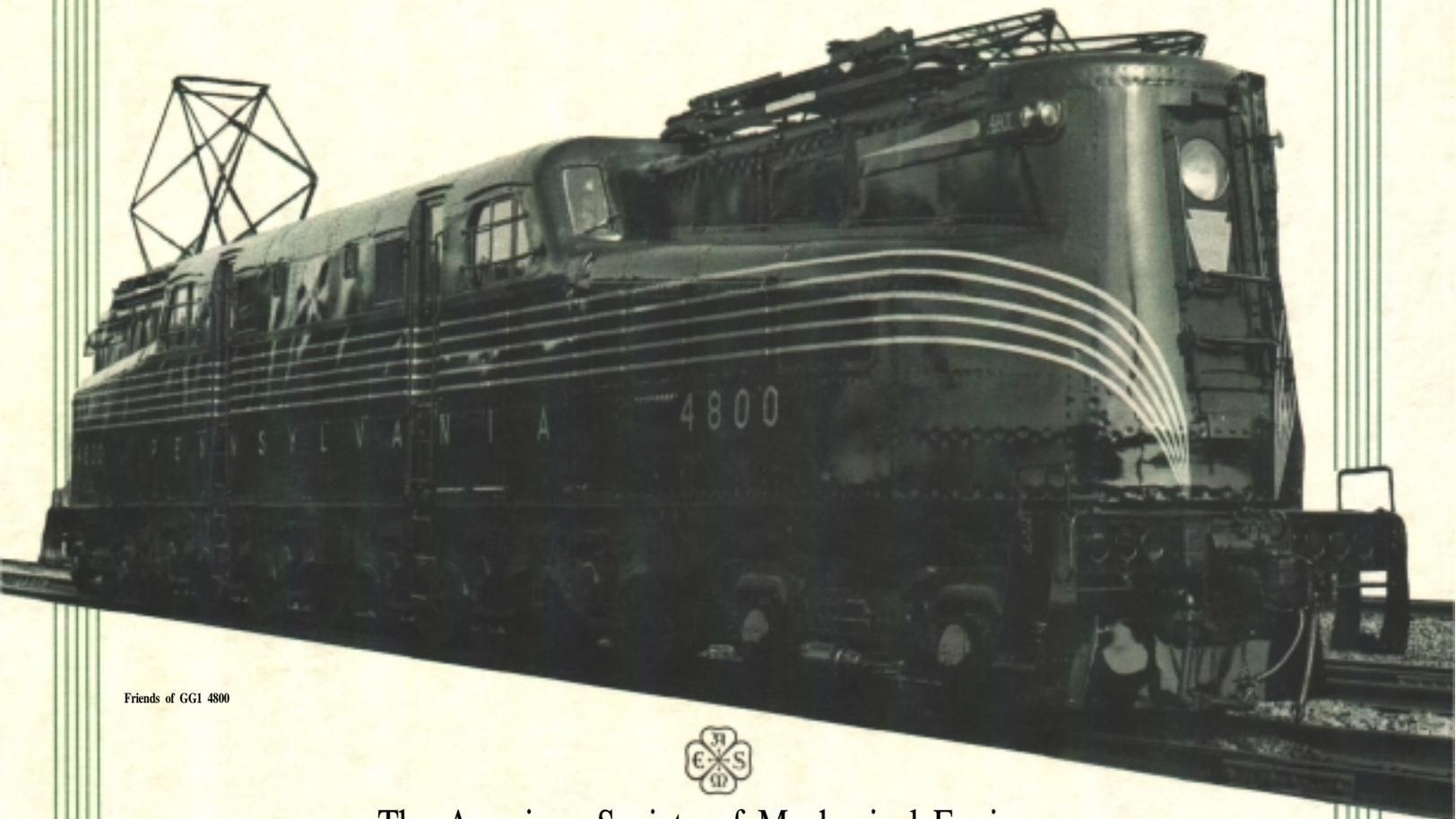


# PENNSYLVANIA RAILROAD ELECTRIC LOCOMOTIVE GG1 4800

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National Historic Mechanical  
Engineering Landmark



Friends of GG1 4800



The American Society of Mechanical Engineers

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Railroad Museum of Pennsylvania  
Strasburg, Pennsylvania  
April 23, 1983

The GG1 was a remarkable design, and so successful, because of its integrative synthesis of innovations from many fields of engineering — mechanical, electrical, industrial.

