T&OC Helper Territory North from Columbus

by

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The New York Central's Toledo & Ohio Central Western Branch, like its sister railroads including the NYC Big Four to Cleveland, C&O to Toledo, PRR (acquired by the N&W in the mid-1960s) to Sandusky and PRR Bradford Line toward Chicago, faced a lengthy uphill grade northward from Columbus. The B&O and PRR Panhandle trains eastbound from Columbus toward Newark also had to surmount a long grade up to Summit Station. In the T&OC's case, the right-of-way rose from 725 feet above sea level at Grandview Tower (Western Branch Milepost 131.7 in the steam era timetable) to 833 feet at Mounds (MP 127.6), 944 feet at Amlin (MP 120.8), and cresting at just over 1,000 feet at Arnold (MP 115). This rise of 300 feet in 16.7 miles represented an average grade of about 0.5% percent. While that slope is almost imperceptible to the eye and does not sound like much of a challenge, it presented a headache of huge portions for the T&OC in steam days.

In railroading operations, a short grade of 0.5% does not create any problems for a well-powered mixed freight train. It is a bit of a heavy lift for a big coal hopper unit train on a wet day, but would not require a helper engine. To illustrate how slight these grades are for nearly anything else but a train, the minimum slant needed to make the water run off an outdoor porch deck is 1/8 inch per foot, just slightly over 1.0%. This slope is not visible and no one notices it standing on a front porch. At 0.5% slope on a flat surface, a drop of water just sits there and does not move toward the low side. But a freight train starts to breathe hard and slow down on a 0.5% grade.

Rail grades of 1.0% or more of any length are a serious obstacle, and those exceeding 2.5% of any length are nearly unpassable for the average train without assistance. Exotic grades, like the Pennsylvania's Madison Hill up from the Ohio River in Indiana, at 5.89%, the steepest U.S. rail common carrier branch, can only accommodate a specially-geared locomotive fitted with rail washers pushing three or four cars at a time, not through trains. The steepest U.S. main line grade of 5.22% on the N&W at Saluda, North Carolina, averaging 4.7% for three miles, required elaborate special operations and emergency exit tracks, much like the runaway truck lanes seen on mountain stretches of highways. But with a short steep hill, the train's momentum carries it a significant distance up the grade, and once the locomotive crests the hill, the problem is solved. In many cases the hill is short enough that the entire train is not even on the grade all at one time. However, if a 0.5% grade extends out for a long distance, say more than five miles, it too constitutes a substantial hurdle. All momentum the train had starting the climb just slowly dissipates, and engine power output adequate to run 50 miles per hour on level ground can barely hold the train's speed up above a crawl.

A further problem on a long tough hill during steam days was difficulty keeping boiler pressure up to the ideal working level. T&OC locomotives, including 2-8-2 H-10s with design boiler pressure of 210 psi and later-era 4-8-2 L-4s with working pressures of 225-250 psi, could enter a grade with a full head of steam and their firebox grates yellow hot, able to sustain full pressure for a considerable time. Prior to the advent of mechanical stokers, it would take two shovels and two strong backs to keep the engine hot when working hard. Entering a grade, the engineer would need to push the Johnson Bar -- the big lever on the floor of the cab that adjusted the steam cut-off ratio in the cylinders -- all the way to the corner to provide for full steam pressure during the entire piston stroke for maximum power. Usually this setting would only be used to start a train, and then once the tonnage is in motion, the "hogger" (the T&OC term for our engineer) would pull back the Johnson Bar to cut off the steam part way through the piston stroke to let the steam admitted to the cylinder fully expand, saving steam, water and fuel (and the fireman's perspiration).

On a short grade, running at full stroke is no problem as the hot locomotive gets the train over the hill in five or six minutes before the original head of steam is consumed. On a long hill, however, the train needs maximum power for perhaps 20-30 minutes. The greater volume of steam exhausting the cylinders at higher pressure and blasting up the stack draws air and partially burned coal up through the fire grate through the boiler and out the stack, requiring greater and greater amounts of fuel to be thrown onto the roaring fire bed. Most steam locomotives, even with an ample fire grate, efficient feed water heater and high-capacity stoker, could not sustain this output too long. Eventually the engineer had to cut the throttle a little to avoid losing heat and pressure at too great a rate. With diesels, this is not a problem. The hogger just puts the throttle handle in No. 8 notch while the fireman has a cup of coffee and watches the gauges. (Cover your ears in the cab of an F9 "covered wagon" as this will be LOUD!) EMD's internal combustion engines are designed to run at full output for more than enough time to summit the longest hill. But the iron horse, like its animal namesake, could not keep up full output indefinitely.

