European Locomotive Experiences: South Coast AQMD Perspective

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Statewide Rail Yard Agreement
Second Public Meeting to Discuss
Future Locomotive Emissions Control Measures
Sacramento, CA
July 13, 2006

Objectives

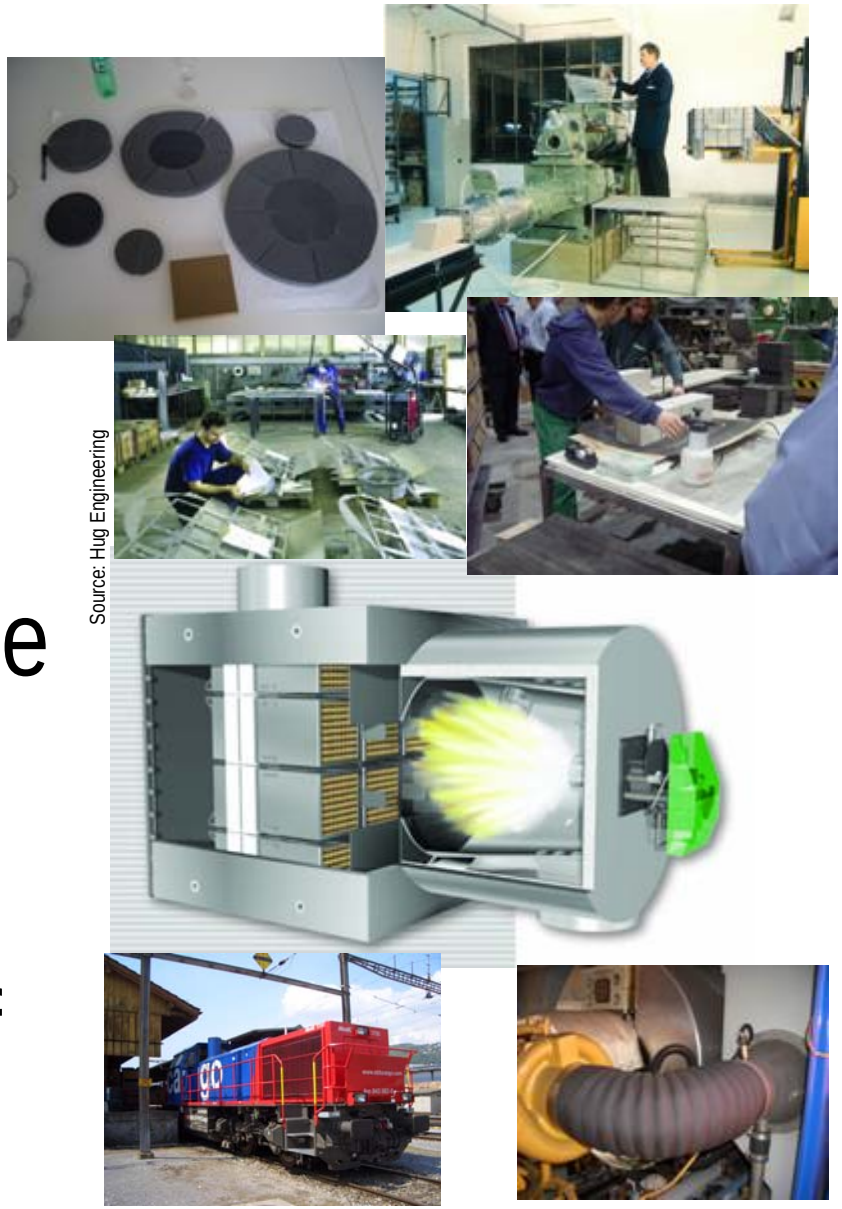
- Gain Common Understanding on State of Technology in Reducing Locomotive Emissions in Europe
- Developments Since Visits in 2005
- Discuss with Operators on Performance
- Discuss Potential for Application to U.S. Locomotives

Swiss Rail Experience

- Planned Delivery of 73 New Diesel Locomotives (2000 Hp) Equipped with Diesel Particulate Filters (DPFs)
- Ultimate Replacement of 800 Diesel Locomotives with 450 New Diesel Locomotives with DPFs
- Use of 50 ppm Sulfur Content Diesel Fuel and Synthetic Lubrication Oils
- One Smaller Locomotive Equipped with DPF and SCR

Hug Engineering

- Leading European Manufacturer of PM and NOx After-Treatment Devices
- Use of Silicon Carbide Based Materials
- Modularized Units Capable of Variety of Applications



