E units A to 9

From the EA of 1937 to the final E9 in 1964, Electro-Motive's 1,300-plus E-series diesels were the locomotive stars of the streamliner era

By Preston Cook

It was the dawn of a new day on May 26, 1934, as a gleaming streak of stainless steel departed Denver and headed east into the sunrise. The Budd-built Burlington Route *Zephyr* was making history as it accelerated toward Chicago, passing through the heartland of America at speeds up to 112.5 mph. The power for the train was a Winton 201A diesel engine, a remarkable and lightweight prime mover that allowed the three-car, articulated streamliner to achieve impressive speeds and operate for equally impressive distances with minimal servicing. When the *Zephyr* arrived in Chicago 13 hours 5 minutes later, it delivered notice to the railroad industry and the world that a new era in rail travel had arrived, the age of diesel-powered long-distance passenger trains.

Ten months later, on March 17, 1935, a group of well-dressed men emerged from black limousines in the Chicago suburb of McCook, Ill., and waded across a barren and muddy field. The group included many of the top management of the General Motors Corp. In a moment that would change railroad history, Harold L. Hamilton took a shovel and turned over the first earth at the site of a new GM plant designed exclusively for the manufacture of diesel locomotives. For many years afterward the shovel would hang with a plaque in the lobby of the administration building at the Electro-Motive Corp. (EMC), which on January 1, 1941, became the Electro-Motive Division of GM (EMD).

For Hal Hamilton, that moment had to be a great victory. Along with Paul Turner he had founded the Electro-Motive Engineering Co. in 1922 at Cleveland, Ohio. His company achieved considerable success in designing and contracting the construction of gas-electric cars for railroad passenger service, but in 1930 Electro-Motive, along with its engine supplier Winton Engine Co., had been bought by GM. The giant corporation hoped to use Winton and Electro-Motive as its gateway into the marine and railroad diesel power markets, but as the Great Depression slowed business, Electro-Motive was gradually

Electro-Motive E8A demonstrator No. 952 presents an image familiar to millions of rail travelers from the 1940s through the '70s. EMD


75
YEARS
952
F
ELECTRO - MOTIVE

Burlington's *Zephyr* skims through Aurora, Ill., on its May 26, 1934, nonstop run that signaled the dawn of diesel-powered streamliners.
CB&Q photo

absorbed by the larger Winton subsidiary and became little more than a storefront for railroad sales within Winton Engine.

All of that changed in the wake of the *Zephyr* and several other streamlined train projects. Charles F. Kettering, who was appointed by GM President Alfred P. Sloan Jr. to head diesel engine development, appreciated the potential for diesel power in railroad applications, and visualized the diesel locomotive as eventually being capable of challenging the best mainline steam locomotives of the day. In February 1935 GM had announced that Electro-Motive would be separated from Winton and provided its own facilities near Chicago. Hal Hamilton was back in business, running the show as the first general manager of the Electro-Motive Corp., a subsidiary of General Motors.

McCook was a just small settlement, so the new facility was called the La Grange plant, to identify with the much larger town just to the north, on the Burlington's main line. While it was being built, GM had to rely on other suppliers to assemble locomotives, and was also dependent on one of those firms, General Electric, for rotating electrical equipment.

Box-cab beginnings

Initially, EMC powered its locomotives with the Model 201A Winton diesel engine, which was built in 8-, 12-, and 16-cylinder variations rated at 600, 900, and 1,200 h.p. The power available was adequate to displace steam switchers, but despite the success of diesels in streamlined lightweight passenger trains, none of the diesel engines used singly had enough horsepower output to challenge steam in mainline service. Hamilton and his chief engineer, Richard M. Dilworth, recognized that successfully competing with modern steam power would require diesel locomotives of from 4,000 to 6,000 h.p., and given the limited power output of individual prime movers, that goal could best be achieved in 1935 with a multiple-unit set of locomotives, each having two engines. The problem was to squeeze two diesel engines into each locomotive carbody, have both engines run together and share load and control functions, and then be able to transmit the control functions to additional identical locomotives in the consist.

The prototypes that would test that premise, and prove to be the first successful mainline diesel passenger locomotives that could replace steam, were a pair of twin-engined box-cabs assembled by GE in Erie, Pa. These were ordered when EMC was still under the control of Winton Engine, and early advertising artwork showed them lettered WINTON DIESEL LOCOMOTIVE. By the time they appeared in May 1935, the letterboards identified Electro-Motive as the owner, reflecting the spin-off of EMC from Winton. Box-cab demonstrators 511 and 512 were each powered by a pair of 900 h.p. Winton 12-201A engines. This was the prototype installation for what would become the engine and transmission package for the first E units two years later.

Experience with the two box-cabs demonstrated their abilities, resulting in a sale of a nearly identical unit to Baltimore & Ohio (B&O No. 50, later GM&O 1200, preserved at the Museum of Transportation near St. Louis), built by GE in August 1935. Next, in September '35, came two semi-streamlined box-cabs of essentially identical specification, Santa Fe Nos. 1 and 1A, with carbodies by St. Louis Car Co. In October and November 1936, EMC again used the same basic machinery package in a series of four cab units for the Burlington's growing *Zephyr* fleet that were assembled at the EMC plant, the first passenger locomotives built at La Grange.

A "standard" passenger line

The repeatedly demonstrated capability of the box-cabs with the twin 12-201A engine package to handle passenger consists on the B&O and Santa Fe led to a design project to develop a line of "standard" passenger locomotives. B&O was interested in having additional diesels, and its mechanical and operating managements figured heavily in the development of the product line. EMC engineers prepared a series of proposals for the B&O. Although the box-cabs rode on two two-axle trucks, the new designs were for five- and six-axle locomotives, since it had been recognized that more than four axles were needed if a twin-engined locomotive were to carry sufficient boiler water for train-heating. B&O expressed a preference for six axles, and the die was cast for the streamlined machines with an A1A-A1A wheel arrangement that would become known as E units.

