

Locomotive Emission Reduction Efforts

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Complaints about locomotive exhaust from residents living near the Anchorage Yard (Government Hill) have all but ceased, thanks to Alaska Railroad efforts on several fronts to cut locomotive emissions. These efforts have dramatically reduced locomotive exhaust emissions not only in the Anchorage Bowl area but throughout our rail-belt system. Efforts fall into six main categories:

1. Invest in 28 new more efficient locomotives
2. Purchase and install engine idle reduction systems
3. Improve train operating and breaking techniques
4. Improve the general maintenance of our older series and new locomotives
5. Switch to ultra low sulfur diesel fuel
6. Investigate of remanufactured / replaced lower-emission engine for older locomotives and pursue EPA Tier-0+ engine emission upgrades.

The Alaska has 51 locomotives.

1. New, Efficient Locomotives to Replace an Aging Fleet

The Alaska Railroad has 15 GP-40 3000 hp and 8 GP-38 2000 hp locomotives purchased about 30 years ago (between 1975 and 1978). In devising a locomotive replacement plan, the ARRC chose wisely to invest in brand new SD70MAC locomotives that significantly increased performance, reliability and efficiency while decreasing fuel and maintenance costs.

In 1999, the Alaska Railroad purchased sixteen (16) SD70MACs at \$1.9 million each. These 4000 hp units were delivered between December 1999 and May 2000, and they immediately began replacing the old GP-40 as the workhorses on the heavy-haul runs for coal, petroleum and gravel.

The Alaska Railroad purchased eight (8) additional SD70MACs in 2004. These 4300 hp versions were also outfitted with head-end power (HEP) units for dual purpose use by passenger and freight trains. Four additional SD70MACs were delivered in late 2007, completing ARRC's locomotive replacement plan.

Greater power and efficiency have translated into major fuel savings. The pulling capability of one SD70MAC is roughly equivalent to two GP-40 engines. For example, three SD70MACs replaced the six GP-40s that are required to haul an 80- to 100-car coal train from Healy to Seward.

According to internally-determined fuel consumption rates, the GP-40-2 consumes 164.4 gallons per hour when pulling in full throttle mode. The SD70MAC consumes 191.9 gallons per hour when pulling in full throttle mode. When considering it takes two GP-40s for one SD70MAC, the fuel savings is considerable – $164.4 \times 2 = 328.8$ (2 GP-40s) – 191.9 (1 SD70MAC) = 136.9 gallons per hour savings realized in using the SD70MACs in place of the GP-40s.

In addition to greater fuel efficiency, the SD70MACs are superior in reducing emissions as well. The reduction was quantified in a Southeastern States Air Resource Managers research project completed in June 2004. The study concluded that there was a marked difference in the average emission factors for line haul operations between the GP-40 and the SD70MAC. Specifically, a comparison of data shows the following break-specific emissions (g/bhp-hr; grams per brake horse power-hour; HC = hydrocarbons; CO = carbon monoxide; NOx = nitrogen oxides and PM = particulate matter):

	HC	CO	NOx	PM
GP-40-2	0.445	1.61	14.82	.291
SD70MAC	0.313	1.51	12.72	.366

The California Environmental Protection Agency Air Resources Board commissioned a Roseville Rail Yard Study in October 2004. The study illustrated Annual Average Diesel PM Emissions in lbs/day, given comparable idling and moving activity within the yard. In comparing locomotive types, the GP40 and SD70MAC Low-end averages were as follows:

	Idling	Movement	Testing	Total
GP-4X	29.4	11.9	4.3	45.6
SD-7X	1.4	0.8	0.3	2.5

High end averages were as follows:

	Idling	Movement	Testing	Total
GP-4X	29.4	16.9	4.3	50.5
SD-7X	1.4	0.9	0.3	2.6

2. Purchase and Installation of Idle Time Reduction systems

Locomotive idle time can consume a lot of fuel and add to exhaust emissions. The railroad has invested in several idle time reduction systems to address this issue. Of the 54 locomotives or self-propelled rolling stock that the railroad has in its fleet, two-thirds (43) are equipped with systems designed to reduce idling. These systems were installed between 2002 and 2005.

