Zemo/CCF TRU Workshop

Reducing emissions from auxiliary transport refrigeration units (auxTRUs)

Via Teams, 26 October 2021

Zemo Partnership

Accelerating Transport to Zero Emissions

COLD CHAIN FEDERATION

The Zemo Report

Brian Robinson

Transport Refrigeration Units

- **Report published in September 2021**
- **Work funded by Transport Scotland**

The objectives of this research were:

- To expand the emissions measurement evidence-base for diesel auxTRUs
- To estimate their real-world impacts on air quality
- To inform Transport Scotland on the potential for policy interventions to control TRU emissions

- **The report (and this presentation) covers three main areas:**
  - Emissions tests on two diesel auxTRU
  - Modelling of environmental impacts across Scotland
  - Next steps recommendations

Emissions tests – units tested

- One 15kW 1.6l unit fitted to an 89m^3 box semitrailer
  - Manufactured in 2014
  - Converted to use R452A
- One 11kW 1.2l unit fitted to a 55m^3 box 26t rigid HGV
  - Manufactured in 2016
  - R404A refrigerant
- Both hired for purposes of testing
- Both checked for correct operation

Emissions tests – test method

- Protocols first developed by Zemo in 2019
- Refrigerated load simulated with pre-cooled water-filled IBCs and cardboard boxes
- AuxTRU runs for several hours simulating periods of pull-down, steady-state (doors closed) and door openings
- Two ambient (chamber) temperatures representing normal summer and winter conditions (15 & 5 °C)
- Two load conditions – chilled and frozen
- Fuel consumption measured via weigh scales
- Emissions measured via specialist exhaust sampling

Emissions tests – results

Table ES1. Test-based averaged fuel and emissions factors

Per hour	Summer Semitrailers	Winter Semitrailers	Summer Rigid HGVs	Winter Rigid HGVs
Fuel consumption (litres per hour)	1.9	1.7	2.3	2.3
NOx production (grammes per hour)	45	32	39	38
PM production (grammes per hour)	1.4	0.9	1.0	0.9
PN production (x 10^{14} per hour)	38	42	44	38
	Annual (Semitrailers)		Annual (Rigid HGVs)	
Fuel consumption (litres per hour)	1.8		2.3	
NOx production (grammes per hour)	39		39	
PM production (grammes per hour)	1.2		1.0	
PN production (x 10^{14} per hour)	40		41	

To further place emissions from auxTRUs in context, the test evidence gathered by this research indicates that, in the specific example of a diesel auxTRU fitted to a Euro VI HGV, the auxTRU would:

- Consume about **$^1/_8$th the fuel**
- Produce about **$^1/_8$th the GHG emissions**
- Produce at least **double (2x) the NOx**
- Emit at least **five times (5x) the Particle Mass**, and
- Emit about **500 times (500x) the number of particles (PN)**, in comparison to the vehicle's Euro VI compliant propulsion engine.

Emissions tests – impacts modelling

- **Per hour emissions figures combined with estimates of numbers of diesel auxTRU TCT vehicles in use (in Scotland) and typical hours per year of use (I = N x H x R)**
- **Vehicle numbers and usage hours based on Cenex research for TfL, scaled to Scotland:**
  - 450 -700 TCT articulated HGVs (NB ≠ number of trailer auxTRUs)
  - 950 - 1,400 TCT rigid HGVs
  - 1,500 – 4,200 hours per year (6 – 14 hours per day, NB ≠ hours auxTRU running)
- **1,400 – 2,100 vehicles equivalent to 4–6 % of all Scottish HGVs (1 in 20)**
  - Diesel auxTRUs add about 1-2% more GHG emissions (on top of propulsion engines)
  - NOx emissions up 5-14%
  - PM emissions up 9-26%

Table 9. Modelled auxTRU usage scenarios

Scenario	Low Use Scenario Rigids	Low Use Scenario Artics	High Use Scenario Rigids	High Use Scenario Artics
Days per year	250	275	300	300
Hours per day	6	10	12	14
Total hours per year	1,500	2,750	3,600	4,200

Recommendations – evidence building

Further baseline auxTRU testing (post 2019 and other manufacturers)

- *Test at least one new auxTRU, certified as being compliant with NRMM Stage V (units entering the market after 1st January 2019). This will provide evidence as to whether such units have demonstrably lower emissions impacts than pre-2019 models*
- *Extend baseline auxTRU testing to include at least one other manufacturer. All three units tested to date have been from the same supplier, so testing of competitor models will ensure the baseline evidence base is more fully representative*

Gather more data on real-world auxTRU usage

- *Gather more comprehensive and nationally/regionally representative data on typical auxTRU operations and duty cycles to inform test process development and allow greater confidence in making overall fleet environmental impact estimates*

Refine test procedures (multi-temp and engine-powered systems)

- *Develop the test procedures to include combined systems that provide both propulsion and refrigeration (e.g. via an alternator) and to assess multi-temperature operations typical of normal cold-chain distribution systems. This will help to strengthen the emissions testing protocols by being more fully representative of normal in-service conditions*

Baseline testing of engine-powered systems

- *Extend baseline testing to other conventional TRU types and vehicles, e.g. alternator driven/3.5t home delivery vans. This will help broaden the evidence base to cover the key alternative approaches to vehicle refrigeration*

Recommendations – operations & alt tech

Embed industry best practice via operational reviews

- *Assess options for provision of operational reviews to encourage uptake of existing best practice emissions saving interventions within the industry (e.g. switching auxTRU off when doors open) and to broaden awareness of alternative technologies and fuels*

Evaluate alternative technologies

- *Evaluate emissions savings from alternative technologies and fuels. There will be a growing need to understand the potential for alternative solutions through like-for-like testing and in-service assessments. This should include consideration of technologies that do not rely on hydrofluorocarbon (HFC) gases with high Global Warming Potential*

Look at retrofit options

- *Evaluate the potential for retrofit solutions to be deployed on the existing auxTRU fleet, including the feasibility and likely effectiveness of fitting Diesel Particulate Filters (DPFs). DPFs have been very effective in reducing PN emissions from road vehicle engines. They may (or may not) have a role to play for some operators to dramatically reduce particle emissions from their diesel auxTRUs at modest cost*