An examination of the impact and effectiveness of IM240 emissions test requirements

Submission

May 2022

VACC
You're in good hands

Contents

About VACC

The Victorian Automotive Chamber of Commerce (VACC) is Victoria's peak automotive industry association, representing the interests of more than 5,000 members in over 20 retail automotive sectors that employ over 50,000 Victorians. VACC members range from new and used vehicle dealers (passenger, truck, commercial, motorcycles, recreational and farm machinery), repairers (mechanical, electrical, body and repair specialists, i.e. radiators and engines), vehicle servicing (service stations, vehicle washing, rental, windscreens), parts and component wholesale/retail and distribution and aftermarket manufacture (i.e. specialist vehicle, parts or component modification and/or manufacture), tyre dealers and automotive dismantlers and recyclers.

VACC is also an active member of the Motor Trades Association of Australia (MTAA) and contributes significantly to the national policy debate through Australia's peak national automotive association

About the SVA

Specialty Vehicles Australia (SVA) is a special interest group within the General Division of the VACC. SVA represents the interests of individually constructed vehicle builders, suppliers, enthusiast groups, vehicle modifiers, and engineering support businesses. The focus of the group is to advance, promote, protect, and support this industry in Australia and to preserve the interests of members.

SVA has consistently lobbied for the removal of the IM240 testing requirement in its current form as a certification requirement for ICVs and modified vehicles due to the financial and compliance burden for consumers and small businesses.

Main Contributor

Tim Woods
Engineering Manager
Bremar Automotion Australia Pty Ltd

Contact Person

John Khoury
E: jkhoury@vacc.com.au
P: 03 9829 1153

Executive Summary

VACC welcomes the opportunity to provide comment on the testing regime for modified vehicles and ICVs that require IM240 testing.

This paper investigates the history of IM240 and raises issues with respect to the use of IM240 as a certification test, issues surrounding IM240 correlation and pass/fail targets, the cost to purchase and maintain a facility based on current VicRoads requirements and the number of vehicles impacted.

Our research has determined that the use of IM240 and pass/fail targets in its current form is commercially unsustainable for private enterprises to provide these testing services.

This paper makes recommendations/amendments to current IM240 testing requirements to allow for a more sustainable, transparent, accessible, and consistent testing regime.

The current testing protocols and business operations of the only Victorian IM240 test facility, and the closure of the NSW Pt Botany facility (currently no reopening date) has caused many businesses, including ICV builders and modified vehicle production enthusiasts, severe financial hardship.

Many current projects have been placed on hold or completed without being certified by an engineer. The current situation is likely to cause many small businesses to cease operation, resulting in a rise of non-compliant vehicles driven on Victorian and interstate roads. Vehicle owners will simply run the risk and drive their vehicles on the road without the necessary emissions testing having been undertaken.

The key objectives of the VACC proposal are to ensure:

- All vehicles meet a minimum standard of environmental protection through practical, consistent, and achievable emission control.
- Multiple service providers are engaged, allowing for a competitive business environment.
- Equipment requirements should be implemented to enable sustainable business models, based on the relatively small number of vehicles that require assessment.
- Testing requirements take into account the parts being used (e.g. out of service parts, parts availability).
- The regulator sets realistic requirements that consider industry knowledge and resources available in Australia.
- A testing regime and requirements that provide a builder with confidence in the outcome prior to commencing and investing in the build.
- Testing requirements acknowledge and consider the difference between OEM certification testing and public testing.
- The scheme is not 'location discriminatory' (i.e. people do not have to travel from Melbourne to another state or where there is only one provider in Victoria).
- Vehicle builder creativity and flexibility in engine selection is facilitated.

VACC is not advocating for the relaxation of vehicle standards; however, the data provided in this report demonstrates the issues associated with the use of IM240 as a certification test and many of the issues associated with the test result limits. With the absence of a fully compliant, easily accessible, and cost-effective IM240 testing facility in Australia, other forms of testing or emissions system demonstration must be investigated.

The testing regime proposed in this report addresses all the above-mentioned objectives, while maintaining a strong environmental stance.

Special Vehicles Australia Industry Profile

According to the most recent VACC survey, the SVA industry is worth $60 million to the Victorian economy. It consists of a cross section of small to medium enterprises. Many Individually Constructed Vehicle (ICV) builders are principally engaged in engineering services, automotive mechanical repair, and service, ICV manufacturers, vehicle modifications and vehicle restoration activities. Key survey findings show:

- 50 per cent of businesses involved with ICVs have been operating for 20 years or more, with less than 18 per cent in business for five years or less.
- 66.7 per cent of businesses have an annual turnover of between $200, 000 and $2 million.
- On average ICV businesses employ nine people. This includes full and part time workers. A large number of small businesses, such as engineering companies, fiberglass and painters benefit as suppliers to the industry.
- Consumers typically spend between $50,000 - $150,000 per ICV build.
- 75 per cent of respondents indicated government regulations are the key factor in limiting the growth of their business.
- Most respondents felt that the cost of between $200 to $600 was reasonable for an emissions test.
- Most respondents supported the removal of the IM240 Test in favour of a simplified test.

