EMD
&
DIESEL ELECTRIC BASICS

Neuse River Valley Model Railroad Club
February 17, 2022

Introductory (or Disclaimer) Comments

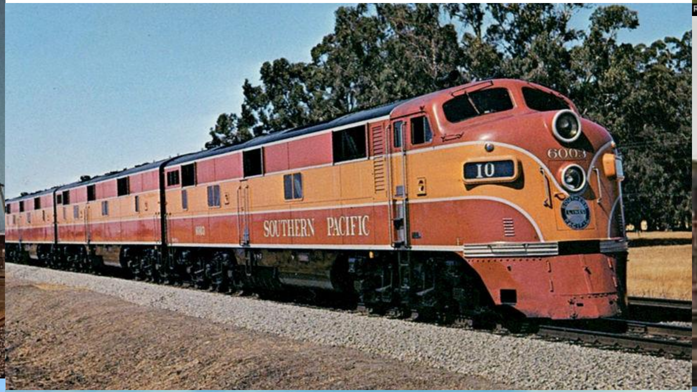
- It’s your model railroad, and you can operate it anyway you want
- I am a macro rivet counter
  - I strive for accurately modeling trains as a whole, their locomotives, passenger or freight cars, their consists, and their operation in the context of the area of country and time period modeled
  - I am not interested in accurately modeling the number of rivets on the side of a box car
- I love steam and electric locomotives, but I love diesel locomotives even more
- Detail of diesel locomotive plastic models today is truly amazing
  - Specific road numbers with specific details at specific time periods available
  - Includes sounds to a specific locomotive
  - In HO available from Athearn Genesis, Scaletrains, Atlas, Rapido, Bowser, Walthers Proto, Intermountain, and Bachmann
  - If you are willing to pay the price

Diesel Electric Locomotive Series

- Series to discuss each of the major diesel locomotive builders, their history, and their various models
  - Many of the locomotive models were produced over a multi-year period, with the manufacturer making numerous external (and internal) changes
  - Model phases – note that manufacturers did not distinguish model phases; this was an invention of rail enthusiasts, primarily the publication *Extra 2200 South*
  - As an example, the F3 was produced in 7 different "phases", not all F3s looked the same
    - Some of the Class I railroads would have multiple phases resulting in great variety
  - All the builders produced models in different phases
- Brief history of the diesel locomotive builder
- Discuss each of the diesel locomotives models produced
  - Number produced
    - Number of original railroad company purchasers
    - Railroad with greatest number delivered
    - Railroad with least number delivered
  - Time period produced
  - Horsepower
  - Tractive effort
  - Engine type
  - Generator type
  - Traction motor type

Tonight's Presentation

- Diesel locomotive basics
- EMD (Electro-Motive) Basics
- If time allows, will discuss EMD History



Diesel Locomotive Types

- Box cabs
- Passenger cabs & boosters
  - Non-articulated
  - Articulated
- Passenger cowl units
- Freight cabs & boosters
- Freight cowl units
- Single engine road switchers & boosters
  - High hoods
  - Low nose hoods
  - Safety cab hood (also known as the North American Cab)
- Dual engine road switchers & boosters
- Switchers
- Transfer units
- Light-weight train power cars

Diesel Locomotive Builders Produced Standard Models

- Generally, diesel locomotive builders produced models that had the same dimensions, layout, horsepower, engine, trucks, generators/alternators, and traction motors
- Some features could be customized
  - Gearing of traction motors
  - Truck bearings
  - Location and type of brake wheel
  - Inclusion of dynamic brake
  - Headlights
  - Number boards
  - Air horns
  - Paint schemes
    - (EMD – designed by industrial stylists of parent GM)
  - Cab shade & awnings
  - Pilots (including plow type)
  - Battery boxes on hoods
  - Fuel tank fillers (location and type)
  - Snow shields

Types of Diesel Locomotive Trucks

- Most diesel locomotives have two trucks
- Type of truck classification based on AAR standards
  - Number of powered axles designated by a letter
  - Unpowered axles by a number
- A1A – two powered axles on each end of truck with a center unpowered (or idler axle)
  - Used for passenger (smooth ride) or branch lines
- B truck – two powered axles
- C truck – three powered axles
- D truck – four powered axles

Oddball Diesel Locomotive Trucks

- 1 truck – one unpowered axle
- 2 truck – two unpowered axles
- 3 truck – three unpowered axles
- 1B truck – one unpowered axle followed by two powered axles

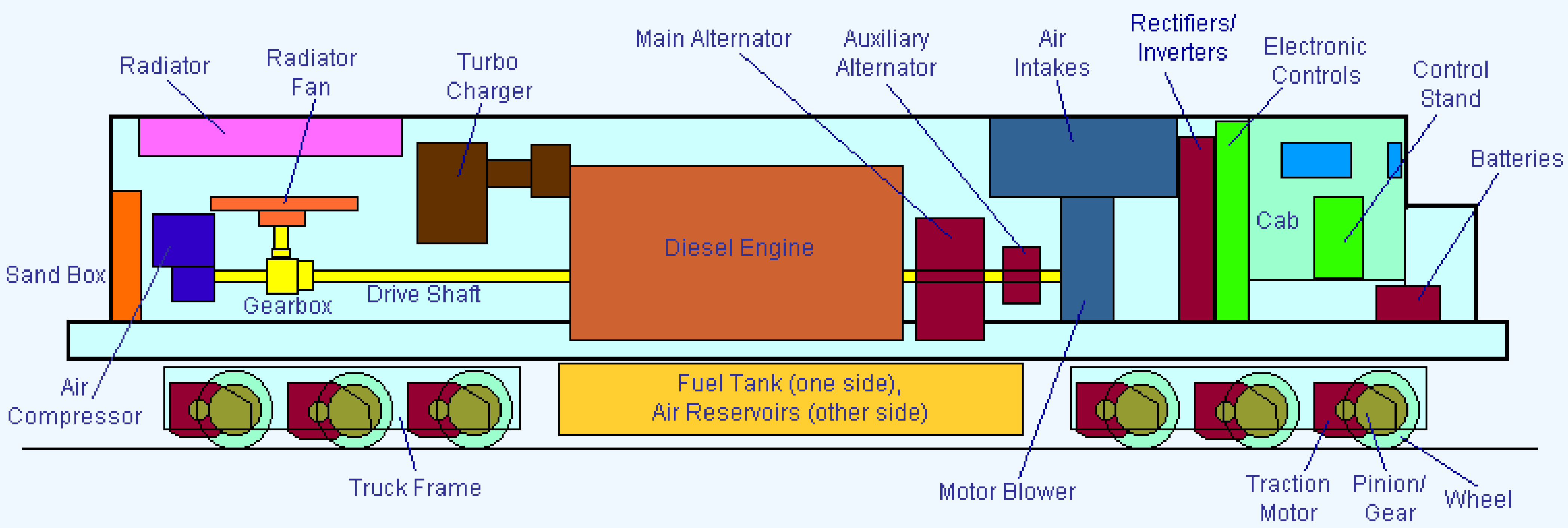
Examples of Diesel Locomotive Truck Powering

