The Modernization of SEPTA'S NORRISTOWN HIGH SPEED LINE

Southeastern Pennsylvania Transportation Authority

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THE NATIONAL CONVENTION

The National Model Railroad Association

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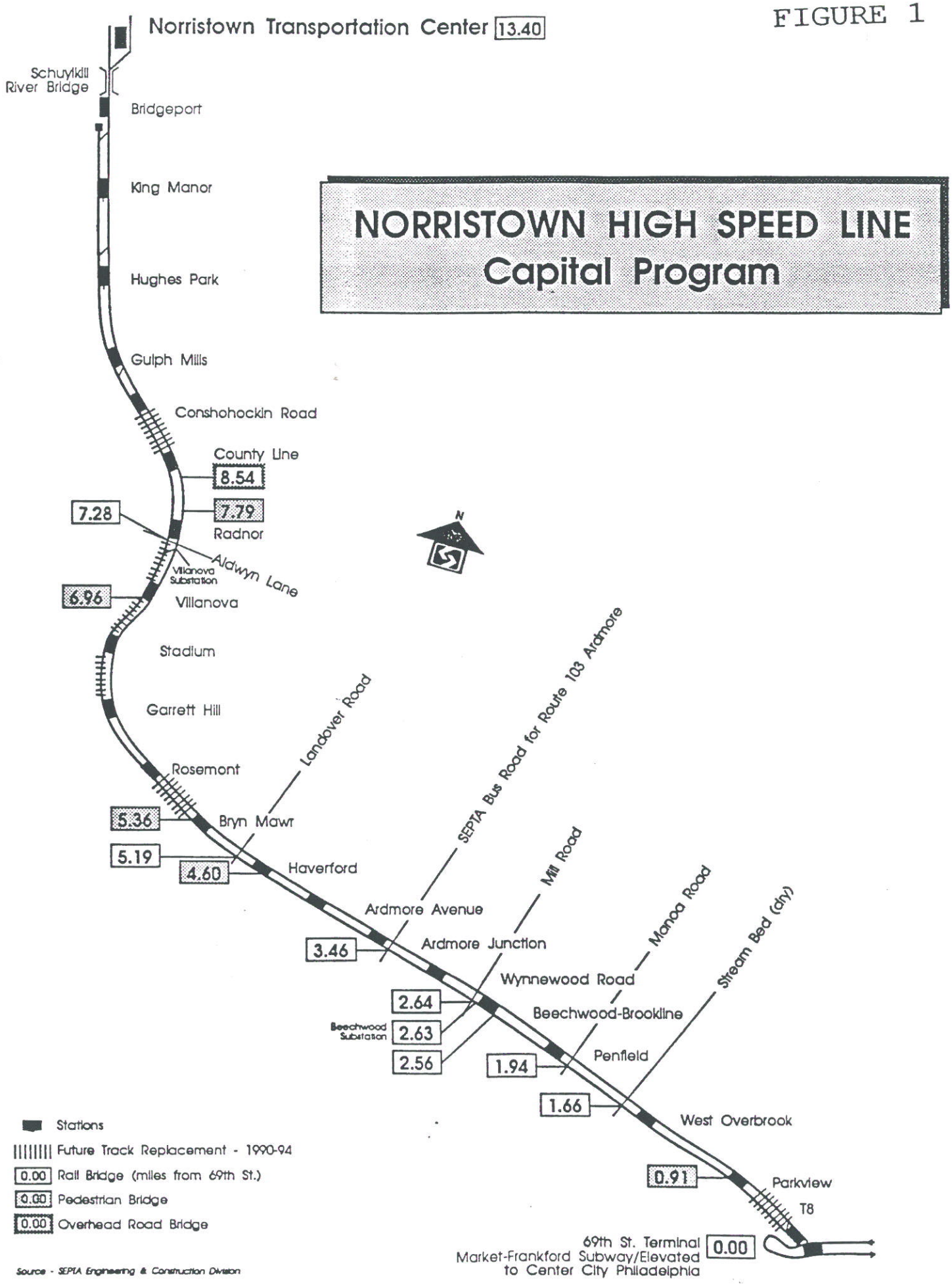
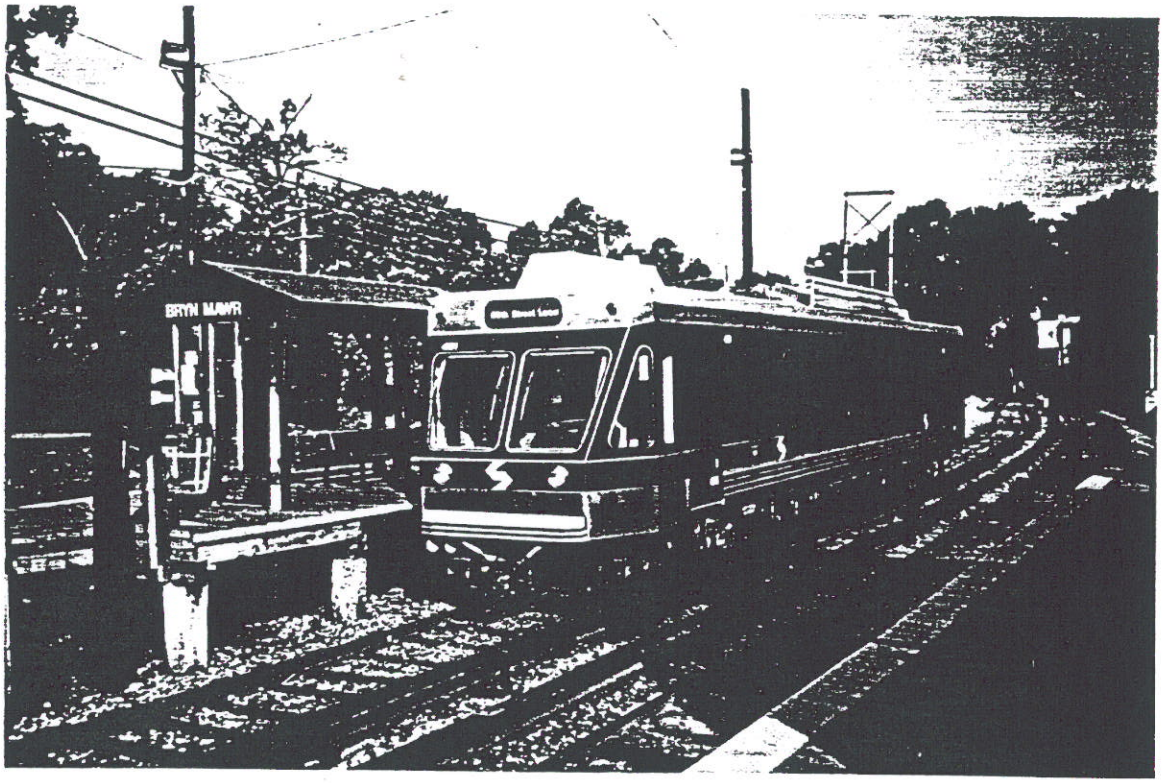
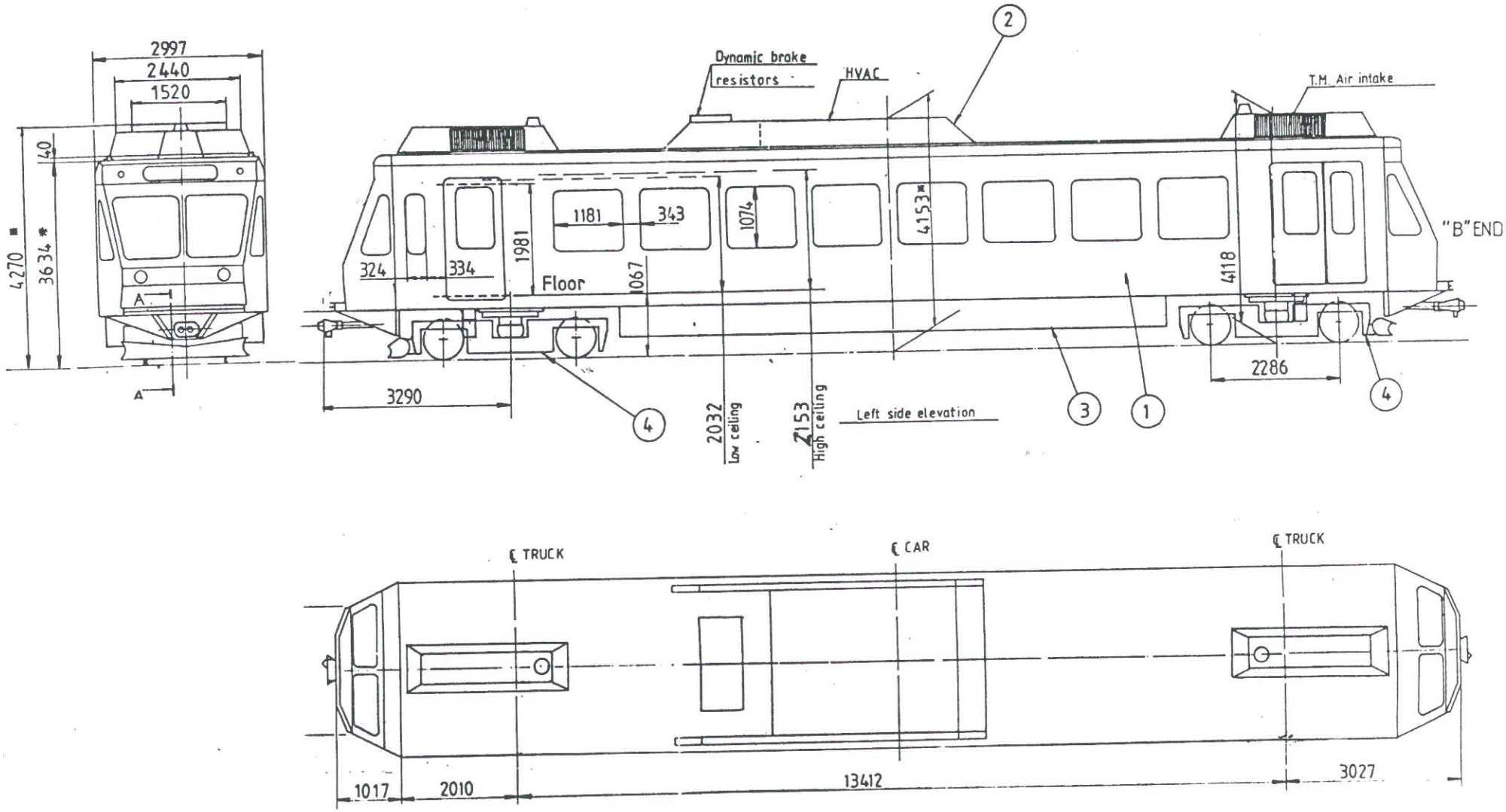
FIGURE 1