1. History of IM240 and procedures

IM240 was an emissions test procedure developed by the United States EPA as an "enhanced" inspection/maintenance vehicle emissions testing program for improving air quality in areas that fail to meet the Federal Government's ambient air quality standards. The test is similar to the Federal Test Procedure (FTP) (ADR 37/00 and 01 is based on US FTP 75) that automotive manufacturers use to certify new vehicle emissions.

A key feature of the original IM240 test procedure is the use of a special inertia dynamo meter to simulate vehicle loads at various speeds during a 240-second drive cycle that includes acceleration, deceleration and cruise modes. The drive cycle is based on segments of US FTP 75 and consists of 2 hills and transient sections.

The test is designed to detect emission problems that often evade detection during a simple idle emissions test, but it requires a trained operator to "drive" the vehicle while it is on the dyno and the special dyno equipment.

As part of the test, NOx (nitrogen oxides), CO (carbon monoxide) and HC (hydrocarbons) are measured throughout the whole cycle using a continuous gas collection system, and then back calculated to determine the grams per km (rather than the more familiar parts per million or percent of concentration).

The pass/fail limits for the IM240 testing vary between each US state and the class and age of vehicle. As per the EPA I/M Briefing book (1995), vehicle manufactures are required to design and build vehicles to meet specified emissions standards, referred to as certification standard. IM240 standards are set at levels two to three times above the certification standards (refer to table below).

To illustrate the difference between certification number and IM240 values refer to table below.

IM240 pass/fail numbers were sourced from EPA IM 240 & Evap Technical Guidance[i], regulatory Tier 1 (Clean Air Act Amendments of 1990) values were obtained from online sources[ii]. For the comparison, Light Duty Vehicles (passenger vehicles) from 1996+ were chosen as this is the most recent vehicle category.

		HC		CO		NOx	
Tier 1 (FTP 75)		0.41		3.4		0.4	
IM240 Pass / Fail	Start Up (g/km) *	0.8	195%	15	441%	2	500%
	Final (g/km)	0.6	146%	10	294%	1.5	375%
** Start-up standards should be used during the first two years of program / test centre operation. All units in g/mile*							

Table 1 – Comparison of Certification Limit to IM240 Limit

From this we can conclude that the IM240 pass/fail numbers for a vehicle 1996+ are far greater than the certification values. In many cases it can be three to five times. It is worth noting that the limits are also different depending on operating length of the facility, for facilities that have been operating for two years or less, there is an increase in pass/fail limits, while no reason is given, it can be assumed it is due to the limited experience of the operators.

It is noted that there are two avenues of passing IM240 as per the US EPA requirements[iii]. The first is the numbers from the full 240 second test. The second is when high emissions levels are measured overall, the computer looks at the second "hill" separately. If the second hill shows low emissions levels, then the vehicle passes. Thus, the two ways to pass helps ensure vehicles are fully warmed up and excess fuel vapours in the canister are purged. It can also remove failure of vehicles based on a singularity spike that may occur on the first section of the test.

2. Issues identified with IM240

2.1 Effect of ambient temperature and fuel

As the roll out of IM240 was occurring in the USA, several reports found inconsistencies of results and the impact of outside influences such of temperature and fuel.

For example, a study conducted by the Colorado Department of Public Health and Environment identified a trend that vehicles tested at high ambient temperatures had substantially higher HC when compared to testing conducted at lower temperature.

- All vehicles were tested in I/M lanes at temp. > 90 degrees
- All vehicles failed two IM240's
- High emissions could not be replicated at the CDPHE lab
- All vehicles < cert. values on the FTP
- No repairable emissions

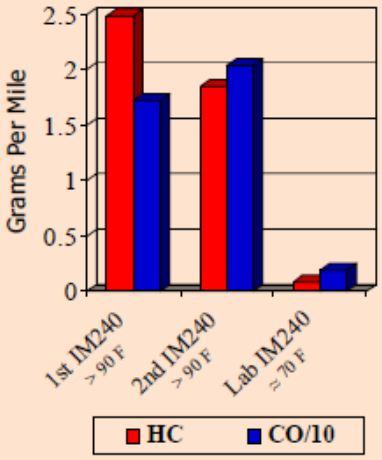

Figure 1 – Exert from report

Ten IM240 failure vehicles were procured for laboratory testing from the inspection and maintenance facility on high temperature days. From the graph in Figure 1, repeatable high emissions (in the order of 10 times) were seen on the same vehicles. The only difference is the temperature that the test was conducted at (90F compared to 70F) (32 degC to 21 degC).

Further investigation supports the claim that ambient temperature dramatically impacted the HC and CO vehicle emissions.