- All EMD freight cab units were two trucks each of two powered axles
  - AAR classification would be B-B (also known as 4-axle units)
- All EMD standard passenger cab units were two trucks each of A1A
  - AAR classification would be A1A-A1A
- All EMD SD units were two trucks of three powered axles
  - AAR classification would be C-C (also known as six axle units)


Diesel Locomotive Propulsion

- Diesel electric
  - DC motors
    - Generators
    - Alternators
  - AC motors
  - Predominate propulsion method worldwide, except in Europe
  - Except for three locomotives, all EMD locomotives produced were diesel electric
- Diesel hydraulic
  - One diesel – one truck
  - Predominate method in Europe for diesel locomotives
  - Significate use in North America – Budd Rail Diesel Car (RDC)
    - Used two GM Detroit Diesels
- Diesel mechanical
  - Gear Drive
  - Shaft Drive
  - Chain Drive
  - Used for small industrial locomotives and diesel rapid transit
    - Light rail

Anatomy of a Diesel Electric

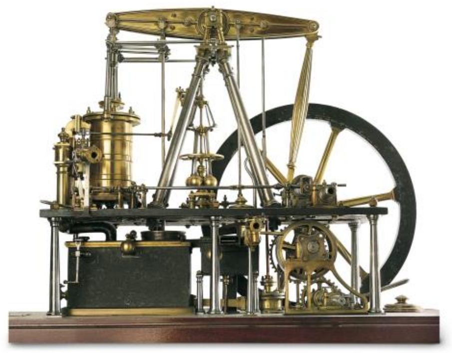


Block diagram of typical US diesel-electric locomotive showing the location of the main parts. There are many variations between different designs and some in other countries use different layouts and techniques, e.g. electrically driven air compressors instead of directly driven.

Click on the part name for a description.

Horsepower Versus Tractive Effort

- Horsepower (hp) is a unit of a measurement of power, or the rate at which work is done
  - hp was adopted in late 18^{th} century by Scottish engineer James Watt to compare output of steam engines with draft horses
- Tractive effort is either the total traction a vehicle exerts on a surface, or the amount of the total traction that is parallel to the direction of motion.
  - Starting tractive effort is the tractive force that can be generated at a standstill. This figure is important on railways because it determines the maximum train weight that a locomotive can set into motion.
  - Continuous tractive effort is the tractive force that can be maintained indefinitely, as distinct from the higher tractive effort that can be maintained for a limited period of time before the power transmission system overheats.

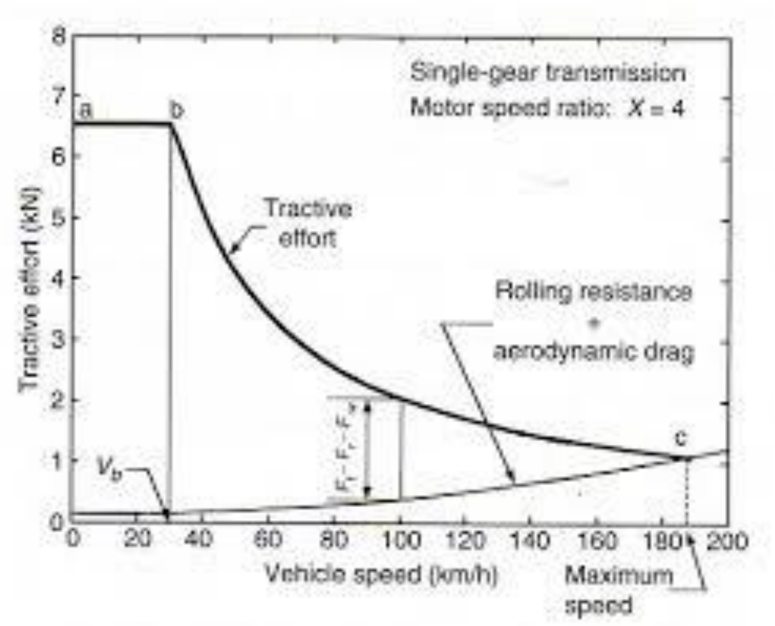


Horsepower Versus Tractive Effort Cont.

- For diesel electric locomotives
  - Typically, horsepower will limit how fast a train can travel.
  - Typically, tractive effort will limit how much weight a locomotive can pull.