NORRISTOWN HIGH SPEED LINE
Capital Program



SEPTA 451, Prototype N-5 car at Bryn Mawr, PA, station August 1992. The prototype car will be returned to the car builder for reconstruction into an acceptable production car to be numbered in the series 130-155. This car provides a new level of comfort and performance for suburban riders.



Principal Dimensions
Norristown High Speed Line N-5 Car

Source: ABB Traction AB

FIGURE 3

Modernization of the Norristown High Speed Line

ABSTRACT

The Norristown High Speed Line (NHSL) is an interurban electric railway connecting the western terminus of SEPTA's Market-Frankford Subway/Elevated Line at 69th Street, Upper Darby, with Norristown, a distance of 13.4 miles. En route, the NHSL serves 22 stations located in Delaware and Montgomery Counties.

The NHSL rehabilitation and modernization program as currently approved or planned for funding involved the acquisition of 26 new multiple-unit electric interurban passenger cars capable of 70 mph *(all of which will be equipped with cab signals and overspeed protection)*; capital spare parts for the cars; installation of a new way-side signal system that is compatible with the new cars and providing cab signal information to the motorman and overspeed command to the vehicle propulsion/braking control system as well as automatic and/or remote control of interlockings; reconstruction of most of the track system; rebuilding of two major passenger terminals; replacement of three electrical substations; addition of two permanently installed portable substations; rehabilitation of several bridges; creation of a new vehicle maintenance and repair facility; construction of new pedestrian bridges to replace old ones; and the construction of new or expanded parking facilities for patrons at passenger stations. Accomplishment of this program should enable SEPTA to present a substantially improved level of safety and quality of service to existing and potential NHSL patrons for the 1990's and into the next century.

During the period 1972-1992, the Federal Transit Administration *(formerly UMTA)* had awarded approximately $122 million in federally funded grants to accomplish $159,000,000 in various capital improvement projects related in whole or largely to the NHSL. Additional funding is anticipated to complete the intended projects that are part of the overall program.

Purpose

The purpose of this paper is to briefly describe the Norristown High Speed Line *(NHSL)* and its modernization program. The line has a number of unique features yet could be a model for others to emulate.

History

A brief history of the Norristown High Speed Line *(NHSL)* is appropriate to acquaint the reader with some of the reasons for that line's unique features. *(For a complete history of the NHSL, the reader is referred to DeGraw, Ronald, The Red Arrow, Haverford Press Inc., Haverford, PA 19041, 1972).*

The Philadelphia and Western Railroad Company was incorporated as a steam railroad in 1902 by financial interests secretly related to George Gould's transcontinental railroad scheme. George began to build a transcontinental system based on the Missouri Pacific, Wabash and Denver & Rio Grande Western stretching from Ogden, UT to Toledo, OH. He built the Western Pacific from Ogden to Oakland, CA, using the D & RGW's earning power to guarantee the WP's bonds. Control of the Wheeling and Lake Erie connected Toledo with Rook, PA, near Wheeling, WV. From there, heavy construction was needed, so Gould formed the Wabash Pittsburgh Terminal Railroad to enter Pittsburgh and to build a hilly extension to Connellsville, PA, for a connection with the Western Maryland which he controlled. The Gould rail empire stretched from Baltimore, MD, on the Atlantic Ocean to Oakland, CA, on the Pacific.

The seemingly independent P&W was incorporated to build from 63rd Street in western Philadelphia to Parkesburg, PA, about 44 miles. The secret plan was to quickly complete the P&W to Parkesburg, then suddenly build on to Lancaster and York, PA, connecting with the Western Maryland at the latter point.

By the end of 1906, Gould was in financial trouble and had to give up his eastern objectives. The P&W stood alone.

The P&W RR Co. was reorganized in 1907 as the P&W Railway Company to allow completion of the line as far as Strafford, PA, 10.6 miles from the then new 69th Street Terminal of Philadelphia Transportation Company's Market Street subway-elevated line to Center City and the ferries.

The line opened to Strafford in 1907. In 1912, the Norristown Branch, 6.5 miles, was opened as a key link in the Philadelphia-Allentown Lehigh Valley Transit Company's interurban line. The Norristown "Branch" quickly became the functional mainline while the Strafford line remained lightly utilized and became functionally a branch.

The steam railroad origin left a legacy of a double tracked grade separated railway, with a maximum grade of 2.5% and maximum curvature of five degrees. This was substantially better than typical interurban electric railways of that period. An eight degree curve at Villanova Junction was added in 1912 when the Norristown Branch was built.

The P&W was modernized in 1930-33, under the direction of Dr. Thomas Conway, Jr., a former Professor of Finance at the University of Pennsylvania's Wharton School. Under Conway's direction, track was upgraded with superelevation of curves increased to eight inches to allow 80 mph. Signals, substations and passenger stations were modernized.

