



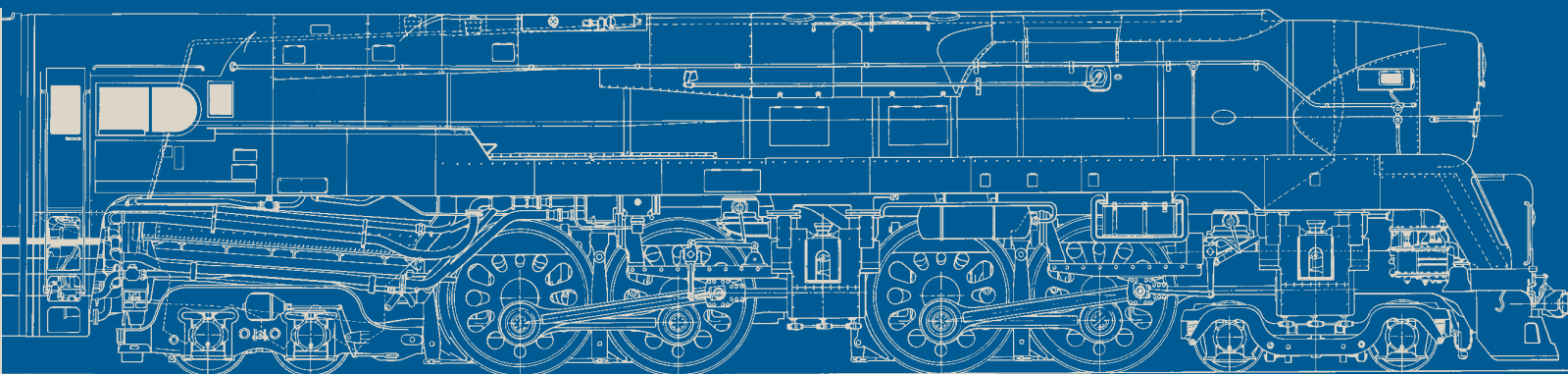
C&O HISTORY

THE CHESAPEAKE & OHIO HISTORICAL MAGAZINE

May 2005 \$5.95



Off the Beaten Path: Pere Marquette (and Pennsy) Steam on the C&O in Virginia



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On the Cover

C&O 2-8-4 No. 2696 (ex-Pere Marquette 1212) at the Gladstone, Va., engine terminal during its sojourn to Virginia and use on James River line coal trains in the last days of steam. More exotic visitors had come to the C&O's Virginia operations in 1946, when a pair of PRR T1 4-4-4s were evaluated. (Jack Manner; C&OHS Collection; PRR T1 drawing by Robert L. Hundman, © Hundman Publishing 1982, reproduced with permission)

C&OHS Calendar

Shows and events of interest to C&OHS members. Contact the editor to have a listing added.

2005 C&OHS Conference and Modeling Symposium	Cumberland, MD	July 20-24, 2005
C&OHS Archives Fall Work Session	Clifton Forge, VA	Sept. 28-Oct. 1/05

The CAN-DO Campaign

Soon, you will receive a letter and brochure announcing the 2005 CAN-DO Campaign. This is the new fundraising program developed by the Society's Board of Directors to provide for charitable giving to the Society's Endowment Fund. The Board established the endowment fund last year along with an investment policy to put the Society on the road to financial stability. The fund will allow the Society to continue to operate in a businesslike manner, create books and publications, and provide financial security for the future. The board established firm guidelines for utilizing the Endowment Fund for the good of the Society.

The CAN-DO Campaign replaces The 490 Club. All 490 Club members will automatically be enrolled in the campaign. All donations will help grow the Endowment Fund. Please take the time to read the campaign literature and make a decision to help the Society continue to meet its mission. All donations are tax

deductible. We have developed some unique gifts for donors that are unavailable for purchase anywhere. An example of this is a two-DVD set of digitally recorded C&O Engineering Department 16mm films from the 1950s. Most footage was shot out of the window of a GP9 or F7. These DVDs are available to donors giving \$250 or more per year. Please refer to the brochure for all the available donor gifts.

Please consider making an annual pledge to the Endowment Fund. Your pledge can be given in a single check, or quarterly throughout the year. The Society will be hosting a reception at the upcoming conference in Cumberland for donors and prospective donors to the CAN-DO Campaign. I hope to see you there.

Remember, a strong and bright future for our organization depends on its financial security. Thank you.

—Dan Navarre

2005 CAN-DO Campaign Chairman
Member, Board of Directors

Contributing to C&O HISTORY

Is there an aspect of the C&O's rich and varied history that you'd like to see presented in these pages?

Why not consider preparing an article and sharing your interest with the readers of **C&O HISTORY**? Authors can rely on the Society's Archives for reference and photographic assistance in article preparation, and the editorial staff can help turn your ideas into a published reality.

We can accept text submissions in almost any format, from typewritten to PC or Mac files and e-mail. Complete "packages"—with finalized electronic *and* hard-copy text, "camera-ready" diagrams and/or maps, and original photos—are ideal.

Short articles often find their way into print faster than major features; either way, it's a good idea to contact the editor before getting started.

—Kevin Holland

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S.S. Badger to Get a Face Lift

from the *Milwaukee Journal Sentinel*,

Apr. 15, 2005, submitted by Russ Schroeder

Battling to keep its hold on the newly competitive Lake Michigan ferry market, the parent company of the *S.S. Badger* has invested more than \$100,000 in renovations to the 52-year-old vessel.

The *Badger's* owners also announced a slight fare increase and—in a none-too-subtle swipe at their high-speed rival, the *Lake Express*—touted their car ferry's reliability.

This season's ferry service will start May 12 for the *Badger*, which runs between Manitowoc, Wis., and Ludington, Mich., at 18 m.p.h. Two days later, the *Lake Express* will start its second season of 40-m.p.h. service between Milwaukee and Muskegon, Mich.

Last year, the *Lake Express* cut into the *Badger's* passenger total, although bad weather and high gas prices probably also depressed travel, said Lynda Daugherty, spokeswoman for the *Badger's* owner, Lake Michigan Carferry Service. The *Badger* and *Lake Express* don't release specific passenger figures, although both claim to carry more than 100,000 passengers a year.

This year, *Badger* passengers will find the vessel has been redecorated and repainted, with a nautical theme in the decor and new crew uniforms, Daugherty said. The *Badger* is also catering more to children and pets, she said.

The *Badger* upgrade follows an announcement that the *Lake Express* is upgrading its first-class cabins. The *Badger* owners said they were stressing the "cruise experience" aboard their larger vessel. The *Lake Express* originally focused its marketing on speed and convenience but now notes that its passengers have said they want the trip to be more a part of their vacation experience.

Last year, in the first year of competition from the *Lake Express*, the *Badger* didn't raise its prices. This year, Daugherty said, rising fuel costs have forced a fare increase.

For spring and fall trips, adult fares are rising from \$44 to \$47 one-way and from \$72 to \$78 round trip. For summer trips, adult fares are rising from \$47 to \$49 one-way and from \$78 to \$82 round trip. For cars, the fare is up from \$49 to \$53 each way.

The *Lake Express* didn't raise its base fares—\$50 one-way, \$85 round trip and \$59

each way for cars—but added a "fuel surcharge" of \$1.25 per passenger each way.

In another sign of the competition, the *Badger* is stressing that it didn't miss any scheduled sailings during 2004. That was a clear reference to the *Lake Express*, which canceled 11 of 295 round trips through September 8 of last year, mainly because of rough seas. The *Lake Express* has never disclosed the total number of trips canceled in the first season which ran through October 31. But it is spending \$450,000 on new stabilizers to provide a smoother ride.

[Editor's Note: The *S.S. Badger* is, of course, the former C&O vessel of the same name. Its new competitor, the *Lake Express*, is a high-speed diesel catamaran.—KJH]

Concern About Amtrak

from the Ashland, Ky., *Daily Independent*, Mar. 21, 2005, submitted by George Greene

Local officials have expressed concerns about the future of Amtrak's *Cardinal* now that it appears the federal funding that subsidizes the rail transport company could be in jeopardy. Concerns stem from a proposal by President Bush to cut the \$1.2 billion Amtrak subsidy from the federal budget, a move some lawmakers have said could be the death knell for the company. The U.S. Senate has voted against an amendment from Sen. Robert Byrd (D-West Virginia), that would have earmarked funding for Amtrak. "Without the federal subsidy, it doesn't have enough money to run itself," said state Rep. Tanya Pullin (D-South Shore). "I was very sad to hear it."

The local legislator authored a state resolution urging the state's congressional delegation to preserve Amtrak's northeastern Kentucky route running from Chicago to Washington, D.C.

Ashland City Commissioner Don Maxwell said the issue over keeping the *Cardinal* is nothing new. In fact, he noted, local officials have been battling the federal government over Amtrak funding since 1980, when cuts were first proposed. As executive director of the Collis P. Huntington Railroad Historical Society in Huntington, Maxwell said experience with the industry has taught him the fight could last at least several months. "It will probably drag on until October when current funding runs out," said Maxwell. "There should be no threat to our service until that time."

In Ashland, where the city has spent about \$1 million in recent years moving and

renovating its Amtrak station, other local officials have been vocal on the matter. The Ashland Board of City Commissioners recently passed its own resolution supporting preservation of the line by calling on the federal government to supply \$1.8 billion in funding for fiscal year 2006. "...The national Amtrak system has been undercapitalized for decades, passenger rail has not been provided with a dedicated and secure source of funding as enjoyed by other modes of transportation," the resolution stated, "and passenger rail has not been supported as have many other nations' systems."

Maxwell still sees reason to remain optimistic about Amtrak's future. He noted the U.S. House of Representatives passed its own resolution to provide funding for Amtrak, meaning senators will have to come up with some counter proposal in their own budget plan.

He said preserving Amtrak is a worthwhile endeavor, particularly in light of the growing number of people who are opting against using airlines as a means of travel.

