North Carolina Leads The Way In Emissions Reduction For Passenger Rail

Ian Stewart and Dave Cook describe the latest developments and emissions controls for older passenger locomotives.

Photograph by Ian Stewart July 17 2014 Charlotte NC.

Photograph provided by EF&EE

Ridership on commuter rail services across the country has been steadily increasing in recent years. This is helping to reduce highway congestion and total vehicle emissions, but many of these commuter lines, such as Metrolink, use conventional diesel locomotives. Though a more cost effective and simpler solution than converting to electrified light rail or further expanding the freeways, existing diesel locomotives are still a significant source of exhaust emissions that are harmful to human health. To address this, as of January 2015, the EPA requires new locomotives to meet Tier 4 emissions standards per CFR 40-1033 which is ultimately good in the long term, but the high cost of these new low emissions locomotives has made their purchase prohibitive to most passenger rail fleets. Conversely, in order to lessen the impact on existing rail operations, EPA regulations also allow EMD passenger locomotives built before 2001 to be rebuilt indefinitely to Tier 0+ standards. Tier 0+ offers little reduction in harmful exhaust emissions compared to the current Tier 4 standard, but Agencies such as Metrolink with units that are due for overhaul or replacement will likely choose to perform basic Tier 0+ overhauls to the majority of their fleets rather than purchase new locomotives. These rebuilt Tier 0+ locomotives would continue to emit high levels of diesel engine emissions in our cities for the next 20 years or more.

Fortunately, the primary technology used in the new passenger locomotives to achieve the Tier 4 NOx levels can be adapted to older locomotives as well. The technology is referred to as Selective Catalytic Reduction (SCR) and uses a consumable Diesel Exhaust Fluid (DEF) that is injected into the exhaust stream. The mixture is then routed through a set of catalysts that are activated by the hot DEF and exhaust gasses to reduce much of the NOx and other pollutants rather than allowing them to be released into the atmosphere. The DEF fluid is non-toxic and carried in an additional fluid tank in a similar manner to many on road diesel vehicles currently in operation. In 2010 Metrolink tested Engine Fuels & Emissions Engineering's (EF&EE) prototype Compact SCR system (CSCR) on one of its F59PH passenger locomotives with an expectation that it would achieve the Tier 4 requirement for NOx reduction. This system demonstrated the potential for the concept's application on existing locomotives by achieving 70% NOx reduction but lower than expected exhaust temperatures and poor DEF mixing caused the system to fall short of 90% NOx reduction goal. The CSCR system as designed was not considered for further assessment and soon after Metrolink elected to purchase 20 new Tier 4 locomotives to replace part of their aging fleet of F59PHs at a cost of $150 Million.

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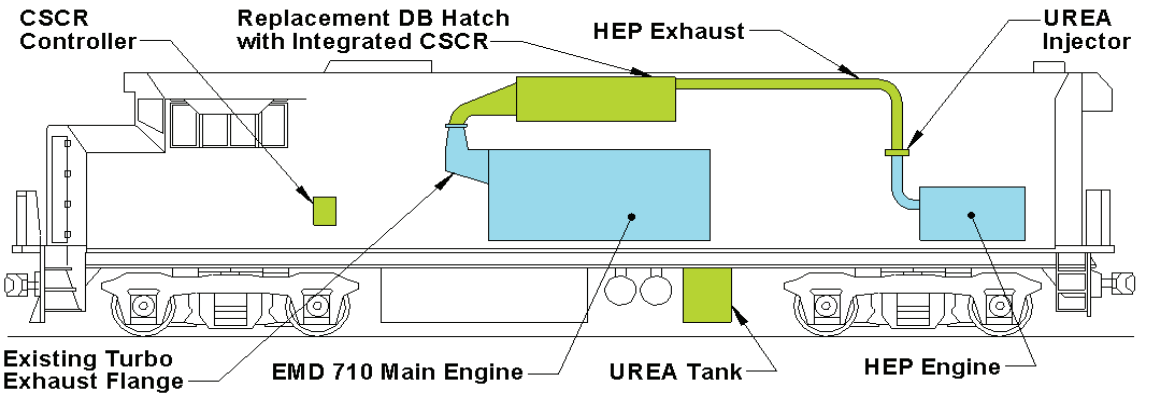
Recently, a new iteration of the CSCR system called the Blended Aftertreatment Systems (BATS) has been developed in California by the team at Rail Propulsion Systems (RPS). The BATS addresses the issues that were inherent to the CSCR and shows promise to provide near Tier 4 emissions reduction for existing passenger locomotives. Passenger locomotives typically have two engines, one main engine that provides propulsion and a second smaller HEP generator engine that