The standard product line that went into production in 1937 consisted of two varieties of passenger locomotives. The larger and more capable ones intended to compete with steam power

They weren't much to look at, but EMC 511-512 (on C&NW at Marshalltown, Iowa) proved the twin-engine concept that was the basis of the E.
Edward H. Meyers photo

B&O dressed up the front of its lone box-cab with some sheet metal. No. 50 is on the Alton's *Abraham Lincoln* at Bloomington, Ill., in 1939.
Paul Stringham photo, Louis A. Marre collection

History takes shape at EMC's new La Grange plant in 1937. Beyond the switchers in the foreground, B&O EA No. 51 glistens in fresh paint.
EMC photo

in hauling conventional equipment were the streamlined EA cab and EB booster units, each powered by a pair of Winton 900 h.p. 12-cylinder 201A engines. The "E" was for "Eighteen-hundred," the horsepower rating of each unit. The locomotives were equipped for multiple-unit control, allowing consists to be assembled to meet the operating needs.

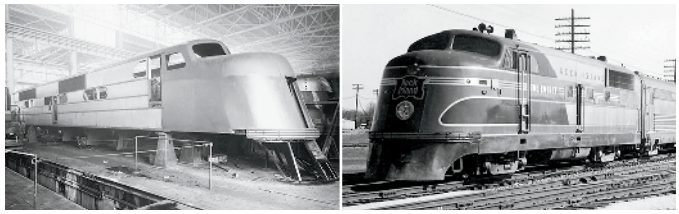
EMC also designed a similarly styled but smaller unit, the TA ("Twelve-hundred" h.p.). Built only for the Rock Island, the TA was a very lightweight locomotive, basically a derivative of the streamlined-train power cars, powered by a single Winton 16-201A. The TA was intended for use with a matching train and had no provision to operate in multiple-unit sets.

Model proliferation

Almost as soon as EMC had designed its product line, railroads accustomed to a high degree of customization in their steam locomotive orders began asking for individualized features. This resulted in a quickly developed progression of locomotive models, all sharing the same basic machinery, but each altered slightly to suit the preferences of the purchaser.

During the early years of E-unit production, Electro-Motive

The final two twin-engined box-cabs, Santa Fe's "One-Spot Twins," with special livery and roof cowling, worked the original *Super Chief*.
Classic Trains collection



EMC's planned standard line of similarly styled passenger diesels consisted of the twin-engined EA (left) and the single-engined TA.
Left, EMC; right, Ross Grenard

used a slightly different model nomenclature system from that commonly used today. Initially, the Sales & Service Department designations for the locomotives were "EA" for the cab units and "EB" for the boosters, followed by the series number (if any). Thus EMD manual No. 2300 for what we now call the E7A lists the model as "EA-7"; the corresponding booster unit was an "EB-7." Beginning with the E8, EMD adopted model designations of "E8A" for the cab and "E8B" for the booster. However, for more than 50 years, railroad history writers have used the later system for the entire E-series, and this article will do so as well. As an example, E7 will indicate the model group, both cab and booster units, with E7A referring to a cab-equipped locomotive and E7B indicating a booster.

In the following pages, we will consider each E-unit model, from the EA and EB of 1937 through the E9, the last of which was delivered in 1964. Only minor differences separate some models, while others, such as the E3 and E8, represent major advances. A table at the end of each section lists the model's engine type, horsepower rating, and production span, as well as the quantities of A and B units built for each railroad that bought the model. Spanning more than a quarter-century, E-unit production totalled 1,349 cab and booster locomotives. To a far greater extent than any other family of diesels, Electro-Motive's E units were *the* locomotives of the streamliner era.

EA/EB
For the 'first' railroad, the first E units

B&O EA No. 51, the first E unit, waits to depart Jersey City with the *Capitol Limited* in May 1953, not long before it went to the road's museum in Baltimore. I. W. King photo, Joel King coll.

Electro-Motive's design of the EA addressed several safety and visibility concerns that had resulted from the operation of the box-cabs, which put engine crews in a very vulnerable position in the event of a collision. In the new design, the cab was elevated and moved back behind a streamlined nose that provided protection. Following several styling proposals based on automotive appearance and the turret cabs used by the Union Pacific, and the creation of at least one notably ugly mockup [see page 50], EMC settled on a design that combined two familiar elements. The EA's nose mimicked the shape of the Budd-built Burlington *Zephyrs*, while the cab was an adaptation of the UP M-10003–M-10006 power units built by Pullman-Standard. The UP features were carried to an extent of including the curved window behind the cab door to give a hint of turret cab lines. By 1937 the earlier streamliners had been extensively promoted in the print media, and the new E unit was a friendly and consistent addition to the motive power on the railroads operating streamliners.

The EA/EB carbody design gave the cooling systems of both engines equal access to incoming air regardless of the locomotives' direction of travel. This was done by placing the engineroom air intakes on the sides of the carbody rather than the ends. Air intakes at the ends had been a problem on the box-cabs, affecting the cooling of the trailing engine. The change was not immediately significant for the EA/EB sets, which were intended to be operated in a pair with the cab unit always in the lead, but it made the locomotive more effectively bidirectional and set the stage for random arrangement of multi-unit consists.

B&O's preference for a six-axle locomotive resulted in the creation of an A1A truck. Primarily the product of design efforts by Electro-Motive's Martin

E1
Super (Chief) power

First Warbonnet: Santa Fe Nos. 2 and 2A pose west of Chicago with the consist of the new streamlined *Super Chief* shortly before the train's June 15, 1937, inaugural. Santa Fe photo

Santa Fe, the other buyer of Winton-engined box-cabs, followed B&O's lead by taking delivery of eight E1A cabs and three E1B boosters in 1937 and '38. These were essentially mechanical duplicates of the B&O EA's and EB's, with Santa Fe's first unit being produced just a month after B&O's first unit. The side window treatment and the application of stainless-steel side panels on the E1's provided the most visible differences from the EA and EB. On the B&O units, the windows where shallower, had rounded ends, and the middle set included the engineroom side access doors.