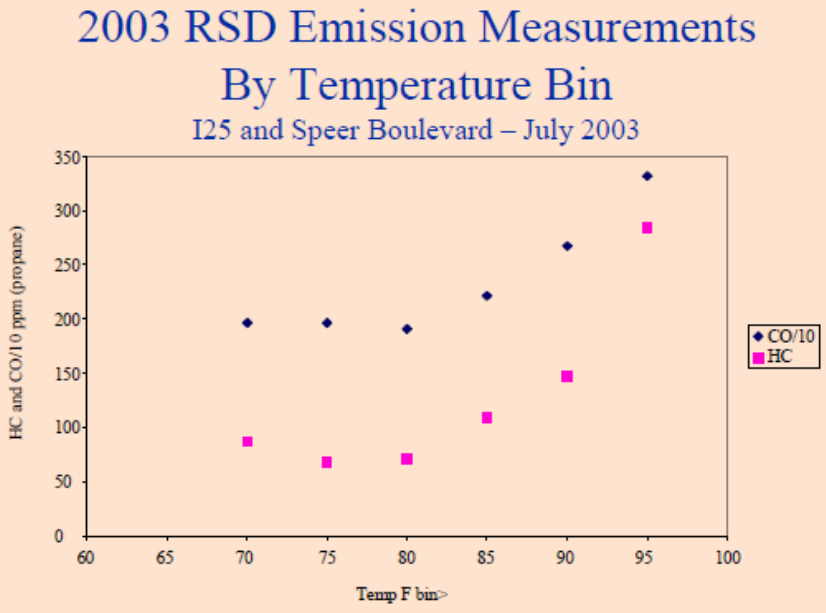

Figure 2 - Exert from report

The graph in Figure 2 shows that there is an approx. 430 per cent increase in HC emissions from ambient temperature of 75F (23.8 degC) to 95F (35 degC). For CO there was approx. 180 per cent increase for the same amount.

Further investigation found that in Colorado there was a trend of higher ethanol content in summer, which coincides with the higher temperatures and hence higher IM240 failure rates.

Therefore, it can be determined that ambient temperature and fuel ethanol content affects the emissions of a vehicle and hence a repeatable IM240 result.

Another study was conducted by General Motors for the SAE[iv] titled 'Impact of Fuels and Ambient Conditions on IM240 Emissions'. The testing was conducted on a single control vehicle with two fuel types (winter and summer) fuel and at five temperatures. As part of this testing, two conditioning methods were used. These are described in Figure 3 (below).

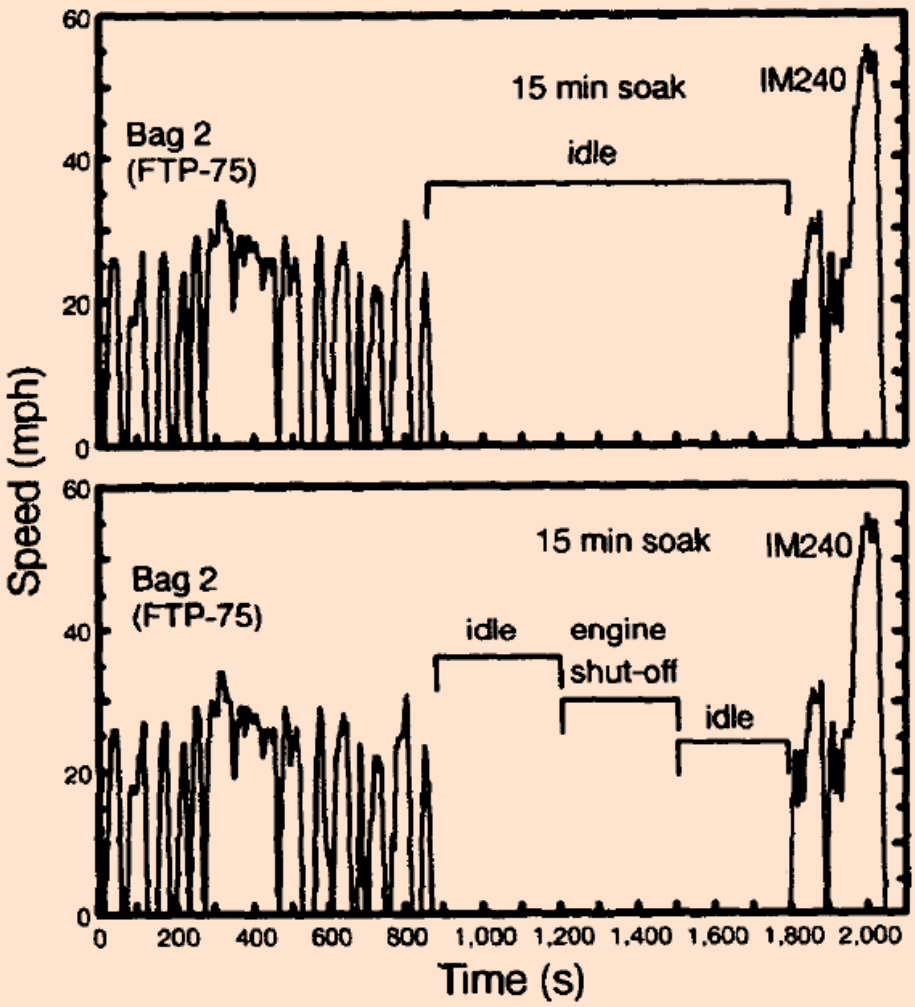

Figure 3 - Images of pre-test conditioning

For reference, baseline testing of the two-conditioning methods was conducted. It can be seen in the following charts, that tail pipe emissions varied depending what pre-test routine was followed.

