

California Environmental Protection Agency



Air Resources Board

**2006 Progress Report on Semiannual Public Meetings
to Evaluate Future Railroad Emission Control Measures**

A joint effort between the
California Air Resources Board (ARB)
BNSF Railway (BNSF) and
Union Pacific Railroad (UP)

**Stationary Source Division
Criteria Pollutants Branch
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I. INTRODUCTION

The Statewide Railyard Agreement (Agreement) between the California Air Resources Board (ARB), Union Pacific Railroad (UP), and BNSF Railway (BNSF) was signed on June 24, 2005 and requires both of California's Class 1 railroads to reduce diesel particulate matter emissions in and around railyards. ARB staff estimates the MOU will reduce diesel particulate matter by 20 percent over 2005 levels within three years. To achieve these emission reductions, the Agreement requires locomotive idling limitations and the installation of idle reduction devices on all intrastate locomotives, the use of low sulfur diesel fuel by all locomotives fueled in California, and a compliance rate of 99 percent for smoking locomotives each year. In addition to the three short-term measures, the railroads and ARB will develop sixteen major railyard health risk assessments (HRAs) to identify the public health risks from railyards and opportunities for future mitigation measures.

The Agreement also requires the ARB and railroads to host two technical evaluation meetings annually to evaluate the development of future railroad emission control measures. The purpose of the technical evaluation meetings per Section 8d of the 2005 MOU, is to "evaluate other medium-term and long-term alternatives" to further reduce locomotive¹ and railyard emissions that go beyond the emission reductions provided by the short-term requirements in the Agreement and "to ensure that the evaluation and implementation of feasible mitigation measures continues expeditiously." Section 8d also requires the parties (BNSF, UP and ARB) to "prepare a brief written progress report on these consultations and make the information available to any interested parties." This document is designed to fulfill these requirements.

ARB staff invited the public, community leaders, local air districts, and other interested parties, including railway companies and equipment vendors, to both of the technical evaluation meetings. The meetings were webcast to enable a wider group to participate. A list of the presentations delivered at these meetings is included as Attachment A of this report along with links to each presentation on the ARB website.

¹ "Locomotive means 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...; and vehicles propelled by engines with rated horsepower of less than 750 kW (1006 hp) are not locomotives (see 40 CFR Parts 86 and 89 for this equipment)." Code of Federal Regulations, Title 40, Part 92.2 definitions, 40CFR92.2.

II. FIRST SEMIANNUAL TECHNICAL EVALUATION MEETING

The first semiannual technical meeting was held in El Monte, California on April 25, 2006. Topics included presentations on switch locomotive technologies, idle reduction device technologies, and suggestions for future control measures. Several vendors (e.g., RailPower and General Electric) gave presentations on their products and answered questions. Agendas for each meeting are included as Attachments B and C and can be obtained at <http://www.arb.ca.gov/msprog/offroad/loco/loco.htm>.

The meeting was structured with a panel of representatives speaking and responding to audience participants from local communities, industry experts, and local air pollution control officials. The panel consisted of Dean C. Simeroth from ARB, Mark Stehly from BNSF, Lanny Schmid from UP, and Darcy Wheelles representing the Association of American Railroads. Dean Simeroth provided introductory comments and context and then led a general discussion of potential future topics. It was agreed that the next meeting should include discussions on the testing and demonstration of diesel particulate filter (DPF) and selective catalytic reduction (SCR) technologies with locomotives.

