

Technology For Locomotive Emissions Reductions – Manufacturer's Perspective

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Agenda

1. Australian Locomotive Fleet
2. U.S. Locomotive Exhaust Emissions Standards
3. Emission Kits for Older Locomotives
4. Review of Recent Testing
5. Next Generation Locomotives

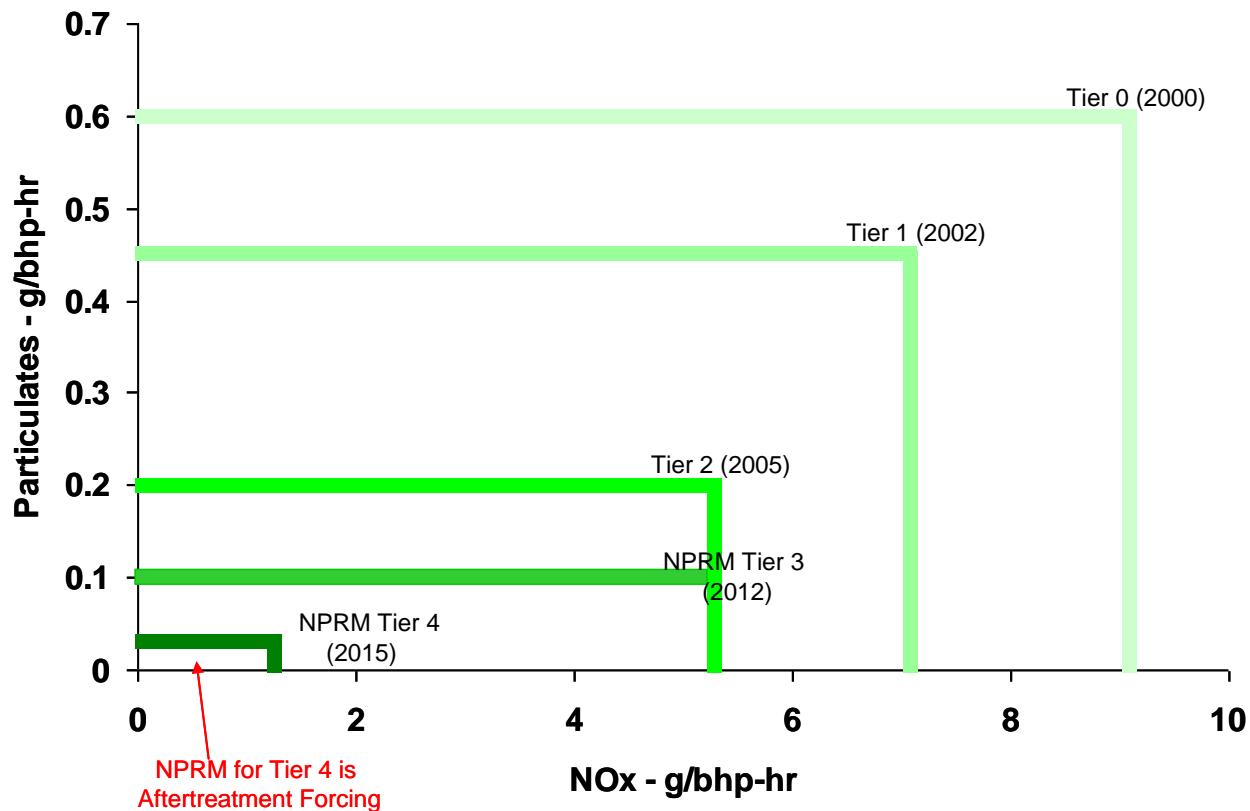
Australian Locomotive Fleet

- About 2,000 total diesel locomotives in Australia
- Average age ~ 30 years
- Only small percent of fleet replaced each year