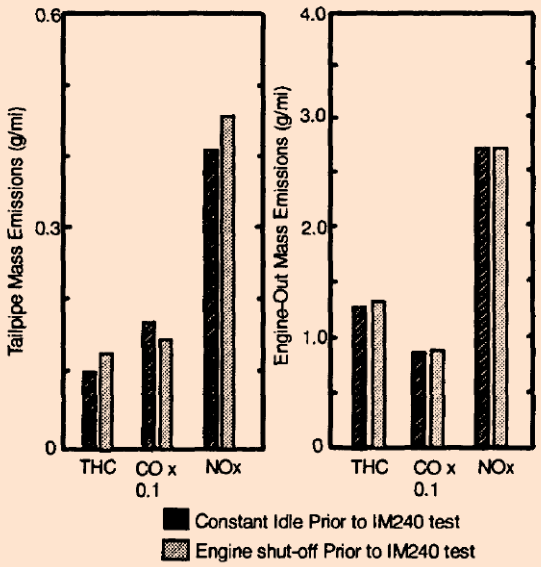

Figure 4 - Baseline test of tailpipe and engine emissions

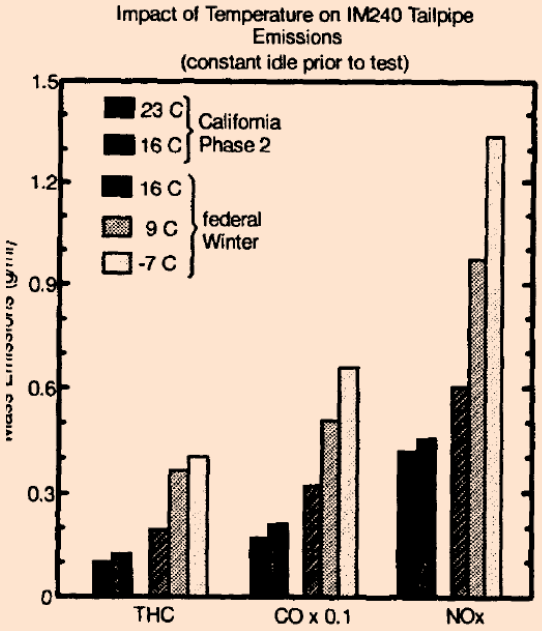

Figure 5 - Tail pipe emissions comparison – constant idle pre-test

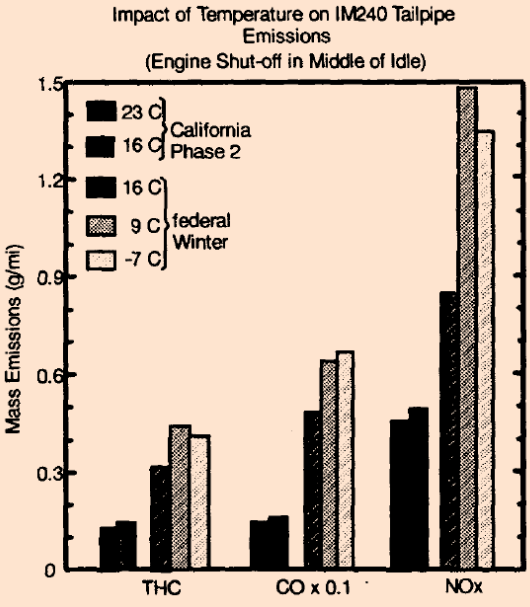

Figure 6 - Tail pipe emissions comparison - engine shut off middle of pre-test

A comparison of Figure 5 and Figure 6 shows that for the same vehicle, there is a significant variation in emissions results with the only variants in testing being fuel type and ambient temperature.

2.2 Variation between runs

Transport Systems Centre conducted a report with respect to drive cycle development "NISE2 –Contract 2 Drive Cycle Development Methodology and Results" (NISE2 – National in Service Emissions Program)[v]

This report detailed testing of approx. 60 vehicles from 1986 to 2002 with varying odometer readings from 37,000 to 394,000km. As part of this testing, multiple IM240 cycles were completed back-to-back. It is noted that each vehicle was tested three times, the first run was discarded and only the second and third runs recorded (reason for this was not noted). There were two forms of emissions captured, modal gas capture and bagged emissions.

Comparing the results between recorded runs two and three found substantially different results. This difference is common between the two methods of emissions capture. It is noted that the results below are an average, so there are occasions of substantially higher and lower differences.

Variation in Results between 2nd and 3rd Cycle Repeat - Average		
Emissions	*Modal Gas Capture*	*Bagged Emissions Capture*
THC	9.6%	11.8%
CO	16.2%	15.9%
NOx	10.5%	10.8%

Some slight variations may occur due to variations in ambient conditions but mainly due to driver operation. As the operator must drive within a speed 'window', difference in the driving trace can occur between two valid runs. Hence the skill of the operator can have a large impact on the result.

2.3 US EPA moves away from IM240

Several states resisted the use of centralized IM240 testing, citing the length of the test and the inconvenience to motorists of driving further to a small number of centralised test stations and equipment cost. The California Bureau of Automotive Repair (BAR) developed an alternative test method to the IM240 called the Acceleration Simulation Mode (ASM) test. Other states followed their lead and developed shorter tests or variations to avoid setting up full IM240 testing facilities.