A. Switch Locomotive Technologies

Gen-Set Switch Locomotives

Dave Davies from National Railway Equipment Company (NREC) gave a presentation on NREC's gen-set switch locomotives. Gen-set locomotives use multiple non-road diesel engine technology to produce a locomotive with approximately 21 percent savings in fuel consumption, and as high as 48 percent reductions in oxides of nitrogen (NOx) and 89 percent reduction in particulate matter (PM) emissions (See page 5 of Dave Davies' presentation). These locomotives are Tier 2 U.S. EPA certified and ARB has verified that this locomotive can be used for ultra low emission locomotive credits provided for under the 1998 NOx Locomotive Fleet Average Agreement for the South Coast Air Basin. UP placed a prototype in service in 2006 that is currently operating in the Los Angeles area and has ordered 60 more gen-set locomotives for use in southern California. The gen-set locomotive presentations are listed in Attachment A and can be found on the ARB website. Further vendor information on gen-set locomotives can be found at: <http://www.nationalrailway.com/sales.asp> and http://www.railpower.com/products_hl.html

Electric Hybrid Switch Locomotives or "Green Goats"

Karen Dzienkowski from RailPower gave a presentation on electric hybrid switch locomotives, commonly referred to as "Green Goats". The Green Goat is a combination diesel generator with a large battery pack (over 300 batteries), ultimately producing about a 2,000 horsepower equivalent powered locomotive. The first Green Goat prototype was developed in 2002 and by mid-2006 RailPower delivered 30 Green Goats

nationally. On average, fuel costs are reduced 40-60 percent. Additionally, these locomotives can reduce NOx and reactive organic gas (ROG) emissions by up to 90 percent and diesel PM by 80 percent (with Tier 3 non-road engines). Other benefits include zero idling time (batteries provide auxiliary power, thus making idling unnecessary) and less noise pollution. The hybrid switch locomotive presentations are listed in Attachment A and can be found on the ARB website. Additional vendor information on electric hybrid locomotives can be found at:
http://www.railpower.com/products_gg.html

Liquefied Natural Gas Switch Locomotives

While MotivePower, the manufacturer of BNSF's four LNG switch locomotives in the early 1990's, no longer had staff available to discuss their LNG switch locomotives, the panel held a short discussion on LNG locomotive technologies. BNSF summarized their use of LNG switch locomotives in the Los Angeles area. BNSF has been operating four LNG switch locomotives in the Los Angeles area for the past 10 years. However, BNSF has not expanded the use of LNG switch locomotives because of the need for separate LNG centralized fueling, limited fueling range of LNG switch locomotives, and special handling and safety requirements when using LNG fuels. Additionally, it takes 30 percent more fuel for an LNG fueled switch locomotive to accomplish the same work as a diesel fueled locomotive.

B. Locomotive Idle Reduction Technologies

Automatic Shutdown Devices (AESS)

Representatives from ZTR and Electro-Motive Diesel (EMD) both gave presentations on the automatic shutdown devices offered from their respective companies. Automatic shut down devices reduce emissions by limiting unnecessary engine idling in locomotives. ZTR manufactures "Smart Start," a shutdown device that can be retrofitted to existing locomotives and EMD makes "Automatic Engine Start Stop" or AESS for new orders. In order to initiate shut down of an idling locomotive, several programmed engineering and safety parameters must first be met (e.g., air brake pressure, engine temperature, battery voltage, etc.). The devices will initiate a safe locomotive engine shutdown once certain parameters are met. The idle reduction device presentations are listed in Attachment A and can be found on the ARB website.

Further vendor information on automatic shut down devices can be found at:

<http://www.ztr.com/smartstart.htm>

<http://www.gmemd.com/en/locomotive/innovations/autostart/index.htm>

(GE did not present but also produces this product)

<https://www.getransportation.com/general/locomotives/parts/GE/Fuel.asp>

III SECOND SEMIANNUAL TECHNICAL EVALUATION MEETING

The second semiannual technical evaluation meeting was held in Sacramento, California on July 13, 2006. This meeting consisted of three panels: European locomotive experiences, locomotive research and demonstration projects, and United States (U.S.) locomotive experiences. Representatives from the railroads, vendors, local air districts, ARB, and the U.S. Environmental Protection Agency (U.S. EPA) provided their perspectives on one or all of these categories.

Agendas for each meeting are included as Attachments B and C and can be obtained at: <http://www.arb.ca.gov/msprog/offroad/loco/loco.htm>.