Qty	Locomotive	Horsepower	Uses	Idle Reduction Equipment
7	GP-38-2	2000 hp	Yard switching and mainline workhorse	EcoTrans
1	GP-38-2	2000 hp	Yard switching and mainline workhorse	Hot Start
3	GP-40-2	3000 hp	Work trains; Whittier & Seward freight	EcoTrans
6	GP-40-2	3000 hp	Work trains; Whittier & Seward freight	None
6	GP-40-2	3000 hp / HEP	Passenger trains (power dining, coach)	None
16	SD70MAC	4000 hp	Heavy freight trains; passenger trains	EMD AESS
8	SD70MAC	4300 hp	Passenger trains (power dining, coach)	EMD AESS

4	SD70MAC	4300 hp	Arrived late 2007; pull freight and passenger trains	EMD AESS
2	P-31 / P-32	Cab Car	Engineer control cab; no pull power	None
1	DMU		Self-propelled "Commuter" car (due to arrive Dec 2008)	Tier 3 control

EMD Auto Engine Start Stop (AESS) – the system, installed on the 28 SD70MAC locomotives, shuts the locomotive engine off after a period of time without use, and starts the engine back up automatically when engine controls are used or when the temperature drops too far down. Specifically, the AESS system is integrated into the locomotive control system, and able to monitor vital parameters whether the locomotive engine is running or not. Automatic shut-down is considered after 10 minutes of idling, if air temperatures are above 35 degrees F and adequate brake pressure is maintained. Start-up is triggered by operator control commands, brake pressure falls, battery voltage falls or air temperatures falls below a set minimum.

KIM Hot Start – this system, installed on one (1) locomotive, is similar to AESS and Smart Start, but with fewer options. This system is similar to the effect of plugging in a car's engine block. The Hot Start system uses a small diesel engine to run hot water through the locomotive's engine, so that the big locomotive engine does not need to run.

EcoTrans K9 APU – this system, installed on ten (10) GP locomotives, monitors the locomotive cab to determine if it is in use. If not in use, based on parameters similar to the AESS, the locomotive engine is shut off. A smaller auxiliary power unit (APU) is used to keep the air built up in hydraulic systems, to keep oil warm, water warm, and the battery charged etc., so there is no need to start the main locomotive engine.

All of these systems successfully reduce the amount of time that a locomotive's engine is idling. Research available on the EcoTrans system underscores the value to fuel efficiency and reduced emissions.

Use of the EcoTrans system is proven to substantially cut emissions and fuel use in railroad locomotives, according to the U.S. Department of Energy (DOE) Energy Efficiency and Renewable Energy Division. A Southwest Research Institute study in 2002 quantified emission reductions and fuel savings from using the EcoTrans K9 Auxiliary Power Unit on locomotives. The unit reduces fuel consumption at idle by as much as 83% and emissions of Nitrogen Oxides (NOx) by 91%, hydrocarbons (HC) by 94%, Carbon Monoxide (CO) by 96% and Particulate Matter (PM) by 84% (per January 2006 DOE fact sheet on the EcoTrans APU).

Fuel savings and emissions reductions are similar in locomotives equipped with the AESS system. *(per AESS Informational Brochure).*

3. Train Operating Policies and Best Practices for Fuel Conservation

The Alaska Railroad trains its engineers to be aware of fuel conservation policies and to follow best train operating practices that are highly effective in boosting locomotive efficiency. An important tool is the ARRC Brake & Train Handling Manual, which has an entire section dedicated to fuel

conservation. This section outlines policies and procedures that promote energy savings in the operation of train locomotives. These include:

- a) **Brake and Throttle Techniques** – designed to use the forces of gravity and track resistance to conserve fuel.
- b) **Shutdown Policy** – For locomotives not equipped with automatic shutdown/startup systems (EcoTrans, AESS, etc.) this policy directs that a locomotive that will not be in use within an hour will be shut down to conserve fuel.
- c) **Isolation Policy** – Locomotives that are not needed to pull in a train consist are “isolated” so that they are not using power to pull. For example, a train with empty hoppers or empty fuel tanks is sent to pick up a load. When empty, not all of the locomotives are needed, so they are turned off. In the case of an empty fuel train traveling from Anchorage to North Pole, the “isolated” locomotives may use only 300 gallons, as opposed to the 1000 gallons that would be used if they were engaged and pulling. This saves roughly 700 gallons of fuel per locomotive per “dead end” (empty) run.
- d) **Idle Control Systems** – employ on-board systems that eliminate unnecessary idling by shutting down the locomotive engine when the locomotive is not in use, or by using a smaller auxiliary engine to keep fluids warm. (Covered in the second section.)
- e) **Maintenance Policy** – crew trained to monitor locomotive operation and report any problem areas to ensure adequate maintenance is performed, thereby keeping the locomotives in peak operating efficiency. (To be covered in the next section, section four.)