In 2000, the EPA recognised the objections to IM240 and chose to allow a more flexible approach to enhanced emissions testing. The EPA decided it would allow states to choose whatever enhanced test procedure works best for their situation, be it IM240, ASM testing on a constant speed dyno, or some other loaded test procedure that also includes NOx and evaporative emissions.

Many objectors to IM240 stated:

- The required test equipment is too expensive and unnecessary. The same results can be obtained with a less costly constant load dyno using an "Acceleration Test Mode" (ASM) test procedure. ASM testing applies a 50 per cent load at 15 mph, and a 25 per cent load at 25 mph, and uses a less expensive emissions analyser.
- The drive cycle part of the test is too complicated, and the results can vary depending on how well the test operator follows the driving trace.
- The cut points are too strict, and too many vehicles fail the test. The failure rate is also influenced by the weather. Hot weather causes more failures to occur than cooler weather.

- Many NOx failures are difficult to diagnose and repair, which makes for unhappy customers when vehicles cannot be repaired properly (high retest failure rates). Many failures are also expensive to fix.[vi]

Currently the EPA has adopted OBD requirements as part of the vehicle emission standards, starting with MY1996 and MY2005 for light- and heavy-duty vehicles, respectively. The OBD requirements include an OBD threshold limit (OTL), usually 1.5 times of the emission standards. OBD monitors emission control components and performs a series of calculations to make sure emission outputs of the vehicle do not exceed the OTLs.

2.4 Summary of key points

- IM240 was designed as an inspection test to identify high polluters.
- USA Pass/Fail limits are minimum two to three times the certified limits of the vehicle.
- Based on Australian testing of 60 vehicles, a large variation between each run can be observed (Variation Between Runs section).
- IM240 as a test requirement in the USA only lasted five years before cheaper and more accessible tests were employed.
- Current EPA emission check using OBD are 1.5 times the emissions standards for in service vehicles.
- Ambient temperature has a significant impact on vehicle emissions.
- Fuel used (summer and winter fuel) impacts vehicle emissions.
- Large variation between IM240 runs can be observed based on dyno operator skill.

3. Cost of equipment

During research on the history of IM240, the cost of the facility that meets the SAE / EPA requirements were raised as an issue by many states, hence cheaper and faster tests were developed.

The equipment priced below either meets or exceeds the requirements lists – as noted by the VicRoads IM240 Testing – Expression of Interest document

- SAE J1094a (emissions and dyno)
- UNECE Regulation 49 (Revision 6) – (emissions equipment)

3.1 Emissions equipment

AVL PEMS machine	Approx. €480,000 pre-delivery and installation
AVL emissions lab equipment	Approx. €400,000 pre-delivery
Cubic Gasboard 9801	Approx. $50,000 USD pre delivery, currency conversion, GST and duty (~$100,000 AUD)
3DatX PEMS device	Approx. $50,000 USD pre delivery, currency conversion, GST and duty (~$100,000 AUD)
SEMTECH DS+ System	$255,000 USD pre delivery, current conversion, GST and duties

3.2 Dyno equipment

AVL emissions dyno	Approx. €300,000 EURO pre delivery, currency conversion, GST and duty
Froude CD60 dyno	Approx. $400,000 ~ 500,000 (2005)
MRW dyno	Approx. $550,000 ~ 650,000 (2005)
Mustang Dyno	$495,700 USD pre delivery, currency conversion, GST and duty

It is noted that many of the dyno machines currently in use in Australian workshops (from Australian companies Mainline and Dyno Dynamics) are performance dyno's and do not meet the original SAE requirements.

3.3 Other costs

The emissions and the dyno are not the only costs involved. Discussions with people involved within the industry have identified other costs that need to be considered:

- Depending on the equipment used, equipment calibration and calibration gases may be required, sources have stated this cost could be in the vicinity of $100,000 a year.
- Due to the variability seen in results due to ambient temperature, the air-conditioning system alone at an OEM emissions facility cost approx. $400,000 a year to operate.
- If the emissions measurement device is separate to the dyno (i.e. such a PEMS machine), investment must be spent on a controller to either link the two systems or develop a system to account for the emissions lag. The cost of this is unknown and dependant on the system.

3.4 Costing summary

The cost to establish a facility that meets the requirements is a substantial investment. Using the cheapest identified PEMS (3DatX PEMS device) and dyno (Froude CD60 dyno), an investment of approx. AUD$500,000 would be required. This price does not include additional costs such as installation of the dyno and control system to link dyno to emissions equipment.

The high cost of equipment that meets the requirements and the need for a lower cost option was raised in the 'Report on the National In-Service Vehicle Emissions Study' (1996), prepared by the Federal Office of Road Safety[vii].

> ***In summary, while the IM240 test showed the best correlation, it is only suited to a centralised approach, with high capital costs and specialist operator skills. The ASM and the two idle tests all had inferior correlation levels, and some were incapable of measuring NOx levels at all. The SS60 test appears to provide the most practicable option for a short test, demonstrating good correlation with FTP results yet being suited to both centralised and distributed operation with relatively low capital costs.***

It is also worth noting that of the equipment studied, only AVL had a sales representative in Australia. All other companies are based overseas with no local sales or support network. This would mean technical support, setup assistance, operational guidance may be difficult to obtain. Therefore, it would be difficult to obtain repairs and complete maintenance in Australia. With no local operations, all repairs / fault resolution must be conducted overseas, dramatically affecting machine downtime.