Bob Fletcher from ARB welcomed everyone and all panel members and attendees introduced themselves. Don Kopinski of U.S. EPA then provided a summary of the current federal regulatory structure of EPA's emissions regulations for locomotives, summarized the impact of locomotive emissions throughout the United States, and provided initial insight as to where U.S. EPA might proceed with its forthcoming new emission standards for locomotives. New U.S. EPA locomotive emission standards could be proposed as early as late 2006 or early 2007.

The presentation is listed in Attachment A and can be found on the ARB website at: <http://www.arb.ca.gov/msprog/offroad/loco/loco.htm>.

A. First Panel Session: European Locomotive Experiences

To learn more about how the rail industry in Europe is addressing locomotive emissions, representatives of ARB, local air districts, BNSF, and UP visited Hug Engineering in Switzerland. Hug Engineering is Europe's primary manufacturer of aftertreatment devices for locomotives. Additionally, Southwest Research Institute (SwRI) visited French passenger railroad (SCNF's) facility in Paris. Since rail operations in the United States differ from European railroads in many ways Class I railways and U.S. locomotive aftertreatment manufacturers are evaluating the new filter technologies to see whether they can be effectively integrated into their operations.

Dean Simeroth from ARB and Henry Hogo from the South Coast Air Quality Management District (SCAQMD) each summarized their experiences during recent trips to Europe, and in particular, to investigate the development and implementation of diesel particulate filter technology on locomotives in Switzerland. Their presentations are listed in Attachment A and can be found on the ARB website listed above. Mike Iden from UP gave a presentation summarizing his conclusions after three visits to Europe in the past 12 months. During his trips, Mr. Iden researched how new technologies are being manufactured and applied to both new and in-use locomotives in Europe as well as in Switzerland. The presentation is listed in Attachment A and can be found on the ARB website listed above. Also, Jennifer Anderson from BNSF provided a

brief summary of her experiences when she visited Europe to observe the use of locomotive emission control devices.

Don Newbury from Miratech Corporation provided a detailed summary of his company's development and application of the Hug Engineering DPF technology to diesel engines and locomotives in the U.S. Currently, Miratech is working with UP, BNSF, and ARB to design a retrofit DPF application for a roots-blown² switch locomotive to be tested in 2006. DPFs are an after-treatment device that can be mounted onto a locomotive's exhaust pipes and may reduce PM up to 90 percent. BNSF and UP funded SwRI to conduct three years of research and testing of different DPFs in the lab. SwRI is now testing DPFs on an EMD locomotive; UP and BNSF are each retrofitting switch locomotives with DPFs for testing in California in 2006. As discussed by SwRI at the July 13th meeting, the current challenges and limitations of DPFs on switch locomotives include space constraints, filter longevity/long term performance, and low exhaust temperatures. In addition, Miratech is working with Hug Engineering to develop a DPF and SCR combination aftertreatment device for locomotives. The presentations are listed in Attachment A and can be found on the ARB website. Further vendor information on DPFs is at: <http://www.miratechcorp.com/soottraps.asp>

Miratech is also developing DOC technology for future testing on U.S. locomotives. DOCs are a passive technology that reduce emissions by capturing the locomotive exhaust and cleaning it. The pollutant gases diffuse through to the surface of the ceramic honeycomb coated with noble metals and react to form hydrogen and carbon dioxide. DOCs can produce 20-40 percent reductions in PM emissions and a 90 percent reduction in carbon monoxide (CO) and volatile organic compound (VOC) emissions. The U.S. EPA has funded SwRI to conduct a year-long study beginning in 2006 on a DOC fitted to an older UP line haul locomotive operating in the Los Angeles basin. As mentioned by SwRI, current challenges and limitations of DOCs include weight and space limitations in the locomotive and exhaust temperature (exhaust must be heated for the device to be effective). The presentations are listed in Attachment A and can be found on the ARB website. Further vendor information on DOCs is at: http://www.miratechcorp.com/catalysts_dieseloxidation.asp.