Prospect (Ohio) Depot Takes On New Role


from the *Columbus Dispatch*,

Dec.26, 2004, submitted by Ronald Weaver

Unused since 1999, the former depot in this southern Marion County village will take on a new life when Mary Arledge opens the railroad-themed Hocking Valley Train Station Restaurant she's managing.

The C&O closed the depot in 1973. A local group later raised money to save the structure from sale or donation to Carillon Park in Dayton. Arnold Joseph, a former mayor, bought the building, moved it two miles to its present location, restored and filled it with all sorts of things beloved by train buffs.

Another train-themed restaurant operated in the depot until five years ago, but the building has been empty since then. Mayor Sandee Lauer and her husband, Kim, bought the complete package, including the memorabilia Joseph amassed for more than 30 years.

Servers will wear uniforms made of bibbed-overall material and cooks will wear conductor's hats. The walls and shelves are covered with photographs, train schedules, railroad spikes, whistles and replica engines. "There's no doubting it's a train station," said Kate Lauer. Since her son and daughter-in-law bought the building in August, she has helped Arledge prepare to open. 

Locomotive histories do not normally involve the interrelationship of between-carrier competition, technology change, corporate policy and politics, economics, finance, engineering, and operations. During their relatively short lives, the Pennsylvania Railroad (PRR) T1s were surrounded by all of this, simultaneously. They were different in more than just appearance.

T1 history has taken some unusual turns since the arrival of the two prototypes in 1942. Initially, reporting on the T1 was reasonably balanced. However, for about 30 years, most popular publications

were not very accurate. Research seemed sketchy, perhaps due to an absence of source documents. The same, sometimes incorrect, anecdotes were repeated over and over and the locomotives' history suffered as a result. More recently, as railroad historical societies catalog more of their archives, considerable new information has become available and more moderate conclusions are developing. Current findings indicate the T1 was not as unusual as we thought.

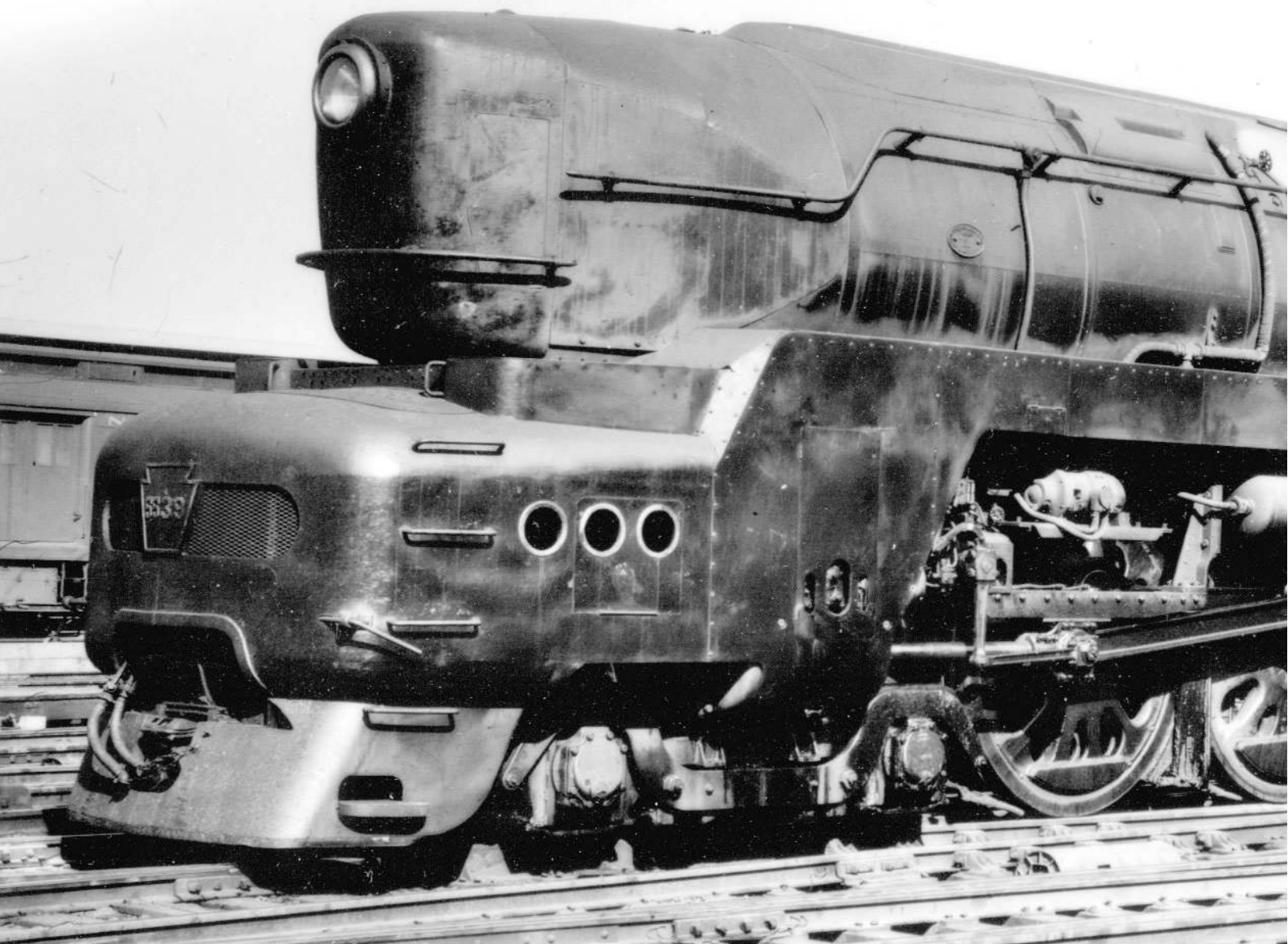
The C&O test report contains information that is not widely known, and some of it contradicts generally accepted beliefs about the T1:

- They handled trains well, particularly at higher speeds.
- They kept schedule and made up delays on most runs.
- They had no excessive tendency to slip.
- The stall at Waynesboro was caused by overloading.

A brief history of the PRR T1

The duplex-drive concept was developed by Baldwin as a solution to steam distribution and dynamic augment problems inherent in large 4-8-4s. It was a valid concern in the 1930s as the machinery parts of 4-8-4s became larger in the quest for more power. Large pistons and main

Chesapeake & Ohio Tests



rods were difficult to balance, and standard piston valves were not efficient at handling large steam flows at high speeds. The duplex design spread power generation over four smaller cylinders and lighter machinery. The idea was to obtain more efficient steam usage and have a locomotive that would be easier on the track structure. This would benefit the railroad by reducing fuel and water usage as well as track maintenance costs.

The duplex concept was valid from an engineering standpoint, but like most improvements it had consequences that may not have been considered in the initial stages of development. A pair of two-axle

engines is inherently sensitive to rail conditions, so particular attention would have to be given to locomotive components (e.g., suspension, sanding), the railroad's physical plant, and proper handling methods. A duplex needed good rail contact and skillful operation to realize the benefits of the design. For these reasons, locomotive and track structure condition were more important than they would be for conventional locomotives. This attention was not free, and performance would have to be good enough to justify the expense.

In PRR's case, if it did not provide the proper conditions for the T1s' operation, it would not realize the advantages attrib-

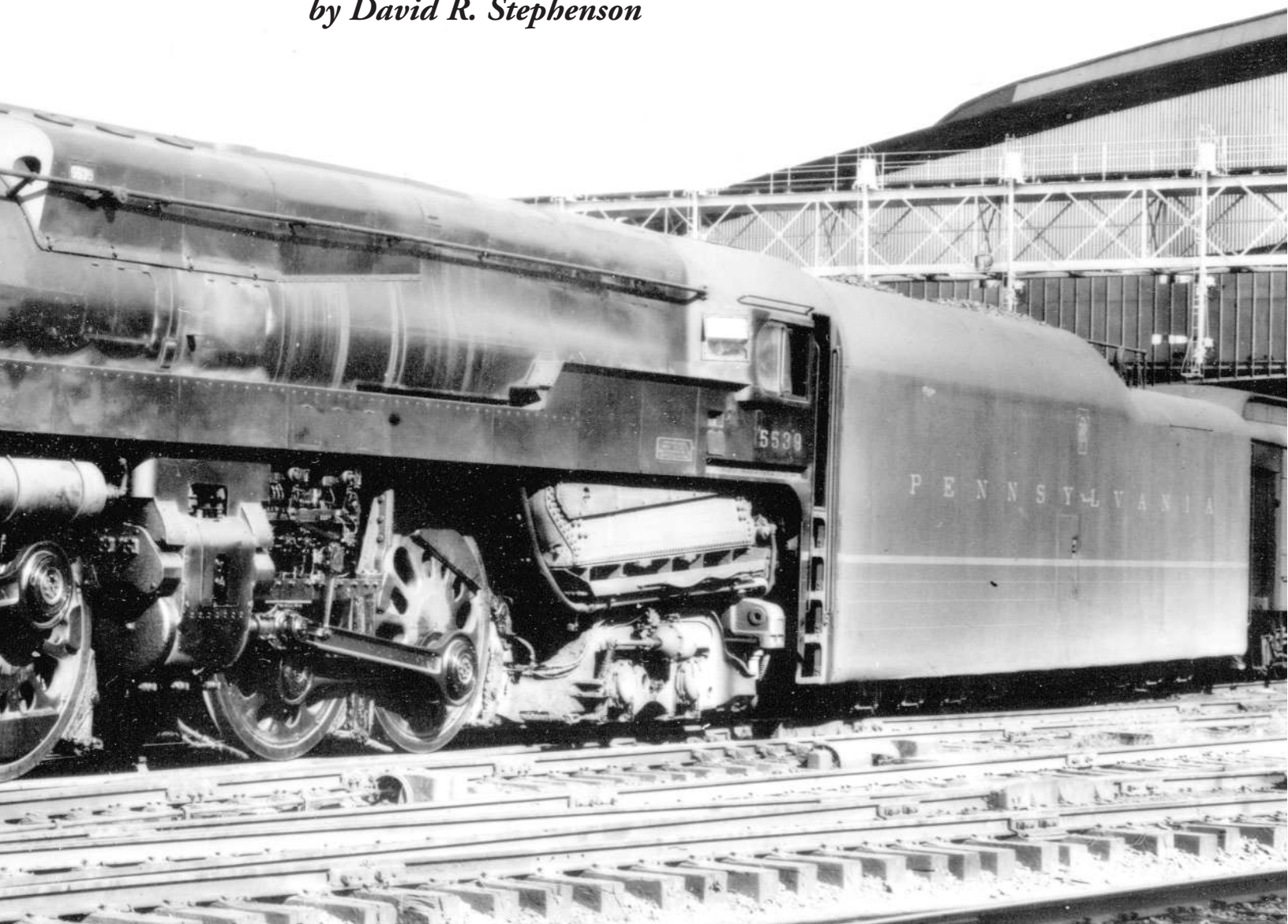
uted to the design. There are examples which demonstrate that the T1 could produce exceptional performance with proper handling, preparation, and maintenance. Equally, if neglected and operated improperly, it would not perform as intended. This is the nature of all complex and powerful machinery: if you don't (or won't) operate it properly, you will not get the benefits.