In 1913, before the era of the GG1, the Pennsylvania Railroad decided to electrify its tracks in the vicinity of Philadelphia. The system, at 11,000 volts and 25 hertz, expanded until by the early 1930s it stretched from New York City south to Wilmington, Delaware, and west to Paoli, Pennsylvania.

With the growth of the electrification came the need for more electric locomotives. In 1931, the PRR ordered two prototypes for what became the P5 class. They were built on rigid frames having a 2-C-2 wheel arrangement (a pair of unpowered two-axle pilot trucks with three driving axles between them). The P5's tracked poorly and generated forces damaging to the rails.

The PRR began to run tests at Claymont, Delaware, to measure the tracking ability of the P5's and other electric locomotives. Tests showed that the tracking of the P5's could be improved by modifications to the suspension, but it could not be brought up to the standards required by the railroad. However, a locomotive which was borrowed from the New Haven Railroad had a 2-C + C-2 articulated wheel arrangement, and it produced lower forces.

As a result of the test program, the PRR ordered two prototype locomotives designed to track better than the P5's. The first was classified R1 and was little more than an enlarged P5 with a 2-D-2 wheel arrangement. This electric followed the railroad's traditional practice of obtaining maximum horsepower from as few axles as possible on a rigid frame. The second electric, classified GG1, had the same 2-C + C-2 arrangement as the New Haven electric, its articulated frames a radical change for the conservative PRR. The GG1 equalization and suspension system provided a "dual tripod" arrangement, that insured equal static load on all driving wheels, regardless of track irregularities and curvature.

After engineers from four companies — the PRR, General Electric Company, Westinghouse Electrical and Manufacturing Company and Baldwin Locomotive Works — designed the GG1 in 1934, construction started on what would become No. 4800.

The locomotive required two frames; each frame was a one-piece casting from the General Steel Castings Corporation and was machined by Baldwin at Eddystone, Pennsylvania. The two frames, each nearly forty feet long, held three driver axle assemblies and a two-axle pilot truck. Driver axles fit into roller bearing boxes that could move vertically in pedestal jaws in the frame. The driver axle was surrounded by a quill on which was mounted a ring gear driven by the pinions of two electric motors. The quill drove a pair of 57-inch diameter drivers through axle spokes, pads, and springs. By this arrangement the motors were rigidly fixed to the frame while allowing the wheels and driver axles to move freely relative to the frame.

The two frames were connected by a joint consisting of a 10-3/8 inch diameter ball held in a socket by a 7-inch diameter pin. Each frame casting has a pivot bearing and two spring-mounted side bearing plates joining it to the locomotive body. Although none of these features were unique to the GG1, they were combined into a design that resulted in one of the best riding locomotives ever built with firm stability at high speed and light wear to the track.

Resting on the frames was a body formed from steel plates riveted to a framework consisting of two trusses. Viewed before the covering plates were added, the truss assembly had the appearance of a small bridge. Ducts in the floor of the body conveyed cooling air from blowers to the twelve traction motors.

Two cabs for the crew were located in the middle of the body. These allowed the GG1 to be run in either direction without the time-consuming turning operation required by a steam locomotive. The cabs' central location protected the crew in case of a collision. This was the first time a PRR electric was initially designed with this crew safety feature. An oil-fired steam boiler for train heat provided 4,500 pounds of steam per hour.

After Baldwin completed the frames, running gear and body, the GG1 was shipped to G.E. at Erie, Pennsylvania. There the electrical equipment was installed. Between the two cabs, the large transformer stepped the 11,000 volts AC down to lower values for the traction motors, blowers, and other electrical equipment. Current for the transformer was collected from the overhead catenary wires by

one of the two pantographs. Steps at the ends of the prototype GG1 led to the pantographs on the roof. But, as long as a pantograph was raised and "hot", access was prevented by a blocking plate at the top of the steps. Throwing a lever swung the plate clear but caused the pantograph to de-energize by dropping.

Three pairs of General Electric GEA-627-A1 electric motors were mounted in each frame. Each pair drove one quill.