B. Second Panel Session: Locomotive Research and Demonstration Projects

Lanny Schmid (UP) opened the session with a summary of UP's efforts pertaining to idle reduction technology, gen-set switch locomotives, DPF and DOC controls, and a summary of the new "hood" demonstration project occurring at the UP Roseville Yard.

² A "roots-style blower" is an engine driven supercharger using twin two- or three-lobe rotors spinning opposite each other inside a precisely machined case. This supercharger design moves large quantities of air at a relatively slow speed.

UP Roseville Locomotive "Hood" Development Project

Tom Christofk from Placer County Air Pollution Control District summarized the "hood" proof of concept project currently under development at the UP Roseville rail yard. The hood is an experimental stationary emission control device for potentially reducing locomotive emissions primarily occurring at the service, test, and repair areas in rail yards. The hood captures the emissions from locomotives and treats the exhaust to reduce the pollutants, with the potential for 99 percent reductions in sulfur oxides (SO₂) and PM, 95 percent reductions in NO_x, and 50 percent reductions for water soluble VOCs. The presentation is listed in Attachment A and can be found on the ARB website. Further vendor information on the hood is available at:

<http://www.advancedcleanup.com/environmentalengineering/index.html>

SwRI Presentation on DPF Technology Application in the United States (U.S.)

Steve Fritz from SwRI provided a detailed summary of the California Emissions Program (CEP) currently sponsored by UP and BNSF and with direction from the ARB. Under the CEP, SwRI developed a low oil combustion kit to reduce the amount of oil consumption in the engine. In the next phase of this effort, SwRI worked closely with thirteen different vendors to develop a retrofitable DPF to be applied to a roots blown switch locomotive. Miratech Corp was selected as the vendor to develop the DPF, and the first prototype was scheduled to be tested on rail track in the 3rd quarter of 2006. The presentation is listed in Attachment A and can be found on the ARB website.

Mr. Fritz also gave a presentation on a project to reduce emissions at SCNF's railroad station in Paris, France. Engineered by Exocat, the facility captures emissions from engine idling and start up and then sends it through a scrubber system before releasing the cleaned air. The facility is a combination of a DPF filter and a SCR. The exhaust gas, treated with urea reactant, passes through fine cell honeycomb-patterned converters, reducing the nitrogen oxide emissions to water and nitrogen. This Exocat technology reduces HC, NO_x, CO, and PM emissions. As mentioned by SwRI, there are significant limitations in versatility as the exhaust hoods are not adjustable and only fit specific locomotives which must be perfectly aligned. The presentation is listed in Attachment A and can be found on the ARB website. Further vendor information on the SCNF facility is at: <http://exocat.europarama.lt/>.

South Coast Air Quality Management District (SCAQMD) Demonstration Projects

Mike Bogdanoff from the SCAQMD provided a summary of three of the District's locomotive demonstration projects: 1) Demonstration of DPF and SCR technology retrofitted to head-end or hotel power for a Metrolink passenger locomotive; 2) Demonstration of DPF technology on a re-powered Pacific Harbor Lines switch locomotive; and 3) Demonstration of SCR retrofitted to an existing passenger locomotive. All three projects are scheduled to begin in the near future. The presentation is listed in Attachment A and can be found on the ARB website.

Finally, Mr. Iden returned to the podium and provided a summary of gen-set locomotive technology and UP's current plan to operate such units throughout the United States. The presentation is listed in Attachment A and can be found on the ARB website.

C. Third Panel Session: United States Locomotive Experiences

Dave Brann from Electromotive Diesels and Peter Lawson from General Electric provided detailed summaries of how new technology has been developed and applied to locomotives. They shared information about engine performance, development issues, and provided insight into the hurdles each company faces in developing newer cleaner engines for the future. Their presentations are listed in Attachment A and can be found on the ARB website.