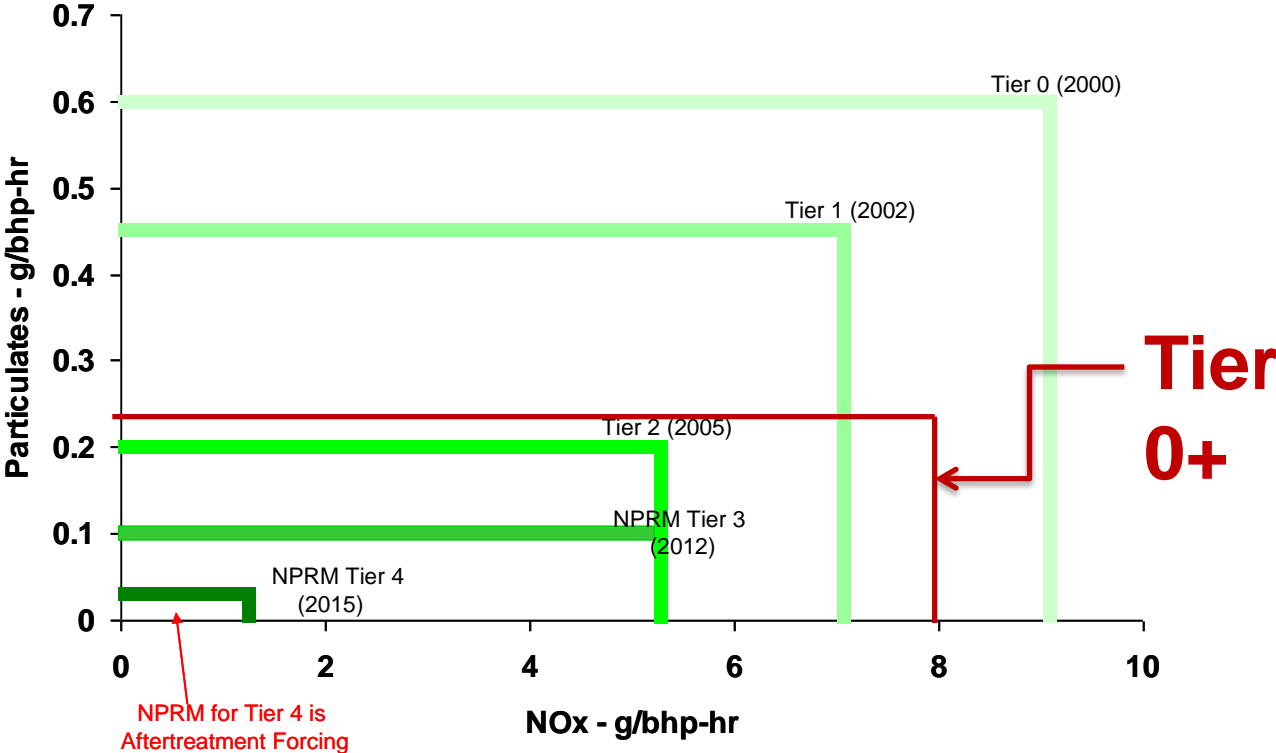
Emissions for U.S. Locomotives

- Major factor in engineering development over past 15 years



Emissions for Existing Locomotives

- Applies to locomotives manufactured since 1973
- Locomotives must be upgraded when they are overhauled



Emissions Kits

- Tier 0+ emissions kits for 645 & 710 diesel engines
- Low oil use power assemblies
- Fuel Injectors & Four Pass Aftercoolers
- Locomotives certified that they meet Tier 0+ with kits applied