Ongoing calibration costs have not been investigated as this detail is currently not available, but there will be ongoing costs relating to this.

3.5 Summary of key points

- Equipment to meet the requirement is a substantial initial investment (approx. AUD $500,000 minimum)
- There are additional costs such as climate control, calibration gases and equipment calibration costs that will impact initial and operational costs
- Equipment that meets the requirement is not available locally, all is sourced from overseas affecting support, guidance, service, and repair.

4. History & Status of IM240 / Emissions Facilities

Below is a list of facilities capable of conducting emissions and their current operational status:

Site	Status
Victorian EPA	Facility used for conducting in-service test – site is closed
ViPac	Pricing started at $600. This increased to approx. $800 before its closure at the end of 2018. Reasons for closure related to required costs to maintain facility (including certification) compared with business return, so it was shut down.
Toyota Altona	Toyota's emission lab at Altona was capable of measuring IM240 to the requirements. This facility conducted some private emissions testing to ADR 37/01 at substantial cost. Due to costs involved in maintaining calibration and maintenance, a method of comparison of a 'gold standard' reference vehicle was employed. The facility is now shut down with no testing being conducted.
VinFast (ex Holden facility)	Emissions labs as part of the proving ground facility, but with the closure of the facility and departure of knowledgeable staff has meant the facility is not operational. Based on discussions with remaining staff, due to very high costs involved in operating the facility and a lack of qualified staff, there is very little / no chance of being operational again, particularly for "retail" testing available to the public.
RMS NSW Penrith Facility	Test site closed with operations now only out of Port Botany facility. Currently unsure if equipment failure or cost was reason for facility closure.
RMS NSW Port Botany	Test facility that is available to the public for a minimal booking fee (approx. $50). Many people travel from Melbourne to Sydney to conduct the testing based on cost and timing issues with the current Victorian provider. As of Dec 2021, the facility is not in operation due to equipment failure. Based on advice received from people associated with the NSW Pt Botany facility, speculation is that the failure will cause site to close due to associated repair / replacement costs.
South Australian Facility	Facility operated by the government, due to high operational costs and issues with calibration, facility is currently shut down with emissions testing conducted by two workshops with workshop grade emissions measurement equipment – simulated IM240.

4.1 Current Situation

Based on the current situation with RMS NSW Port Botany facility, ABMARC is the only provider in Australia capable of conducting testing to VicRoads requirements. ABMARC use a AVL PEMS (Portable Emissions Measurement System) to measure emissions while using Kangan Tafe Institute dyno. It is noted that current equipment does not meet the original IM240 testing requirements.

The industry has raised several issues with the operation of the ABMARC that is affecting both individual vehicle builders and business operators in this sector.

These include:

- High cost of testing - currently $2,500 per test.
- Limited access to testing - testing is conducted once a month, if sufficient bookings numbers are not received, all bookings will be moved to the next month in the hope of reaching their required quota in the future time period.
- No access to vehicle during testing - cannot view the test or setup.
- Two valid test runs only.

The high costs associated with ABMARC testing is affecting how businesses operate in this area.

S&M Engineering is one such example and has vast experience with IM240 testing of modified vehicles, having 25 vehicles tested over the previous 2 years, at the Pt Botany facility.

Of the 25 vehicles tested, an average of 8 drive cycles with fine tuning between each run was required to achieve a pass result. The fine tuning was done based on S&M engineering experience and advice from the Pt Botany staff.

Based on the average number of tests runs and dyno tuning required to achieve a pass result, it made / makes using ABMARC for testing completely unfeasible.

Time and cost for 8 Tests	ABMARC	Pt Botany Facility
Cost	8 x $2,500 = $20,000	$50 (booking fee)
Timeframe	To be determined – due to having to find 8 separate booking date	1 booking (1 day)

It is noted that the comments with respect to AMBARC are not a criticism of their operation and business activities. It is an acknowledge of the costs involved with privately operating a facility that meets VicRoads current requirements and to have a profitable business model.

Therefore, it can be judged that the requirements and expectations of the industry are not in line with ABMARC's business operation and hence a commercially viable private testing facility (basedon VicRoads' current requirements).

4.2 Emissions testing service fees

The chart below details the cost of emission testing throughout Australia and historically in Victoria. It can be observed that the current costing is not in line with other testing procedures / facilities or with historic testing in Victoria.

Figure 7 - Emission Testing Fees

Reasons for the high test's costs include:

- Full privatisation of testing
- Requirement of the private sector to profit from activity
- Very high equipment and test requirements in Victoria compared to other states

5. Vehicles impacted

The vehicles impacted by the requirement for an IM240 Test fall into two categories:

- modified production vehicles; and
- individually constructed vehicles (ICVs).

Of these two categories there are only a small subset of each of group that are required for IM240 testing.