That was the problem getting up out of Columbus on most of the northbound lines. A legacy of ice age geology, the land rises at a constant incline for over 15 miles. Even if a T&OC train had good speed up from West Columbus, which was unlikely because the train would be creeping through the decrepit yard track at no more than ten miles per hour, the engine would be straining hard up past Mounds, and down on its hands and knees inching the tonnage up past Amlin, Kile and over the first summit at Arnold. There was no flat or downhill stretch in there for the train to regain speed. This incline is so steady that on a clear dark night from Scottslawn (MP 108) you can actually see a northbound locomotive headlight all the way down at Mounds, about 17 miles distant.

The T&OC coped with the hill north from Columbus in steam days by designating it "helper territory, running from West Columbus Yard to what was then called "Helper Siding" at T&OC MP 112.5 in the old timetable. The T&OC assigned an extra steam locomotive as a helper engine to assist heavier northbound freight and coal trains to surmount this high flat ridge looming above the City. A train crew of three, including an engineer, fireman and conductor, would be dispatched out for helper duty, using one of the T&OC's muscular H-class 2-8-2 mikados or L-class 4-8-2 mountains. This job was a "light engine" only - no caboose. Normally the helper was on the head end, ahead of the road engine, which made it simpler to uncouple and take siding when the job was completed. For a shift of eight or more hours, the crew would sequentially either double-head or push trains up to Helper Siding, cut off there and wait for a clearing in the traffic to run back down to the yard, take on water and repeat the process with the next train. The 1947 timetable helper rules indicate that for lighter tonnage trains, the helper cut off at Kile (MP 118.3), rather than running all the way to Helper Siding.

During the steam era, the T&OC also had helper territory north from Kenton. These helpers coupled onto the rear end behind the caboose, with the air cut in, and the train would stop atop the hill on the main track at a designated point 1.9 miles north of Kenton for the helper to uncouple and back down to Kenton yard. South of Columbus, the T&OC used helpers on the head end from Hobson to Albany. On northbounds from Corning, one helper would be used just ahead of the caboose on Columbus or Thurston trains, cutting off at New Lexington. Two helpers on the rear just ahead of the caboose would be assigned to trains proceeding north from Corning bound for Toledo via the Eastern Branch at Thurston, with the "New Lexington Helper" in front and the "Johnstown Helper" aft. After grinding up Moxahala Hill and through the two long tunnels there, the first helper would be cut off at New Lexington, with the second helper pulling ahead to recouple and proceed to Johnstown, 29 miles north of Thurston, where it would be cut off.

<u>Why Helpers</u>?

One option a railroad has when confronted with a substantial "controlling grade" on the line, (i.e., the most challenging grade between origin and destination) is simply to dispatch shorter trains so the power of a single road engine (the locomotive assigned to take the train from origin to destination) would be adequate to get the tonnage all the way to the other end of the run. If the line had multiple steep grades over its entire length this would be the only efficient solution.

Another option is to send underpowered trains out on the road, but have them "double" the hills. "Doubling," which we unfortunately had to do once in awhile on the T&OC south of Columbus around Moxahala and Albany, is a labor-intensive process where you stop a stalled train on the main line, uncouple in the middle and take the first half over the hill to a siding, run the locomotive back to pick up the other half, and then reassemble the train at the siding beyond the hill, and proceed. This works, but it takes a good two hours to complete and thus it jams up the line unacceptably, preventing any other traffic from passing.

Therefore, for a line like the T&OC with long steep grades only in several short section, it would more effective to make up bigger trains, and utilize a helper just for the mileage where needed, then have the helper cut off and return to assist the next train rather than running excess power over the remainder of the line where no helper is necessary. This requires fewer engine hours and crew hours per ton of freight moved.

Front or Rear?

In Ohio, helpers sometimes couple onto the front of the train ahead of the road engine and pull the train forward, and sometimes they couple onto the rear and push. There are advantages and disadvantages to each method.