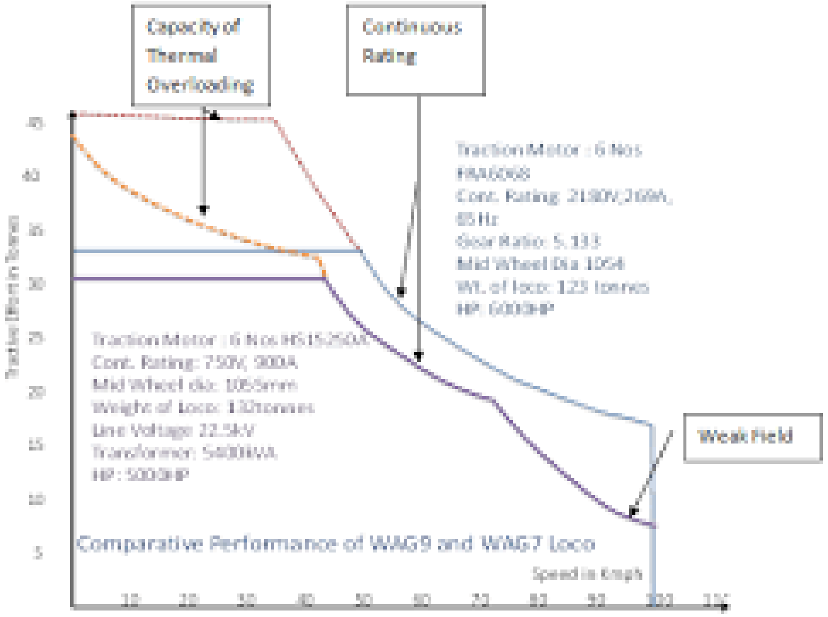
Tractive Effort

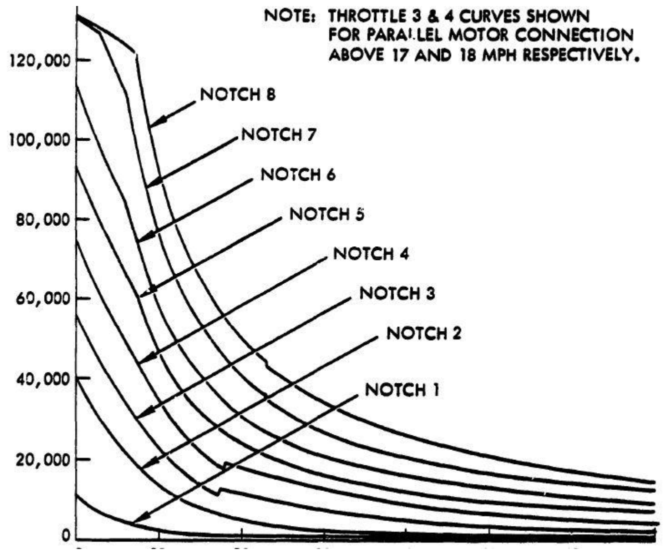
- Specifications of locomotives often include tractive effort curves, showing the relationship between tractive effort and velocity.
- For diesel electric locomotives, maximum continuous tractive effort is at a minimum continuous speed.
- Starting tractive effort can be calculated from the <u>amount of weight</u> on the driving wheels, combined stall torque of the traction motors, the <u>gear ratio between the traction motors and axles, and driving wheel diameter</u>.



Tractive Effort Cont.

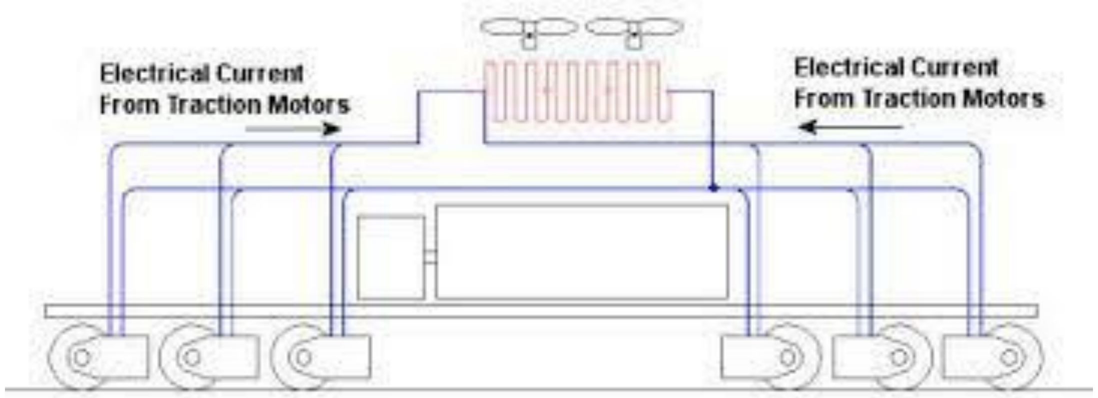
- Theoretical vs. Actual
- Tractive Effort vs. Engine/Generator Speed
  - EMD had an 8-notch throttle
- Traction Motor Transition
  - Series-parallel (slowest)
  - Series-parallel shunt
  - Parallel
  - Parallel shunt (fastest)
  - Automatic vs Manual
    - Through E7/F3 manual
    - F7/GP7/E8 and beyond automatic





DYNAMIC BRAKING

- Use of an electric traction motor as a generator when slowing a vehicle such as an electric or diesel-electric locomotive
- “Rheostatic" if the generated electrical power is dissipated as heat in brake grid resistors, and “regenerative" if the power is returned to the supply line
- Dynamic braking reduces wear on friction-based braking components, and regeneration lowers net energy consumption



EMD – Electro-Motive Division

Progress Rail
A Caterpillar Company

- EMD is 100 years old in 2022, following are the names it used in its history
  - 1922 – Electro-Motive Engineering Corporation
  - 1922 – Electro-Motive Corporation (EMC)
  - 1941 – Electro-Motive Division of General Motors (EMD)
  - 1988 – General Motors Locomotive Group (GMLG)
  - 2005 – Electro-Motive Diesel, Inc. (EMD)
  - 2010 – Electro-Motive Diesel of Progress Rail Services, Caterpillar Inc. (EMD)