5.1 Modified Vehicles

Below is a table showing the matrix of vehicle and engine emissions categories and their requirement for testing, as per Vehicle Assessment Signatory Scheme (VASS) Bulletin 13 Revision:

EMISSION STANDARD FOR MODIFIED VEHICLES IN VICTORIA

Vehicle	Engine	Modified	Test	Requirement
Certified to ADR 26, 27, 27a-c and 36	Certified to ADR 26, 27, 27a-c and 36	No	Assess to Comply	ADR
Certified to ADR 26, 27, 27a-c and 36	Certified to ADR 26, 27, 27a-c and 36	Yes	Idle	EPA REGULATION
Certified to ADR 26, 27, 27a-c and 36	Certified to ADR 37/00-01, ADR 79/00-04	No	Assess to Comply	ADR
Certified to ADR 26, 27, 27a-c and 36	Certified to ADR 37/00-01, ADR 79/00-04	Yes	Idle	EPA REGULATION
Certified to ADR 37/00-01, ADR 79/00-04	Certified to ADR 37/00-01, ADR 79/00-04	No	Assess to Comply	ADR
Certified to ADR 37/00-01, ADR 79/00-04	Certified to ADR 37/00-01, ADR 79/00-04	Yes	IM240	ADR

Figure 8 - Emissions Standard in Vic for Modified Vehicles

From the table, it can be determined that only one category of vehicles requires IM240 test, that is ADR 37/00 or later vehicles with a modified ADR 37/00 or later engine. For vehicles prior to ADR 37/00 with modified engines (even with modified ADR 37/00 or later engines) must do a simplified emissions test. This emissions test is conducted by the VASS engineer using workshop equipment.

5.2 Individually Constructed Vehicles (ICVs)

Below is a table showing the matrix of vehicle and engine emissions categories and their requirement for testing:

Unmodified 37/01 of later engine with other items as per VicRoads 'deem to comply guidelines'	Yes	'Deem to comply' – no testing required
	No	IM240 testing to 37/01 level

From the table, it can be determined that only ICV's that do not meet the 'deem to comply' requirements require IM240 testing.

5.3 Number of vehicles requiring IM240 testing

To help determine the size of the impacted community an email was sent to all VASS certified engineers to sign off engine modifications and ICVs. Each VASS was asked to provide the number of vehicles that are under their supervision that has either required emissions testing in the past two years or is currently on their books as waiting/requiring a test in the near future.

Of the respondents, there were:

- 120 modified vehicles
- 30 ICVs

Assuming these vehicles will be tested (if available) in the next 12 months, that is 150 vehicle tests required in a three year period. It should be noted that these numbers do not account for potential non-compliant vehicles that are modified without obtaining proper engineering certification, so the actual number of vehicles requiring an emissions test is likely to be higher again than the numbers stated here.

Using the collated numbers as a reference, the number of modified vehicles (120 for a three-year period) compared to the number of registered vehicles (5,151,172 for VIC 2021) is only 0.0000233 per cent of the Victorian fleet.

As for the number of ICVs, (30 for a three-year period – so assume ten a year) compared to the number of new vehicle sales for the calendar year of 2021 (272,733 – VFacts) is 0.0000366 per cent.

As a contributing factor to the emissions emitted by the Victorian fleet (both new vehicles and total fleet), the vehicles in which these rules apply to contribute a very small amount. Hence over regulation of these vehicles does not contribute in a measurable amount to the reduction of Victorian fleet emissions.

5.4 Noncompliance

A point of concern raised during VASS discussions was the number of people not pursuing testing. After the VASS discussing what is required, and the issues surrounding IM240 testing (cost, uncertainty of a pass, time frame) with the potential client, many do not come back.

One VASS, who is heavily involved in IM240 testing has stated that for every one test that he does, there are three that do not call back. Another advised that he receives on average an enquiry a day. As an extension of those comments, due to what is perceived difficulty and high costs associated with emissions testing, as well as the uncertainty the vehicle will even pass, many people are choosing to either not proceed with the project or continue with the project and not undergo appropriate emissions testing leading to non-compliant vehicles being driven on Victorian roads.

This result is not within the best interest of the VASS, the EPA, VicRoads, the car building community, modification community or the health and safety of the public.

6. Business Case Calculations for Private Operators

To establish a business case for private operators several factors need to be considered.

These include:

- Calculations based on an extension to an existing business. For a business where the sole purpose is emissions testing, there will be other business-related expenses that have not been noted. Please note, these values are based on high-level conservative assumptions (including no finance fees). It also does not include maintenance and calibration costs, which will only increase the ongoing costs.
- Staff with emissions testing and tuning experience - $90,000 PA.
- Start-up costs include installation, set-up and trailing equipment - $50,000 (one off – rough estimate).
- Equipment (emissions measurement machine and dyno – cheapest option mentioned above) $500,000 – with five-year return on initial investment.
- 50 vehicles per year (based on previously identified market need).
- Premise rental space and utilities - $5,000 per month estimate ($60,000 PA).

	One off Investment	Yearly Cost	5 Year cost
Equipment	$500,000		$500,000
Installation & Setup	$50,000		$50,000
Staff (experienced operator with emissions / tuning experience)		$90,000	$450,000
Rental & Utilities		$60,000	$300,000
		Total	$1,300,000

Figure 9 - High level summary of costs over 5 years

For a five-year return on initial investment, a high-level total cost over five years is $1,300,000.