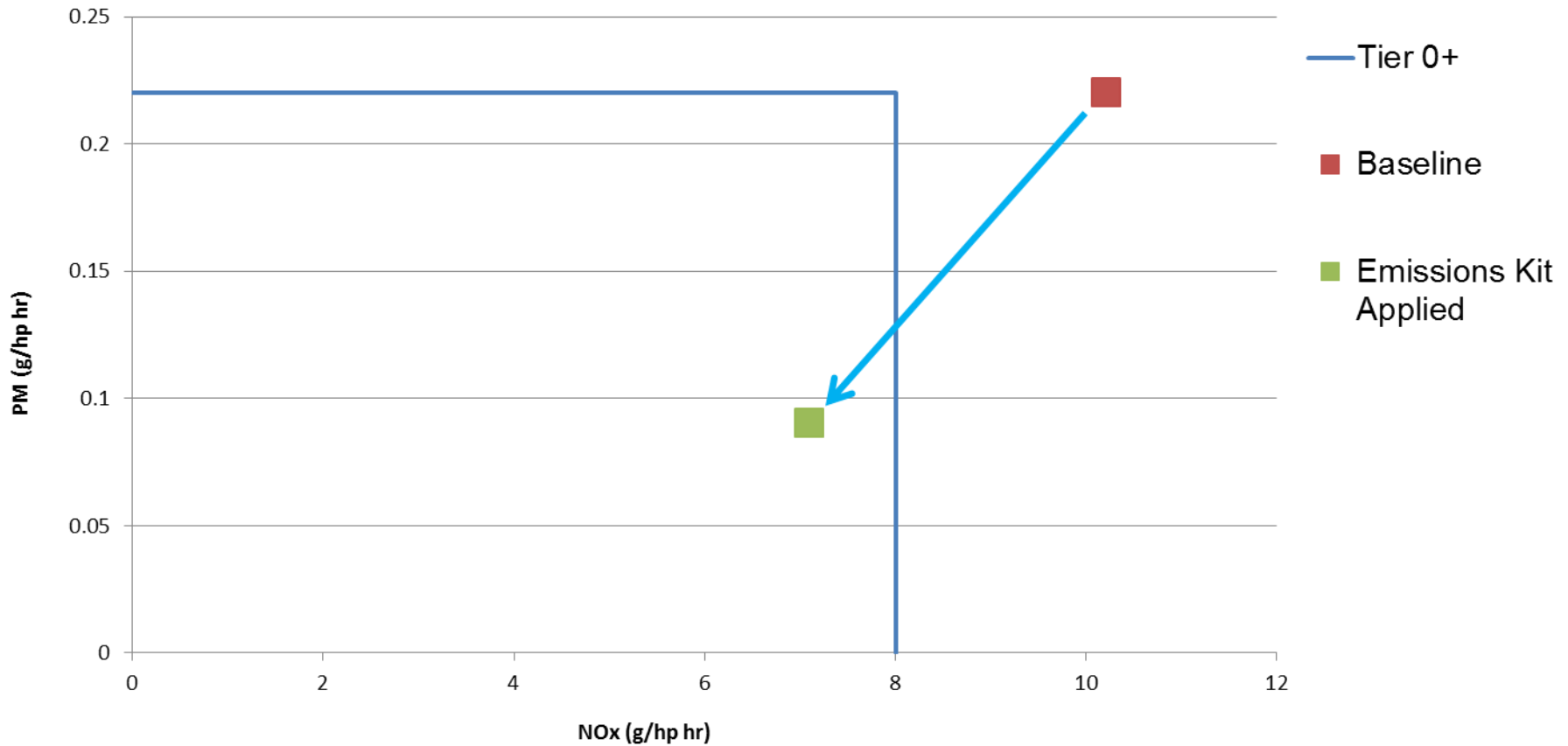


Tier 0+ Kits for Australian Locomotives

Engine	Tier 0+ Kit	Comments
12-645E	40162002	Normally Aspirated
16-645E	40162005	Normally Aspirated
12-645E3B	40169282	Alternate kit 40188099 has Haynes injectors
16-645E3B	40162008	Includes 4 Pass Aftercoolers; Alternate kit 40188101 has Haynes injectors
16-645E3C	40169278	Includes 4 Pass Aftercoolers
12-710G3	40171611	
12-710G3A	40171611	
16-710G3A	40156921	Includes 4 Pass Aftercoolers
16-710G3B	40156917	Already has 4 Pass Aftercoolers
12-710G3-ES	40168671	Locomotive has Electronic fuel injection and separate aftercooling.
16-710G3-ES	40161852	Locomotive has electronic fuel injection & separate aftercooling