Santa Fe initially assigned the E1's to transcontinental streamliners like the *Super Chief* and *El Capitan*. Later, they worked regional trains in California.

A particularly memorable aspect of the Santa Fe E1's was the "Warbonnet" paint scheme, developed by GM artist Leland Knickerbocker specifically for them [see pages 46]. In a world of drab steam locomotives, it was a stunning accent of color that immediately became associated with the railroad. All subsequent Santa Fe carbody passenger diesels, even those not built by Electro-Motive, plus some second-generation cowl and hood units, got the Warbonnet scheme. The road retired the red-and-silver scheme after joining Amtrak in 1971,

No. 55 models the original EA livery in Philadelphia in the mid-'40s. Frank & Todd Novak coll.

Blomberg, who also handled much of the carbody and structural design [see page 38], the truck became a standard feature of all E-unit production.

B&O, the only EA/EB buyer, used them on top passenger trains to New York, Chicago, and St. Louis. In 1953, it returned the historic units to La Grange, where EMD rebuilt them to E8 specifications. One unit was exempted from the program: No. 51, the first EA, went to the B&O's new museum in Baltimore, where it can be seen today.

EA/EB	201A • 1,800 h.p. • 5/37–6/38	
	A units	B units
B&O	6	6

Here's No. 2 again, at Willow Springs, Ill., on first 11, the *Kansas Cityan*, in November '46. The B unit is an Alco DL110. C. H. Kerrigan photo

but revived it in spectacular fashion on hundreds of wide-nose freight locomotives beginning in 1989.

As with the B&O EA's and EB's, EMD remanufactured the Santa Fe E1's into E8's during the mid-1950s.

E1	201A • 1,800 h.p. • 6/37–4/38	
	A units	B units
ATSF	8	3

E2
Unique styling for Union Pacific

***City of San Francisco* engines SF-1 and SF-2, perhaps on temporary assignment to the *City of Denver*, idle at 40th Street in the Mile High City on April 6, 1941.** Two photos, Richard H. Kindig

The only E2's were a pair of A-B-B sets delivered to Union Pacific beginning in October 1937. They were for use on the newly reequipped streamliners *City of Los Angeles* (jointly operating with the Chicago & North Western) and *City of San Francisco* (C&NW and Southern Pacific). Externally, the E2's were heavily customized, with a unique, bulbous nose and large chrome-rimmed portholes, resembling UP's earlier M-10003–M-10006 streamliners. Mechanically the E2 was, like the E1, a clone of the EA.

A fascinating aspect of the E2's and their trains was the use of electric head-end power (HEP) in addition to steam heat and air conditioning. The electric plant consisted of a pair of Winton 8-201A engines in a special power car, called a "Baggage-Auxiliary-Engine-Dormitory" by the railroad. The HEP system on this train was 220 volts A.C. with a total generated power of 600 kW. One of the early discoveries from this application was that electric heat proved more fuel-efficient for train heating than steam. However, the large fleets of cars built with steam heat for service with steam locomotives remained for several decades in long-distance service. Large city commuter operations began switching over to HEP by the 1960s, but it took several years into the Amtrak era before HEP became prevalent for long-distance equipment.

When newer E units arrived after

Again at Denver, on Nov. 27, 1937, E2's LA-1, LA-2, and LA-3 roll in with the *City of Denver*, on which the units are being broken in.

World War II, the E2's were taken off the *City* trains and divided among the three partners. *City of San Francisco* unit SF-1 went to the SP, on which it ran as No. 6011A, then 6017, before going to EMD as the core for an E7. Its two Winton 12-201A engines rested in a scrap yard for many years and were eventually acquired by the California State Railroad Museum. One of the engines was subsequently transferred to the Illinois Railway Museum for future display. The *City of Los Angeles* cab, No. LA-1, became C&NW 5003A and was eventually scrapped. Union Pacific got the four E2B's, which it used as trade-ins for E8B's.

E2	201A • 1,800 h.p. • 10/37, 12/37	
	A units	B units
UP	2	4

E3
The 567 era begins

Bumped from their original *400* run, C&NW 5002B and a sister curve through Great Lakes, Ill., with a Chicago-bound train in January 1952. George Krambles photo, Krambles-Peterson Archive

General Motors engineers identified a number of problems with the Winton 201A engine, resulting in a series of design changes and field modifications. The 201A was very messy, prone to leakage, and challenging to maintain. The individual cylinder valve gear covers were held down only by their own weight, typical of slow-speed early diesels. The poor seal resulted in an engine room full of oil fumes. Also, the exhaust manifold sat in a channel in the roof where it was exposed to rain that leaked down onto the engine. In addition, the limitations of designing and building engines in Cleveland and then shipping them to La Grange for installation had become apparent. It made better sense to have the engine manufacturing and technical support at the site where the locomotives were being assembled and tested.

Consequently, EMC expanded the La Grange plant in 1937 so a new two-stroke engine could be built on-site. It was designated the Model 567, named for its swept displacement per cylinder in cubic inches (Winton engines were named for their engineering project numbers). It was not a totally new design, and actually resurrected some features of the Winton 201 that had preceded the 201A. The 567 also eliminated many complications of the 201A that had been included in the engine for marine service, concentrating instead on the needs of a locomotive installation. This included provision for higher capacity power takeoff at the front and rear of the engine for driving cooling fans and auxiliary equipment.

Concurrent with the development of the 567 engine, EMC designed its own line of traction motors and main generators. Manufacture of these key components took place in-house, ending reliance on vendors who were also selling electrical equipment to competitors.

The first E's to get the 567 engine were the E3 and E4. The designations did not follow the order of production, most likely because the model numbers were assigned when the sales release to Engineering was issued, resulting in the first E4 being built several months before the first E3. This might have been driven by the desire of GM and the Seaboard Air Line to display a set of new locomotives at the New York World's Fair, which opened in spring 1939. The E3 and E4 were identical but for a nose door on the E4.

