THE OUTSTANDING FEATURES AND MANY LIVES OF C&O 614

By Eugene L. Huddleston

In its time under steam and in its varied uses, the Chesapeake & Ohio's 4-8-4 of 1948, No. 614, has the distinction of being one of the most-photographed steam locomotives of all time.

There have been two stages to No. 614's life: first, in revenue service first as a passenger and then as a freight engine, and later as an excursion engine. In the latter capacity, from runs on the Chessie Safety Express and the autumn New River excursions through its appearance early in 1985 on Ross Rowland's ACE 3000 tests, to its Iron Horse Enterprises excursions in the late 1990s in

New Jersey, this hardy Northern-type passenger locomotive (called the "Greenbrier" on C&O) proves, if anything, what a well-made locomotive it was originally. Back in 1947, when the five new Greenbriers were ordered, it was "nothing but the best" in ordering motive power, for the future of passenger traffic on C&O looked assured. Those who rode standing-room-only passenger trains so frequently in World War II were expected to continue their patronage, and C&O Chairman Robert R. Young put so much of his company's money into passenger projects that he seemed reckless to many and a hero to a few. Also, the future of steam power looked assured because C&O was a great coal-hauling road.

Thus, when new power was in line after World War II to replace aging class J-2 4-8-2s in mountain territory and class F-19 4-6-2s on more level divisions, there was no doubt that for level service the L-2 class 4-6-4 of 1942-the world's heaviest Hudsons-would be duplicated, and for mountain service, the J-3 Greenbriers (4-8-4s) of 1934-35 and 1942, the biggest-in terms of height, length, weight, and boiler diameter-two-cylinder engines ever to serve on C&O with the exception of the giant 2-10-4s of 1930.

The Greenbriers were thus bigger than the famed Van Sweringen Berkshire (2-8-4) freight locomotives of the Nickel Plate, Pere Marquette, and C&O. In 1947 C&O was still "on a roll" in spending for freight and passenger locomotives, and the austerity program would not come until 1949, when an order for 25 "mine run" Mallets was reduced to ten and 30 brand-new 0-8-0 switchers were sold as second-hand, and when wholesale cuts were made in local passenger service.

The C&O spared no expense in getting nothing but the best in passenger power in 1947. Although they were built to the same basic specifications as the earlier J-3s, engines 610-614 had numerous improvements in appliances and specialties. Proof is found in the cost of the J-3a class (Nos. 610-614). Although direct figures are not available, one can extrapolate their costs from the cost of each of five class L-2a Hudsons purchased at the same time. Lloyd Stagner provides the evidence: "Costing $353,346 each, these later L-2s were among the most expensive steam locomotives ever built, costing 80 percent more than the first eight L-2s bought in 1941." The new J-3s must have cost near or above this figure. The assumption that they would cost more is that they were bigger; but one can also assume that since the J-3a engines lacked the "Franklin System of Steam Distribution" (poppet valves) their price would be reduced somewhat relative to the L-2a Hudsons. The C&O got a lot for its money; engines 610-614 were "superb" according to locomotive historian and author Robert A. LeMassena.

One feature showing C&O would settle for nothing but the best was an advanced braking system; namely, a brake stand in the cab capable of adapting to electrical control the trains air brakes. Electro-pneumatic brake controls on 610-614 were compatible with the order to Pullman-Standard late in 1946 for 284 lightweight cars to completely replace the C&O's heavyweight passenger equipment. For the feature to work, all cars in the train needed compatible wiring and piping. Each car would then be independent of the others in the train. Electricity permitted instantaneous brake application no matter how long the train, in contrast to the standard method of reducing air pressure in the "train line." Electrical control of the brakes made for smoother braking on fast passenger trains by safeguarding against wheel sliding and at the same time maintaining higher average retardation during brake applications.

The feature was never used because the car order was eventually severely cut back due to delays in delivery and to needs to economize in passenger spending.