Ten new cars were ordered that would be a major advance. Conway sought a car that would be the fastest possible for the P&W's demanding profile, yet be economical to operate and attractive to passengers. Conway realized that if the P&W was to compete with the newly electrified railroads and the ever increasing number of automobiles, the P&W would have to provide all of the time savings in the interline trip with Philadelphia Rapid Transit Company's *(PRT)* Market-Frankford subway elevated line. PRT had no plans to speed up its service. The P&W had to do it all.

Substantial research went into the new car design. Dr. Felix Pawlowski, Guggenheim Professor of Aeronautics at the University of Michigan, ran wind tunnel tests on more than 30 carbody designs. The result of his tests was a finding that his streamlined design would consume 43% less power than a conventional "box" car of similar size at 70 mph.

The new cars were 52'2" long, 9'2" wide and only 10'6" high, had parabolic streamlined ends, low floors, skirting for both appearance and airflow and a distinctive roof end that curved down over the cab. The aluminum body helped keep weight down to 52,200 lbs. The cars had four GE706 motors of 100hp each which drove the car at a speed of 83 mph on straight level track.

Their appearance quickly earned the name "Bullet", a fitting label for what was the first aluminum bodied aerodynamically designed railway car in the U.S. The ten Bullets delivered in 1931 and the eleven older 60's *(later 160's)* provided all P&W service until recent years.

P&W shares and bonds were acquired by the Philadelphia Suburban Transportation Company, "Red Arrow Lines", in 1948, and P&W merged into PST's corporate structure in 1953.

Southeastern Pennsylvania Transportation Authority *(SEPTA)* became a transit operator on September 30, 1968 when it acquired the assets and business of the Philadelphia Transportation Company. SEPTA had previously subsidized

the commuter railroads of Philadelphia through operating agreements. SEPTA took over PST on January 20, 1970, and hence acquired what had been the P&W. The latter was identified by SEPTA as its Route 100-The Norristown High Speed Line *(NHSL)*.

The line operated relatively routinely until the latter 1980's. While its equipment was old, it was not scheduled for replacement because SEPTA had other more urgent critical items needing immediate attention. However, in 1985-86, several events occurred that caused the NHSL to be shut down for several months. A number of cars suffered electrical fires as a result of deteriorated insulation. Several other cars were involved in accidents. The number of operable cars fell so low that operation could not be sustained, so the line was shut down in August, 1986. Very reduced service was resumed in October as several cars were repaired, but the inner part of the line was served by buses. Ridership plummeted.

SEPTA's Rail Equipment Department surveyed the industry for available used cars that could be operated on the NHSL. Of the few types that were available, the Chicago Transit Authority 6000 type was selected, and ten married pairs were obtained. Seven were modified slightly and given a light overhaul and were placed in service December, 1986, which allowed full service to be restored. The last two Bullet cars *(206 and 209)* made their last revenue trips in August, 1990. Five ex-Market-Frankford Subway Elevated Car *(Budd 1960)* were modified in 1989 for use on the NHSL.

In the early 1980's, SEPTA staff decided that major renovation of the NHSL would be necessary. The "NHSL Recapitialization Task Group" was formed May 24, 1984; it was sometimes referred to as the "P&W Committee". By 1985, most significant decisions had been made, and a list of projects drawn up that included nearly everything as follows: vehicles, shop and yard, track *(including third rail)*, substations, signals, stations, and parking. Passenger terminals were added to the program, and a complete program to rehabilitate or replace bridges was begun. A major in-house effort was the car specification. Funding needs were estimated by SEPTA staff and a capital program laid out that covered a number of years. These estimates were the bases of capital grants.

The Program

Over the years 1976-1994, the following projects will have been completed.

Cars

A total of 26 new multiple-unit interurban passenger cars will be acquired, including capital spares, at a cost of $55 million. The new cars have been designated as SEPTA Type N-5 because they will be the fifth car type designed to have served the Norristown line since it opened in 1912. The new cars have a stainless steel body 65'2" long, 9'10" wide and 14'0" high. Trucks are 7'6"

wheelbase, with truck centers 44'0". Weight is nearly 78,000 lbs. The carbody is the largest that could fit into the NHSL's clearances without major changes in way-side structures *(See Figure 3)*. Some minor way-side changes were necessary to accept the new cars.