The E3 retained many of the styling features of the Winton E's, but in a redesigned carbody specifically rearranged for the 567 engine. One E3, demonstrator No. 822, had the smooth nose and recessed headlight of the EA and E1. EMC soon revised the design to put the headlight in a raised housing that allowed better light concentration ahead.

The 567's in the E3 were installed in reverse of the arrangement in the 201A-powered E's. The 201A's had been placed with the generators toward the rear, along with provision for driving the cooling fans from the generator end. This had been done because the 201A lacked an adequate power takeoff for fan drives on the front of the engine. The air intake and Roots blower of the 201A were at the front, while in the 567 the air intake and blowers straddled the generator, and the engines were oriented with the generator forward. There were power takeoffs at each end of the engines to drive cooling fans, so the fan compartments and radiator air intakes were over either end of each engine. The radiators themselves were above each bank of cylinders, with the exhaust stacks projecting between the left and right banks. This layout provided better cooling air flow for both directions of operation, and provided two air sources for each engine's radiators to reduce the possibility of snow blockage.

Brand-new FEC 1002 poses with an ACL *Champion* consist. FEC photo, Seth Bramson coll.

The E3 repeated one design flaw of the early E's: The boiler water tank was beneath the cab floor. This was done to make it easier to fill the tank from steam locomotive facilities, but the railroads came to prefer using ground-based hoses. Consequently the fill location on the side of the cab became a hazard that required using a ladder or holding a hose overhead to connect it. The nose water tank also resulted in the weight distribution shifting toward the rear of the locomotive as it consumed boiler water, making the unit increasingly slippery on its lead truck as the water was used up.

EA/EB, E1, and E2 production added up to 29 units; the E3 total was 19.

E3	567 • 2,000 h.p. • 3/39–6/40	
	A units	B units
ATSF	1	1
ACL	2	0
C&NW	4	0
CRI&P	2	0
FEC	2	0
KCS	3	0
MP	2	0
UP	1	1

E4
Seaboard orders a front door

Seaboard 3000, at Washington in 1940, was the first E unit with Electro-Motive's 567 engine and electricals, a status EMD marked at its 1964 scrapping. O. H. Borsum photo, Paul Lubliner coll.

When ordering diesels for its *Silver Meteor* and *Orange Blossom Special*, the Seaboard Air Line Railway wanted crewmen to be able to move from a trailing A unit to the first car in the train, or from the front of an A unit to another locomotive, without having to get down on the ground. What the customer desired was a nose door that provided protection but could be concealed. Designing this into an E3 was complicated by the 20-degree slant of the nose—a simple door would leave a man dangerously exposed. EMC's Martin Blomberg overcame this difficulty by devising a retractable, hydraulically operated nose vestibule and door. The system swung upward and out from the nose, positioning the vestibule in close proximity with the rear door of an adjacent locomotive or the end door of a passenger car. Seaboard was the only road to specify this feature, which prompted EMC to create a new model number, E4. Otherwise, the E4 was identical to the E3.

Blomberg's unique E4 nose door. EMC

The E4 achieved a high level of visibility early in its career thanks to a display during the first season of the 1939–40 New York World's Fair. An E4A and E4B were positioned at an entrance to the GM pavilion. The A unit was lettered for both GM and Seaboard and given No. 1939 for the fair. The left side of the A unit and the right side of the B unit were sheathed with glass panels, and the interior was illuminated for night viewing. The rear of the B unit projected through the glass wall of the GM building, and could be entered from inside the pavilion.

E4	567 • 2,000 h.p. • 10/38–12/39	
	A units	B units
SAL	14	5

E5
Inspired by the Zephyrs

Still gleaming after nearly two decades, CB&Q 9912-A and another E5A accelerate the *Morning Zephyr* out of Chicago in 1958, after red nose stripes replaced black ones. Dan Pope coll.

The E5 is apparently another case of minor variations occasioning a separate model designation. Produced exclusively for the Burlington Route, it was basically an E6 sheathed in stainless steel. As with the E3 and E4, the opening sales release for this model was apparently placed earlier than that for the first E6, resulting in a lower model number, but the E5's period of production is entirely contained within the production span of the E6, and the two models are identical internally.

The attractive and durable application of stainless steel sheathing to these locomotives was intended to be consistent with the streamlined *Zephyr* trains of 1934–39, and the E5's were all given names as was the practice with the *Zephyrs*. The grilles flanking the headlights of the *Zephyrs* were replicated in black paint on the E5's, which proved to be extremely long-lived and reliable performers, serving the railroad well into the 1960s. At the time of their retirement, they looked almost as good as they did when new. One survives, in operating condition, at the Illinois Railway Museum.

E5	567 • 2,000 h.p. • 2/40–6/41	
	A units	B units
CB&Q	11	5

E6
Last of the slant-noses

MoPac 7002 and an E6B depart Denver with the *Colorado Eagle* in August 1947. The A unit carries the names of the train's two partners, MP and Rio Grande, below its eagle emblem. Most roads specified standard rectangular side windows, not portholes. Frank and Todd Novak coll.

The differences between the first E6 and the predecessor E3 are extremely subtle and have caused confusion among railroad historians, since the recorded production periods overlap. Although external differences are minimal, the machinery design would have required a different parts catalog and operators manual.

The actual overlap involves only two locomotives. The first E6, completed in January 1940, was built for display in the second season of the New York World's Fair, replacing the Seaboard E4A, which was delivered to the railroad and put into service. (The Seaboard E4B was at the fair for both seasons.) The E6, lettered for GM and numbered 1940 for the exhibit, also joined Seaboard's fleet after the fair. The sole E3 completed after the beginning of E6 production, Kansas City Southern No. 3 with a build date of June 1940, had most likely been ordered prior to the introduction of the E6.

(Confusion also surrounds a third unit, Atlantic Coast Line No. 501. Completed in November 1939 as an E3A, it was damaged soon thereafter, possibly while en route from EMC to the railroad. It returned to La Grange for repairs, and emerged as an E6. It's now at the North Carolina Transportation Museum.)