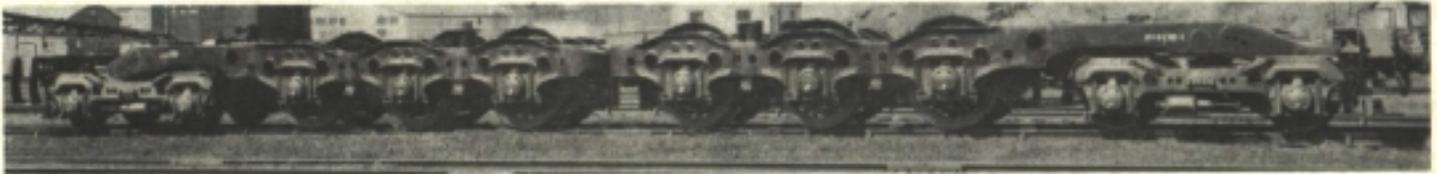
After installation of the electric equipment, the prototype GG1 was painted, numbered 4899 and turned over to the PRR. Following ten weeks of competition with the R1, the GG1 emerged victorious and traded numbers with the R1. It received the number 4800 which was the first in a class that ultimately was to total 139 units.

Before actual production of the GG1's started, the PRR called in industrial designer Raymond Loewy. He persuaded the railroad to weld the production bodies instead of riveting them. As a result, No. 4800 became the only GG1 with a riveted body shell and so gained the nickname "Old Rivets". Loewy also created the legendary five gold-stripe paint scheme that was first used on No. 4800. After the spacing between stripes was decreased, the scheme was applied to the other GG1's and many diesels that the railroad later acquired.

On January 28, 1935, No. 4800 pulled the first electrically powered train from Washington to Philadelphia. On the return trip No. 4800, at Landover, Maryland, set a speed record of 102 mph for that section of track.

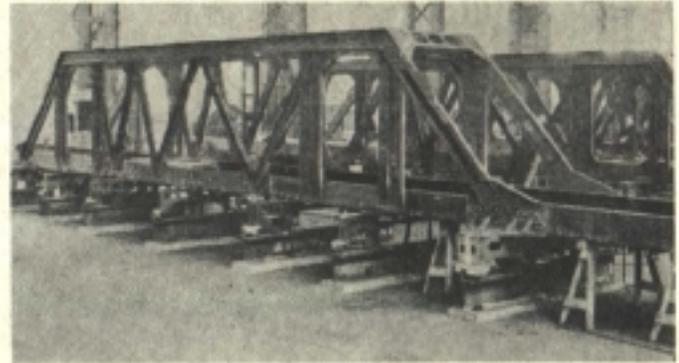
No. 4800 remained in service on the PRR and later Penn Central and Conrail, until October 1979, when the main transformer failed. As it was too expensive to repair, No. 4800 was retired.

The Friends of GG1 4800 was formed under the Lancaster Chapter, National Railway Historical Society, to raise money to save and restore No. 4800. In 1980, the Chapter bought No. 4800 from Conrail for the scrap price of \$30,000. With funds raised, No. 4800 was cosmetically restored to its 1935 appearance by the Strasburg Rail Road and volunteers. On November 20, 1982, No. 4800 was dedicated at the Railroad Museum of Pennsylvania at Strasburg, Pennsylvania, where it is on display.



RRM Pa

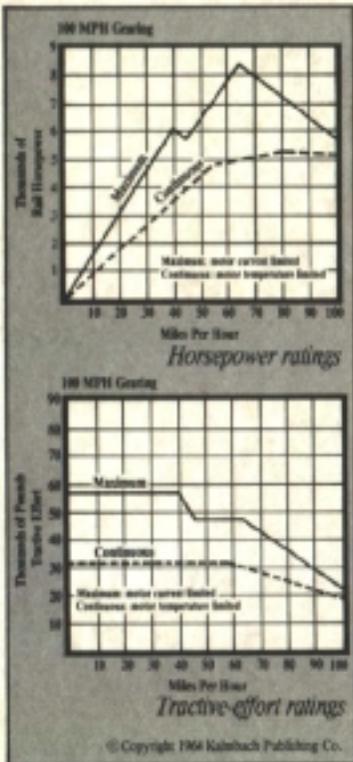
The two articulated frames of the GG1 are connected by a ball-and-pin joint. Springs partially support the body (upper near right). The GG1 body is supported by two trusses joined into a bridge-like structure (lower near right). Ducts below the floor convey air from the blowers to cool the traction motors (far right). The first GG1 is seen preparing to leave Baldwin Locomotive Works for General Electric Erie Works where electrical equipment was added (below left). Electric locomotives are built at Altoona Shops. The frame and running gear assembly are seen below right.