The car builder was a joint venture of ASEA/AMTRAK. ABB was later formed by a merger of ASEA *(Swedish General Electric)* and Brown-Boveri *(Swiss)*. Contract award and Notice-To-Proceed occurred December 11, 1987. AMTRAK's Beech Grove, Indiana, shop was to assemble the cars; the carbody shells were fabricated by SOREFAME, Lisbon, Portugal, a Budd Company licensee. The first two shells arrived at Beech Grove in April 1989.

The agreement between ASEA and AMTRAK called for ASEA to obtain all foreign-supplied equipment and AMTRAK to supply all domestic equipment. Each was responsible for its own systems engineering. While AMTRAK had overhauled its own cars and had assembled WMATA subway cars, AMTRAK had not designed and built a car from scratch.

Design and fabrication of the first car proceeded very slowly. On September 26, 1990, prototype Car 451's body was lowered onto its trucks at Beech Grove. It was thought that delivery was imminent, but various tests were not passed. In early 1991, 451 was taken to ABB's facility at Elmira, NY, where it was completed. It was delivered May 22, 1991 to SEPTA.

During early 1991, AMTRAK withdrew from the project as an active participant. ABB entered into a subcontract with Morrison-Knudsen Company, Hornell, NY, to assemble the remaining cars.

Testing of 451 continued through 1991 and into 1993. Production cars began to be delivered in June-July 1993.

These cars feature the first three phase a.c. drives to be ordered for a production fleet in the U.S. use. Each truck is driven by its own d.c.-a.c. inverter providing variable voltage *(0-465v)* variable frequency *(0-165hz)* power to two ASEA MJA 280-2 motors of 155kw *(208hp)* each. With four such motors, the car will have the best power to weight ratio of any car built to date, namely about 85 lbs./hp. This compares with about 130 lbs./hp for the Brill Bullet P&W cars and 136-140 lbs. for PATCO cars.

Acceleration and deceleration are 3.0 mphps, with 0-70 mph to be reached in 51 seconds. The high horsepower should allow the cars to maintain 70 mph track speed up the several 2.5% grades on the NHSL. Stopping distance is specified as 1,295 feet.

They will seat 60 persons in comfortable seats having 42" width cushions. A conscious decision was made to provide very comfortable seating to attract the off peak discretionary rider even though this may result in two to four more peak hour standees.

A roof mounted package air conditioning unit is similar to that used on SEPTA's Kawasaki LRV's delivered in the early 1980's.

The new N-5 cars are expected to be as much of an advance over contemporary cars as was the 1931 Brill Bullet over its contemporaries.

Maintenance Facility

It was decided to rehabilitate the original 1908 P&W car shop building near 69th Street Terminal, Upper Darby, PA. A study was completed by a general engineering consultant of SEPTA's, and the building was found to be basically sound, although in need of renovation. The roof and floor, in particular, need renewal. Design work completed. Construction began in January 1993, with completion scheduled for 1995. The lengthy time allows for the building to be kept in service during reconstruction.

Track Renewal

All of the old 85 lb./yd. bolted track of the NHSL will be replaced with new 115 lb./yd. continuous welded rail. Concurrently, the old 50 and 75 lb./yd. third rail will be replaced in 150 lb., all of having plastic coverboard. Some relatively recent 100 lb. running rail remains.

Substation Modernization

All three substations on the NHSL have had their equipment replaced with new silicon rectifiers and associated new transformers and switchgear.

During reconstruction of Beechwood and Villanova, 1988-91, each was replaced by a mobile 2,00kw unit originally obtained for temporary use while Media-Sharon Hill LRT substations were rebuilt. One will be permanently installed at 69th Street and the other at Haverford to provide a total of five substations on the NHSL.

Signal System Modernization

The project that will tie the program together will be an entirely new bi-directional cab signal and control system.