Testing June, 2015 – 9024 with 16-710G3A Engine

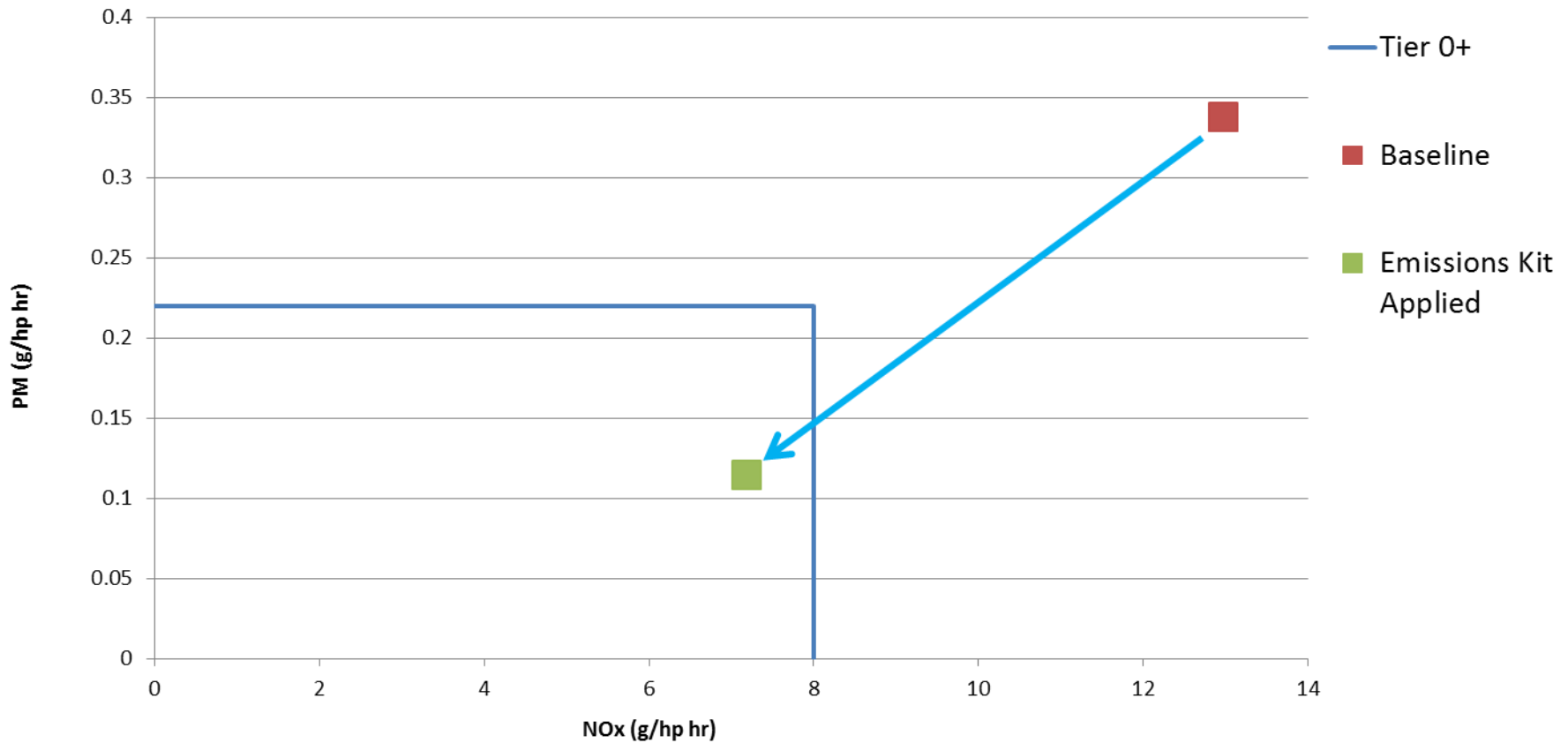
PM and NOx Results - 9024



Testing June, 2015 – 8113

With 16-645E3B Engine

PM and NOx Results



Current Testing

- Optimization of injection timing
 - Improved fuel consumption
 - Reduced CO₂
 - Higher NO_x emissions
- Application of High Capacity (T3) Oil Separator on 710 Engine

Voluntary Emission Reduction



SD70ACe-LCi Loco for BHP Australia Meets U.S. EPA T2 Emissions

GT46C-ACe Gen II

- Locomotive configured to meet U.S. EPA Tier 3
- Variable speed inverter drive for fans and blowers to reduce parasitic loads and reduce noise
- Locomotives will arrive in mid-2016



GT46C-ACe Gen II

Questions