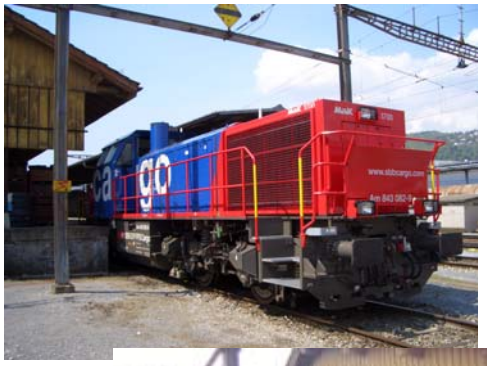
Source: Hug Engineering

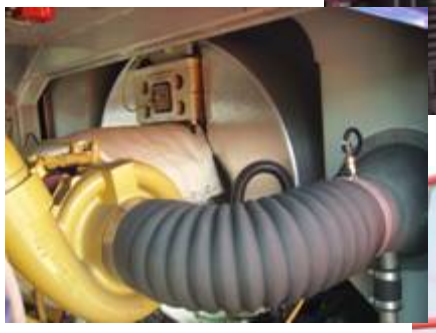
Potential Application to U.S. Locomotives

- After-Treatment PM and NOx Technologies Are Feasible on Locomotives
- Need to Use Low-Sulfur Content Diesel Fuel
- Retrofits Being Tested
- New Locomotive Considerations for After-Treatment Devices

Switcher Locomotives

- New Swiss Rail Locomotives Similar to Switchers
- DPF Integrated into Carbody





Line-Haul Locomotives

- Existing Locomotive Retrofit Demonstration
- DPF Integrated into Carbody
- Vossloh Locomotive Offering 3,500 Hp Locomotives with DPFs

Source: Hug Engineering

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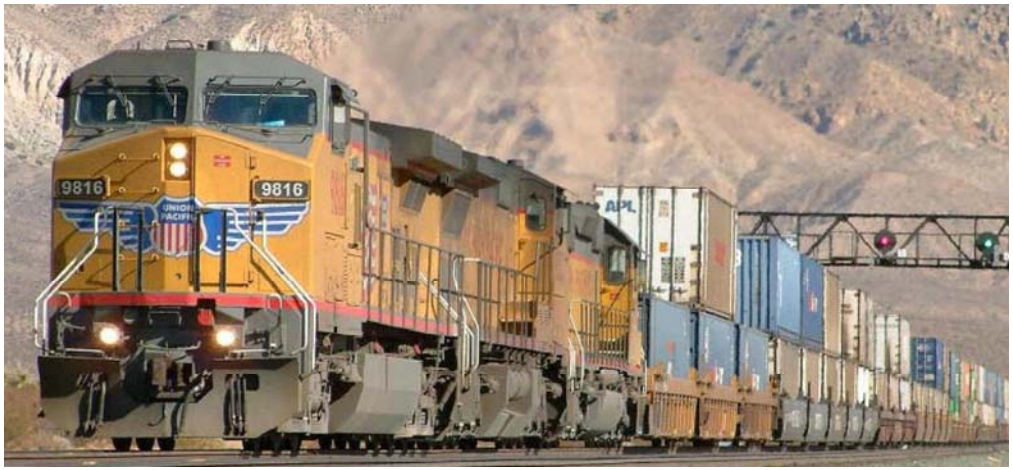
Retrofitting Line-Haul Locomotives

- Space Consideration
- Potential Muffler Replacement
- Ability to Retrofit Above Carbody



GE Proposal

- Submitted to CARB ICAT Grant Program
- Retrofitting Line-Haul Locomotives
- “Our Proposal is to Use a Fiberous Ceramic Media Type Filter Using the Principle of Depth Filtration to **Reduce Size, Weight, Cost, and Backpressure** of the Filter.”

GE Proposal

- "The Technical Goals of the Proposed Project Are to Design a DPF for a 4500 Hp Locomotive Engine that will Reach 90% PM Filtration Efficiency with a Maximum Duty Cycle Fuel Consumption Penalty of 1%, With No Adverse Impact on System Reliability, While Minimizing the Initial Cost of the System. The System Should be Retrofittable to Most Existing GE Locomotives That Use Electronic Fuel Injection"

Summary of Retrofit Technologies

- Modular Approach to Address Space
- Diesel Particulate Filters
  - Ceramic Pleated Filters
  - Ceramic Fiber Filters
- NOx Reduction Potential - SCR
- Retrofits Within Car-Body or Above

Conclusion

- Should Pursue Demonstration Programs as Provided in Section 8(c)(ii) – Retrofit or Rebuild of Existing Line-Haul Locomotives With Low Emitting Technologies
- Remaining Monies Should Be Used to Demonstrate Technologies As Provided in Section 8(c)(ii) for GE and EMD Engines