The T1 has been endlessly called slippery. Part of this legend is true—the two prototypes *were* slippery for various reasons, some silly, some serious. It is also unarguable that the T1 could be more prone to slip compared to a conventional

the PRR T1

Just weeks after completing a series of test trips on the C&O, Pennsylvania Railroad T1 4-4-4-4 No. 5539 was back in the service of its owner, awaiting a morning departure from St. Louis Union Station on October 4, 1946. (J. R. Quinn Collection)

by David R. Stephenson



4-8-4 under identical rail conditions. This is a disadvantage of the duplex drive concept and cannot be ignored or dismissed. A conventional 4-8-4 will always have better adhesion under highly variable rail conditions. If a railroad cannot provide good track, consistent maintenance, and competent handling, a duplex will not be a reliable performer. C&O must have been the right combination because neither adhesion nor reliability problems were noted in the test report or subsequent correspondence.

Contrary to some accounts, the T1 was not intended to be the next K4 (PRR's notable 4-6-2) for general service. It was designed to match the performance of the GG1 electric, and to replace doubleheaded K4 power on PRR's "Blue Ribbon" fleet, a group of heavy, limited-stop trains. The T1 was not designed for stop-and-go local service, nor handling heavy grades unassisted. PRR's only significant mainline grade ran west from Altoona to Gallitzin, Pa., and passenger trains of any size were always assisted over this short section.

The T1s' unique appearance may have contributed to the legends surrounding these locomotives. Early descriptions of the T1 were as flamboyant as its styling. Over the years, some anecdotes reached mythic proportions, with just about as much basis in fact. Some considered it the next evolutionary step over the general purpose 4-8-4. It wasn't. The T1 as built for PRR was optimized for specific service requirements. It was not a go-anywhere, do-everything design, which restricted its adaptability and desirability to other roads. This would first be confirmed on C&O and reinforced two years later on N&W.

PRR's interest in having C&O test the T1

For all practical purposes, the T1 was out of a job at the time the production order for 50 was completed in 1946. Dieselization of PRR's first-class trains was underway in response to significant postwar financial problems and competitive pressures from New York Central. PRR had to lower operating costs immediately, and diesels were one of several ways to accomplish that goal. Once PRR made the commitment to dieselize, it tried to find an application for the T1 on roads still committed to coal burning steam locomotives such as C&O. If the virtually-new T1s could be sold, PRR would be able to reduce its losses.

C&O's purpose in testing the T1

C&O had its own reasons to be interested. It had two groups of 4-8-4s on the property in late 1946. Although specifications were similar, the second group was heavier than the first (see Table 1, below). All were built with friction bearings (except for the engine truck) and bar frames. During World War II they were equipped with roller-bearing driving axles. In spite of these improvements, the J3s were showing signs of their extensive use in the early postwar period. In addition, the older 4-6-2s and 4-8-2s were almost completely worn out by this time. Although passenger traffic was declining, C&O decided to increase its passenger fleet. It was time for new locomotives.

According to Chief Mechanical Officer C. B. Hitch, C&O was looking for a locomotive which could handle principal passenger trains between Charlottesville, Virginia, Cincinnati, and Toledo, Ohio. The 175 miles west of Charlottesville was through mountainous territory, having sustained grades of 1.42% to 1.55% eastbound and 1.52% westbound. The remainder of the routes to Cincinnati and Toledo were in relatively flat country. Published data indicated that the T1 might be suitable for service on both flat and mountainous territory, with a few minor modifications. However, some of this data did not reflect the specifications of the tested locomotives or over-the-road performance capability.

At the time of the tests, Chesapeake & Ohio was using both 4-8-4s and 4-6-4s, and having one class of locomotive to do both jobs would have been an improvement. This was the reason C&O wanted to make the test. Consequently, two T1s were borrowed from the Pennsylvania Railroad from September 4 through September 14, 1946, and tested to determine their suitability to meet C&O's operating conditions.

Specifications

Table 1, below, lists the specifications of both classes of C&O's 4-8-4s in service in 1946 with those of a production-lot T1.

A quick glance indicates that the C&O J3s and the PRR T1 were fairly similar with respect to engine weight, weight on drivers, grate area and engine tractive effort. A closer look, however, reveals a substantial difference in total tractive effort because the C&O J3s were equipped with boosters.

Description of tests

PRR 5511 was the first T1 loaned to the C&O for the test program, and received its initial assignment at Huntington, W. Va., on September 4, 1946. Before completion of the test runs, PRR recalled the locomotive on September 7, 1946, and replaced it with 5539 on September 11, 1946. T1 No. 5539 left C&O after a final run to Cincinnati on September 14, 1946.

TABLE 1 Mechanical Specifications of C&O 4-8-4s and PRR T1

	C&O J3 600-604	C&O J3 605-606	PRR T1 5539
Wheel arrangement	4-8-4	4-8-4	4-4-4-4
Cylinder, bore and stroke	27.5" x 30"	27.5" x 30"	19-3/4" x 26"
Boiler pressure, psi	255	255	300
Driver diameter	72"	72"	80"
Tractive effort, engine, lbs	66,450	66,450	64,650
Tractive effort, booster, lbs	14,355	14,355	none
Tractive effort, total, lbs	80,805	80,805	64,650
Direct heating surface, sq. ft.	525	519	490
Indirect heating surface, sq. ft.	4,937	4,974	3,719
Total evap. htg. surface, sq. ft.	5,462	5,434	4,209
Superheating surface, sq. ft.	2,342	2,315	1,680
Grate area, sq. ft.	100	100	92
Weight on drivers, lbs	278,300	292,800	279,910
Engine weight, lbs	477,000	506,300	508,500
Tender weight, lbs	381,700	388,020	442,500
Total weight, lbs	858,700	894,320	951,000

All tests were conducted in C&O's regular passenger service. No special test runs were made, in contrast to later tests on N&W. No. 5511 was tested from Huntington to Clifton Forge, Clifton Forge to Toledo, and Toledo to Hinton. No. 5539 was tested from Huntington to Charlottesville, and Charlottesville to Cincinnati (See Figure 1).

coal and water used were estimated by the traveling engineer from the PRR, who accompanied the locomotives on all test runs. Summary data for these items were included in the test report.

C&O stated that the locomotives were worked at maximum capacity when accelerating from a stop and on grades where the train speed fell below the allow-

when starting or at low speeds is not clear.

Results of tests

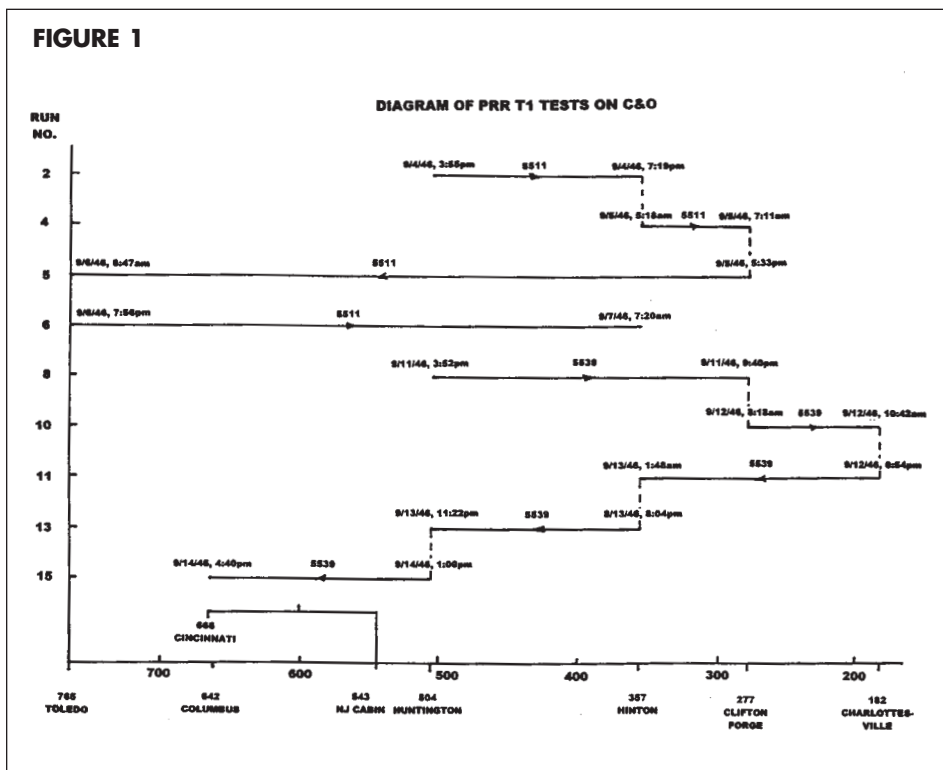
Although the PRR T1 was designed to haul a trailing load of 880 tons on level tangent track at a speed of 100 miles per hour, C&O noted that it was not possible to test the locomotive at its design speed due to restrictions. Nonetheless, there are many examples of 80+ mph running between South Portsmouth and Newport, and one 82.5 mph reading between MP 583 and MP 584.