But the fact remains that the brake stand in the cab of Nos. 610-614 was the then new and advanced Westinghouse 24-RL type, for only it was compatible with the installation of electrical controls. Controls on most locomotives were still the 8-ET type (Nos. 600-604 had the even earlier 6-ET). The 24-RL, which would become standard for diesel cabs, was used because its stand had the fittings built in for applying the the optional transmitter necessary for operating the electro-pneumatic brakes.

Simply amazing is the expenditure of so much money to produce a "state of the art" locomotive in the waning days of steam. It seems nothing was sacrificed to equip the new Greenbriers with the latest features and best appliances. Enthusiasm was still the word in 1947, as this writer well recalls from being told about the order for five more Greenbriers from Lima Locomotive Works by locomotive engineer Vince Hiltz (later promoted to traveling fireman). Invited into the cab of a big T-1 2-10-4 waiting to leave the Russell yard, I learned these "super" engines would be delivered in June 1948. Among the innovations Mr. Hiltz described to the young steam fan (that I can recall today) were an aluminum cab and boiler jacket, a boiler and solid cast engine frame of nickel steel, and, of course, electro-pneumatic brakes. If he mentioned a streamlined jacket (which had been planned initially for the five new 4-8-4s and 4-6-4s), I don't recall it; neither do I recall his mentioning Franklin poppet valves for the new Greenbriers in keeping with the poppet valves that had been applied to the Pacifics rebuilt as Hudsons in 1946-47 and that would be applied to the five new Hudsons coming from Baldwin Locomotive Works in 1948. Mr. Hiltz did not discuss the major dimensions of the locomotive, of course, for they were mostly identical in all three orders for the Greenbriers. There was, however, one significant change in dimensions, as LeMassena pointed out. On 610-614 the combustion chamber ahead of the smokebox was made a foot longer; the tubes and flues, thus reduced a foot in length, were, at 20 feet long, precisely the length needed for best absorption of heat. And enlarging the combustion chamber, in the words of Ralph Johnson, "increases the length of the path the gases must travel before entering the flues and thereby allows more time for combination of the combustibles and air."

Author Brian Reed says about all C&O 4-8-4s: "To transmit adequately the 148,000-lb. piston thrust, tandem or articulated main and side rods were fitted to the main and third pair of drivers, and this reduced main crankpin loading by 50%." Reed also wrote: "The diameter of the back course of the [Greenbrier's] boiler at 100 inches was exceeded only by the 102 in. of the Santa Fe's 3776 and 2900 classes ..."

As these construction details confirm, one reason C&O 614 has lasted so long and performed so well is its durability, achieved at an expenditure of so much money that clearly someone high up in C&O management had a real commitment to steam. That person, according to author Doug Nuckles, was probably Ed Hauer, the last remaining member of the Advisory Mechanical Committee, which had originally designed the C&O 4-8-4s. Hauer served on the AMC as

engineer of motive power, 1936-42; in 1942 he left to become assistant and associate director of the Office of Defense Transportation in Washington. In July 1944 he returned to AMC as engineer of motive power where he served until its assumed dissolution in 1949. The original design of the Greenbriers in 1935 and 1936 had been done by William G. Black and Alonzo Trumbull of the Erie-dominated Advisory Mechanical committee, but these men were long gone by 1948.

It would be helpful if the men on the Advisory Mechanical Committee in 1936 were still around so we could ask them about an appliance that came as original equipment on all the C&O 4-8-4s. These were over-fire air jets, otherwise known as "smoke consumers." Four of them could be seen on each side of the firebox, running parallel with the fire bed a couple of feet or so above it. They had come into use on American railroads in response to the smoke abatement movement, characterized in most large American cities by ordinances that fined emissions of black smoke from coalfired boilers, whether stationary or moving. There were no generally publicized policies spelled out for their use, nor was there consistent use of them even on the same railroad. It seemed those in charge of fuel economy and smoke abatement were embarrassed about them. It is next to impossible to find articles about them in the trade press, and anecdotal evidence suggests that enginemen objected to their use principally because they were quite noisy. (They made use of steam jets to force air into the firebox above the fire. The forced air had to be heated; otherwise the advantage of more oxygen for combustion would be lost to the low temperature of the air from the atmosphere.) Eventually, dampening material was applied at the jet openings, in order to insulate the high-pitched sound. None of the 12 Greenbriers had these mufflers (which usually looked like tin soup cans), although 610-614 did have the four openings on each side staggered so that the air eddies would circulate more freely above the firebed.