Why Talk About EMD

- From 1934 to 1984, EMD was the dominant diesel electric locomotive builder not only in the USA, but in the world
    - Every year during this period it outsold its competition combined
    - At a minimum it had 60% of the market in a year with a high of 89% market share
    - Competitors sometimes received orders because EMD could not guarantee delivery in a timely manner, or because railroads wanted to assure there would be competition
- EMD did not invent the diesel electric locomotive concept, but it perfected it
- EMD developed the mass production of locomotives using assembly line concepts – it could produce up to 10.5 locomotives/day just at the La Grange facility
    - Compared to its competition, EMD produced nearly all of its major components
- The 567 diesel engine, first produced in 1938, was rugged, dependable, easier to maintain than the competition, weighed as much as 50% less than the competition, and was modular (could be produced in V-6, V-8, V-12, and V-16 versions with the same components)
- EMD spent more money on research than its competitors, resulting in many innovations
    - GM did not take any profits from EMD until the late 1950's
- The hard-driving GM organization spent considerable sums of money on marketing, sales, engineering, customer service and support, parts availability, and development of technical personnel

EMD Subsidiaries and Affiliates

- 1949 - 1988 – General Motors Diesel Division (Canada)
  - London, Ontario
  - Besides EMD locomotives, GMD produced their own unique designs
  - Able to sell locomotives to all British Commonwealth countries with no tariffs
- General Motors Industria Argentina
- General Motors South Africa
- Clyde Engineering (Australia), Div. of GM
  - Dominate locomotive builder for many years
- Electro-Motive Diesel Africa Limited (Sub-Sahara Africa)
- Bombardia Transportation has acted as a subcontractor to assemble diesel locomotives for Mexico
- Licensees for EMD locomotives and parts – Germany, Sweden, Belgium, Spain, Croatia, Russia, Brazil, China, South Korea, India

EMD Notable Individuals

- H. L. Hamilton – Along with Paul Turner founded Electro-Motive Engineering Corporation (later EMC)
  - He was a former fireman on the SP, a manager with FEC, and a wholesale manager with White Motor Co.
  - Leading EMD for many years, he went on to become a VP of GM in charge of all diesel engine manufacturing
- Charles F. Kettering – Legendary inventory and engineer, who was head of research at GM from 1920 to 1947, and founder of Delco – holder of 186 patents
  - Inventor of the electric cash register, electric starting motor, leaded gasoline, freon refrigeration, and Duco lacquers and paints, which allowed mass produced color automobiles and trucks
  - Although not a direct employee of EMD, developed the Winton 201 engine, revolutionizing locomotive and heavy equipment industries
  - Along with Hamilton, he developed the technology for mass produced locomotives (La Grange)
  - From the President of GM to the assembly line worker, they called him the “BOSS”
- Eugene W. Kettering, son of Charles Kettering – Was responsible and the central figure for the development of the EMD 567 engine and the Detroit Diesel 6-71 engine
  - Joining Winton Engine in 1930, he was in charge of diesel engine research and development at EMD until 1960, served as Assistant Chief Engineer to Dick Dillworth
- Richard “Dick” Dillworth – Chief Engineer at EMD from the 1930’s to the 1950’s
  - Responsible for the external design and the internal layout of the FT and all subsequent freight cab units
  - Along with GM stylists, responsible for the external design of the GP7
    - Dillworth wanted an ugly locomotive so that RR brass would keep it away from mainlines to run on branch lines only
- Martin P. Blomberg – Inventor and engineer at Pullman and EMD
  - With Pullman from mid 1920’s through 1935, he was partially responsible for the UP M-10000
  - Coming to EMC (EMD) in 1935, he was responsible for the A1A truck under the EA and the B truck under the FT
  - He was also responsible for the AAR Type A truck that would be used under yard switchers not only for EMD, but also under yard switchers for Baldwin, Lima, Fairbanks-Morse, and eventually Alco

EMD Major Competitors

- ALCO – 1924 to 1968
  - 1940 – 1953 produced as Alco-GE (joint venture)
  - Former subsidiary Montreal Locomotive Works acquired rights to ALCO designs and continued production of locomotives until 1988
- Baldwin – 1937 to 1957
  - During part of this time locomotives produced as joint venture with Westinghouse, and then as controlling interest by Westinghouse
  - 1950 – merged with Lima-Hamilton to form Baldwin-Lima-Hamilton

- Fairbanks-Morse – 1939 to 1958
  - Continued to produce locomotives for Mexico until 1963
  - Used opposed piston design for diesel engines
- General Electric – 1960 to present
  - Now owned by Wabtec (formerly part of Westinghouse Air Brake)
- Lima-Hamilton – 1949 to 1951
  - Baldwin merger because of their heavy construction equipment lines

EMD Major Competitors

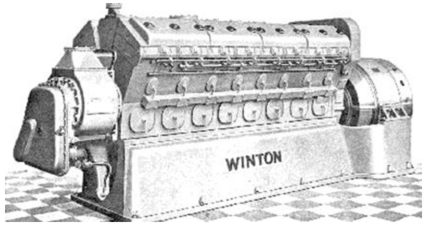
- Krauss-Maffei – 1961 to 1964
  - Started horsepower race with its diesel hydraulics
- MotivePower, Inc. – 1971 to present
  - Merged in 1999 with Westinghouse Air Brake to form Wabtec
  - Formerly known as Morrison-Knudsen Railroad Division, MK Rail Subsidiary, Boise Locomotive Co., and Motive Power Industries
  - Specializes in locomotive rebuilds, natural gas, and commuter locomotives
  - Has always been headquartered in Boise, ID
- Siemens Mobility – 2012 to present
  - With production facilities in Sacramento, CA, specializes in Passenger and Commuter locomotives
- National Railway Equipment – 2007 to present
  - Specializes in Gen Sets and environmentally friendly rebuilds
  - Currently for sale
- Alstom – 2004
  - Specialized in commuter locomotives
  - Better known for its electric locomotives in the USA and Canada
  - Responsible for design and manufacturing of the TGV in France

Two-Cycle vs. Four-Cycle Engines

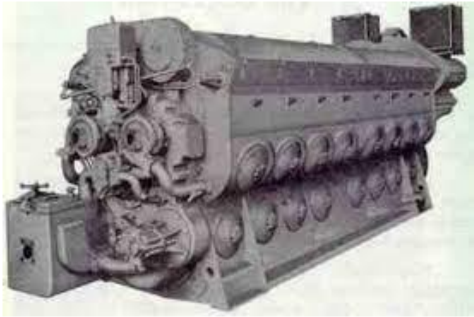
- Most engines are 4-cycle, which break up the necessary steps for combustion into 4 steps: Intake, Compression, Power, and Exhaust. Each step is performed in a stroke of the piston, either upwards or downwards.
- 2-cycle engines consolidate the intake and exhaust steps into “events”, while continuing to perform the Compression and Power strokes (hence “2-cycle”). In the Compression stroke, the piston moves upward. The fuel is ignited and the Power stroke harnesses this energy just as it would with the 4-cycle. This is where it differs. Near the bottom of the power stroke, valves and/ or ports are opened to simultaneously exhaust waste gasses and draw in fresh air.