The T1s were not equipped with boosters, which made them slower in starting than C&O's 4-8-4s. In spite of that, C&O noted that no trouble was experienced in getting away from stations with any train handled with the exception of Train No. 46 at Waynesboro, where the grade is 1.31%, and Train No. 1 leaving Craigsville side track where the grade is 1.44%. At Waynesboro it was necessary to use a pusher and at Craigsville it took ten minutes to start the train.

According to the test report, a maximum starting drawbar pull of 50,245 lbs. was developed with 5539 leaving Clifton Forge. This same engine also developed a drawbar pull of 50,276 lbs. near MP 245 west of Craigsville, at a speed of 6-1/2 miles per hour. A maximum drawbar horsepower reading of 5,012 was developed climbing North Mountain near MP 240 (Augusta Springs) at a speed of 42.5 miles per hour on a grade of 1.35%. None of these numbers was corrected for acceleration.

Analysis of results

Over the years, the T1s' performance during the C&O tests has been described



C&O dynamometer car DM-1 was used to record data related to drawbar pull, speed and milepost location. C&O made corrections to the dynamometer readings which reflected the effects of grade resistance on the locomotive. However, it did not make similar corrections for curve resistance or acceleration. The amounts of

able maximum. There was no back pressure gauge or similar device on the locomotives to indicate the rate of working. Consequently, they were worked with a full throttle and the shortest cut-off at which boiler steam pressure and water supply could be maintained. Whether this means that full throttle was always used

TABLE 2 PRR T1 Test Run Synopsis

Run No.	Hours Allowed	Hours Used	Difference (Minutes)	Comments
Run 2	3.55	3.40	9	Time recovered—train received late, arrived Hinton on time.
Run 4	2.17	1.88	17	Time recovered—train received late, made up time.
Run 5	12.42	13.23	- 49	Time lost—train received late, arrived Alderson on time, lost time at stations after that.
Run 6	10.03	11.40	- 82	Time lost—train received late, lost time at stations.
Run 8	5.87	5.79	5	Time recovered—train received late, arrived Clifton Forge on time.
Run 10	2.58	2.53	4	Time recovered—train received late, lost time at Waynesboro, made up all lost time.
Run 11	4.75	4.90	- 9	Time lost—train received late, lost time starting at Craigsville, made up all but one minute of running time, lost time at station stop.
Run 13	3.33	3.30	2	Time recovered—train received late, made up time.
Run 15	4.03	3.67	22	Time recovered—train received very late, made up time.

unfavorably. Nothing in the test report supports this negativism. The test report shows that overall performance was good to commendable. According to Mr. Hitch, both locomotives steamed well, rode well and showed no excessive tendency to slip. The T1s handled C&O's assignments well with two exceptions, one clearly beyond the capacity of the locomotive and the other a marginal capacity situation. They kept the schedule, and when assigned to already-late trains, made up running time (see Table 2, previous page).

Problems did occur. Time was lost due to the starting problems at Waynesboro but the T1 recovered the delay by the end of the run. Time was also lost due to a similar situation at Craigsville, and in this case the T1 made up all but one minute of lost running time by the end of its assignment. On some runs, there were several lengthy delays en route, but they were due to excessive station time or unexplained stops. None were listed as chargeable to the locomotive.

Overall, time was recovered on six of the nine runs. On Run 11, nine minutes were lost attributable to the locomotive and a long station stop at Clifton Forge. On Runs 5 and 6, 131 minutes were lost attributable to long station stops and other causes. Timetables from August 18, 1946, and October 20, 1946, were used to make this comparison.

C&O criticisms of T1 performance

Chesapeake & Ohio criticized the PRR T1s' performance in two related areas: low drawbar pull at low speeds and sluggish acceleration from stops.

C&O observed that the T1s were not achieving their rated drawbar pull when starting and at speeds below 40 mph. It referred to Baldwin data, specifically a curve presented by Ralph Johnson at the New York Railroad Club on May 17, 1945. This curve was not included in the test report.

There are several possibilities to explain this condition. First, C&O did not correct their dynamometer car readings for acceleration, which would understate actual drawbar pull developed by the T1. This alone would produce variances between dynamometer readings and published information, C&O's two reference sources. After making this correction, drawbar pull and horsepower would be different (both higher and lower). But why bother to make such a correction?

A dynamometer reading does not consider that the locomotive must expend some of its power to accelerate itself as well as the train, and a locomotive's mass is considerable. The dynamometer has no way of measuring this force. Without knowing the total amount of power being expended to accelerate both the locomotive and train, a reasonable estimate of locomotive power cannot be obtained. Generally this problem is avoided by using specific testing methods.

Dynamometer cars measure locomotive drawbar pull most accurately when speed is constant. This can be achieved several ways. Braking locomotives were frequently used during tests, located behind the dynamometer car and considered part of the trailing tonnage. Train brakes were applied to hold the speed constant. Another way was to ballast the train with additional cars, so that the locomotive speed would stabilize at a single value, given the load and grade conditions over the test route. Either way, speed was constant while the dynamometer readings were made. If this is not done as part of the tests, the drawbar pull reading will not reflect the locomotive's actual performance.

However, none of the constant speed methods are appropriate for use in normal passenger service where speeds are variable and a schedule must be maintained. As a result, some adjustments must be made to get realistic information. Unfortunately, these adjustments can be very approximate, particularly where large changes of speed and drawbar pull occur between recorded data points. But this is the hand

that history has dealt, so we have to make the best of it.

Adding this component to the analysis does not indicate that C&O engaged in unsound testing methods, because few railroads corrected their dynamometer car data for acceleration. The relatively large excess drawbar pull of passenger locomotives is used to start trains rapidly and recover from slow orders with minimal delay. As an initial step, I corrected all maximum drawbar pull readings for acceleration, both starting and at speed, in an attempt to obtain more reasonable results (see Table 3 and Figure 2, below).

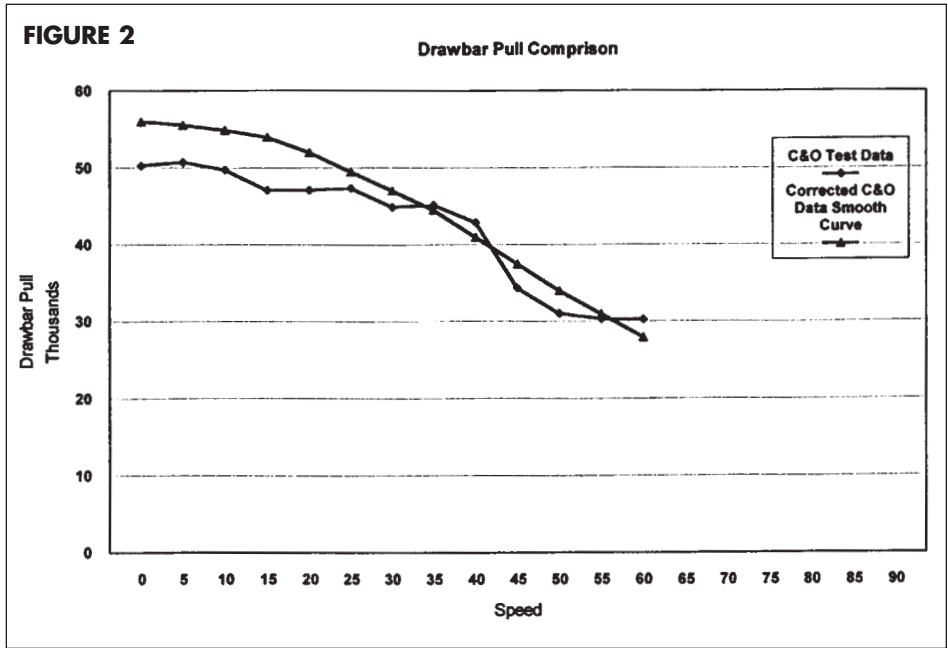
Corrections below 30 mph are generally computed over large speed differentials. Adjustments of this sort reflect broad averages and are less accurate than those computed using smaller speed changes.

As you can see, these corrections answer part of the question. The T1 did better than the 50,245 lbs attributed to it

TABLE 3

Maximum Drawbar Pull Ratings

Speed	C&O Test Data	Corrected for Acceleration
0 mph	50,245	55,844
10	49,726	54,000
20	47,065	51,000
30	44,933	50,204
40	42,891	40,933
50	31,047	34,000
60	30,311	28,000



by C&O's dynamometer car readings. The actual maximum drawbar pull was closer to 56,000 lbs. But if rail conditions permitted and peak drawbar pull could be developed, the actual result should be in the range of 60,000 to 61,000 lbs. Why is there still a difference?

We will have to look other possibilities to determine what the cause may have been, and enter the dreaded area of speculation. This is where most of the mischief to the T1s' history has been done. However, there are some consistent facts to keep in mind during this process.

Both T1s produced similar maximum corrected DB pull readings when starting: No. 5511—54,035 lbs leaving White Sulphur Springs; No. 5539—55,884 lbs leaving Clifton Forge.

Operating conditions were also remarkably similar. Both trains contained 11 cars, weighing 923 and 946 tons, and grades were 0.50% and 0.56% ascending.

Part-throttle starts may have been used. The test reports notes that a PRR traveling engineer was on board for all test runs. PRR enginemen have said that the best way to operate the T1 was to use light throttle when starting up to about 25 mph, then use whatever throttle setting is appropriate. There's a good reason for this. The tractive effort of a steam locomotive varies significantly over one revolution of the drivers. In the case of the T1, rated tractive effort is 64,500 lbs, which is an average value. This value is based on 32,250 lbs for each engine set. Actual tractive effort varies from about 26,000 lbs to 39,000 lbs for each engine. This variation is applicable to any locomotive, but it can produce unique control problems in a four-cylinder locomotive. If too much steam is supplied from the throttle, one of the engines may slip while the other does not. In order to avoid this problem, the locomotive is best started on part throttle to get the two engine sets in motion. This approach will reduce useless slipping while getting under way. It will also produce a drawbar pull that is less than the rated amount at very low speeds. This may be what the dynamometer car was recording. However, recall that C&O specifically stated the locomotives were worked at maximum capacity when accelerating from a stop. Whether the enginemen were making exceptions to this procedure based on local conditions and their experience, we don't know, so available evidence is inconclusive.