Late afternoon sun catches the nose of IC 4002 as it leads a sister E6A west through Elmhurst, Ill., with the *Land o' Corn* on August 20, 1949. H. M. Stange photo, Krambles-Peterson Archive

One small but externally visible change introduced in the E6 was the replacement of the gravity fill on the boiler water tank with a pressure fill connection low on the side of the carbody. This reflected the railroads' preference for using pressure hoses to fill the tank rather than running water down from a standpipe into a gravity fill. Some earlier production E units were retrofitted by their owners with the revised water tank fill.

The introduction date of the E6 was timed closely with the implementation of a significant improvement in the crankcase design of the 567 engines. From the 1938 introduction of the 567 through late 1939, the engine used steel castings in the construction of the top deck area. This version of the 567 engine was called the "U" deck because of the shape of the

L&N 757 heads the *Southland* at Knoxville in 1958 or '59, after large number boxes had replaced smaller originals. Jim McClellan photo

Three ACL E's, led by E6A 520, haul a train south out of Philadelphia in February 1958, when freak snow disabled GG1's. Jim McClellan photo

exhaust riser well in the center of the engine vee. Electro-Motive encountered cracking problems with the 567U engine. An improved engine featuring a fabricated welded top deck, designated the 567V, was introduced early in 1940, coinciding closely with the production of the first E6.

Another externally invisible but mechanically significant change was developed partway through the E5-E6 production run. The 567 engine had a tendency to aerate the lubricating oil at high engine speeds, with bubbles entrained in the oil seeking the high point in the engine to vent, which resulted in them popping out at the camshaft bearings on the top deck. The 567 had initially been designed with a dry oil sump and a separate oil storage tank. Electro-Motive engineers determined that the standing time of the oil in the tank at high throttle notches was not adequate to let air in the oil vent, and in the middle of E5 and E6 production they decided to change the engines over to wet sump, where they could store a much greater oil volume. This required a piping change to limit the oil height in the external tank, making it into a feed chamber for the main pump rather than the entire oil storage. The modification proved successful, so all subsequent production used wet oil sump design. A modification kit that EMD sold to customers was installed on most if not all of the locomotives previously completed.

There were two notable aberrations in the "standard" E6 line. Electro-Motive built a derivative for the Rock Island in the form of two single-engined "power/baggage" locomotives, RI Nos. 750 and 751, built in August 1940 and given Model AB6. These distinctive machines had square-fronted cabs and were designed to address the particular needs of joining the Colorado Springs and Denver sections of the *Rocky Mountain Rocket*. The AB6 would trail the conventional power westbound [next page], to be separated from the train at Limon, Colo., and continue to Colorado Springs, while the train with conventional cab units proceeded to Denver; eastbound, the process would be reversed. RI 750 was given a second engine in late 1948, with No. 751 following suit in '49, eliminating their baggage compartments. They ended up in the Chicago commuter pool, in which they operated until the early 1970s. (Another RI unit, E6A No. 630, was the last active E6, running until 1977.)

Another E6 variant, also in August 1940 and also in the "power/baggage" configuration, was the single Model AA, Missouri Pacific No. 7100. This was a more or less conventional E6A with the rear engine omitted and the engine well plated over, equipped with side baggage doors. Although MP 7100 did not have a passenger compartment, it was effectively an extension of the motor car line that had given Electro-Motive its start in the mid-1920s. It served its entire life with a single engine and was retired in 1962.

Selling to the tune of 120 units, more than all previous E models combined, the E6 was a breakout product. It easily beat back the first serious competitor to the E-series, Alco's DL109 family, which, although introduced at the same time as the E6, sold only 78 units to seven roads.

With America's entry into World War II, Electro-Motive was assigned priority in procurement of materials for the building of critically needed FT freight locomotives, and was also authorized to complete E6's that had been ordered prior to December 7, 1941. EMD built its last E6 in September 1942, and would not resume passenger locomotive production until the first E7 in February 1945.

Oddities: RI's two AB6's were box-cab/E6/baggage car hybrids. MP's AA was half E6A, half baggage car. AB6, EMD; AA, Louis A. Marre

E6	567 • 2,000 h.p. • 1/40–9/42		
	A units	B units	Other
ATSF	4	3	0
ACL	22	5	0
B&O	8	7	0
C&NW	5	0	0
MILW	2	0	0
CRI&P	5	0	2*
FEC	3	1	0
IC	5	0	0
KCS	2	0	0
L&N	16	0	0
MP	2	2	1**
SAL	3	0	0
SOU	7	4	0
UP	7	4	0
* Model AB6. ** Model AA.			

E7
Best-selling passenger diesel of all time

Rock Island E7 633 and one of the two unique AB6's [previous page] bring the westbound *Rocky Mountain Rocket* into its first stop, Englewood on Chicago's South Side, circa 1948. Note the NYC Hudson at right, ready to head up to La Salle Street. B. L. Stone photo, Krambles-Peterson Archive

As World War II drew to a close and government restrictions on allocation of materials for locomotive construction were eased, Electro-Motive began work on a replacement for the E6. In constructing hundreds of FT freight units just before and during the war, EMD learned a lot about how to build locomotives more efficiently, and was eager to apply these lessons to its E-unit line. Running parallel with another engineering department project to develop a successor to the FT, the redesign of the E unit was kept fairly modest, and the E7 retained many of the features of the E6.

The most noticeable change was in the nose. The rakish slant of the pre-war E units' prow was gone, replaced by the F unit's "bulldog" nose contours, allowing some simplification in the manufacturing process by using similar stamped and molded plates on both product lines. However, the underlying structure of the E7 nose was considerably different from the FT's, since the centerplate positioning for the front truck on an E unit was farther aft than on an F. Using the shorter nose on the E7 provided several feet of additional space in the front of the engine room that enabled a needed rearrangement of the air reservoirs, water tank, and battery compartments.

