Build us the biggest! said Union Pacific. Here is Big Boy, said Alco, because

Size Matters

By Steve Lee

To call Union Pacific's 4-8-8-4 a big locomotive would be akin to calling the Mona Lisa a nice painting. Built in two lots in 1941 and 1944, the 25 Big Boys were the acme of steam locomotive development for the American Locomotive Company, and were so successful they still made money for UP more than a decade after its managers had chosen to dieselize.

The Big Boy was the result of a design effort which had already produced two successful series of 4-8-4 Northerns and 4-6-6-4 Challengers For the new 4-8-8-4's, the Alco-UP engineering and design team didn't need to break too much new ground—they only had to refine and enlarge what they'd already developed and proven in service.

The design team started with a performance-based requirement, for a locomotive that could pull 3600 tons up the 1.14% ruling grade between Ogden, Utah, and Evanston, Wyo., without a helper—and worked up the design to meet those needs. The locomotive they produced exceeded expectations, as evidenced by successive increases in the Big Boy's tonnage ratings once experience revealed their capabilities. Ultimately, the Big Boys were rated at 4450 tons on this district, 23.6% more than planned.

The Big Boys were *big* locomotives, so big that before the first one was delivered, UP had to invest money to enlarge facilities at engine terminals where the Big Boys would be fueled, watered, and maintained. Turntables of 135-foot length were installed at Ogden and Green River and Laramie, Wyo. Cheyenne, Wyo., got a 126-foot table. Several roundhouse stalls at each terminal were lengthened so the new locomotives would fit inside. Water standpipes not already raised to clear the tall tenders on the 4-8-4's had to be raised so they could swing over the tenders of the 4-8-8-4's.

Locations outside their usual territory, such as Denver and North Platte, were not equipped with the long turntables, and had to turn them on wyes,

Previous pages: Big Boy at its finest, as a fast freight hauler across Wyoming's high desert west of Laramie. Said photographer Robert Hale, "This is about the best action I've been able to get on the Big Boys." We must agree.

and use only roundhouse stalls aligned straight across the turntable from inbound tracks. At those locations most 4-8-8-4 inspections and repairs had to be done outdoors.

Union Pacific's right-of-way also required investment to accommodate the Big Boys. The distance between adjacent tracks had to be increased on sharp curves so the smokebox overhang to the outside of curves would not result in sideswipes. Cuts on curves had to be widened for the same reason, as did curved tunnels such as between Devil's Slide and Morgan, Utah. Certain bridges and culverts had to be strengthened. Some trackage in terminals and yards had to be realigned. Even with all that, employee timetables carried long lists of speed restrictions specific to the Big Boys, and they were prohibited from some tracks owing to their size and weight.

An Alco success story

Conventional wisdom holds that of the three steam locomotive builders, Alco, Baldwin, and Lima, the latter was the innovator, and Alco and Baldwin followed its lead. The same wisdom holds that Baldwin was the champion at building big locomotives in volume.

Where Alco differs from its competitors was

HENRY R. GRIFFITHS JR.

Extra 4002 East drifts downgrade on double track on the eastern slope of Sherman Hill, probably prior to the construction of the Harriman cut-off in 1952-53. In the distance a westward freight rains hot cinders onto a right-of-way burned bare by the volcanic journeys of UP's big engines.

its ability to build big locomotives in large quantities at a competitive price, *and* innovate. Of the three builders, Alco was the biggest proponent of three-cylinder power, and developed the ultra-high-pressure Delaware & Hudson compound 2-8-0's and the triple-compound 4-8-0. Lima's engineering staff and plant craftsmen certainly produced many successful designs; however, Union Pacific's Challengers and Big Boys demonstrate Lima had no monopoly on original thought.

While a few dogs emerged from Alco's factories, they were greatly outnumbered by success stories. Prior to and during its collaboration with UP, Alco's design team collaborated with New York Central's engineering team to produce excellent 4-6-4 Hudsons, 4-8-2 Mohawks, and ground-breaking 4-8-4 Niagaras.

At the time, every large railroad had its own engineering staff, some with almost as many mechanical engineers and draftsmen as the builders. While this produced a lot of waste, duplication, and "not-invented-here" prejudice, when an innovative builder was paired with a progressive railroad staff, successful locomotives resulted.

The Big Boy, like UP's 4-8-4's and 4-6-6-4's that preceded, was a joint design effort of Alco's

engineering staff and UP's Bureau of Research and Mechanical Standards. There's a surprising degree of standardization and parts interchangeability among the three types. Hundreds of drawings are common to all, with only a specific dimension here and there separating them.

While such standardization is to be expected with vendor-supplied appliances, here it extends to such items as basic firebox design; design of boiler courses; and seams, piping, and many running gear parts. The spring rigging, for example, designed (and patented) by Alco's Jerry Blunt, is almost identical among the three, with certain springs, pins, bushings, and hangers being fully interchangeable.