PRR T1 No. 5511 paused at Clifton Forge, Va., during testing on the C&O in September 1946. This locomotive operated on the C&O between September 4 and 7, at which time it was recalled by the Pennsy. Its replacement, PRR No. 5539, tested on the C&O between September 11 and 14. Note the modified front-end treatment applied to this locomotive, as compared with the original portholed configuration visible in the portrait of PRR No. 5539 on pages 4-5. (C&OHS Collection)

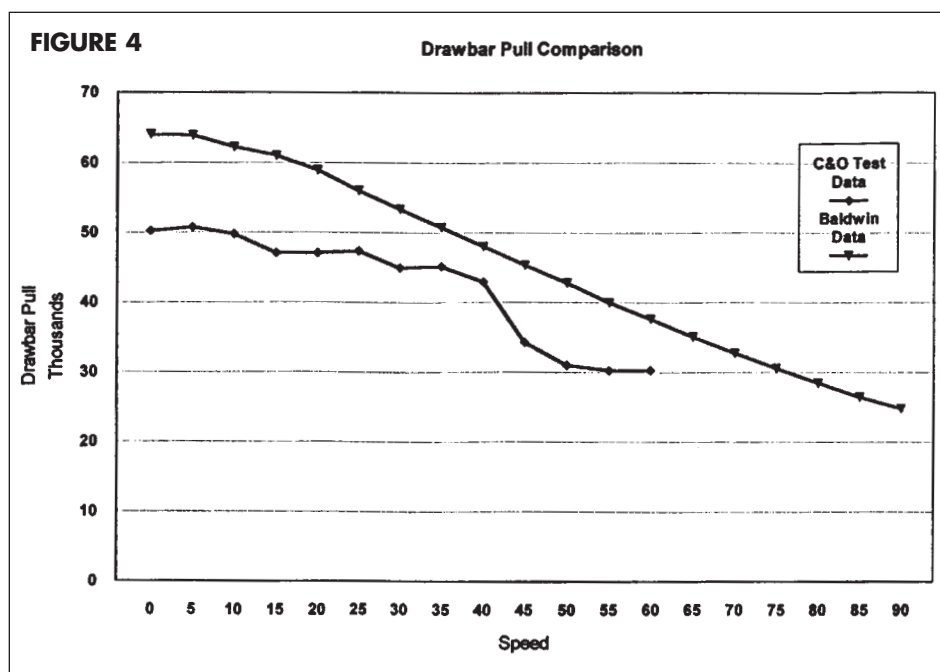
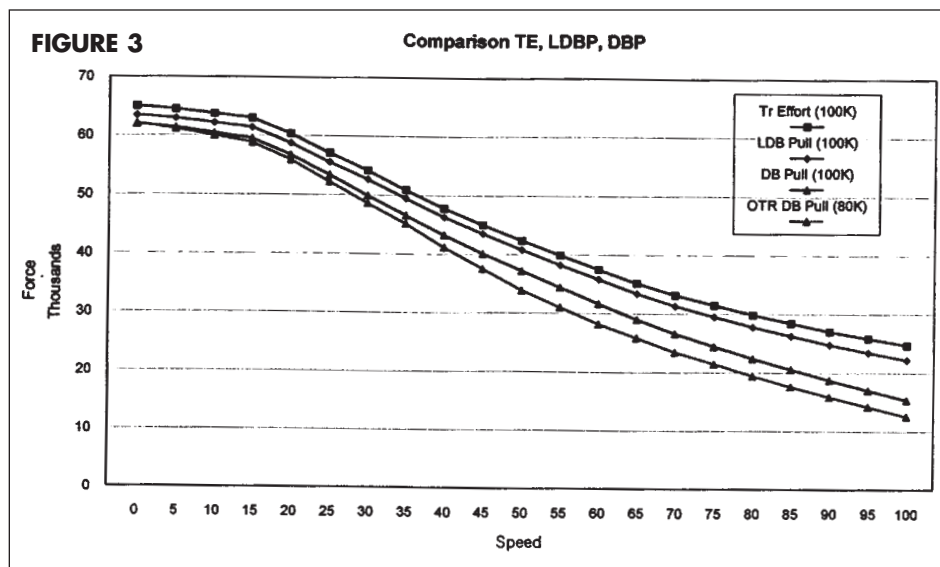
More likely, C&O based its opinion on inappropriate information. Although certain curves are mentioned in C&O correspondence to PRR, the attachments have not been found. There are several possibilities: (1) the use of a drawbar pull curve presented by Baldwin, (2) the use of other curves that may have been part of the same presentation, or (3) curves that are not described and are, therefore, unknown.

C&O cites data obtained from the Baldwin Locomotive Works' report covering the Pennsylvania tests, presented before the New York Railroad Club by Ralph Johnson on May 17, 1945. A curve labeled drawbar pull and drawbar horsepower was used during this presentation. At first glance this seems to be comparable to what would be developed during dynamometer car testing in over-the-road service. However, this curve was developed from Altoona test plant data in 1944, and is the same as a graph presented in the PRR test report (Altoona Report, Figure 77, page 100). This graph illustrates locomotive drawbar horsepower (LDBHP) and drawbar pull, and they are not measured at the rear of the tender. Data such as this are useful in analyzing locomotive performance, but the results do not include

rolling resistance of the locomotive and tender, nor wind resistance. Both are significant factors.

The "drawbar" distinction is important. Locomotive drawbar pull (LDBP) is always higher than drawbar pull (DBP) at the rear of the tender, the property which a dynamometer car measures. If C&O used LDBP as a standard of comparison, it was overstated for two reasons. First, it was based on much higher evaporation and firing rates than would normally be achieved during over-the-road dynamometer tests. Second, C&O may have been misled by the term drawbar without additional explanation as to where it was measured. This is an example of terminology taken out of context. Generally, drawbar means at the rear of the tender. However, when considering PRR data, an extra step is required.

To further complicate matters, the Baldwin graph of LDBP and LDBHP is corrected to 100,000 lbs steam per hour because this was a standardized measurement used by PRR in its test plant analysis. If Baldwin claimed the graph was representative of what the T1 could do in over-the-road service, it was definitely overstating its case. Actual drawbar horsepower (DBHP) at the rear of the tender,



considering a more realistic evaporation rate, would be less than Baldwin's graph indicated.

In order to determine how much the difference would be, we need to consider the various measurements of horsepower at different locations on a locomotive. This often causes confusion and results in many erroneous comparisons. The importance of adjectives cannot be overstated! (See Figure 3.)

Indicated horsepower is measured in the cylinders. This reflects the best a locomotive can do based on the quality and quantity of steam delivered from the boiler. It is computed using indicator diagrams which measure conditions in the cylinders. C&O did not measure this as far as we can tell. Locomotive drawbar horsepower is measured at the rear of the locomotive. It

is always less than indicated horsepower because it reflects machinery losses. This information is only available from tests where the locomotive is run on a stationary test stand without its tender. The final quantity, drawbar horsepower, is measured at the rear of the tender. This reading is still lower because it reflects machinery losses, rolling resistance of both the locomotive and tender, and air resistance losses. All of these different horsepowers can be compared provided the locomotive is operating under consistent conditions. This is why PRR used a standard of 100,000 lbs of steam per hour for the T1. The highest three curves in Figure 3 reflect this.

In actual service, a T1 could not generate that much steam economically. As discussed earlier, C&O did not gather detailed evaporation data during the tests,

only averages over an entire assignment. However, based on this data, something on the order of about 80,000 lbs of steam per hour would be a reasonable amount when the T1 was working at or near its peak output. The fourth curve approximates the operating conditions during the tests, and would be an indicator of what the dynamometer car would be measuring.

Based on the above explanation, we can see that comparing dynamometer readings of drawbar pull with test plant readings would make the T1 appear deficient when it was not (see Figure 4). If C&O did, in fact, use the Baldwin curve, its comparison would have been based on an inappropriate graph.

Another source was mentioned in C&O's correspondence: Franklin Railway Supply Company's Bulletin No. 26. This document was published sometime after Ralph Johnson's presentation. A review of this source reveals that it, too, reflects results obtained on the Altoona test plant in 1944. As a result, no additional clarifying information can be drawn from it.

Because the test report is inconclusive and other evidence is either inappropriate or contradictory regarding very low speed drawbar pull, I'll have to venture into an area that I don't like very much: opinion. I believe the test data used by C&O was unsuitable for at least two reasons. First, under the testing conditions described, it is not possible for the dynamometer to measure the locomotive's maximum drawbar pull. If it were possible to set the train brakes, open the throttle (without the locomotive slipping or the train moving), a reliable maximum reading could be obtained. However, because the train begins to move almost immediately, the opportunity for a maximum reading vanishes, and the excess drawbar pull is not measured.

Second, excess drawbar pull is reflected in the acceleration rate. Unfortunately, to measure this rate, considerably more data would have to be gathered over the initial mile because of rapid speed changes. Drawbar pull and speed readings would have to be taken frequently in order to get a picture of what was happening. Generally accepted correction methods applied to large increases in speed over relatively long distances become broad averages, which by their nature, do not reflect specific conditions. As a result, criticisms made by C&O may reflect their experience, but they are not supported by test data.

Typical drawbar horsepower curves from test data

To sum up the results of the test runs, I've compared drawbar horsepower from the test data and test data corrected for acceleration (see Figure 5). There is no reliable data above 60 mph that would reflect maximum or near-maximum capacity working, so the curves are truncated at that speed. Nonetheless, the corrected curve shows a maximum drawbar horsepower reading of about 4,600 at 50 mph. This may not sound very spectacular compared to some of the numbers that have been used or misused in the past, but this is sustainable, over-the-road drawbar horsepower at the rear of the tender, the most conservative possible measurement. For additional perspective, I've included several DBHP curves, which reflect the results of different methods and sources: C&O test data, C&O corrected data, results obtained on N&W, and an average curve incorporating several different methods of estimating DBHP (see Figure 6). From this comparison, you can see that the over-the-road horsepower curves are very similar and tend to follow the same pattern, indicating that the C&O, N&W and average curves are realistic. For contrast, I've also included the previously discussed Baldwin curve which reflects LDBHP. It indicates how overstated the Baldwin curve would be if it were used as a standard of measurement for dynamometer tests.