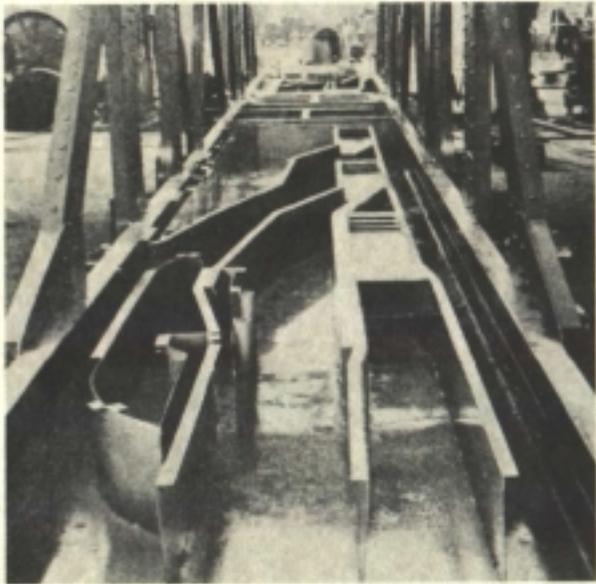
PRR



Baldwin Locomotive Works  
H.L. Broadbelt Collection



H.W. Pontin  
H.H. Harwood Collections

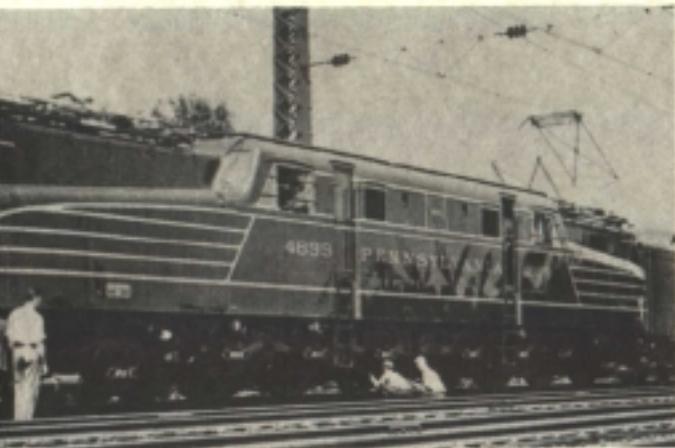


PRR



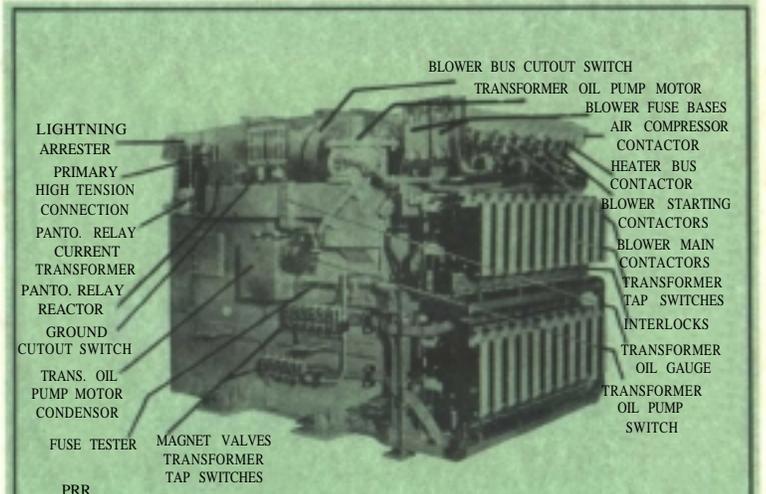
PHMC

GG1 frames—note workers at left, center, and right for scale. Note 1-piece cast frame on overhead hooks — each GG1 has 2 frames, articulated by center hinge.



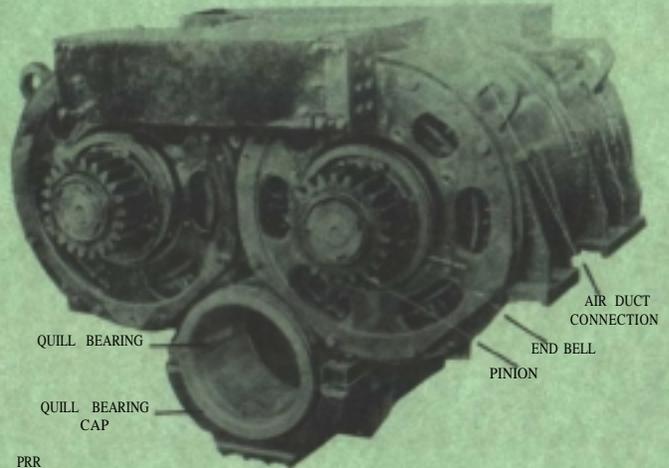
G.E.