A helper, especially on the rear end of a train, assists to get a heavy load started on a grade. The helper can push in the train's slack from the rear end, allowing the road engine on the front to start up the train with full use of the slack. (The train's "slack" is about one inch of "free play" in the coupler knuckles and five inches in the spring-loaded drawbars of each car - a 100-car train is about 50 feet longer with the slack fully stretched out when being pulled.) An engineer starting with the slack bunched in only has to start one car at a time from a dead stop, rather than trying to yank the entire 5,000 or 10,000 ton train into motion all at once, which would be impossible. A helper pushing from the rear on a moving train also reduces the strain on coupler knuckles and drawbars near the road engine on the front, reducing the chances for a broken knuckle or pulled drawbar disaster which would tie up the line for hours.

The drawback with the rear helper in the steam days (with no walkie-talkies or cell phones) is that there was only rudimentary communication between front and rear of a train. It took more time to couple and uncouple on the rear, especially at the conclusion of the helper service past the hill. Getting on and off, the helper crew would have to rely on steam whistle signals (easily audible for several miles) and watching the main air brake line pressure gauge to determine what the road engineer wanted them to do.

Our timetable published a list whistle signals used for rear helpers and doubling over hills, as well as other situations. When the road engine received a green signal to proceed, the hogger would give two long blasts, which the rear helper would acknowledge with two short chirps. If the hogger needed to back up, he would give three long blasts. Once underway, the rear engineer would be guided by pressure in the brake line. If it dropped below 80 psi, that meant to reduce throttle and prepare to stop. It would have been hard to hear a whistle on a rear end helper engine underway with no cut off on the steam, but the air pressure was a reliable way to communicate.

Dangerous Work

For a time during the steam era, the T&OC used rear helpers up from West Columbus to Helper Siding. Several of the older men told of a practice in which by pre-arrangement, as the train picked up speed approaching Helper Siding, the crew on the caboose would sit down on the rear platform and kick shut the angle cock valve on the caboose side of the brake hoses, pull up the coupling pin, then signal the helper engineer to cut throttle and ease away, letting the train continue without stopping to cut off the helper. When the helper engine eased back, its brakes would set as the air hoses separated and released the brake line pressure. The helper engine would come to a quick stop, and the crew would dismount and close the angle cock on the front of the helper locomotive so it could restore 80 psi in the air brake line to release locomotive and tender brake shoes, and proceed into to Helper Siding.

Unfortunately, as is always the case when you take a short cut working with heavy equipment, there eventually was a disaster of awful proportions. A T&OC crew was in the midst of this maneuver when apparently the train brakes went into "emergency." "Emergency" brake application means the air pressure drops rapidly below 80 pounds per square inch, which causes a port on each car's brake system to open resulting in all the brakes of the entire train grabbing almost simultaneously. This happens if the train comes uncoupled and the brake hoses part, or it can be done intentionally by the engineer or conductor on the caboose by opening the brake valve quickly all the way, so the air pressure on the brake line "dumps" (drops rapidly). But with the angle cock closed on the rear of the caboose, the air pressure drop did not extend to the helper engines brakes. The heavy engine, still under full steam with no brakes applied, plowed through the caboose killing the conductor and flagman. After that, this "flying cut off," if it ever was legal, was prohibited by timetable rules.

Also in Ohio, I believe by law as well as timetable rule, when using a rear-end helper pushing behind the caboose, the caboose crew had to get off and ride the helper cab.

There was always a risk of the helper engine running through the caboose, or more likely, derailing it or flipping it over. The theory is that each car takes the force applied from the rear and transmits it to the car ahead. But if the load is too heavy, and the force from behind is too great, lighter cars (especially a 30-ton caboose) may buckle sideways or upwards at the couplings, especially on a curve. To illustrate this, imagine taking five dominos on a table, putting them end to end and then pushing this experimental "train" forward applying force with your hand to the rearmost domino. That is easy and little can go wrong. Next try pushing a brick with the five dominos, applying force with your hand on the rearmost one. If your table top is nice and slick and all dominos are exactly lined up right, it might work, but most often the train of dominos buckles and pops upward or out sideways. A caboose is not the place to be with 10,000 tons of train on one end and 5,000 horsepower pushing on the other.

T&OC Mid-Train Slave Units

For a time after the Penn Central merger in 1968, the railroad tried using radio-controlled "slave units" on 220-car coal unit trains north from Corning to Toledo. The engine crew controlled three SD40s on the head end, plus three more back 100 cars deep, by means of a radio system that gave the engineer an independent throttle for the units back in the middle. The PCRR also experimented with deadheading crews up to Galatea siding, and cutting off the slave engines there and running them light back to West Columbus or Buckeye Yard. However, this proved to be too complex for ordinary service, and it never caught on.