Maximum drawbar horsepower readings are always of considerable interest, but taken out of context they can be deceptive. The highest reading for the entire test was 5,012 DBHP at 42.5 mph, achieved climbing North Mountain on Run 10. However, in order for this figure to reflect actual conditions at that point, it needs to be corrected for acceleration, or in this case deceleration. Because the T1 was gradually slowing on the grade, the corrected reading would be about 4,850 DBHP, still a respectable number.

Problem areas

Although the T1 generally performed satisfactorily, there were two incidents on the Mountain Subdivision which indicated that C&O needed more capability for this difficult stretch than the T1 had to offer. First, we have to clear up one piece of misinformation that has plagued T1 history for many years: the stop at Cotton Hill.

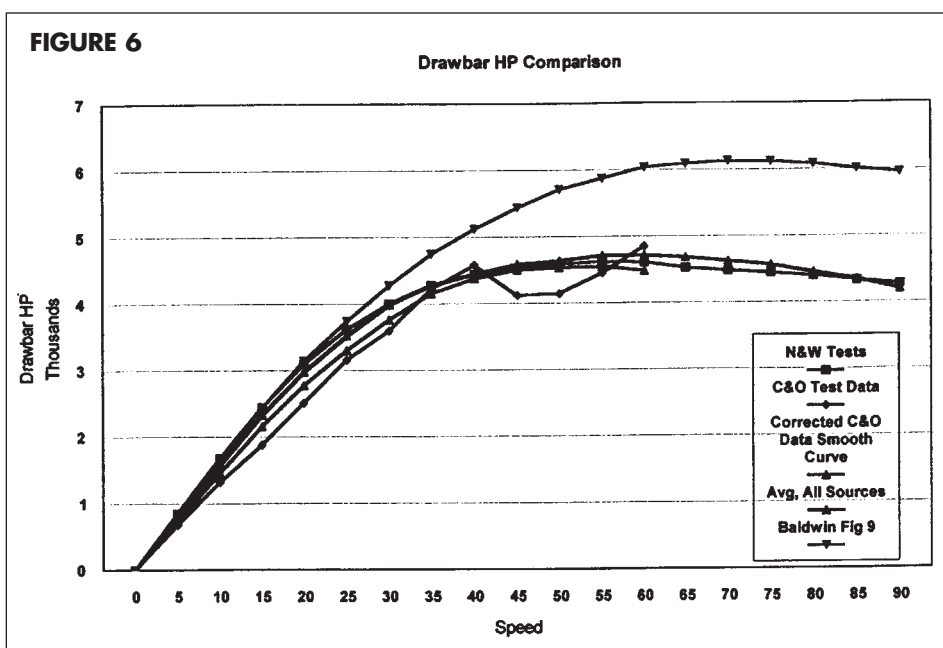
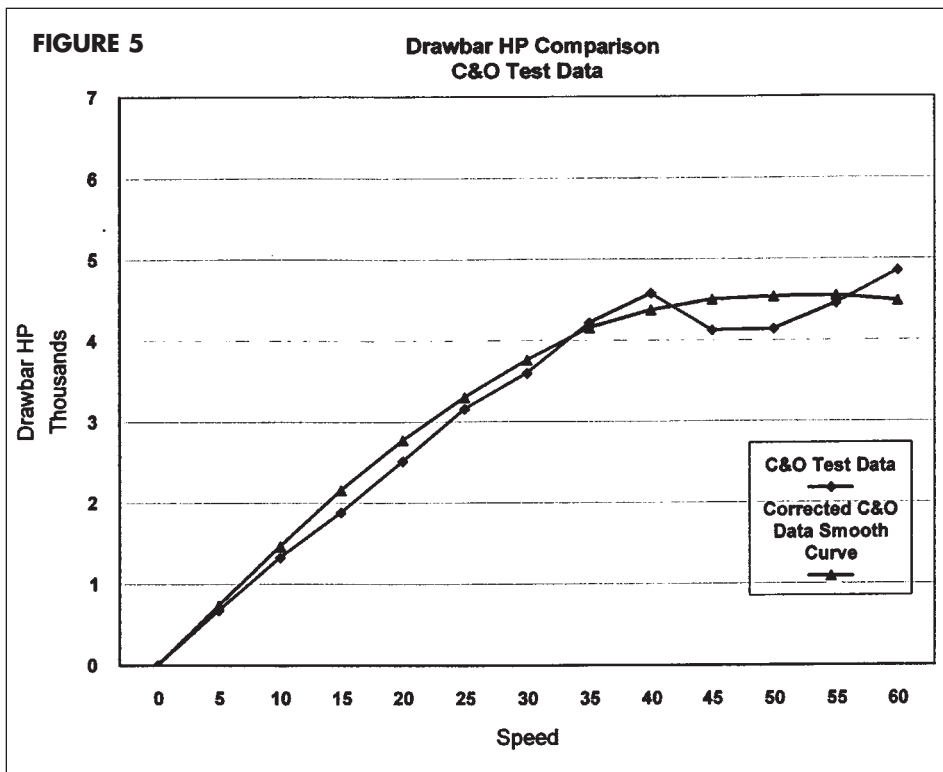
Eastbound at Cotton Hill

In *C&O Power* (Stauffer, Shuster and Huddleston) the T1 is described as being unable to start the eastbound *FFV* at Cotton Hill with a train of 14 cars. Considerable slipping is described in the attempt to start the train. Relief power was dispatched from Handley to get the train moving. This description has been widely quoted since its publication in 1965. Unfortunately, it was incorrect.

To his considerable credit, Dr. Eugene Huddleston, one of the co-authors of *C&O Power*, revised this description in

his book *Riding that New River Train*. There he stated that the stall occurred at Waynesboro, Va., not Cotton Hill. He also noted that the grade was considerably more difficult. Regrettably, this book has not been as widely read as *C&O Power*, and his change may have gone unnoticed.

Consequently, the circumstances surrounding this incident need to be examined. On September 11, PRR T1 5539 was assigned to Train No. 6, the *FFV*, at Huntington for a run to Clifton Forge. The C&O test report and correspondence between C&O and PRR substantiate Dr.





Leading a westbound test run at Clifton Forge in early September 1946, PRR T1 No. 5511 was caught in the shadow of the C&O's under-construction Moderne-influenced coaling station. Had the test results and other subsequent events unfolded differently, could ex-PRR T1 duplexes have led the *Chessie*, in development at the time of the T1 test runs? (C&OHS Collection)

Huddleston's revision. The stop at Cotton Hill was recorded at 30 seconds, with no qualifying remarks. The train made a routine stop, then proceeded on its way east. Nothing untoward happened at Cotton Hill. So where and when did things go bad for the T1?

Eastbound at Waynesboro

The next day, September 12, 1946, 5539 continued its run and was assigned to Train No. 46, the *Sportsman*, from Clifton Forge to Charlottesville, 96 miles east. At Waynesboro, 5539 failed to start its train of 13 cars and 1,098 tons. Contrary to the description found in

C&O Power, C.M.O. Hitch states, "The 5539 did not slip but failed to start the train at Waynesboro after taking slack several times. It was finally necessary to call on a yard engine for assistance, which engine was cut off as soon as the train was well in motion."

A cursory examination indicates the T1 should have been able to start this train. Estimating methods such as Davis equations show total train resistance would have been about 48,000 lbs. The T1 could generate a drawbar pull (at the rear of the tender) of about 61,000 lbs., more than enough to overcome this. But there was another variable to consider.

Photographic evidence suggests most C&O passenger cars in 1946 were equipped with friction bearings. Based on several generally accepted engineering sources, this type of bearing would have added 22,000 lbs. to as much as 31,000 lbs. more starting resistance when the train was stopped. Unless slack could be taken effectively, total train resistance would be about 70,000 lbs. using the lower of the two values to reflect bearing temperature conditions during a brief stop. With the train stretched on the grade, the T1 would be at least 9,000 lbs. short of being able to start (see Figure 7). Apparently attempts to take slack were not successful. Excess starting resistance would win; No. 5539 would lose.

C&O's 4-8-4s could start trains under these conditions because they developed starting tractive effort and drawbar pull that were greater than the T1. Using C&O's locomotive diagrams as a reference, the J3s developed a total starting tractive effort of 80,805 lbs. including booster. In contrast, a T1 develops a starting tractive effort of 64,650 lbs., 20% less than a J3. The starting drawbar pull of the J3 and T1 would be about 77,000 lbs. and 61,000 lbs. respectively. Only T1 6111 would compare favorably with a J3 because its total tractive effort was 78,140 lbs. including a booster. Interestingly, T1 specifications supplied by the AMC in the test report reflected a T1 with booster. C&O may have expected the booster-equipped T1 to be available, but neither of the T1s tested was so equipped.

Based on the above information, it's obvious why a J3 would have had no difficulty starting a 13-car train at Waynesboro. Its drawbar pull would have been more than enough to overcome 70,000 lbs. of starting resistance without taking slack.

Additional insight can be gained by examining what C&O expected of its own passenger locomotives over the Mountain Subdivision. Although C&O's 4-6-4s developed a total tractive effort similar to that of a T1, they were not assigned to this Subdivision. Instead, C&O used three other classes of power: 4-8-2s, 2-8-4s, and 4-8-4s. The J3 4-8-4s in particular were specifically designed for this subdivision.