Above, the GG1 is seen being inspected during the tests at which it outperformed its rival R1 to become the first in a new class of PRR electric locomotives. At left, No. 4800 leaves Washington, D.C. with the Colonial bound for Boston (1935).



- BLOWER BUS CUTOUT SWITCH
- TRANSFORMER OIL PUMP MOTOR
- BLOWER FUSE BASES
- AIR COMPRESSOR CONTACTOR
- HEATER BUS CONTACTOR
- BLOWER STARTING CONTACTORS
- BLOWER MAIN CONTACTORS
- TRANSFORMER TAP SWITCHES
- INTERLOCKS
- TRANSFORMER OIL GAUGE
- TRANSFORMER OIL PUMP SWITCH
- LIGHTNING ARRESTER
- PRIMARY HIGH TENSION CONNECTION
- PANTO. RELAY CURRENT TRANSFORMER
- PANTO. RELAY REACTOR
- GROUND CUTOUT SWITCH
- TRANS. OIL PUMP MOTOR CONDENSOR
- FUSE TESTER
- MAGNET VALVES TRANSFORMER TAP SWITCHES

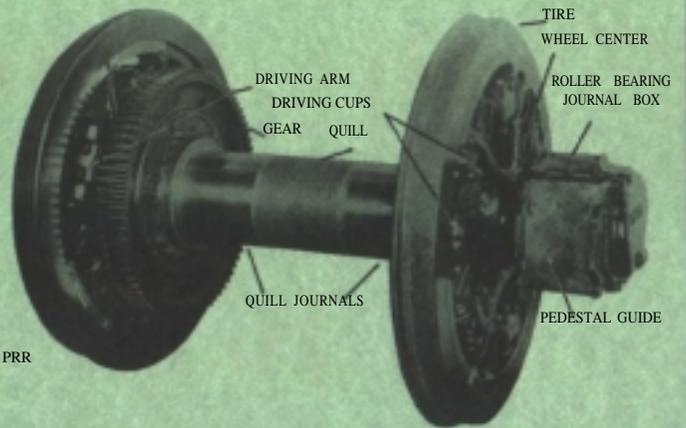
No. 4800 originally had an air-cooled transformer, but later an oil cooled one was substituted like the one shown above.



- AIR DUCT CONNECTION
- END BELL
- PINION
- QUILL BEARING
- QUILL BEARING CAP

PRR

Twin General Electric traction motor assembly.



PRR

Inside the hollow quill is the axle to which the wheels are attached and which turns in the roller-bearing journal boxes. The quill fits in the bearings of the motor assembly which bolts to the frame. This arrangement allows the wheels to shift relative to the frame in response to varying track conditions

# THE GG1 CLASS

The GG1's, as a class, served longer in front-line duty than any other class of locomotives in history — steam, electric, or diesel — in the United States or overseas.

In December 1934, soon after the PRR chose the GG1 to be its new electric locomotive, it ordered 57 GG1's. Baldwin built 25 chassis and shipped them to the PRR's shops in Altoona, Pennsylvania, where the railroad was building 18 additional chassis. Out of these, 34 received Westinghouse equipment, while G.E. apparatus went into the other nine. At Erie, G.E. built the chassis and installed the electrical equipment into the remaining 14. All parts were interchangeable in spite of the different manufacturers involved. Delivery started in April of 1935 and continued through August.

Expansion of the PRR's electrification system west to Harrisburg, Pennsylvania, authorized in 1937, required that the railroad order more electric locomotives. Pleased with the GG1, the PRR began, in late 1937, to build more GG1's at Altoona. GG1's continued to roll out of Altoona every year until June, 1943, when the last of the 139 was delivered. Unlike No. 4800 and the 57 in the first order, these 81

had drop couplers that could be folded down to give a more streamlined appearance.