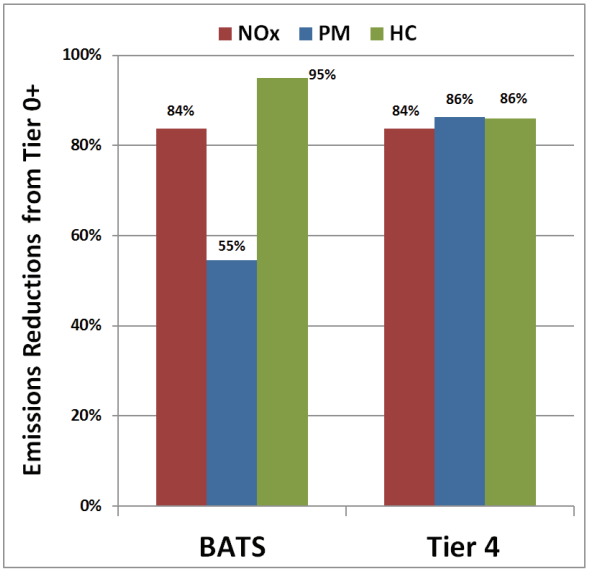


provides hotel power for the passenger car climate control, interior lights, etc. In the previous CSCR demonstration the system only addressed the main engine exhaust and suffered from poor mixing and insufficient heat to provide the expected performance throughout the operating range. The BATS combines the exhaust streams of both the main engine and the HEP engine and directs them into a single large SCR unit. The two exhaust streams are configured such that DEF is injected into the hotter HEP engine exhaust which is then combined with the main engine exhaust in such a way as to ensure proper mixing prior to passing through the catalyst elements.

With this new configuration, both the main engine and the HEP engine exhausts will pass through the SCR resulting in total NOx emissions at Tier 4 levels, HC reductions 35% better than Tier 4 levels, and PM emissions at Tier 3 levels. As show in the graph, these are similar to Tier 4 emissions reduction from the allowable Tier 0+ levels for existing locomotives.

To date, achieving Tier 4 emissions reduction levels has proven difficult or less of a focus for locomotive manufacturers. For freight locomotives, EMD has announced it will not have a Tier 4 freight locomotive available until at least 2017 and GE is offering Tier 3 locomotives that are called Tier 4 'Credit User' locomotives by using emissions credits until the banked emissions credits are exhausted. For passenger locomotives, none have been put into revenue service as yet, and the performance of the new EMD units purchased by Metrolink may not be known until sometime in 2016.

Alternately, the CSCR system demonstrated in 2010 did show sufficient potential to warrant further attention by other agencies leading to a recently initiated assessment project of the Blended Aftertreatment System by North Carolina Department of Transportation (NCDOT). The BATS is to be installed on an existing F59PH operating on their Piedmont Express over the 172 mile route between Raleigh and Charlotte, North Carolina. The system is currently being fabricated by manufacturers in California and will be statically tested on a locomotive in Southern California prior to being shipped, installed, and assessed over a period of months in passenger service in North Carolina starting in June 2015. NCDOT is in a unique position in that parts of the Piedmont Corridor are considered a "non attainment" region for air quality, similar to the Metrolink San Bernardino line, and has been granted funding to address the issue through research efforts to be carried out in a collaboration with North Carolina State University. Once verified in service, the BATS could be installed on all of the passenger locomotives in NCDOT's fleet which should make a real and measureable different in air quality along the route. Metrolink currently has 29 pre 2001 F59 locomotives that have not been rebuilt since they were manufactured over twenty years ago. Once the performance of the BATS has been verified by ARB, it may be incorporated into a remanufacture kit eligible for California funding (Carl Moyer) allowing for low cost overhaul and upgrade of these Metrolink locomotives.



Blended Aftertreatment System

A complete locomotive overhaul with this remanufacture kit should cost approximately $2 million, or less than 1/3 of the cost of a new Tier 4 passenger locomotive. Put another way, for 30% of the cost of a new passenger locomotive, Metrolink could overhaul an existing F59PH locomotive with the BATS retrofit package restoring this proven platform to like new condition, allowing it to provide many more years or of service but now, in a more environmentally friendly manner.

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