ATTACHMENTS

Attachment A: List of Presentations and links at ARB's website

Attachment B: Agenda for April 25, 2006 Technical Evaluation Meeting

Attachment C: Agenda for July 13, 2006 Technical Evaluation Meeting

Attachment A

List of Presentations and Links

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Attachment A: List of Presentations and Links

April 25, 2006 Presentations

<http://www.arb.ca.gov/msprog/offroad/loco/loco.htm>

- 1.) *"Multi-Engine Gen-Set - Ultra Low Emissions Road-Switch Locomotive"* by National Railway Equipment Company
http://www.arb.ca.gov/railyard/ryagreement/genset_nrec.pdf
- 2.) *"Electric Hybrid Locomotives"* by RailPower Technologies Corp.
http://www.arb.ca.gov/railyard/ryagreement/hybridloco_railpower.pdf
- 3.) *"AESS and Other Emission Reduction Strategies"* by ElectroMotive
http://www.arb.ca.gov/railyard/ryagreement/aess_electromotive.pdf
- 4.) *"Smart Start"* by ZTR Control Systems
http://www.arb.ca.gov/railyard/ryagreement/smartstart_ztr.pdf

July 11, 2006 Presentations

<http://www.arb.ca.gov/msprog/offroad/loco/loco.htm>

- 1.) *"EPA's Rulemaking for Clean Diesel Locomotives"* by U.S EPA
<http://www.arb.ca.gov/railyard/ryagreement/071306epa.pdf>
- 2.) European Locomotive Experiences
 - *"European Locomotive Experiences: South Coast AQMD Perspective"* by South Coast AQMD
<http://www.arb.ca.gov/railyard/ryagreement/071306hogo.pdf>
 - *"Diesel Particulate Filter (DPF) Technology for New & Retrofitted Locomotives in the US and Europe"* by Union Pacific
<http://www.arb.ca.gov/railyard/ryagreement/071306iden.pdf>
 - *"Exhaust Emissions Controls for Diesel Locomotives – Experience in Europe"* by MIRATECH Corp.
<http://www.arb.ca.gov/railyard/ryagreement/071306newburry.pdf>

3. Locomotive Research and Demonstration Projects

- *"Locomotive Research and Demonstration Projects: Advanced Locomotive Emission Control System Demonstration at Roseville Rail Yard"* by Placer County Air Pollution Control District
<http://www.arb.ca.gov/railyard/ryagreement/071306placer.pdf>
- *"Controlling Diesel Locomotive Start-Up and Idle Exhaust Emissions at SNCF l'Ourcq (Paris, France)"* Southwest Research Institute
<http://www.arb.ca.gov/railyard/ryagreement/071306fritz2.pdf>
- *"California Emissions Program: PM Reduction from EMD Switcher Locomotives"* by Southwest Research Institute
<http://www.arb.ca.gov/railyard/ryagreement/071306fritz.pdf>
- *"Low-Emission Locomotive Projects"* by South Coast AQMD
<http://www.arb.ca.gov/railyard/ryagreement/071306bogdanoff.pdf>
- *"Hybrid Locomotives: Better Economics, Better Environment"* by Rail Power Technologies Corp.
<http://www.arb.ca.gov/railyard/ryagreement/071306dzienkowski.pdf>
- *"Ultra-low Emissions "Gen-set" Switch Locomotives"* by Union Pacific.
<http://www.arb.ca.gov/railyard/ryagreement/071306iden2.pdf>

4. United States Locomotive Experiences

- *"Electro-Motive Diesel, Inc. Locomotive Experiences"* by Electro-Motive Diesel, Inc.
<http://www.arb.ca.gov/railyard/ryagreement/071306brann.pdf>
- *"GE Transportation: Driving toward lower emissions"* by General Electric.
<http://www.arb.ca.gov/railyard/ryagreement/071306lawson.pdf>

Attachment B

Agenda for April 25, 2006 Technical Evaluation Meeting

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Attachment C

Agenda for July 13, 2006 Technical Evaluation Meeting

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