The P&W had conventional three color way-side railroad-type signals having no rapid transit type track trips. One of the early decisions of the modernization program made in the 1970's was to install a cab-signal system with overspeed control. The accidents of 1986 substantiated the need for such a system.

The 100hz system used on the Northeast Corridor where SEPTA's Regional Rail Division commuter trains operate was adopted. *(A similar system is used by PATCO)*. The following codes have been specified: 0 pulses per minute *(PPM)* = 0 mph; 75 ppm = 15 mph; 120 ppm = 30 mph; 180 ppm = 45 mph; 270 ppm = 55 mph; and 420 ppm = 70 mph.

A control panel has been provided at Suburban Transit Division's Victory Avenue, Upper Darby, Control Center. All switch machines will be new, electric with hand-throw capability.

Completion will occur in late 1993.

Bridge Improvements

Bridges of the NHSL date from 1906-08 when the 69th Street-Villanova segment was built and 1911-12 when the Villanova-Norristown portion was built. All had suffered from benign neglect of a hard pressed private owner followed by an under-funded public agency.

All were inspected in recent years and were placed in three categories. "Critical" had to receive immediate attention; "priority" would receive attention as soon as "critical" was attended to and the others placed in annual programs three to five years in the future.

The Schuylkill River Bridge, about 3,800 feet in length between Bridgeport and Norristown, was renovated under grants received in 1983-84. Track and steel/aluminum composite third rail were included.

Three "critical" bridges at mileposts 3.45, 5.19 and 7.28 were included. Bridge 3.46 at Ardmore Junction was completely replaced in 1990. Bridge 5.19 over Landover Road was renovated in 1991. Bridge 7.28 over Aldwyn Lane at Villanova Junction had the deck replaced, one abutment replaced, and the other renovated and repaired. It was completed in June 1992.

Five "priority" bridges on the south end of the line were included in a study and design contract awarded in April 1989. The study phase was completed in 1990. It was determined that most can be rehabilitated, and that has been scheduled for 1994-95.

County Line Road, Bridge 8.54, was replaced by highway agencies in 1989.

Four pedestrian bridges were completely replaced under a $975,000 project during 1987-89. These are at Parkview, Haverford, Bryn Mawr and Villanova. All new precast concrete deck girders replaced fabricated steel through trusses that were seriously deteriorated. The only old type footbridge remaining was Bridge 7.79 at Radnor. Its replacement was completed in April 1992.

69th Street Terminal Improvements

Restoration of 69th Street Terminal to its original 1906 grandeur was carried out under a $14,750,000 project that culminated in a rededication October 27, 1988. The terminal had been designed to an excellent functional plan, so no major changes were necessary or desirable. A clutter of retail stands was removed, the skylight over the "great hall" restored *(it had been blacked out with paint during World War II)* and lighting fixtures restored to their original appearance.

The project included accessibility for the handicapped.

The Norristown Transportation Center

The Norristown Transportation Center *(NTC)* replaced the old P&W terminal with a new multi-modal terminal that includes a new NHSL elevated station, with spur, a bus loop with enclosed waiting room at ground level and direct access to the DeKalb Street Regional Rail Division *(ex-Reading Company)* station and its parking lot. The NTC is at mile 13.4 whereas the old P&W terminal was at mile 13.7. The old terminal and elevated structure beyond the NTC were demolished during the period May 17 - June 15, 1989. Dedication of the NTC occurred July 14, 1989.

Future Possibilities

King of Prussia Extension: A branch extension of about three miles from a junction near Hughes Park to the King of Prussia Mall and industrial center will be restudied.

Operating Plans: Operation of the NHSL has always been based on frequent operation of one- or two-car trains on as fast a schedule as is feasible. Although only 13.7 *(now 13.4)* miles long with 22 stations would seem to be inherently slow, but by innovative operations, speeds have been high.

All stations are unattended, and fare collection is on board.