What worked, what didn't

UP's 4-6-6-4's of 1936 had upset some long-held theories. As did the 4-12-2's before them, the Challengers employed flat-bottom fireboxes and mud rings to keep overall size within turntable length limits without sacrificing grate area. This design also shifted weight to the drivers from the trailing truck. Critics have argued this firebox arrangement was inferior to the traditional slope design, but in practice, there was no difference in performance or costs between the two.

Too, the early 4-6-6-4's proved that articulateds could be more than a plodding drag freight engine. The Challengers ran efficiently at high speeds, utilizing their high-horsepower production capabilities without damaging the track or shaking themselves to pieces, yet still had high starting tractive effort. The excellent ride and tracking qualities of the Challengers (and later the Big Boy) was largely due to the four-wheel engine truck, which gave them great stability at speed and eased them through curves, switches, and crossovers.

Some decisions did not turn out as hoped. The first series of 4-8-8-4's, like UP's second series of Northerns, was equipped with Elesco Type E superheaters. This provided an increase in total heating and superheating surfaces as compared with the Type A, and promised reduced coal consumption. In practice, the Type E proved more costly to buy and had higher maintenance costs and failure rates.

An early problem with the Type E was burning of the return bends, which was eventually solved by shortening the length of the superheater units to get the return bends farther away from the firebox. Eventually, the units were shortened 23 inches, with a corresponding reduction in total superheating surface area. Ongoing headaches with Type E's convinced UP that the savings in coal created by the Type E's were more than offset by higher maintenance costs and down times. The second series of 4-8-8-4's, the fifth series of 4-6-6-4's, and third series of 4-8-4's came with Type A superheaters and were better overall performers.

Another weakness was the exhaust steam injector. This infernal device, sometimes called a "poor man's feedwater heater" due to its lower cost, was used instead of the tried-and-true Worthington type S or SA feedwater heater after experience with the first two series of Challengers, some of which had

JOHN SHAW

Big overhang for Big Boy on even modest curves—the 4016 between assignments in the cindery realm that was Rawlins, Wyo., in the age of steam.

Worthington 6SA's. While the 6SA was probably the best one ever used by UP, its value was diminished by its need for a pump that was heavy and required mounting directly to a locomotive's bed frame. With the large diameter of the boiler on the Challengers and Big Boys, this was not feasible without major changes in the design of the locomotive, the pump, or both.

On the Challengers, the 6SA hot water pump was mounted in the only place it would fit, at the bottom front of the smokebox. This location made it difficult to access the pump for routine service and repairs, which were frequent due to unanticipated vibration. The vibration caused leaks and

other problems including high stresses on the smokebox itself, both from the weight of the pump and from the action of its pumping.

A few other things were corrected. The exposed air pump aftercoolers on the front handrails didn't stand up to the vibrations inherent in their location and method of mounting, and were vulnerable to damage during smokebox inspections and front-end repairs. They were replaced with Wilson aftercoolers located behind the air-pump shield out of harm's way, and mounted to better resist vibration.

The drifting throttle, used on descending grades, proved to be a primary cause of midnight creepers—engines moving unattended at engine terminals. These were removed. The actuating rods for the Nathan mechanical lubricators proved fragile, so they were replaced with a chain-and-sprocket drive system that looked weird but was reliable.

Several changes were made in an effort to lower operating costs. Ten-inch steel boards were added to the tops of the tender coal bunkers, increasing coal capacity by 4 tons to 32 tons level full. The 4005 was converted to oil fuel in December 1946. It steamed well, but could not carry enough fuel to consistently make it from one oil tank to the next, because oil tanks were fewer and farther between than coal chutes. It was converted back to coal in March 1948. The 4019 was equipped with "elephant-ear" smoke deflectors for a short time in late 1945 and early 1946.