Gulf, Mobile & Ohio 103A and 103 leave St. Louis on the *Abraham Lincoln* in 1963. Alton Railroad got them in spring 1946, one year before it merged into GM&O. Frank and Todd Novak coll.

The steam generator water tank was installed under the carbody next to the fuel tank, solving the problems of inaccessibility and inconvenient fill arrangements that had plagued the earlier E units. On the E7, the water could be filled by gravity, so filling did not require pressure to force it into a tank located higher than the fill connection, and there was no need for climbing up the side of the locomotive to reach the tank fill. In the swap of tank locations, the batteries, which had been located under the frame on earlier E's, were moved up into the nose. This turned out to be another less than satisfactory solution, as hydrogen from charging was an irritant to the crew and posed some risk in such close proximity to the control stand in the cab, while the front position of the batteries also posed a risk in the event of a collision. In the E8 and E9, EMD moved the batteries again, into boxes along the walls of the steam generator compart-

Having traveled down the Coast Line on a 12-hour overnight run from San Francisco, SP's *Lark* arrives at Los Angeles Union Passenger Terminal in September 1957. The diesels, all in SP's famous *Daylight* colors, are E7A 6017, an E7B, and an Alco PA. John Dziobko photo

ment, a much better location where they were easier to ventilate and maintain.

During the production of the E7, EMD addressed one unnecessary complication in the A1A Blomberg truck. Since the beginning of the E-unit series, the trucks had been built with a drop transom (the connecting piece between the ends of the frames) at one end of the frame, and a straight transom across the other end. The drop-transom end went under the coupler pocket; the straight transom end faced the center of the locomotive. During the E7 production, the truck was changed to having drop transoms on both ends, allowing the truck to be applied facing in either direction.

The significant design drawback of the E7 was that there was no provision or room in the carbody for dynamic braking. When Alco introduced what came to be known as its PA1 passenger diesel in September 1946, with its very capable dynamic brake installation, it put EMD at an immediate disadvantage in marketing, especially to the western railroads. The E7 was already larger, heavier, and involved more material and assembly costs than the PA.

Despite its drawbacks, the E7 did not suffer from the reliability problems that plagued the passenger diesels of the other builders (Baldwin and Fairbanks-Morse had also entered the market), and EMD was able to sell 428 E7A's and 82 E7B's in a little over four years. The grand total of 510 units made the E7 North America's best-selling passenger diesel, a record it still holds. The last ones ran in 1980, on NJ Transit's North Jersey Coast Line.

Boston & Maine 3806 and Maine Central 710 curve into MEC's station at Waterville, Maine. It's July 1959—6½ years since MEC gained independence from B&M—but No. 710 has yet to trade its B&M maroon for MEC green. Preserved MEC 4-6-2 470 stands at left. Dan Pope coll.

E7 102, one of eight Pere Marquette E7's ordered before its June '47 merger into C&O, leads Grand Rapids–Petoskey, Mich., train 105 across the 1,170-foot-long High Bridge, 98 feet above the Manistee River 5 miles north of Wellston. C&O removed the bridge in 1955. John B. Corns coll.

Lightning-striped NYC E7's rumble across the St. Joseph River bridge into Niles, Mich., on November 8, 1952. They are on train 376, the *Chicago Mercury* for Detroit, which is moments away from its stop at Niles' handsome stone depot. H. M. Stange photo, Krambles-Peterson Archive

The smallest E fleet belonged to Spokane, Portland & Seattle, which owned just one unit: E7 No. 750. The loner and F3 800 pull out of Portland with the combined Portland sections of GN's *Empire Builder* and NP's *North Coast Limited* in mid-1968. Matt Herson photo, F. and T. Novak coll.

Bangor & Aroostook boasted the second-smallest fleet of E's, half of which is represented by E7 No. 11 at Caribou, Maine, in 1960, the year before BAR went freight-only. Dan Pope coll.

E7	567A • 2,000 h.p. • 2/45–4/49	
	A units	B units
Alton	7	0
ACL	20	10
B&O	18	0
BAR	2	0
B&M	21	0
CofG	10	0
C&O	4	0
C&EI	3	0
C&NW	26	0
CB&Q	44	0
MILW	10	0
CRI&P	11	9
FEC	17	3
GN	13	0
IC	14	4
L&N	12	0
MEC	7	0
MKT	2	0
MP	14	8
NYC	36	14
PRR	46	14
PM	8	0
SLSF	6	0
SAL	32	3
SP&S	1	0
SOU	18	0
SP	5	10
T&P	10	0
UP	7	11
WAB	4	0

E8
Redesigned, inside and out

The Pennsylvania had both the most E8's and the most E's overall, 134; rival NYC placed second on both counts (the roads held the same ranks for E7 ownership). The 1950–52 delivery period of Pennsy's E8's spanned the road's switch from dark green to Tuscan red for passenger diesels, as shown in this mid-1950s scene of 5894 and an older sister coming off the Rockville Bridge at Marysville, Pa. Bob's Photo

Following the modest redesign that produced the E7, EMD engineers had turned their attention to improving their road-freight locomotive product, resulting in the discontinuance of the FT and the development of the F2 and F3. These models introduced many new features intended to speed the production process and reduce the amount of time a locomotive spent in the space-critical "final assembly" stage of production. Eugene Kettering, the son of GM Research Laboratories boss Charles F. Kettering, was a brilliant engineer who had joined Electro-Motive earlier in the 1940s and worked extensively on engine development during the war years. In the postwar period, Gene Kettering turned his considerable talents to improving the "packaging" of the builder's various locomotive lines.

A redesign of the E unit had been made particularly urgent by Alco's introduction of the PA1 in 1946. The PA had an extremely capable dynamic brake system, but the E7 could not accommodate one. Kettering and his team responded to this challenge with a complete redesign of the E unit, retaining only the general size and the main machinery components of its predecessor, while placing these components in a totally different arrangement.