At present, rush hour service consists of Norristown express trains and Bryn Mawr locals. All trains stop at Ardmore Junction. Norristown trains run express, 69th Street-Bryn Mawr, then local beyond. Yet, even where running local, station stops are conditional "flag stops". An intending passenger must push a

button to light a lunar white signal to alert the train operator to stop. A "stick circuit" with a timer keeps the light on until a train stops at the station and contacts an offside fourth rail to extinguish the light. An express train contacts the fourth rail too briefly to extinguish the light. This is a homemade P&W device and is unique to the NHSL.

After sufficient new cars are available and the Radnor turn back is in service, an improved operating plan will inaugurate up to three classes of service: Norristown Express, Radnor Limited and Bryn Mawr Local. Initially, single car trains are planned. If ridership grows as anticipated, certain services would receive two car trains.

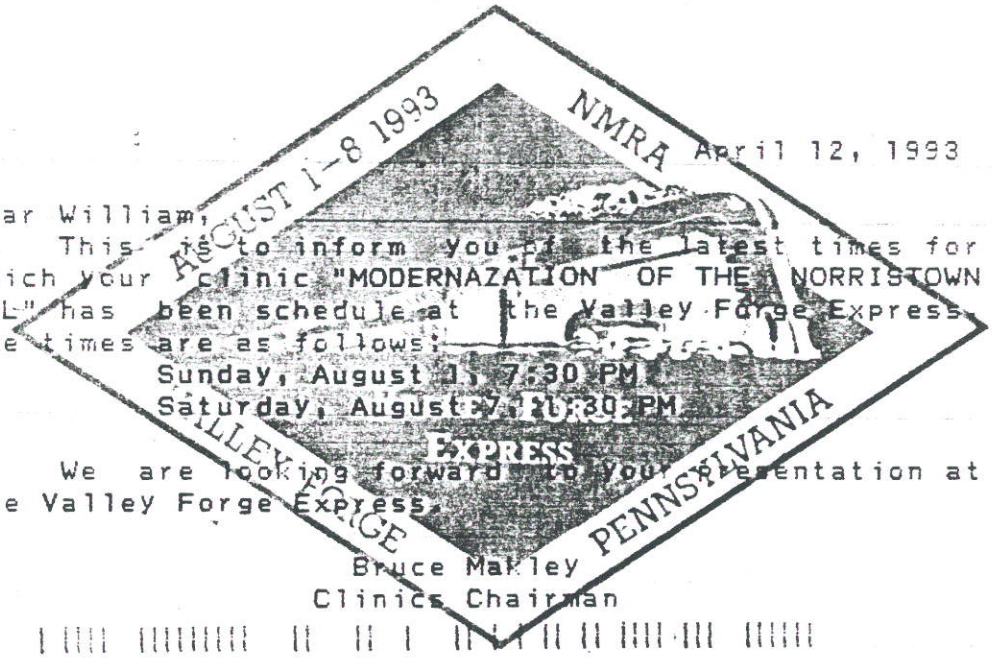
Conclusion

The projects presently being built plus those planned for the near future will transform the Norristown High Speed Line into a suburban transit facility that will provide a substantially improved level of service and safety to existing and potential new NHSL patrons for the 1990's and into the next century.

The modernized NHSL provides an example that could be of use to transit agencies where abandoned or underutilized railroad rights of way may be available. Its light rail characteristics of one- or two-car trains operating frequent service provide a higher level of service than commuter railroad at a lower operating cost and allows a lower investment than typical "heavy rail" installations.

The NHSL does not fit any conventional modal definition and that, perhaps, is a definite virtue. Its existence can encourage planners to consider its unconventional yet very successful features that have served the public for over 80 years.

JWV:das
6/23/93



April 12, 1993

Dear William,

This is to inform you of the latest times for which your clinic "MODERNAZATION OF THE NORRISTOWN HSL" has been schedule at the Valley Forge Express. The times are as follows:

Sunday, August 1, 7:30 PM

Saturday, August 7, 10:30 PM

We are looking forward to your presentation at the Valley Forge Express.

Bruce Makley
Clinics Chairman

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(continued from other side)

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For each family member — $ 5.00

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