

Quantitative Analysis
Unregulated
Tier 4
Near Zero Emission
Locomotives

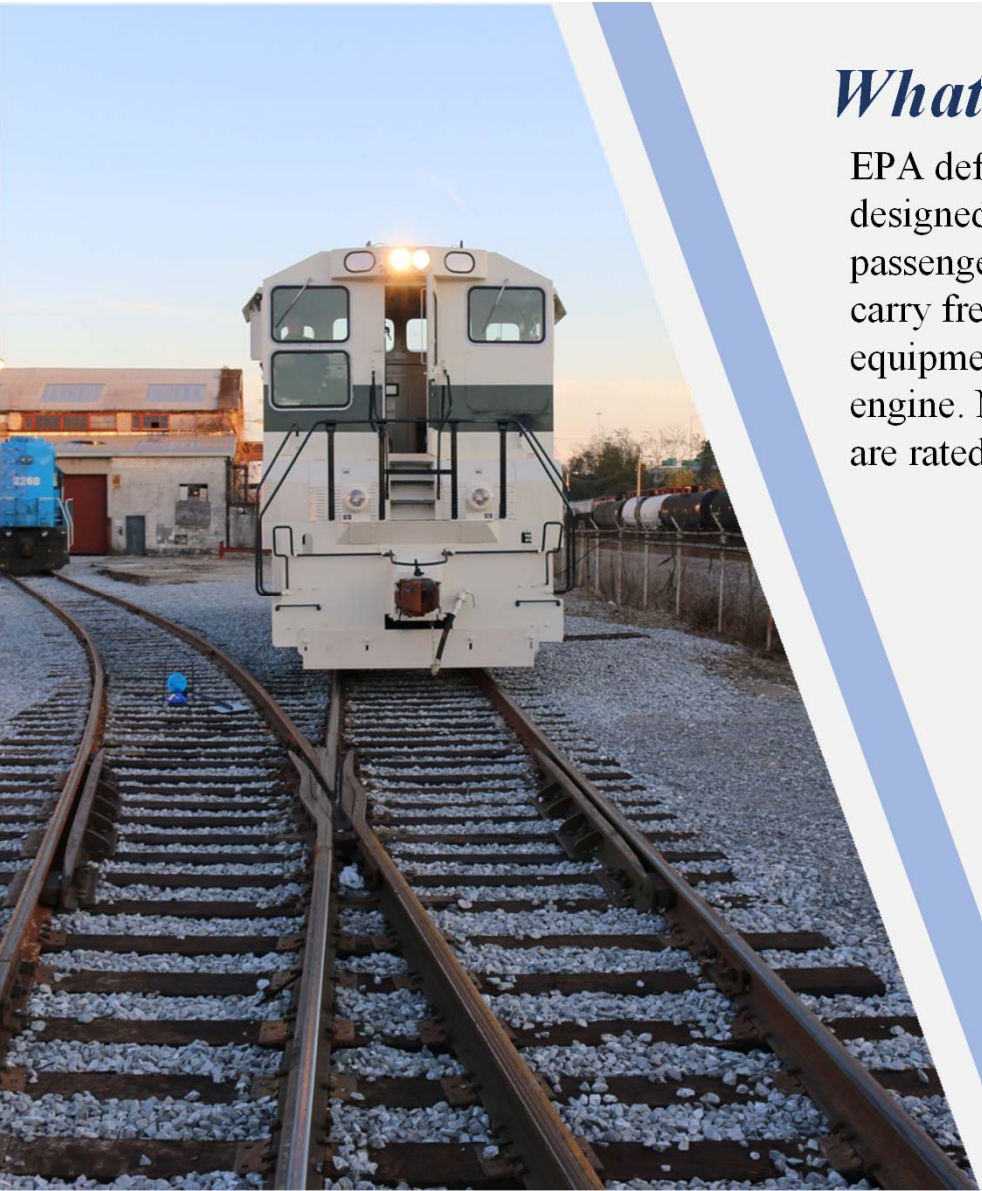
December 8, 2021
South Coast Air Quality Management District
Diamond Bar, California
Proposed Rule 2306





KLW NZE32CE DE T4L

3218 bhp
Reduces emissions by over **98%**
Reduces fuel consumption between **25-35%**
Increases starting tractive effort up to **50%**



What is a locomotive?