EMD Diesel Engines – Two-Cycle

- Winton 201 A – Constructed from 1934 to 1939
  - Cylinders – Inline 8, V12, and V16 with 60^0 Vee
  - hp from 600 to 1,200
  - Used in Zephyr to SW/NW/E2
  - Pioneered lightweight welded engine blocks that allowed mass production



- 567 – Constructed from 1938 to 1966
  - 567 represents the cubic inches displacement per cylinder
  - Cylinders – V6, V8, V12 and V16 with 45^0 Vee
  - Produced in 12 different models
  - Began turbocharging engines in 1958
  - hp from 600 to 2,500
  - Used in SW1/NW2/E3A/FT to GP35/SD35
  - Early models could be retrofitted with parts from later models, increasing reliability and potentially increasing hp



- 645 (also known as the E and F engine) – Constructed from 1965 to 1993
  - 645 represents the cubic inches displacement per cylinder
  - Cylinders – V8, V12, V16 and V20 with a 45^0 Vee
  - Produced in 7 different models
  - Produced in turbocharged and non-turbocharged versions
  - hp from1,000 to 4,200
  - Used in 38/39/40/45 lines (including -2) through 49/50 lines
  - Some 645 subassemblies could be installed in 567 engines, increasing reliability and potentially increasing hp
  - Parts still made and engine will be manufactured upon request

EMD DIESEL ENGINES CONT.

- 710 (also known as the G engine) – Constructed from 1984 to present
    - For domestic production until 2014 (Tier 3) and credit units until 2019
        - Continuing in production of export locomotives, including Canada and Mexico
    - Two-cycle
    - 710 represents the cubic inches displacement per cylinder
    - Cylinders – V8, V12, V16 and V20 with a 45^0 Vee
    - Produced in 16 different models
        - 4 models were export only
        - Some models were different to meet new Tier 1 through Tier 3 air quality stds
        - Some models were different due to fuel injection versions
    - Produced in turbocharged versions only
    - hp from 2,150 to 5,500
    - Used in 59/60/70/75/80 lines and 20/22/32 ECO rebuild locos
    - Many sold to MPI for use in commuter locomotives
    - 710 engine has recently passed all tests to be certified for Tier 4 compliance
    - Currently being built under license in many countries
        - Including stationary and marine applications

EMD DIESEL ENGINES CONT.

- 1010 (also known as the 265H) – Constructed from 1996 to present
  - 265H V16 produced in 1996-1998 only for the SD90MAC (70 units)
    - Hundreds have been built for China, India, and Australia – After 2009 built under license in China and India
  - 1010 (also known as the J engine) V12 has been installed in the SD70ACe-T4 only 2016 to present (123 units to date)
  - Four-cycle
  - 1010 represents the cubic inches displacement per cylinder, 265 represents the cylinder diameter in mm
  - Produced in two models, all turbocharged
    - 265 uses twin turbochargers, 1010 uses a unique triple turbocharger design
    - 1010 uses Exhaust Gas Recirculation (EGR) to meet Tier 4 standards for NOx
  - hp 4,600 to 6,300
  - Used in the 90 line and the 70 Tier 4 line

EMD Gear Ratio Performance

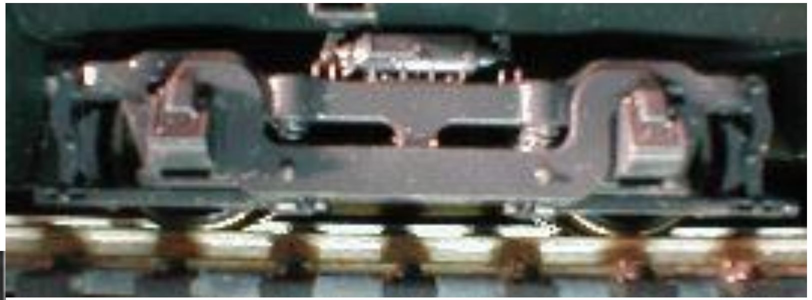
GEAR RATIO PERFORMANCE FOR A F7 WITH 40” DIA WHEELS		
GEAR RATIO	SPEED IN MPH	STARTING TRACTIVE EFFORT
65:12	55	85,000 lbs
62:15	65	64,600 lbs
61:16	71	59,600 lbs
60:17	77	55,200 lbs
59:18	83	51,200 lbs
58:19	89	47,800 lbs
57:20	95	44,600 lbs
56:21	102	41,800 lbs
55:22	117	36,200 lbs

- E units had 36” diameter wheels, resulting in reduced speed of approximately 5 mph
- Most common gear ratio for freight units was 62:15 or 61:16
- BNSF uses 60:17 gear ratio for most of its mainline C-C road switchers
- UP used the 59:18 gear ratio for its DD40AX and SD40-2 “Fast Forties”
- Most FP units used 59:18 or 58:19 gear ratios
- Most E units used 57:20 or 56:21 gear ratios
- Milwaukee used 55:20 gear ratio for its FP7s and E units
- Within certain limitations, gear ratios could be changed