Aside from the apparently unproven smoke consumers, one's examination of a list of appliances for the new locomotives reveals a consistency that conforms with past selections of practical and proven specialties, such as Franklin high-speed trailer truck booster, Alco reverse gear (with long notched quadrant for ease in setting valve cutoff), Baker valve gear, and Box-Pok driving wheels. Because many other locomotives on many other railroads used Alco reverse gear and Baker valve gear, there was little to set them apart. However, American railroads only selectively applied boosters and Box-Pok drivers. Franklin Railway Supply Company's advertising in the 1947 Locomotive Cyclopedia is a good source of information on boosters. "The locomotive

booster provides increased drawbar pull at starting ... by applying power to otherwise idle trailing ... wheels. The increase can be effective to 30 or 35 mph and can be as much as 15,000 pounds at starting. The booster is a simple reciprocating double-acting steam engine which is self-contained and is attached to the frame of the [trailer] truck through a three-point suspension. It transmits its power to the [rear] axle through an idler gear which can be engaged or disengaged at will. It uses an air-operated control which is semi-automatic."

Box-Pok drivers were so special they call for some commentary. The ad for the Box-Pok in the 1944 Locomotive Cyclopedia, by its manufacturer General Steel Castings, tries to explain it: "As the name implies, it has box-section spokes instead of the usual solid type, is stronger ... and is also arranged for proper counter-balance [and cross-balance], reducing dynamic augment at rail .... thus permitting higher speeds with less wear and tear on the locomotive and track." Ralph Johnson, chief engineer at Baldwin Locomotive Works, explained the advantages of the disc-type driving wheel with more precision: "A difficulty encountered in balancing driving wheels is the fact that there is often not sufficient room in the wheel to take the amount of lead required for proper balancing ... . There are now on the market several types of disc or box-section wheels which not only are stronger than the spoke type but make it possible to reduce the diameter of the axle and crank pin hubs, hence lightening the upper part of the wheel and affording more space in the lower half for the lead in the counterbalance. This type of wheel also eliminates the trouble experienced from shrinkage cracks in spokes and provides equal pressure of the rim on the tire."

A puzzling exception, however, to the use of practical and proven specialties was selection of the Hancock exhaust-steam injector, which was an anomaly not only on the new Greenbriers but in C&O motive power practice generally. On road engines of the modern steam era there were, as required by law, two methods of getting water into the boiler, one by the "non-lifting" livesteam injector, a fairly simple device usually mounted under the cab on the engineer's side of the locomotive. (Evidence of such an injector seen from inside the cab was the big priming lever located on the floor of the cab below the engineer's seat box.) The second method could be another injector, installed on the left side. But usually a feedwater heater was installed, more complicated and thus more expensive than an injector but guaranteed to be more efficient-at least when the engine was running-because it used exhaust steam from the cylinders to heat cold water from the tender before it was pumped into the boiler.

If one considers the "late steam" period beginning with the T-1 2-10-4 of 1930, he will find unbroken, on new C&O road and passenger locomotives, the use of the Worthington "open" type feedwater heater ("open" in that the exhaust steam mixes directly with the feedwater from the tender). Even on the C&O F-19 Pacifics rebuilt into L-1 Hudsons in 1946 and 1947 the Worthington open type replaced the Elesco "closed" type supplied new to the Pacifics new in 1926; likewise, the M-1 steamturbo-electrics of 1947-48, Nos. 500-502, had Worthington open types hidden under the cowling. Needless to say, all preceding Greenbriers were so equipped. An exhauststeam injector-whether a Sellers, an Elesco, or a Hancock-had never been applied to a prior C&O steam locomotive. If C&O could afford the Worthington during the Great Depression, why could not the company in 1948-the year that broke all coal-loading records on C&O-select this brand again?

