, because the flywheel supplies much of the energy during acceleration, there is a smaller surge of current drawn from the third rail during the acceleration and as a result the voltage level on the third rail is more nearly constant. As a consequence of these three features, the Energy Storage propulsion system has the following benefits:

I. Reduction in Energy Consumption
- A. Reduced energy costs (Reductions in propulsion energy by more than 40% are possible in theory)
- B. Reduced energy demands on electric utility companies
- C. Ancillary benefits in the Environment, in the conservation of national resources, and in favor of the national balance of payments

II. Lower Waste Heat
- A. Cooler tunnels and stations, resulting in a more pleasant environment for passengers and employees and in a cooler ambient for the underfloor equipment
- B. Reductions in requirements for air conditioning of cars and stations

III. Improved Stability of Third Rail Voltage
- A. Greater reliability and life of control circuits
- B. Capability of higher car acceleration rates on an existing electrification
- C. Reduction in the required power rating for electrical substations of subway systems which are in the design stage

In addition to the above, the fact that energy is stored on-board the car enables an ES car to operate on its own power during certain emergencies (e.g., when third rail power fails under conditions in which the motorman is allowed to proceed to the next station to discharge passengers).

There are additional benefits which result from the particular equipment used on the ES cars. Primarily,

1. The chopper, which is used for propulsion control, is more energy efficient than conventional control equipment
2. The separately-excited traction motors provide an inherent spin-slide protection for the car
3. There is more dynamic braking than in a conventional car (because of the use of separately-excited traction motors) which results in lower friction brake shoe wear and higher wheel life.

The Energy Storage Project:

The equipment to be described in this report evolved from discussions which began in 1965 between representatives of The Garrett Corporation (AiResearch Manufacturing Company of California), Metropolitan Transportation Authority (MTA), and New York City Transit Authority (NYCTA). The discussions started as an exploration to find significant applications in the public transportation field for Garrett's expertise in high speed rotating machinery and for its developing interest in electric propulsion equipment.

The interaction between the high technology manufacturer and the operators of a major transit system brought the proposed design through many evolutionary stages. Thus, for example, the original Garrett concept of large flywheel on each car which would eliminate the need for third rail contact, except at periodic recharging stations, became one with a smaller wheel used for storage of only one stop's energy for immediate re-use on the next acceleration. With the evolution of the basic concept, the flywheel changed from the large wheel mounted with a vertical rotational axis into two small units rotating along fore-and-aft axes.

With the definition of the hardware to a point which seemed practical to both the manufacturer and the user, an application was made to the Urban Mass Transportation Administration (UMTA) of the United States Department of Transportation and to the New York State Department of Transportation for funds to carry out development and testing of the equipment. These funds were granted to MTA and a contract was signed by Garrett and MTA in January 1972.

In order to evaluate the capabilities of the system, Energy Storage (ES) propulsion equipment was installed by Garrett under two NYCTA subway cars (Type R-32, built in 1965), in place of the conventional propulsion equipment. Initial testing of the two ES cars was performed on UMTA's Rail Transit Test Track at the Transportation Test Center in Pueblo, Colorado. Extensive testing of the cars is underway on the NYCTA, under the direction of MTA, and is to be followed by a reliability and energy efficiency trial of the cars in revenue service on several routes of the New York City Transit System.

This report provides a description of the Energy Storage equipment and discusses the development of the design. The report, which was written by MTA, describes engineering work performed in nearly all cases by Garrett. The results of the testing of the ES components and subsystems and of the completed cars will be presented in a separate report to be published subsequent to the completion of the test program.