4. Improved Maintenance for Peak Performance / Efficiency

The Alaska Railroad has comprehensive preventive and repair maintenance policies in place for locomotives engines, as well as heavy equipment and work vehicles. Locomotives are monitored daily for correct horsepower, excessive exhaust, and routine analysis of the oil, mechanics can determine if the engine is not running at its peak, detecting plugged filters, leaks and other problems. Visual inspections take place daily, while oil sample analysis occurs every 30 days. When a locomotive is performing properly there will not be any issues with horsepower or wheel slip problems. Engines that are well-maintained burn fuel more efficiently, and emit less exhaust for the horsepower provided.

5. Use of Ultra Low Sulfur Diesel Fuel

ARRC’s locomotives fall into the non-road category, and as such must begin using Low Sulfur Diesel (LSD) fuel beginning June 2007 and must phase into use of Ultra Low Sulfur Diesel (ULSD) by 2012. Low Sulfur Diesel has a maximum of 500 ppm while Ultra Low Sulfur Diesel has no more than 15 ppm. The Alaska Railroad already made the switch to ULSD in 2007, five years ahead of the EPA mandated phase in for this type of fuel.

ARRC’s trucks and other road-accessible heavy equipment fall into the road category of diesel engines. EPA mandated that road vehicles switch to LSD (500 ppm) by June 2006, and to ULSD by 2010. Again, ARRC met and exceeded this mandate, by switching to ULSD in early 2006 for all of its diesel trucks and vehicles.

Sulfur from burning high-sulfur fuels combines with oxygen to create sulfur dioxide, or “acid rain.” By lowering sulfur in fuel, this byproduct is nearly eliminated. The biggest benefit is the reduction of “soot” particulates in the air. Exhaust emissions are expected to decrease by 90%. ULSD has about 7% less BTU combustibility, so 3-4% more fuel may be used, but the dramatic reduction in particulates is by far worth the small dip in energy.

6. Locomotives Engine Overhauls Include Emission Control Improvements

Even though the Alaska Railroad has invested heavily in newer locomotives in the past decade, the fleet still includes a number of older locomotives, and even the SD70MACs can be made to run more efficiently and with fewer emissions. The Alaska Railroad has a plan to overhaul existing locomotive engines to further improve fleet emissions and fuel efficiency to EPA Tier standards. This decision is driven by business cost (fuel), environmental stewardship (Green Star and philosophical commitment), and regulatory factors (EPA 40 CFR, Parts 9 & 85, which mandate greater control over locomotive engine emissions, as measured by tiered criteria).

ARRC recently enhanced its locomotive fleet by selling its oldest locomotives – the four MP-15s – in 2009. The MP15 locomotives could not be remanufactured or rebuilt to meet any EPA Tier standards. Likewise, the Railroad sold 3 of its 4 RDC self-propelled rail cars, which were quite old. The remaining RDC is no longer in revenue service.

The Railroad’s new Diesel Multiple Unit (DMU) self-propelled railcar, which arrived in April 2009, already meets EPA Tier 3 standards.

The Railroad has embarked on methodical schedule to upgrade its GP40 and GP38 locomotive engines to meet higher tiered standards. Three GP40s were upgraded to Tier 0 standards in 2009. The Alaska Railroad will receive a \$700,000 EPA grant in 2010, which will accelerate emission upgrades in 2010, Four GP40s are scheduled for overhaul and their emission systems will be upgraded to Tier 0+ at the same time.

ARRC’s oldest 16 SD70MAC 4000 HP locomotives purchased in 1999 currently meet Tier 0 standards. Between 2010 and 2015, assuming enough funding, ARRC would stagger a major overhaul of two to three each year to bring these locomotives up to Tier 0+ standards.

Finally, the eight SD70MACS 4300 HP locomotives purchased in 2004, which currently meet Tier 1 standards, would undergo similar overhauls to meet Tier 1+ standards.