EMD Trucks

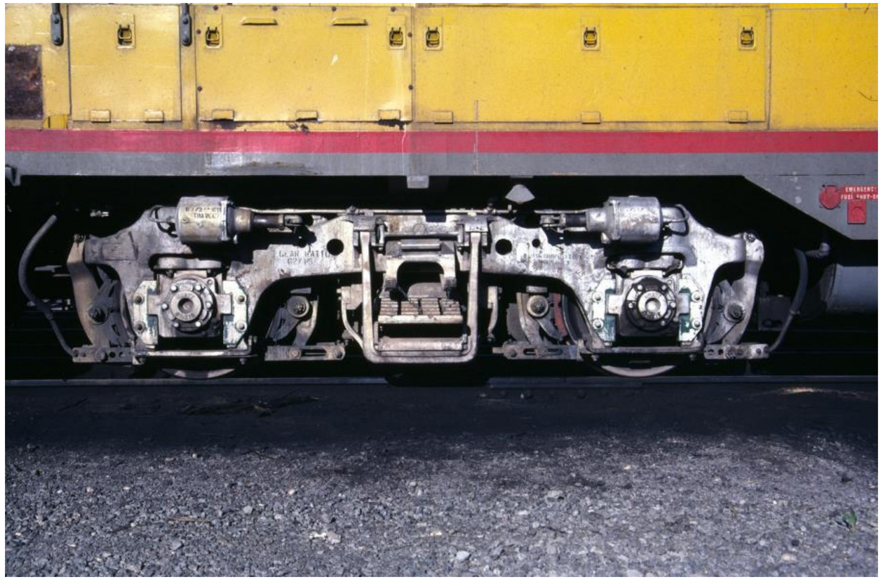
- Switcher trucks (B-B)
  - AAR Type A introduced in 1936, and the Flexicoil B introduced in 1955

- E passenger trucks (A1A-A1A)
- Introduced in 1937



EMD Trucks Cont.

- F and GP Trucks (B-B)
  - Blomberg B (EMD officially called it the “2 Axle Outside Swing Hanger Truck”)
    - Introduced in 1939
    - Recognized as the best engineered 2-axle freight truck in the world
    - Installed under 2-truck units from the FT to the 40 line
    - Likely the most produced diesel locomotive truck in the world
    - Still in use today



EMD Trucks Cont.

- Blomberg M
  - Introduced in 1972 and was used until F59PHI construction completed in 2001
  - EMD will still manufacturer upon request
  - Used under GP -2 38/39/40 units and 49/50/59/60/60M, and F40P/F59P units
  - Hydraulic shocks were installed on opposing ends of the journal boxes, and rubber pads replaced the leaf springs to enhance ride quality, reduce maintenance, and increase adhesion
  - Truck was simplified by reducing brake cylinders per locomotive from 8 to 4
  - Used as basis for the Blomberg X truck installed under MPI commuter locomotives
  - Blomberg B and Blomberg M trucks are interchangeable from the 38/40 line forward

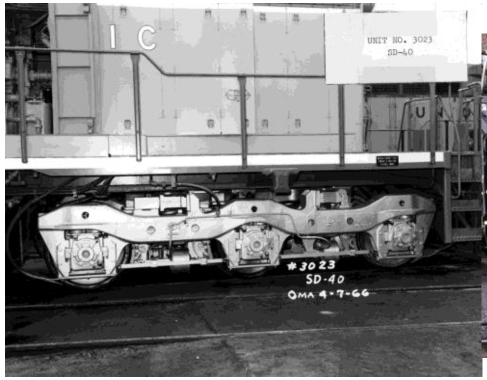
EMD Trucks Cont.

- HT-B
  - Experimental high adhesion truck manufactured in 1977 and 1978
  - Installed under 10 GP40X units supplied to SP and UP
  - Offered as an option for GP49 and GP50 units, but no orders received
  - Utilized a double rubber pad sandwich design on both sides of truck which lowered the center of gravity and significantly increased adhesion
- NH FL9
  - Used a modified Flexicoil B truck and a modified Flexicoil A1A truck which included third rail shoes for electrical operation

EMD Trucks Cont.

Phase 1 1952-1966

- SD Trucks C-C
  - Flexicoil C
    - Introduced in 1952 and produced until 1979
      - This was due to Conrail buying SD40-2s with Flexicoil trucks due to the problems with the HT-C truck under the Amtrak SDP40Fs
    - Produced in 4 different phases
    - Installed under SD7, SD9, some SD18, SD24, SD35, SD38, SD39, SD40, SD45, and some SD40-2
    - Still in use today



Phase 2 1967

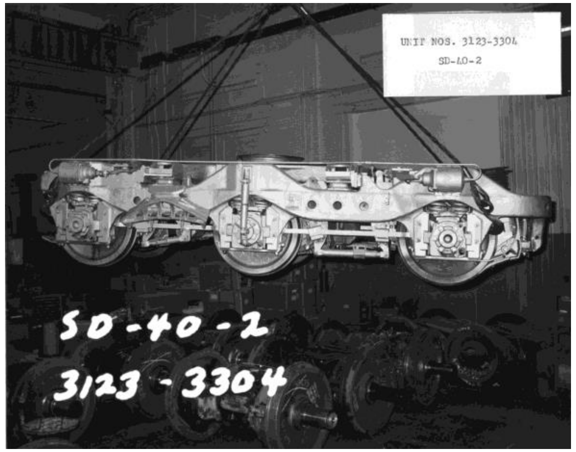
Phase 2 modified

Phase 3 1968

Phase 4 1969-1979

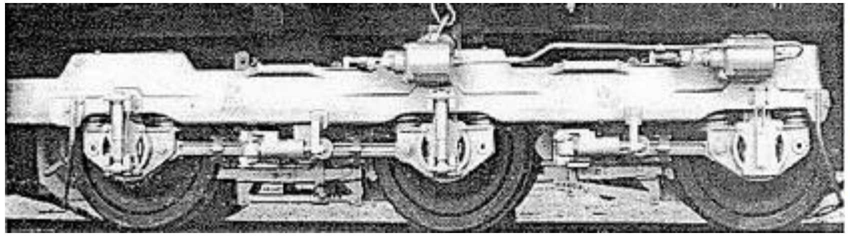
EMD Trucks Cont.