By some accounts, the exhaust-steam injector was a second-rate appliance, whether the Hancock, Elesco, or Sellers brand. They simply were not as efficient as a feedwater heater. Alfred W Bruce, in his authoritative history of the steam locomotive, called the exhaust-steam injector the "poor man's feedwater heater," meaning that it tried to combine, not always dependably, the simple function of the live-steam injector with the more complicated exhauststeam feedwater heater. (The Hancock started with live steam and switched over to exhaust steam while the engine was working.) Bruce's epithet suggests that the chief intent of selecting the appliance was to have the benefits of a feedwater heater without the expense of purchasing one. Yet no expense seemed spared otherwise on C&O Greenbriers 610-614 in order for them to be first-rate in every respect. Already mentioned above were the electro-pneumatic brakes, the aluminum cabs and boiler jacket, and the nickel-steel boiler plating and cast-steel frames; there were also roller bearings used on more bearing surfaces than on any previous C&O locomotive-including Timkens on the main and side rods and crank pins.

Why, when no expense was spared otherwise to make 610-614 first-rate, would C&O be inconsistent in equipping its new Greenbriers? A.W Bruce not only labeled the exhaust-steam injector a "poor man's" heater, he tended to put it down while explaining its function: "In this device the required energy to enter the boiler was imparted to the feedwater in two stages: the first by the use of exhaust steam and the second by the use of live steam. It started as a relatively simple device, but soon became more and more complicated and is in little use today [1952]." There's no "luxury" here! The three manufacturers of exhaust-steam injectors in the late-steam era were: William D. Sellers Co. (Sellers),

the Superheater Co. (Elesco), and Locomotive Equipment Division of Manning, Maxwell, Moore, Inc. (Hancock). Interestingly, Bruce, a high official at American Locomotive Works, denigrated exhaust steam injectors, even while his own company supplied to Union Pacific's last Challengers and to all "Big Boys" Elesco exhaust-steam injectors. Union Pacific's reason for not using the Worthington open-type (model SA) on its big articulateds was the difficulty of finding space under the smoke box for the hotwater pump and its piping.

Whatever the reason for UP's using it, the Elesco gave some problems according to Union Pacific locomotive authority William Kratville: "The operation of the Elesco exhaust-steam injector required a two-phase starting sequence, the first being priming the line, the second the admission valve. If the injector failed to pick up, which occurred frequently, the engineer's non-lifting injector [the Nathan] had to be cut in. It was often necessary to `double gun' (using both injectors) if the Elesco was not doing the proper job. An operational situation affecting the exhaust-steam injector was that when the throttle position was changed it often broke the circulation and the injector cut out forcing the `double gunning."'

It is not known whether the Hancock exhaust-steam injector gave trouble on engines 610-614. Presumably it did not, for the appliances remained in use during the years 610-614 were in regular passenger service, plus the year or so all five were in freight service on the James River line and the additional year 610 and 614 worked on freights eastward out of Russell, Kentucky. Steam locomotive historian Phil Shuster warns not to jump to conclusions about the Hancock's performance on 610-614. There is nothing in the "files" to indicate they were ever troublesome or that employees did not

know how to use them effectively. When all five Greenbriers went into storage in 1953, they were equipped with Hancocks, and when in 1955 Nos. 610 and 614 were pulled off the storage line and returned to heavy freight service for over a year, they retained the Hancocks. (During this time they, of course, also retained their Nathan live-steam injectors, located under the cab on the right side. The only appliance that appeared removed before the 1955-56 firing up was the second turbo-generator, located on a bracket on the right side above Nos. 3 and 4 drivers.) Around the time in 1956 that 614 (numbered 611 to avoid renumbering of leased RF&P Northern No. 614) was put in storage outdoors at Russell, Kentucky, it lost its Hancock; this is known because photos of No. 611 (614) in storage at Russell show it removed. A major part of its equipment-

including the pump-was located on the fireman's side just ahead of the trailing truck on a large flat bracket which was an extension of the locomotive's cast-steel underframe connections.