EPA defines a locomotive as a self-propelled piece of on-track equipment designed for moving or propelling cars that are designed to carry freight, passengers, or other equipment, but which itself is not designed or intended to carry freight, passengers (other than those operating the locomotive) or other equipment. Traditional locomotives are propelled by a single prime mover engine. Non-traditional locomotives, which are propelled by two or more engines, are rated in total power by the sum of the rated power of each engine.

- Minimum brake horsepower: 1006
- Maximum brake horsepower: 1006 to 5,000 and above
- Switch locomotive: 1006 bhp to 2300 bhp
- Line Haul locomotive: 2301 bhp to 5,000 bhp and above

EPA Locomotive Emission Tier standards:

- Uncontrolled
- Tier 0
- Tier 1
- Tier 2
- Tier 3
- Tier 4
- Tier 5**

* Reference Code of Federal Regulations Title 40 1033.901 Definitions.
** Proposed by the California Air Resources Board in April 2017 and not yet adopted by the U.S. EPA

New Accessory Drive Assembly

Rebuilt AR10 Alternator

New Radiator System

New Air Compressor

New MTU Engine

New Inertial Filter

New Cab

New ZF Gearbox

Rebuilt Trucks and Traction Motors

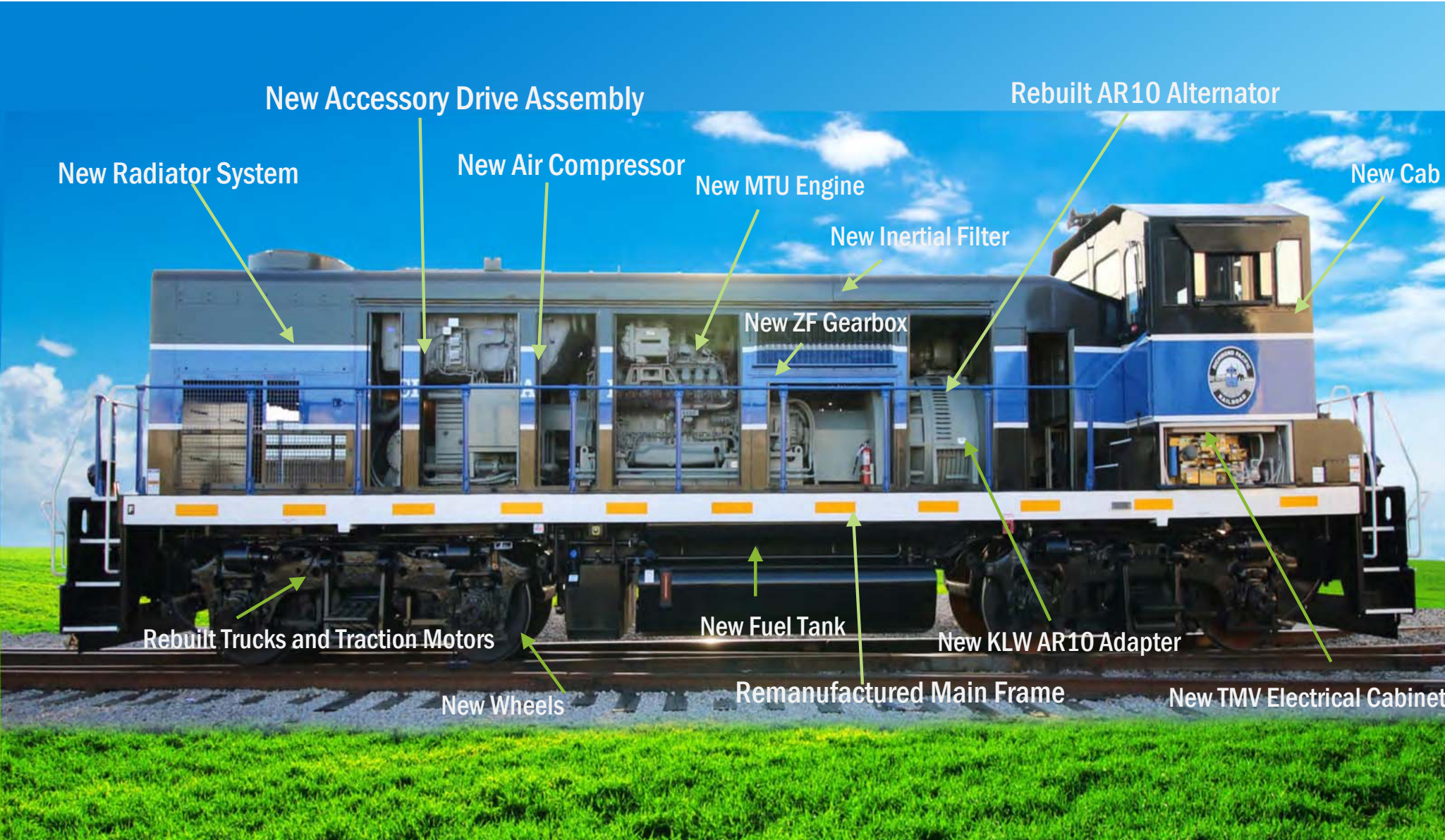
New Fuel Tank

New KLV AR10 Adapter

New Wheels

Remanufactured Main Frame

New TMV Electrical Cabinet



SWITCH SERVICE	HC	CO	NOx	PM	GP/BHP-Hr
Unregulated	1.10	2.40	19.80	0.44	23.74
Tier 0	2.10	8.00	11.80	0.26	22.16
Tier 1	1.20	2.50	11.00	0.26	14.96
Tier 2	0.60	2.40	8.10	0.10	11.20
Tier 3	0.60	2.40	5.00	0.10	8.10
Tier 4	0.14	2.40	1.30	0.03	3.87

Unregulated to Near Zero Emission	HC	CO	NOx	PM	GP/BHP-Hr
Unregulated	1.10	2.40	19.80	0.44	23.74
Tier 4 KLW NZE Baseline for Switch	0.02	0.01	0.20	0.00	0.23
Percent Change Reduction	-98%	-99%	-99%	-100%	-99%

TIER 4 STANDARDS VS NEAR ZERO EMISSION