- HT-C (also called the HTC truck)
  - Was introduced in 1970 on the SP SD45X and began production in 1972, and was last mass produced in 1993
    - EMD will manufacturer upon request
  - Produced in two different variants
    - First variant – steel secondary coils
    - Second variant – steel/rubber hybrid secondary coils
  - Characterized by two dampening struts over the center bearings
  - First EMD C truck to have all traction motors facing in same direction
  - Significant improvements in tractive effort and weight shift during braking
    - SD40-2 has same tractive effort as the SD45
  - Amtrak SD40F had hollow bolster trucks, which exhibited significant yawing in high speed curves resulting in derailments
  - Was used on the SD38-2/SD40-2/SD40-2/SD40T-2/SD45-2/SD45T-2/SD50/SD60/SD60M
  - Still In use today
  - HTC is not interchangeable with the Flexicoil C

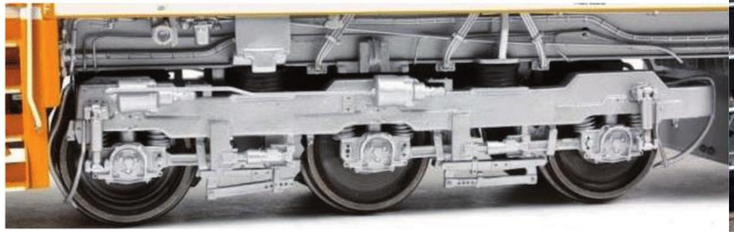


EMD Trucks Cont.

- HTCR Radial Truck
  - Was introduced in 1991 on the SD60MAC, went into production in 1993, and still in production
  - Introduced the concept of a steerable locomotive truck
    - Was a decade in development
    - Was as much of a significant development as AC traction motors
    - Increased adhesion by as much as 100% over previous designs, more evenly distributed axle loads, reduced wheel and rail wear, and improveHTCd ride quality
  - Produced in two variants, the HTCR and HTCR-II
    - HTCR produced 1993 to 1995, HTCR-II produced 1996 to present
    - HTCR-II is a bolsterless design using rubber springs at the four corners, 45” dia. wheels (HTCR uses 42”), split journal bearing adaptors, and an electric parking brake
  - HTSC – EMD offers a less expensive, non-steerable version, but only CSX has ordered
  - EMD supplies BNSF with a B1 HTCR-II designated as P4
  - HTCR not interchangeable with HTC or Flexicoil



HTCR



HTCR-II

HTCR-II P4

EMD Trucks Cont.

- DD Trucks D-D
  - Flexicoil D
    - Was introduced in 1963 for the DD35B with the last manufactured in 1971 for a DDA40X
    - Is the largest (longest and heaviest) diesel locomotive truck ever built for railroad service
      - Was considered an engineering marvel when introduced
    - The inner axles could slightly shift sideways to accommodate curves
    - Only one operating locomotive exists that still uses the Flexicoil D, UP 6936
      - Current status is unknown as it is in storage with Heritage Fleet steam engines, but has not been out of the Cheyenne roundhouse since July 16, 2016

EMD Model Lines

- SW/SC-SW - Switchers
  - Originally meant six hundred hp-W for welded frame, C for cast frame
  - From 1949 forward, came to mean any switcher of any horsepower
- NW/NC - Switchers
  - Meant nine hundred hp- W for welded frame, C for cast frame
  - Usage discontinued after 1949
- E – A1A Passenger Cabs and Boosters
  - Originally meant eighteen hundred hp
  - From 1939 forward, came to mean any A1A passenger cab or booster units of 2,000 to 2,400 hp
- TA – B-B Passenger Cabs – only one model produced in 1937
  - Meant twelve hundred hp
  - Dimensionally was the forerunner of the FT
  - Only A units built
- T/TR – Transfer
  - B-B+B-B, all but one were cow-calf locomotives

EMD Model Lines Cont.

- F – Freight Cabs or Cowls, or B-B or C-C Passenger Cowl Units
  - Originally meant fourteen hundred (rounded up from 1,350 hp), FT meant Fourteen Twin since A & B units semi-permanently coupled with drawbar instead of coupler
  - From 1946 through 1959 meant B-B A & B freight cab units
    - Can be used for passenger service with steam generator
  - From 1968 through 1971 meant C-C freight cowl units
  - In 1974 meant C-C passenger cowl units
  - From 1976 to present meant B-B passenger cowl units
- BL – B-B Branch Line units
  - From 1948 to 1949 meant a B-B semi-streamlined hood unit
- FP – B-B Passenger Cabs or C-C Passenger Cowl Units
  - From 1949 to 1959 meant B-B passenger cab units
  - From 1967 to 1968 meant C-C passenger cowl units
  - A variation were the NH FL9s, which were B-A1A units that could run as diesel electric or third rail straight electrics built from 1956 to 1960

EMD Model Lines Cont.

- GP – General Purpose B-B Road Switchers
  - B-B general purpose road switchers built from 1949 to 1994
  - From 1949 to 1960 built as high short hood, with a few exceptions
  - From 1961 through 1994 most built with low short hood, with some exceptions
  - Some built with steam generators for passenger service, including the distinctive torpedo boat style
  - Some B units built
  - M suffix means North American Safety Cab (wide cab)
- SD – Special Duty C-C road Switchers
  - C-C special duty road switchers built from 1952 to present
  - From 1952 to 1960 built as high short hood, with some exceptions
  - From 1961 to present most built with low short hood, with some exceptions
  - Some built with steam generators for passenger service
  - Only SD24B units built for UP
  - T suffix means tunnel motor (T4 means complies with Tier 4)
  - F suffix was for Canadian cowl units (Draper Taper)
  - M suffix means North American Safety Cab
  - I suffix means WhisperCab
  - AC suffix means alternating current traction motors
  - e suffix means complies with emission standards up to Tier 3 and implies North American Safety Cab
  - -P6 suffix means one inverter per axle versus one inverter per truck
  - -P4 suffix means a B1-1B wheel arrangement (for BNSF only)

EMD Model Lines Cont.