End of Helpers - the Diesel Locomotive

During steam days, a typical T&OC northbound freight train was about 50 cars, and the typical coal hopper unit train would be no more than 4,000 tons. Sixty-five cars was considered a really long train in that era. The principal northbound scheduled freights in the timetable, NT-5 and NT-7, often moved in two or even three sections of 50 cars or fewer, each with its own engine and caboose. Many of these trains needed helpers to get up past Arnold Hill. But after the mid-1950s when the New York Central had fully dieselized, trains grew to over 100 cars, and coal drags exceeded 10,000 tons, all without helpers.

The physics of steam vs diesel is very interesting in this regard, and illustrates one of the main reasons that diesel power elbowed steam out of the way. The basic principle is that you can start and move about one ton of train with one horsepower on level ground. However, the critical tasks are getting the train started from a dead stop, and keeping it moving up a hill.

Horsepower is a theoretical measure of the ability of a power source (engine) to do work. Technically it is the amount of sustained force needed to lift 33,000 pounds one foot in one minute. This measure was developed by the English steam engine pioneer and innovator James Watt in the late 18th century to help sell pumping engines as a replacement for the use of horses turning treadmills to lift water from mine shafts. Watt deliberately made it complicated so one could not compare horses and machines very precisely.

In a steam locomotive, horsepower is largely a function of the square feet of the firebox grate (over 120 ft^2 in a big engine with a four or six-wheel trailing truck to support a wide grate, larger in later-era articulated locomotives where the firebox extended over top of the rear driving wheels) plus the total square feet of evaporative surface and superheater surface in the boiler (over 7,000 ft^2 of total tube area and over 2,000 ft^2 of superheater in the biggest locomotives). The limiting factors are the railroad's loading gauge (i.e., the line's maximum allowed height, width and length for engines and cars and maximum permitted weight per axle) and the length of the boiler, which is limited by the loading gauge and track curvature, as well as the maximum length of turntables at the roundhouses. (On the NYC's lines like the T&OC, the loading gauge was medium size at best, further limited by the NYC's use of Baker valve gear with its "wide elbows," necessitating slightly narrower boilers.)

For diesel units, the horsepower is a function of piston displacement. Really large diesel engines can be mounted on a single frame, but more importantly, you can just add more units to the consist, under control of a single engineer up front. Thus with steam, the practical maximum ever reached would be about 7,500 hp on a single throttle, but with diesel there is no upper bound. I recall taking a train south from West Columbus one night with four covered wagons and five hood units, with a combined 20,000 hp. This was done for "power balance" to get extra units back to West Virginia for northbound runs, but it was interesting to be able to make full track speed of 50 mph in number 4 notch.

The NYC's steam engines, while not matching the horsepower of the really big machines like the C&O's imposing 2-6-6-6 Alleghenies or N&W's articulated A and Y-class engines (2-6-6-4s and 2-8-8-2s) seen in Central Ohio, did not lack for muscle. At 4,100-4,500 hp, they were close to the output of a four-unit consist of EMD F7 "covered wagon" diesels of the 1940s or a pair of the average bigger diesel hood units of the 1960s.

However, the effective work a locomotive can do with a heavy train starting and pulling uphill is measured not by horsepower, but by a different quantitative expression known as "tractive effort." Expressed in "foot-pounds," this tells us in essence how hard a locomotive can pull against a drawbar in a given moment, while horsepower is an expression of how much dynamic force an engine can deliver on a continuous basis. High horsepower is essential for higher top speed and for maintaining speed once the train is moving, but it is wasted if the locomotive cannot apply it fully to the train because the driving wheels slip on the rails.

The simple difference between steam and diesel is that steam engines, for all their great strength (horsepower), often could not deliver it to the train on a sustained basis without slipping.