Tier 4 to Near Zero Emission	HC	CO	NOx	PM	GP/BHP-Hr
Tier 4 EPA Emission Standards	0.14	2.40	1.30	0.03	3.87
Tier 4 KLV NZE Baseline for Switch	0.02	0.01	0.20	0.00	0.23
Percent Change Reduction	-86%	-96%	-85%	-100%	-94%

Line Haul Service	HC	CO	NOx	PM	GP/BHP-Hr
Unregulated	0.48	1.28	13.00	0.32	15.08
Tier 0	1.00	5.00	8.00	0.22	14.22
Tier 1	0.55	2.20	7.40	0.22	10.37
Tier 2	0.30	1.50	5.50	0.10	7.40
Tier 3	0.30	1.50	5.50	0.10	7.40
Tier 4	0.14	1.50	1.30	0.03	2.97

UNREGULATED STANDARDS VS NEAR ZERO EMISSION

Unregulated to Near Zero Emission	HC	CO	NOx	PM	GP/BHP-Hr
Unregulated	0.48	1.28	13.00	0.32	15.08
Tier 4 KLV NZE Baseline for Line Haul	0.02	0.01	0.20	0.02	0.25
Percent Change Reduction	-96%	-99%	-98%	-94%	-98%

Tier 4 to Near Zero Emission	HC	CO	NOx	PM	GP/BHP-Hr
Tier 4 EPA Emission Standards	0.14	1.50	1.30	0.03	2.97
Tier 4 KLW NZE Baseline for Line Haul	0.02	0.01	0.20	0.02	0.25
Percent Change Reduction	-86%	-99%	-85%	-33%	-92%

Near Zero Emission Switch	NOx	PM	GP/BHP-Hr
Unregulated	-99%	-100%	-99%
Tier 4	-85%	-100%	-94%
Near Zero Emission Line Haul	NOx	PM	GP/BHP-Hr
Unregulated	-98%	-94%	-98%
Tier 4	-85%	-33%	-92%

Observations and Analysis of Near Zero Emission Locomotives

- Rail yards in California are full of unregulated locomotives operating in switching services throughout the state
- Unregulated locomotives generate a minimum of 13.0 to 17.4 gp / bhp-hr or more of NO_x and a minimum of 0.32 to .44 gp / bhp-hr or more of PM
- Replacing these unregulated locomotives with Near Zero Emission locomotives would remove 99% of the NO_x and PM currently being emitted in the yards
- Existing unregulated locomotives in these yards will emit more NO_x and PM in 1 year than the Near Zero Emissions locomotives will in 100 years





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