Text references in *C&O Power* and *Chesapeake & Ohio's Greenbrier Type 4-8-4 Locomotives* state that 14 heavyweight cars were the standard or maximum consist for a single J3. Elsewhere, *C&O Power* and *The Van Sweringen Berkshires* state that

FIGURE 7

**RUN NO. 10, START AT WAYNESBORO, VA
13 CARS, 1,098 tons**

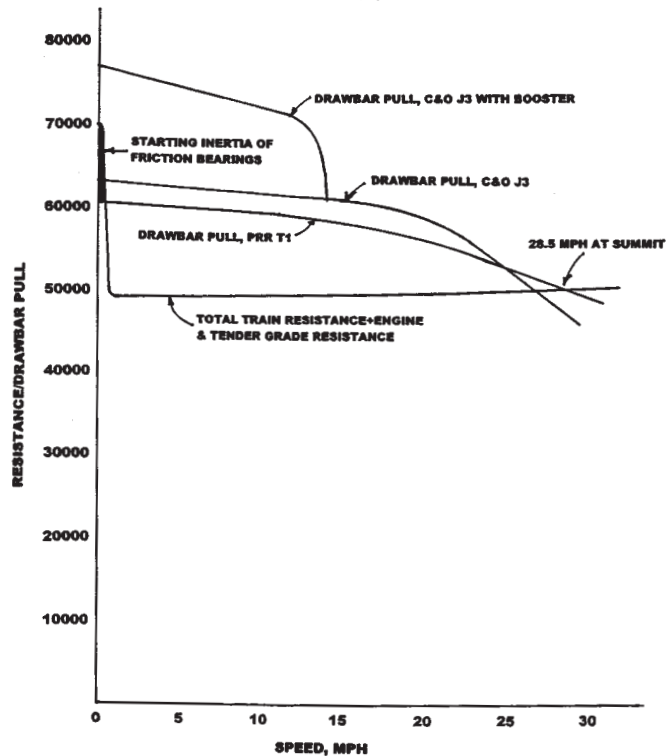
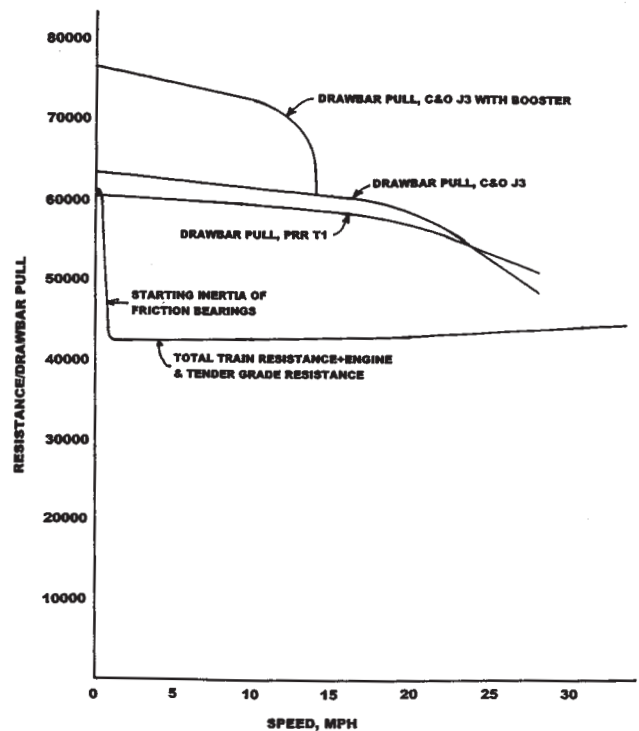


FIGURE 8

**RUN NO. 11, START AT CRAIGSVILLE, VA
11 CARS, 946 tons**



trains over 12 cars were doubleheaded on the Mountain Subdivision. Although the two references are inconsistent, they center around 13 cars as the break point for doubleheading.

Photos in *C&O Power* show doubleheaded K4s with a train of unspecified length, doubleheaded J3 and J2 power with 14 cars, and doubleheaded J3 and J3a engines with 14 cars. Therefore, photographic evidence in *C&O Power* suggests that 14-car trains were doubleheaded. Contradicting this in *Greenbrier*, a single J3 is shown with 15 heavyweight cars, reportedly near Afton. However, this photo was not taken at Afton, as the caption states, but rather near South Anna and Doswell. This location was confirmed by D. Wallace Johnson using the original negative and information from the photographer, J. I. Kelly.

Based on both text and photos in *C&O Power* and *Greenbrier*, it is safe to say that some trains over 12 cars were doubleheaded, and 14-car trains were routinely doubleheaded. Consequently, a 13-car eastbound train would likely have been doubleheaded under normal conditions.

If C&O's normal assignment guideline was 13 cars for one of its J3s with a tractive effort of 80,805 lbs. and if the T1

were loaded proportionally to its tractive effort of 64,650 lbs., the T1's assignment over the Mountain Subdivision would have been limited to ten cars. However, because the tests were run with regularly scheduled trains, tonnage adjustments were not possible. That being the case, the T1 should have been doubleheaded on both its assignments in order to be consistent with C&O's normal operations. On September 12, 1946, No. 5539 was going it alone, and at a considerable disadvantage. By C&O's own guidelines, it was overloaded.

The "Waynesboro incident" has been cited as an illustration of the T1's failure to perform. It is not a good example. C&O did not expect one of its own 4-8-4s to start a 13-car train at this location on a normal basis, in spite of its greater capability. The T1 did not have such a reserve in its favor.

Let's look at the unusual sequence of events during the Waynesboro stop. The test report indicates that the entire station stop at Waynesboro lasted six minutes. This included loading and unloading passengers, completing head-end work, attempting to start several times, failing, calling a yard engine, attaching it to the rear of the train, then starting the train eastbound to Charlottesville. This seems

to be a relatively short time to accomplish these tasks. I emphasize this is conjecture, but did C&O realize the T1 was over its capacity for this assignment, but decide to try it anyway? Having a locomotive standing by would have assured minimum delay if the experiment failed.

At this point, we've gone over the operational details at two locations, Cotton Hill and Waynesboro. For the sake of perspective, let's look at 5539's overall performance for its entire assignment from Clifton Forge to Charlottesville with information taken from the test report. The T1 received its train 18.5 minutes late at Clifton Forge, and delivered its train to Charlottesville 15 minutes late, making up 3.5 minutes. The final miles of Test Run No. 10 are worth noting. Once starting resistance was overcome at Waynesboro and the pusher cut off, 5539 accelerated up the 1.31% grade, reaching 24 mph at MP 206 near the top of the grade and 28.5 mph at the summit, MP 205.7. Once over the top, it attained 46 mph then braked for the first of 25 six- and seven-degree curves. This portion of the run offered no opportunity to make up time. As curvature eased toward the bottom of the grade, 73.5 mph was reached at MP 194, near Crozet. The dynamometer read 4,925

drawbar horsepower (DBHP) passing MP 191 (approximately 4,565 DBHP corrected for speed change) as 5539 worked the 1.2% grade to Oakland at 56.5 mph. Speeds of 45 to 65 mph were maintained over the sawtooth profile of the remaining line to Charlottesville. The timetable allowed 45 minutes to Charlottesville Union Station; the T1 did it in 37 minutes running time start to stop, 39.5 minutes start to start. By the end of the run in Charlottesville, the T1 made up all six minutes lost at Waynesboro and gained 6.5 minutes on the schedule.

Westbound at Craigsville

Later the same day, Sept. 12, 1946, No. 5539 was assigned to Train No. 1, the *George Washington*, at Charlottesville for a run west to Hinton. About 63 miles into the run, 5539 had trouble starting its train of 11 cars and 946 tons at Craigsville. This is one car more than it should have had, based on its capability. However, there are no details indicating why the T1 would not start the train right away.

In some respects, starting conditions at Craigsville were more difficult than at Waynesboro. The grade just west of the station was steeper at 1.44%, and the entire train was stopped on the grade. Taking slack here would be even more difficult.

The test report refers to 5539 starting from the side track. Craigsville was not a scheduled stop for No. 1. However, it was a scheduled stop for an opposing train, No. 6, the *FFV*, due at 10:40 pm, just a few minutes before No. 1 arrived at 10:50 pm and took the siding just west of the station. This may have been a regular meet because if both trains were on schedule, this would be the logical siding to use. Because the total wait time for No. 1 was only three minutes, the *FFV* may have already been close by. Had No. 1 been on time, it may have held the main while No.

6 was in the siding, and run the 1.5-mile hill without stopping.

In any event, No. 1 stopped and the T1 had to start the train when it was located entirely on the 1.44% grade. Ten minutes were spent getting the train under way. Although assumptions have been made in the past, the test report makes no reference to slipping (or lack of it). C&O's general comment that the locomotive showed no excessive tendency to slip may indicate this was another example of not being able to start the train. Starting resistance of the entire train would have been about 61,000 lbs., nearly equal to the rated drawbar pull of the T1 (see Figure 8, previous page). However, if the T1 could have caught sufficient slack, a tall order on a 1.44% grade, it could have more easily started the train and proceeded over the summit at MP 245.3. In this instance, 5539 was successful.

Once underway, additional time was lost because of a long station stop at Clifton Forge, but the T1 made up all but one minute of running time by the end of its assignment. This recovery was due more to sharp operation on the long downgrade to Hinton than any display of power on the T1's part.

For the same reasons discussed earlier, a J3 would have had no trouble starting a similar train at Craigsville. This is another example of why the J3s were designed as they were for assignments on the Mountain Sub.

The tests were wrapped up soon after this. No. 5539 worked its way west to Cincinnati where it was returned to PRR September 14, 1946.

T1 influence on further C&O steam locomotive design

In spite of the fact that C&O did not have any further interest in the PRR T1, it may have had some influence on subsequent orders for its steam passenger loco-

motives. The L1 4-6-4s must be excluded from consideration because their construction was started in May 1946, before the T1 tests. Although their design incorporated poppet valve gear technology at the time, it did not reflect any results from the T1 tests.

Some of the T1s' features were found in C&O's last two orders for steam passenger power, but most were coincidental.

The third series of 4-6-4s, L2a's 310-314, were ordered in 1947, several months after the tests concluded, and delivered in August 1948. They had cast frames and were fully roller bearing equipped. They were also equipped with Franklin Type B rotary-cam poppet valve gear, which had outside drive shafts. This was an improvement over the T1s' inaccessible inside valve gear drive boxes with Type A oscillating cam gear.