For a steam locomotive, "tractive effort" is calculated by an arbitrary formula, which multiplies the steam pressure psi by the square inches of the piston bore by the length of piston stroke and divides by wheel diameter. (Logically a longer piston stroke or crank radius on a smaller diameter wheel gives a better leverage for each power stroke.) Tractive effort is measured in three ways, including starting, maximum and continuous, the latter two of which depend on speed, and the last of which also depends on continuous horsepower output rating. The formula for starting tractive effort per cylinder is:

$t = (c \times P \times d^2 \times s) / D$

where

- *t* is *tractive effort*
- *c* is a constant representing losses in pressure and friction; normally an Association of American Railroads figure of 0.85 is used
- *P* is the boiler pressure in psi
- *d* is the piston diameter (bore) in inches
- *s* is the piston stroke in inches
- *D* is the driving wheel diameter in inches

Really big articulated steam engines like the Union Pacific 4-8-8-4 “Big Boys” or the B&O 2-8-8-4 "Yellowstones" could generate 130,000 to 152,000 pounds of tractive effort. Super-heavyweight Virginian 2-10-10-2s provided 176,000 pounds, the record for a production model locomotive. The NYC’s H-10a class 2-8-2s built mainly by Lima and Alco in the mid-1920s, with 63-inch drivers, produced up to 66,640 pounds. The NYC’s Alco and Lima-built L-2 and L-4 class 4-8-2s in use from the 1930s to their retirement in the mid-1950s, with 69 and 72-inch drivers, produced a maximum of 60,618 pounds of starting tractive effort. The NYC was known as a “water level route” historically, with few steep grades on its system. The NYC did not develop or stable really heavy engines for its affiliates, with the exception of the hefty Alco 2-8-4 Berkshires ordered for the Pittsburgh & Lake Erie in the waning days of steam.

In contrast, even the earliest diesel era equipment, the GM Electro-Motive Division F7s, could generate about 50,000 pounds of tractive effort per unit, or 200,000 pounds in a standard “ABBA” consist of four units, roughly 160 percent of what a T&OC steam road engine plus helper together could deliver. Four EMD F9 covered wagons provided 210,000 pounds. A single SD40 unit of the late 1960s produced 92,000 pounds of starting tractive effort, and 82,000 pounds of continuous effort at 11 mph. Working in a consist of three units, these big engines offered double the pulling power of a steam-era NYC road engine and helper combined.

Another factor is wheel slippage. Unlike steam engines, which at best had 65 to 70 percent of their weight on the driving wheels and tended to slip when trying to start a heavy load or sustain speed on a hill, the diesels had 100 percent of their weight on powered axles and seldom stumbled. Each set of wheels under a diesel usually has a traction motor distributing the dynamic force from the internal combustion engine. With roughly equal horsepower, a set of four covered wagons applied force to 16 axles, while the browniest steam engine, say one of the enormous Virginian 2-10-10-2s, had 10 powered axles. You could not do more with the steam engine, due to maximum weight that could be placed on an axle without risking damage to the rails. With diesels, you could just add more axles or more units to the consist. With steam, the only option was to add another locomotive, meaning another crew to pay, additional water stops and a need to deadhead the unit back to balance up power in both directions on the line. Diesel units not needed in the downhill direction on the line did not need an extra crew to get them back, they just stayed coupled together on the return trip.

The diesels, while lacking the glamour or emotional appeal of a sweating steam locomotive with exhausting steam blasting up the stack, really are impressive and elegant machines. With four covered wagons, a T&OC crew could walk their heaviest freight train right up out of West Columbus, run past Mounds at 20 miles per hour, and roll over the crest at Arnold without a helper. By the 1960s, with three bigger six axle SD40s and 45s, at 3,000 to 3,600 hp and 90,000 pounds or more of pulling power per unit, we could do the same with the 10,000-ton Peabody coal unit train, even on the slipperiest wet night.

T&OC Helpers Fade into History

So without much fanfare, once the diesels took over on the T&OC in the mid-1950s, the T&OC's regularly-assigned helpers quickly disappeared.

The only helper duty we saw on the T&OC by the 1960s was the rare instance where a coal train out ahead of one of our freights would lay down on a hill, usually at Moxahala on the south end, or if a northbound crew lost power in one of their units up at Arnold or on the hill just north of Kenton. Using radio communication, the dispatcher might have us cut off our engines, pull up and couple onto the disabled train, and push it over the hill, then come back for our train.

Helper Siding was pulled up by the 1960s. Today it is hard to find the place where it reposed for so many years, now just a wide spot along the right-of-way, ideal for picking black raspberries in July. I could find no sign of the turning wye that one old-timer mentioned was used there to point the helper engines south for the half-hour run back to Grandview.

[*This material is from memory, notes and old-timer stories heard 45 years ago. Corrections and additions are most welcome!*]