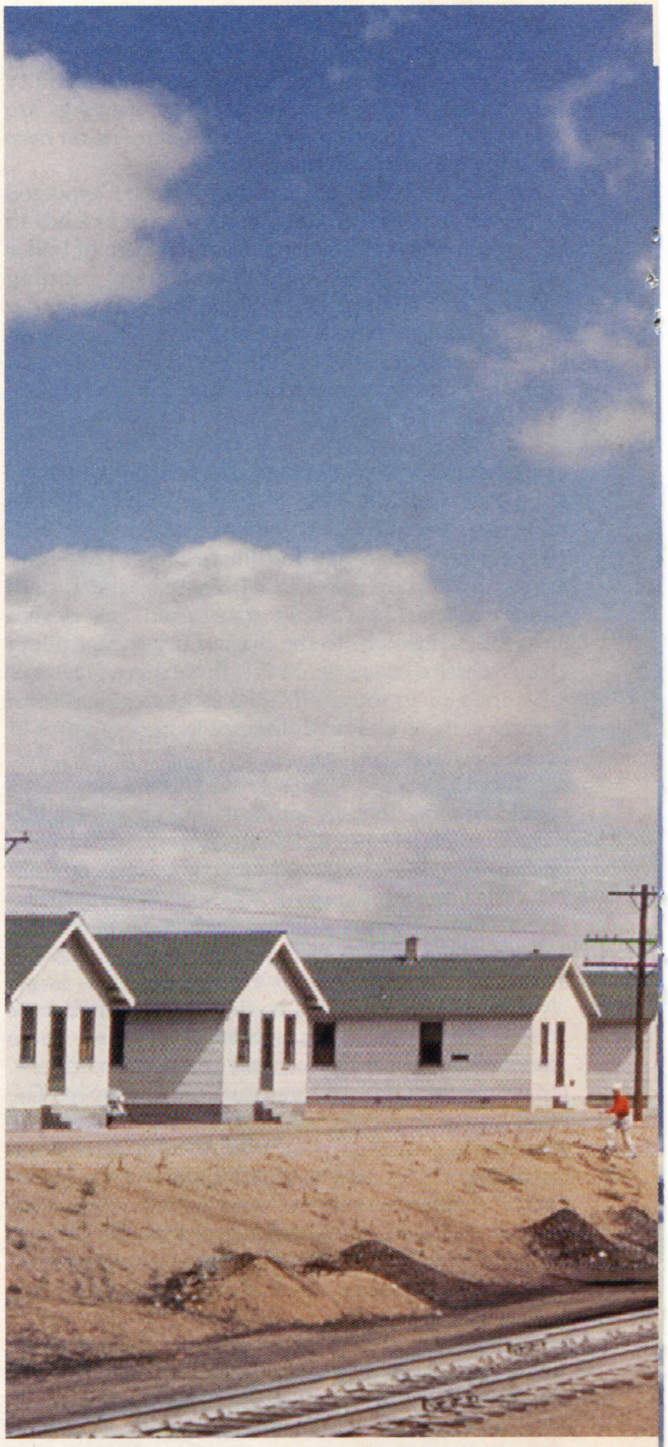
Nothing on earth like them

To the men who fired them, ran them, and maintained them, the Big Boys were simply the biggest and the best. Conversations with those who spent the early part of their railroad careers on and around the 4000's always elicit a tone of respect and reverence. But they seldom call 'em Big Boys; they were just "4000's."

If you ask them, these veterans will tell you how powerful the 4000's were. They'll tell you how in every dimension they seemed almost overwhelmingly large. They'll tell you how there was nothing louder, and how hot they were in tunnels—so much so that the after several engine crews had the skin burned off their ears in hellish trips through tunnels, the company issued leather hoods that covered the head. These were connected to a hose providing cool breathing air.

They tell of how the 4000's would steam even with entire grate sections burned out, broken, or missing. A small boy, said one veteran, could keep a Big Boy at 300 lbs. pressure, as long as he could reach the stoker valves.

They tell of a boiler so long that two water glasses, one above the other on each side of the cab, were necessary to keep track of the water level going up and down hills. They tell of cabs big enough to hold a union meeting, and a firebox so large it could, and often did, burn 22,000 pounds of coal an hour. Could you hand-fire if the stoker quit? No way, unless you were drifting downhill.



Did I mention they were loud? One retired engineer said that nothing on earth was louder than a 4000 working through a tunnel, to which another retorted, "Oh, yes there was! Two of 'em double-headed, especially if you were on the second one."

Several 4000's were involved in major derailments or collisions, some of which resulted in crew fatalities, though none were scrapped because of wreck damage. Eight of the 25 are preserved, at Cheyenne, Dallas, Denver, Green Bay, Wis., Omaha, Neb., Pomona, Calif., St. Louis, and Scranton, Pa.

TWO PHOTOS, JOHN SHAW

Extra 4001 West takes on coal at Harriman, Wyo., on the low-grade ascent of Sherman Hill completed in 1953. This very well could be the last new main-line coaling tower built in the U.S.

The pinnacle, then the fall

By the late 1930's, Alco was at the top of its game in the steam locomotive business. But by 1941 American railroads, except for a few holdouts, had lost interest in steam. Orders for new steam locomotives dictated by wartime restrictions and increased traffic levels indicated to Alco managers a continuing market. It was wishful thinking—by 1944 even the UP wanted diesels, instead of the 55 4-8-4's, 4-6-6-4's, and 4-8-8-4's it received that year from Alco. UP would order no more.

Alfred W. Bruce, in his 1952 *The Steam Locomotive in America,* said the Alco 4-8-8-4 "... probably represented the maximum development of the articulated steam locomotive with a reasonable axle loading for manifest freight train operation, since it incorporated both four-wheel leading and trailing trucks to provide maximum boiler capacity and riding stability at high operating speeds."

For Alco, there can be no better illustration of how far and how fast the mighty fell than to note that only 20 years passed between Alco's biggest and best steam designs and its biggest diesel failure, the Century 855—also built for Union Pacific. ■

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