While the E7 had the front of both engines facing the rear of the carbody, which was the accepted practice in most locomotives, Kettering's team turned the rear engine around to have the two diesels "facing" each other in the carbody, with the rear (generator) ends toward the ends of the locomotive. The designers moved the electrical cabinets, which had been in the left walkway of earlier E units, to the centerline of the locomotive, as had been done in the F units. This substantially shortened the cable runs and reduced the complexity of assembling the locomotive.

The engine accessories for the E8 were mounted in a rack as on the F units, and on the E8 it was also possible to mount an engine-driven air compressor compactly beneath the accessory rack. The E8's prime mover was the 567B engine, which was very similar in basic design to the predecessor 567A but introduced a combined oil strainer box for the scavenging and main oil systems. This eliminated a great deal of individual piping from the front of each engine, since the oil passages were cast into the structure of the strainer box. The rear of the 567B included a power takeoff for driving the auxiliary generator, and an improved rear cover arrangement that was stronger and less leak-prone than its predecessors.

Between the two main engines of the E8 and their respective cooling hatches, there was enough space in the upper carbody to allow the installation of a dynamic brake hatch that was essentially identical to the hatch being used in F3

Wabash 1000 leaves the big grain elevators of Decatur, Ill., behind as it accelerates east with the St. Louis–Chicago *Blue Bird* on June 1, 1952. H. M. Stange photo, Krambles-Peterson Archive

Southern 2927 displays its original livery at Augusta, Ga., in April 1952. Black replaced the green in the '60s, but President Graham Claytor brought the green back, with bigger lettering, in which guise the E8's (renumbered to the 6900's; 2927 became 6904) became celebrities as power for the non-Amtrak *Southern Crescent*. W. B. Cox photo, Krambles-Peterson Archive

and F7 locomotives. This was not an ideal placement because it required long cable runs, but there was no other viable location in the locomotive. If a customer did not need dynamic braking, a plain hatch or a hatch containing an additional boiler water tank could be substituted.

The E8's cooling system was a unitized roof hatch assembly similar to the arrangement used in the F2 and F3. The main generators for the E8 were provided with companion alternators that produced alternating current, the frequency following the engine speed. This was used to power cooling fans that simplified installation of the cooling hatch since no alignment of drive shafts or fan belts was necessary. The A.C. power was also used for an additional ventilation fan built into each of the two cooling hatches. This fan assisted in directing air flow to the rear of the engine where the engine air filters, Roots blowers, and main generator were located, providing cooler air for combustion and also helping to ventilate the main generator.

Lessons that had been learned in 1946 from early experience with the F2 and F3 were quickly adapted in 1947 and '48 for application to the new E unit. The findings from winter-operation problems on the F's were particularly valuable

Frisco named its E units after notable horses. E8 2021 *Gallahadion* (1940's Kentucky Derby winner) stands at K.C. in 1954. Dan Pope coll.

in the design of E8's cooling system, and a number of features like winterization hatches that had been developed retroactively for the F's were incorporated into the E8 design right from the start. On the E8 hatch, the flow of the No. 1 cooling fan could be diverted through a flapper valve set for winter/summer operation. In the winter, the warm air flow from the fan would be fed back through a roof-mounted duct into the carbody pressurization fan, bypassing the outside filter grille, and its warm air output could help to avoid filter icing.

Another winterization problem that was effectively addressed in the E8 was the situation where extremely cold weather could freeze a boiler water tank or its piping. On the EA through the E6, the water tank had been under the cab and needed steam heating in the winter to keep it above freezing; on the E7, it had been under the carbody, making it even more liable to freeze. The E8 introduced a combined fuel and water tank with an arched divider plate running the length of the tank. Since the bottom and the sides of the water tank section were surrounded by the fuel tank, and return fuel from the injectors was quite hot when returned to the tank, this helped to keep the water and piping from freezing.

The loss of steam generator output in cold weather could be a critical problem for the train crew as well as the passengers, since it not only deprived the train of heat but also cut off heat to the locomotive cab heaters and to the heating coils in the boiler water tank. EMD offered the E8 and later the E9 with an option for dual steam generators rather than a single unit, this being done primarily to improve heating reliability. In later years, when the steam generators were removed from E units to convert them to head-end power (HEP), many of the locomotives were changed over to water heaters supplied by the engine

E8's on the future EL: Erie's *Lake Cities* (above left) rolls west down the road's broad right of way at Disko, Ind., on Independence Day, 1951. Two months later, on September 8, DL&W's eastbound *Lackawanna Limited* climbs out of Scranton, Pa. H. M. Stange photos, Krambles-Peterson Archive

cooling system. These tended to be a bit less effective than steam heat because diesel engines tend to run cold at low throttle notches. Electric cab heat started to appear late in the life span of the E8 and E9, but the auxiliary generator output of these locomotives was usually not enough to provide adequate electric heat if one engine was shut down.

The rectangular side carbody windows used on most E7's had proved to be prone to water leaks. They were abandoned on the E8 in favor of four portholes on each side. Two on each side were hinged to allow running hoses and cables into the engine room for servicing the locomotive in the shop.

During the production life of the various E-unit models, the weight of the locomotives had gradually increased as features were added. The Winton-engined units typically weighed in at just over 300,000 lbs., but a typical E7 was 315,000 lbs. In the E8, particularly those with two steam generators, total weight could exceed 330,000 lbs. This began to take a toll on the A1A Blomberg truck that had served since 1937, and partway through E8 production the main frame of the truck was strengthened. This resulted in "light frame" and "heavy frame" versions of the truck, which are quite noticeable in the height of the frame adjacent to the center axle. Functionally these trucks were interchangeable, and in the later years of E8 and E9 usage, it was not unusual to see a unit with a light-frame truck under one end and a heavy one under the other.

The earlier E units had achieved excellent market penetration already, and when the E8 rolled out in 1949, the railroads were around the halfway point in dieselization. With this timing, and considering that Alco, Baldwin, and F-M were all offering similarly capable competitors, the E8 did well to approach the sales totals of the E7. Over four years and four months, EMD built 460 E8's (421 A units, 39 B's), just 50 shy of the E7's total.