Luckily, No. 614, saved from scrapping, was stored until 1975 when it was cosmetically restored at the C&O's Huntington Shops and put on display at the B&O Museum in Baltimore. Finally, in 1979, No. 614 was taken to the Hagerstown (Western Maryland) shops and, after restoration costing 1.5 million dollars, was "fired up" again.

From the time in 1980 when No. 614 returned to "service" hauling the Chessie Safety Express and the Family Lines Express, through its tests as 614T on the ACE 3000 project in 1985, to its last excursions in New Jersey, the locomotive has been equipped with a second Nathan live-steam, non-lifting injector, the redundant injector fulfilling federal requirements that there be a back-up means of supplying water to the boiler. Such injectors, being less complex in construction and operation than the exhaust-steam type, would presumably have a longer life in storage. No longer occupied by the Hancock apparatus, the small frame-connected platform ahead of the trailing truck (left side) has since 1980 been occupied by a hose and reel assembly.

A retrofit little affecting the original appearance of No. 614 is the Union Switch & Signal cab signal and speed-control system installed by NJ Transit in 1998. The inductive pickup device is mounted just behind the leading truck.

A nagging question remains: why did C&O motive power officials (and what was left of the Advisory Mechanical Committee formed in the Van Sweringen heyday) choose the Hancock live-steam injector when customary practice, as revealed here, would have been to select for new power a Worthington type SA feedwater heater, the best feedwater heater available? Other than mere caprice, which is unlikely, two explanations seem possible. One is that word came down from a high executive officer of the railroad, outside the motive power department, that he would not countenance a "Cadillac" of a passenger locomotive because a disproportionate amount of the company's revenues was being already being spent on improving and maintaining passenger service. Lloyd Stagner, in North American Hudsons, labeling Hudsons 310314 "Cadillacs," pointed to their costing $353,346 each, as noted earlier. Thus Baldwin and Lima-Hamilton were sending the C&O luxury passenger locomotives at a time when the company seemed to be less and less in need of them.

This period was, of course, when Chairman of the Board Young's energized attempts to "spend" the C&O into becoming a big-time passenger carrier were starting to meet opposition from some stockholders. The pronouncement from on high could have come at a time when certain decisions about construction of the locomotives had already been made and could not be reversed. The boilers of nickel-steel would have already been fabricated and the aluminum cab already assembled, and roller bearing side and main rods already custom made for this order. But it would not have been too late to cancel the streamlined jacket that was planned for Nos. 610-614, nor would it have been too late to cancel appliances like feedwater heaters. The only objection to this supposition might be that Hudsons 310-314, ordered at the same time, came equipped with Worthington SA feedwater heaters, and aside from deleting the streamlined jacket from the order there seemed no effort to cut back on the Hudsons' appliances otherwise.

Another possibility is that the official, or officials, charged with selecting appliances like injectors, feedwater heaters, valve gear, reverse gear, lubricators, stoker, etc., did not make their decisions based on "systematic tests or hard economic analyses," in the words of Robert A. LeMassena; in fact, he said the selection of appliances was "hardly a rational decision" and could be influenced by many factors, including "affiliations involving traffic managers of railroads and suppliers." One cannot rule out the possibility of an offer of "gifts" from the sales representative for Manning, Maxwell, Moore to select that company's Hancock exhauststeam injector. The "good old boy" personal contacts and the "gifts" from such sales representatives could come close to being bribes. This writer has heard of only one such alleged "bribe" in the railroad industry. In the course of an interview over his experiences with the Jawn Henry steam turbine locomotive, I learned from a retired Norfolk & Western motive power official that he thought the lubricants supplied by a certain major oil company (used in the locomotive "lubritoriums") were not "worth a damn." He claimed that the only reason that brand was used was that the sales representative kept the men involved in the decision regularly supplied with famous and flavorful Virginia Smithfield cured hams!