During World War II the GG1's helped the railroad tremendously. For example, before the war on the day of Franklin D. Roosevelt's second inauguration, 68,000 passengers were carried in a single day to set a record for the railroad. To accomplish this, the railroad had to stop all freight trains for 12 hours. But on Christmas Eve, 1943, with all the GG1's delivered, the railroad carried 179,000 passengers — and the freights continued to run. The PRR's efficient electrification system, and its ability to help keep trains moving on the east coast, is credited with having prevented nationalization of the railroads as had happened in World War I. The GG1's were the keystone in this successful electrified network.

In 1959, the 25th year of the GG1's, the PRR calculated that the GG1 fleet had accumulated 337 million locomotive miles. Each locomotive had gone around the world an average of 97.4 times.

Today the life of the average diesel locomotive is estimated to be 15 to 20 years. The GG1 with the shortest life was 25 when it

was retired. Eight GG1's, although near retirement, were still running daily in 1983 for New Jersey Transit in the New York City area. All eight were about 44 years old.

Born in the Depression and hardened in war, a class of elegant electrics — the GG1 — continues to serve today.

## SPECIFICATIONS

Continuous HP .....	4620
Short-term HP .....	Up to 8500
Weight on drivers, pounds .....	303,000
Weight on trucks, pounds .....	172,000
Total weight, pounds .....	475,000
Horsepower, each armature .....	385
Rigid Wheelbase .....	13' 8"
Length over coupling faces .....	79' 6"
Height of pantograph locked down .....	16' 0"
Width of cab .....	10' 4-3/16"
Gear ratio .....	24 to 77
Speed, maximum MPH .....	100
Line voltage, AC .....	11,000



# ACKNOWLEDGMENTS

The ASME Susquehanna Section gratefully acknowledges the efforts of all who cooperated on the landmark designation of the Pennsylvania Railroad Electric Locomotive GG1 4800.

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### *Highlights of No. 4800's Career*

- Built in 1934
- Outperformed the R1 to become the first in a class of 139 GG1s
- Only riveted body GG1
- Styled by the famed industrial designer, Raymond Loewy
- Pulled the first electrically powered train out of Washington, D.C. and set a speed record for that stretch of railroad at 102 mph
- Attained a top speed of 128 mph during braking tests in 1935
- Removed from service in October 1979, after 45 years and 2 months of operation
- Accumulated approximately 5 million miles of service
- Displayed nine different major paint schemes during its active life
- Restored in 1982 to its 1935 paint scheme by the Friends of GG1 4800

NATIONAL HISTORIC MECHANICAL ENGINEERING LANDMARK  
PENNSYLVANIA RAILROAD GG1  
ELECTRIC LOCOMOTIVE NO. 4800  
STRASBURG PENNSYLVANIA  
1934-1979

THE 4620-HORSEPOWER GG1 WAS PRIMARILY A PASSENGER LOCOMOTIVE, ROUTINELY OPERATING AT OVER 100-MPH, BUT WAS USED IN FREIGHT SERVICE AS WELL. CONCEIVED BY THE PENNSYLVANIA RAILROAD, AND BUILT BY THE BALDWIN LOCOMOTIVE WORKS AND GENERAL ELECTRIC COMPANY, NO. 4800 LOGGED NEARLY 5 MILLION MILES IN ITS 45-YEAR LIFE. IT WAS THE PROTOTYPE FOR A 139-UNIT FLEET BUILT DURING A DECADE TO SERVE ON THE PRR'S ELECTRIFIED LINES, AND THE ONLY ONE WITH RIVETED BODY SHELL, THE REMAINDER WERE WELDED. THE STUNNING SUCCESS OF THE GG1 CLASS WAS DUE IN LARGE PART TO ITS FLEXIBLE SUSPENSION SYSTEM, WHICH PROVIDED FULL AND EQUAL TRACTION FOR ALL DRIVERS REGARDLESS OF TRACK CONDITION.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS - 1983

The GG1 4800 Electric Locomotive is the 65th National landmark to be designated since the program began in 1973. Since then 11 International Landmarks and 5 Regional Landmarks have been recognized by the Society. Each represents a progressive step in the evolution of mechanical engineering and each reflects its influence on society, whether it is of significance in its immediate locale, in the country, or throughout the world. For more information about this and other programs sponsored by the ASME National History and Heritage Committee, please contact the ASME Public Information Department, 345 E. 47th St., New York, NY 10017 (212/705-7740).

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