RF&P 1014 (left) for ACL train 88, the *Florida Special*, and 1002 for Seaboard train 22, the *Silver Star*, wait at Broad Street Station in Richmond, Va., in March 1962. Dan Pope coll.

E8	567B • 2,250 h.p. • 8/49–12/53	
	A units	B units
ATSF	8 (E8m)*	5 (E8m)*
ACL	7	0
B&O	21 (5 E8m)*	22 (6 E8m)*
B&M	1	0
CP	3	0
CofG	2	0
C&NW	21	0
CB&Q	40	0
CRI&P	14 (1 E8m)*	0
C&O	31	0
DL&W	11	0
Erie	14	0
GM&O	1 (E8m)*	0
IC	16	2
KCS	5	0
L&N	4	0
MKT	9	0
MP	4	0
NYC	62	0
PRR	74	0
RF&P	15	5
SLSF	17	0
SAL	11	0
SOU	17	0
SP	1	0
T&P	8	0
UP	18	28
WAB	14	0

* E8m's were partial upgrades of older E units.

E9
The ultimate E unit

E9's in their glory: Union Pacific 943, 900B, and 911B lift the first (sleeping car) section of the eastbound *City of Los Angeles* up Cajon Pass on July 11, 1964; following this train up the hill will be four more E's with the *City*'s coach section. Imagine the sound! Tom Gildersleeve photo

Electro-Motive introduced the E9 in 1954 as part of an overall upgrade of its product line that went with the change from the 567B to the 567C engine.

The E9 was a near duplicate of the E8, with the most prominent external feature being the use of Farr filter grilles over the carbody air intakes. These had been introduced very late in E8 production, replacing the horizontal-strake General Electric grilles. The rows of cupped rectangular intake slots on the Farr grille acted as an inertial filter, making it harder for large particles of dirt in the airstream to make the turn and enter the opening. Shortly after introducing the E9, EMD discontinued sales of the GE grilles (General Electric was entering the locomotive market as a more direct competitor) and offered only the Farr grille for service replacements. As a result, some E8's that were damaged in service received the Farr grille in rebuilding. E9's built after July 1954 had the upper headlight lens flush with the casing, not recessed as on earlier E's

Electrical improvements in the E9 included traction motors with higher continuous current ratings, a more capable dynamic brake unit, improvements in electrical controls, and the provision of automatic backward transition. The E8 had been equipped with automatic forward transition, but stepping "backward" as speed decreased required the intervention of the engineer. The automatic transition system introduced on the E9 was later purchased by many railroads for retrofit onto their E8's.

The first E9's rolled out of La Grange five months after the last E8's. By this time, most railroads had dieselized their top passenger trains, and many E9's were replacements for older diesel locomotives. Reflecting this, as well as the downward trend in rail passenger service, E9 sales totaled only 100 cab units and 44 boosters over 9½ years.

E-unit epilogue

The E9 proved to be the finest and most capable of the long series of E-unit designs, but its introduction was at a time of accelerating decline for the American passenger train. E-unit sales had begun to wane late in E8 production as complete dieselization of the railroads approached and other passenger diesels appeared in the market. Some of this competition was from EMD's own F units, which became more capable passenger engines with the higher boiler water capacity offered in the FP7 and FP9. Steam-generator-equipped GP7's and GP9's also cut into E-unit sales, particularly as ridership declined and railroads became more concerned with what uses they could make of their locomotives after passenger trains were discontinued.

In the 1960s, more powerful turbocharged prime movers enabled locomotives to equal or exceed the performance of the E9 at much lower initial cost and operating expense, sealing the fate of the twin-engined E's. Two examples are the SDP35 road-switcher and FP45 cowl unit.

When Amtrak was formed in 1971, the few railroads with second-generation passenger diesels kept them for freight service, but these and other roads gladly turned their E units over to the new carrier. Amtrak's fleet of 270 E units, all E8's and E9's, saw it through its first decade before the F40PH took over completely.

A few roads turned to using E units for freight. Penn Central, which retained E7's and 8's for commuter work, also used them in intermodal service. Rock Island frequently used its Chicago commuter E's on freight trains on weekends. Erie Lackawanna, which left the intercity passenger business in 1970, modified some of its E8's specifically for freight duty. EL equipped them with automatic backward transition, removed the steam generators and changed the tanks to fuel only, and fitted the locomotives with 38-inch wheels, which were required to for 62:15 freight gearing in the E-unit truck. EL's freight-modified E's operated up through the Conrail takeover in 1976, and were retired soon afterward.

E units put out of a job by train-offs were often "trickled down" into suburban operations. As they entered the commuter pool, the E's often displaced dual-purpose road-switchers that were freed up for freight work. The captive fleets of commuter coaches were among the earliest cars converted to electric heat and air conditioning, and many E's were modified with HEP engines replacing the steam generator(s) in the rear compartment. In Chicago, E units were practically the standard commuter power into the mid-'70s, when the F40C and the F40PH arrived on the scene. The last big E fleet, two dozen Burlington Northern units in Chicago suburban service, quit in 1992.

Today, E units are the jewels of many museum collections, representing the high quality of rail travel and customer service that prevailed early in the diesel era. The fact that so many have survived [see page 92] is a tribute to the dedicated preservationists who thought enough of them to acquire and restore these impressive locomotives.

E9	567C • 2,400 h.p. • 5/54–1/64	
	A units	B units
B&O	4	0
C&EI	1*	0
CB&Q	16	0
MILW	18	6
FEC	5	0
IC	10	4
KCS	1 (E9m)**	0
SAL	1	0
SP	9	0
UP	35	34

* Rebuilt from E7. ** E9m's were partial upgrades of older E units.

Amtrak 408, an ex-Milwaukee Road E9, has just begun its run with the Minneapolis–Chicago *Hiawatha* as it crosses the Stone Arch Bridge in September 1973. Steve Glischinski photo