The third set of C&O 4-8-4s, J3a's 610-614, was ordered March 20, 1947, six months after the tests were concluded, and delivered in June 1948. These locomotives had cast frames, Boxpok drivers, and were fully roller-bearing equipped. However, these features were found on many late 4-8-4s and likely had little to do with the T1. Although poppet valves were considered, the J3a's were built with conventional Baker valve gear. Their boiler design was different from both the T1 and C&O's previous 4-8-4s. As a matter of interest, it had features similar to NYC's S1b Niagara (see Table 4).

Toward the end of steam, larger diameter but shorter flues and increased firebox volume were incorporated into many designs to increase combustion efficiency and evaporative capacity. The T1, J3a, and Niagara reflected this.

Conclusion

The tale of the T1s' brief sojourn on C&O was not as dramatic or as negative as past accounts claimed. They worked well within their capacity, handled some large trains and kept the schedule as far as running times are concerned.

But they were not the "mountain" locomotives C&O needed. Operating conditions on the Mountain Subdivision were demanding, involving stations located on significant grades and curves. C&O needed locomotives with considerable starting drawbar pull, and the J3s had boosters to ensure their capabilities would be adequate. Both T1s lacked this device and were no match for C&O's J3 at low speeds.

TABLE 4 Comparison of Combustion Specifications

	C&O J3	PRR T1	C&O J3a	NYC S1b
Grate area	100 SF	92 SF	100 SF	101 SF
Direct heating surface	519 SF	490 SF	482 SF	503 SF
Indirect heating surface	4,974 SF	3,719 SF	4,339 SF	4,320 SF
Tubes and Flues	(62) 2-1/4" (220) 3-1/2"	(184) 2-1/4" (69) 5-1/2"	(56) 2-1/4" (177) 4"	(55) 2-1/4" (177) 4"
Tube length	21'	18'	20'	19'-10"

This should have been known ahead of time, because the problems encountered were predictable using indicators generally available in 1946. It was clear C&O needed higher starting tractive effort and capability at moderate speeds and the T1 was designed for horsepower at higher speeds. The J3 and subsequent J3a were the right choices for C&O's conditions.

On the other hand, the T1 was too much locomotive for the more moderately graded sections of C&O. Large 4-6-4s, such as the L2s, were more than adequate for the tonnage and speed requirements there. There was no compelling reason for C&O to purchase a locomotive with the power capability of the T1. C&O's additional 4-6-4s were also the right choice.

Epilogue

The duplex idea never caught on and PRR remained the only proponent. During the late 1930s and early 1940s, conventional locomotive design changed. New materials were developed. Lighter reciprocating and rotating parts were used and counterbalancing improved. As things turned out, large 4-8-4s did not produce the problems that were predicted. Consequently, the duplex solution no longer had a problem to solve. Union Pacific's 80-inch-drivered 4-8-4s (classes FEF-2 and FEF-3), built from 1939 through 1944, had no problems in sustained high speed operations. N&W's 70 inch-drivered J class 4-8-4s, built from 1941 through 1950, were unmatched for acceleration and getting heavy trains over mountain grades. They also showed beyond any shadow of a doubt that driver diameter had little effect on performance at higher speeds.

Finally, in 1945, the NYC Niagara happened. Here was a locomotive that could match the T1 at all but the highest speeds, and do it day-in and day-out without special treatment. It was moderately sized and could go almost anywhere. It didn't require particularly deft handling, was very reliable, could operate in most types of service, and didn't require specialized maintenance. And none of these three examples deviated from one of the main tenets of locomotive design: simplicity.

The duplex concept needed more work, but as the 1940s wore on, time, money, and corporate will ran out for the T1 in the face of PRR's postwar economic problems. Its history became one of incomplete development.

For the next several years following the C&O tests, the T1s did their intended assignments in PRR passenger operations. During this time, they were rapidly displaced by diesels, some of which were already on the property before the production run of 50 units was completed in 1946. As the T1s were shifted from their original assignments, they were assigned to secondary service, and most were gone by about 1952.

The T1s' performance, whether good or bad, was not a significant factor in their replacement. Their early retirement was caused by superior economics of diesels and their immediate application to PRR's heaviest and most prestigious trains. PRR had literally hundreds of simpler, cheaper, go-anywhere K4 Pacifics to handle its remaining secondary operations until the end of steam. In the face of dieselization, the T1 just didn't matter.

C&O's newest 4-8-4s and 4-6-4s, ordered after the tests, fared no better than the T1. Although they were last and most modern conventional steam passenger locomotives built by Lima and Baldwin, they, too, were out of their intended jobs in a few years. Optimism for steam power may have been present during the tests in 1946, but it faded quickly and soon disappeared. No steam locomotive, conventional or cutting edge, would last much longer.

Acknowledgments

I want to acknowledge the assistance of the following people who were involved in the extensive background research for this article: Phillip Atkins, Chris Baer, Christopher Barkan, Chuck Bardon, Neil Burnell, Thomas Dixon, Eric Hirsimaki, Eugene Huddleston, D. Wallace Johnson, Ed King, J. Parker Lamb, the late Charlie Meyer, Phillip Shuster, Vernon Smith, and Tim Zukas.

They answered my endless questions and furnished historical information about C&O operations, J3 and T1 performance, dynamometer testing, and acceleration corrections. Their help in locating obscure documents and small, yet significant details made this analysis possible. Hopefully the final result of all our efforts will shed some light on the oftentimes clouded history of the PRR T1.

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THE PERE MARQUETTE *in Virginia*

After the merger of the Pere Marquette Railway into the C&O in June 1947, some of its steam locomotives were renumbered and re-lettered CHESAPEAKE & OHIO, while others retained their PM numbers and lettering. The latter were locomotives whose equipment trusts had not run out and they had to remain lettered for the company in whose name the trusts were held.¹

Pere Marquette had forty 2-8-4 Berkshires that were very similar to the C&O's 2-8-4 Kanawhas, and therefore as the dieselization of the PM neared completion in 1951, a number of these locomotives were considered for transfer to the

C&O's Chesapeake District. (After the merger the C&O was divided into two districts, both of which operated almost autonomously as they had as separate companies: The Pere Marquette District, comprising all the old PM lines; and the Chesapeake District containing all the old C&O proper.)

Dieselization was also proceeding rapidly on the Chesapeake District, so this arrangement didn't last very long before the PM locomotives were retired. The locomotives transferred to the Chesapeake District were of the classes N1, N2, and N3, most of which had been re-lettered and re-numbered. However, five individual locomo-

tives of the N1 and N2 classes were still in PM paint. The locomotives transferred to Clifton Forge as a maintenance and operational base were:

N1 class lettered/numbered C&O:

2650-2661

N2 class lettered/numbered C&O:

2670-2681

N3 class lettered/numbered C&O:

2685-2699

N1 class lettered/numbered PM:

1218, 1222, 1225

N2 class lettered/numbered PM:

1230, 1235²

Since certain of the PM numbers conflicted with C&O Mikado numbering it



was directed that if any K-2 or K-3 with conflicting numbers were in service they should be "lined out and set aside" immediately.³

The transfer of these PM locomotives seems to have been accomplished in April 1952. They were intended for use on coal trains between Clifton Forge–Richmond–Newport News. They were initially given a 15 mph speed restriction on the James River Viaduct at Richmond, but this was later changed to 25 mph.

The only photo we can find of a Pere Marquette lettered engine involved in this batch is shown at left: No. 1218 handling an empty coal train out of Richmond on the James River line on June 1, 1952.

The color photo on the cover of this magazine shows the renumbered 2696 at Gladstone, Va. Another black-and-white photo, on page 19, illustrates the renumbered C&O 2697 with a 160-car loaded train coming down the James River at Eagle Rock, Va., in June 1952.

left: Pere Marquette 2-8-4 Berkshire No. 1218 heads up a westbound empty coal train at milepost 6, just out of Richmond, on the Rivanna Subdivision on June 1, 1952. (J. I. Kelly; D. Wallace Johnson Collection)

below: This beautiful portrait shows C&O 2697 (ex-PM 1213) in a classic pose at Chicago while still in service on former PM lines on September 19, 1949. (Charles T. Felstead)







There are also photos showing locomotives with C&O numbers handling trains out of Russell, Ky., but we have no documentation on file regarding these operations. The correspondence files outlining the orders to transfer the engines to Clifton Forge all center around the period of mid-to-late March 1952.

Phil Shuster in *C&O Power* indicates that the transferred Pere Marquette locomotives actually operated out of Columbus and Russell, as well as Clifton Forge.

The reason for this transfer of power must indicate that not enough diesels were on hand on the Chesapeake District to handle the business, whereas the PM District had gone all-diesel in late 1951. It would seem, however, that enough of the C&O's own K-4s would have been available to run out the time until more diesels arrived. Why did C&O not retire the PM Berkshires at once?

Notes

- 1 C&O letter signed by R. G. McGehee "on line" April 3, 1952.
- 2 C&O Bulletin No. 7, Newport News, Va., March 27, 1952.
- 3 C&O letter, Clifton Forge, Va., dated March 27, 1952.

At least one of the former Pere Marquette Berkshires was repainted using a C&O FOR PROGRESS logo on the tender: No. 2699, illustrated here at Detroit, Mich., in September 1948. The publication of another photo of this particular locomotive in the book *C&O Power* has, over the years, occasioned much confusion about how C&O tenders were painted. As far as we know, this is the only locomotive with this application. (Joe Schmitz Collection)

opposite top: C&O (ex-PM) 2-8-4 No. 2696 heads east with an empty coal train out of Russell, Ky., in April 1952. (Gene Huddleston; C&OHS Collection COHS-1303)

left: C&O (ex-PM) 2-8-4 No. 2697 brings a 160-car coal train down the James River Subdivision, just out of Clifton Forge at Eagle Rock, Va., in June 1952. (Gene Huddleston; C&OHS Collection COHS-1273)





Pennsylvania Railroad T1 4-4-4 No. 5511 at Clifton Forge, Va., during testing on the C&O in September 1946. (C&OHS Collection)