- SDP – Special Duty Steam Generator Equipped C-C passenger units
  - C-C road switcher style steam generator equipped passenger units built from 1964 to 1970
  - C-C cowl style steam generator equipped passenger units built from 1973 to 1974
    - F suffix means cowl style
- DD – D-D Dual Diesel Hood Style Freight Units
  - D-D hood style (road switcher) freight units built in both cab and booster configuration built from 1963 to 1971
  - X suffix meant experimental wide cab units built for the UP
- MP – Multi-Purpose B-B Switcher and Light Freight Units
  - B-B Switcher car body built on Blomberg B or M trucks built between 1974 and 1987
  - Designed for heavy duty switching or light duty over the road freight
  - Could and did be in multiple unit operation with GP and SD units
- Other model designation variants existed that are obscure and too numerous to list

Brief History of EMD

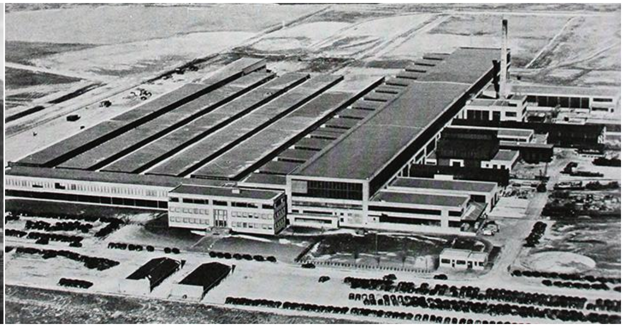
- 1922 – Electro-Motive Engineering Corporation founded in Cleveland
  - By H. L. Hamilton, former SP fireman, former manager at FEC RR, and former wholesale manager for truck maker White Co
  - Eventually becomes a VP for GM, responsible for all diesel engine manufacturer
- 1924 – Completes its first “doodlebugs” railcars for CGW and NP
  - Assembled by St. Louis Car Co. with all components from other suppliers, including Winton gas engines

- 1927 – Completes first locomotives for RI
  - Box cab conversions using Winton distillate engines
- 1930 – GM buys both Electro-Motive and Winton Engine Co.
  - GM desires Winton Engine Co. to jumpstart its efforts to become a major player in diesel engines, but discovers its biggest customer is EMC
- 1934 – EMC is specified to supply engines for the first streamliners
  - Distillate engine for the Union Pacific articulated M-10000 *City of Salina*
  - Diesel engine for the Burlington articulated stainless steel *Zephyr*

Brief History of EMD Cont.

- 1936 – Construction started in 1935, EMC opens its new 200,000 sf plant outside of Chicago
    - Located in McCook, IL, it would takes its name from the mailing address – **La Grange**
- 1937 – First E constructed
- 1938 – 567 diesel engine introduced
- 1939 – First SW1 constructed and FT freight unit begins its demonstration tour
- `1941 – GM merges Winton Engine Co. and EMC to form the Electro-Motive Division
- 1946 – EMD delivers its first export locomotives
- 1947 – EMD constructs the first dome-equipped passenger train, *Train of Tomorrow*
- 1948 – Flooded with orders, EMD operates three manufacturing plants
    - Plant No.1 – La Grange, Plant No. 2 – South Chicago for parts and subassemblies, and Plant No, 3 – Cleveland for switchers and road switchers



Brief History of EMD Cont.

- 1949 – Production of the F7 and introduction of the GP7, first road switcher
- 1950 – GMD opens a new plant in London, Ontario
- 1952 – Introduction of the SD7, first 6-axle road switcher
- 1958 – Introduction of the SD24, first EMD turbocharged locomotive
- 1960 – Last of the F cab units produced, NH FL9
- 1964 – Last cab unit produced, UP E9A
- 1966 – Last 567 engine produced and introduction of the 645 engine and the “40” line
- 1972 – Introduction of the “-2” line
- 1984 – Introduction of the 710 engine and the “60” line



Brief History of EMD Cont.

- 1986 – Final SD40-2 is produced
- 1988 – GM announces that nearly all production will shift from La Grange to London, ON, and will change name from EMD to GMLG
- 1991 – GMLG adopts the wide-nose “safety cab”
- 1993 – Final locomotive w/645 engine delivered (Metra F40PHM-2), ends final regular use of E9A, and GMLG announces the end of production of locomotives at La Grange
- 1994 – In partnership with Siemens AG, GMLG opens the AC-traction era in railroading with a BN order of 350 SD70MAC locomotives
  - BN order introduces the radial (self-steering) trucks and the WhisperCab
- 2000 – GMLG receives the largest order in the history of railroading, 1,000 SD70M locomotives from UP


Brief History of EMD Cont.

- 2000 – Unused buildings at La Grange are demolished, including the legendary High Bay where thousands of EMD locomotives were built
- 2005 – GM sells GMLG to Greenbriar Equity Group and Berkshire Partners LLC, and is renamed Electro-Motive Diesel
- 2010 – Caterpillar-owned Progress Rail Services announces deal to buy EMD for $820 million
- 2011 – Progress Rail produces its first domestic and export locomotives at its newly opened plant in Muncie, IN
- 2012 – Progress Rail announces closure of the London, ON plant and produces its last locomotive, an UP SD70ACe
- 2018 – Progress Rail announces closure of all facilities in La Grange, including the legendary EMD engine plant, except for Management and Sales; moves engine production to a new facility in Winston-Salem, NC



Questions

1604
EMDX
1604
ELECTROMOTIVE
THE NEXT GENERATION OF PROGRESS
SD70ACe-T4
1603

- a remarkable advance in the art of diesel-engine construction developed as a lightweight two-cycle engine with a weight of only 20 pounds per horsepower, a highly efficient ratio for submarines. The frame was of welded steel, a radical departure from accepted practice, but a feature that facilitated mass production. One of the key innovations was the unit injector, by means of which solid fuel (unmixed with air) was fed into the cylinder under thousands of pounds of pressure.