It seems certain that C&O No. 614 will eventually end up in a museum-hopefully displayed indoors. When it does, observers will be able to peer between the driving wheels and see something they don't often see on steam engines-the big cylindrical air reservoir, cast into the frame, sitting above the axles and driving boxes and filling practically all that hidden space, this tank replacing the multiple

smaller reservoirs mounted below the running board on older locomotives. They will not be able to see the piping and pumps and condenser of the Hancock injector, but they will see the Box-Pok drivers, the 24-RL brake stand (if access to cab is provided), and the Nathan injector (or injectors).

Above all, they will not be able to see 614's stubborn traction, unless it is by way of a video tapes of the engine's passage with a long excursion up the Blue Ridge on the C&O in Virginia or up the Allegheny Front on the B&O in northern West Virginia in the early 1980s. On those steep grades No. 614 proved its mettle by seldom, if ever, slipping.

A ratio calulated for every steam locomotive was its "factor of adhesion." According to Ralph Johnson, Baldwin's chief mechanical engineer, "Ca ratio of adhesion of 4 is generally used, or 25 per cent of the adhesive weight. For electric and dieselelectric locomotives, a ratio of 3.33, or 30 per cent, is allowable as the torque on the wheels with a motor drive is more uniform than with a reciprocating steam engine."

A steam locomotive with a factor of 4 or above should not slip on clean, dry rail. Any number below 4 (calculations are usually carried to the hundreth) increases the chances of slipping with a load, either in starting or at speed. The C&O J-3 4-8-4s had adhesion factors well over 4: for Nos. 600-604 it was 4.11; for engines 605-606, the figure was 4.41; and for Nos. 610-614, a factor of 4.29. For comparison, the "EA." on the RF&P's "Virginia Statesmen" 4-8-4s (Nos. 613-622) of 1946. leased by the C&O for freight service out of Russell in 1955-56, was 4.24. The ex-Reading T-1 of 1945, No. 2101, used in Chessie Safety Express excursion service on C&O in 1977-78, had an EA. of 4.09, and the famous NYC Niagara 4-8-4s of 1946, 4.47. The most well-known streamlined 4-8-4s, the N&W Class J, had EA.s below 4 even before steam pressure was increased on all of them in the fall of 1945 to 300 psi. At 275 psi, the E A. was 3.93 and from 1945 on, with 300 psi, it was 3.6. (Raising steam pressure of course increases the tractive effort; on the Class J there was no corresponding increase in adhesive weight, that is, weight on drivers.)

Discussion of the details of C&O Greenbriers 610-614 might seem insignificant in the larger scheme of things but not to those who recognize what a mechanical marvel the steam locomotive really was. They find delight in a prime mover that has its power and functions clearly in view, unlike those of a jet aircraft engine or a space rocket engine where the operator punches in a code for starting the

action rather than releasing a lever or opening a valve or reading a gauge and where observers have to view the take-off or liftoff from a considerable distance.

No- 614 in Today

Following several years of operating excursions based in New Jersey, Ross Rowland, the owner of C&O 614, announced his intention to sell the locomotive at auction. No buyers surfaced, however, and the again stored Greenbrier faced an uncertain future.

As this magazine went to press in late January 2002, news arrived that No. 614 had found a new home in northeastern Pennsylvania, under the ownership of Andrew J. Muller and his Reading & Northern Railroad. No. 614 would thus join ex-Reading T-1 No. 2102 and ex-Gulf, Mobile & Ohio 4-6-2 No. 425 on the R&N's steam roster. Watch for details as they become available in future issues of the C&OHS Magazine.

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Visit the Official Web Site of former Chesapeake & Ohio Steam Locomotive #614 at http://www.co614.com