Based on pre-determined current demand for testing (50 vehicles per year – 250 vehicles over a five-year period), the minimum service fee is $5,200 per test. This does not include an operator's profit, which would have to be substantial due to the large size of the initial investment.

This costing does not consider possible out of state testing or additional test operators. When/if the RMS NSW facility comes back online, many people will choose to test their vehicles there (due to lower costs, fees approx. $50), vastly affecting the 150 vehicles who are prepared to do testing in Victoria. Based on current discussions with VASS signatories, approximately 50 per cent of people have either gone or plan to go to NSW, reducing the Victorian based testing number to 75 vehicles over a three-year period.

The minimum fee to payback equipment over a five-year period is $10,400. This new higher fee will only drive further people to the NSW facility reducing the numbers in Victoria.

Vehicles Per Year	Minimum Service Fee
50	$5,200
25	$10,400
10	$26,000

Figure 10 - Impact of vehicle reduction on service fee

Businesses who have shown interest in setting up approved test facilities, have stated that these numbers (or their own ROI calculations) are completely unviable and will not pursue it any further.

These numbers further explain the issues seen with IM240 and emissions testing in Australia. The number of vehicles required to do testing does not justify the high upfront and ongoing costs (from either the public or private sector) for the current testing and equipment requirements. This is also raised in the report on the National In-Service Vehicle Emissions Study 1996.

7. Emissions Limits for IM240 Test

For the purpose of this report, the emission limits for IM240 discussion will be broken into ADR 37/00-01 and ADR79/XX.

7.1 ADR37/00-01

The IM240 limits for relating to ADR 37/00 and 37/01 relate to two vehicle classes. As per the "Vehicle Impacted" section of this report, these classes are ADR 37/00 and 01 with modified engines and ICVs that do not meet the deem to comply limits.

Petrol passenger car emission standards (g/km)

ADR	Standard	Date[1]	CO	HC/ NMHC[2]	HC+NO_x	NO_x	Particulate Mass	PN[3]	Test cycle
ADR37/00	US'75	Feb 1986	9.3	0.93/–	–	1.93	–	–	US FTP 75
ADR37/01	US'90	Jan 1999	2.1	0.26/–	–	0.63	–	–	US FTP 75

Figure 11 - ADR 37/00 and 01 Information

ADR 37/00 and 01 measures CO, HC and NOx using the US FTP 75 drive cycle.

It is the author's understanding that VicRoads used an RMS NSW (RTA at the time) report 'Establishing ADR 37/01 Compliance – A short test with limits – My 2003'[viii].

This report has been reviewed and several issues have been identified that impacts the conclusions raised and hence the relevance of the pass / fail numbers used for IM240 tests to ADR 37/00 and ADR 37/01 limits.

The report studied 64 vehicles that were either:

- Part of the RTA fleet
- Vehicles in ANCAP's fleet (new vehicles prior to being crashed as part of the new car assessment program)
- Vehicles that were part of Orbitals test fleet

These vehicles were tested at the NSW Botany facility using their equipment.

The results have been graphed with the associated ADR 37/01 emissions limit.

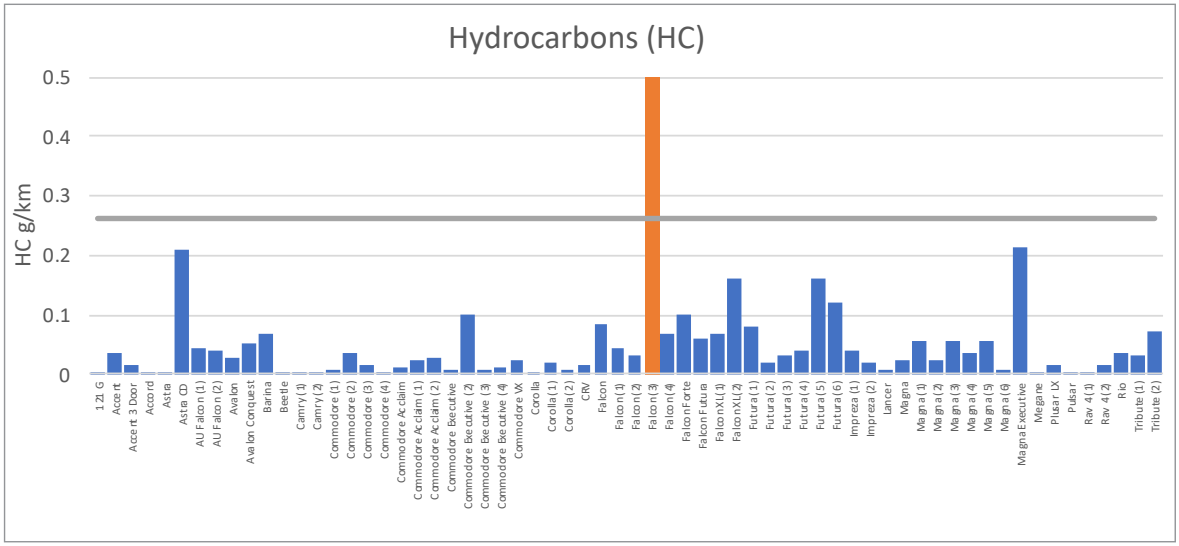

Figure 12 - HC results

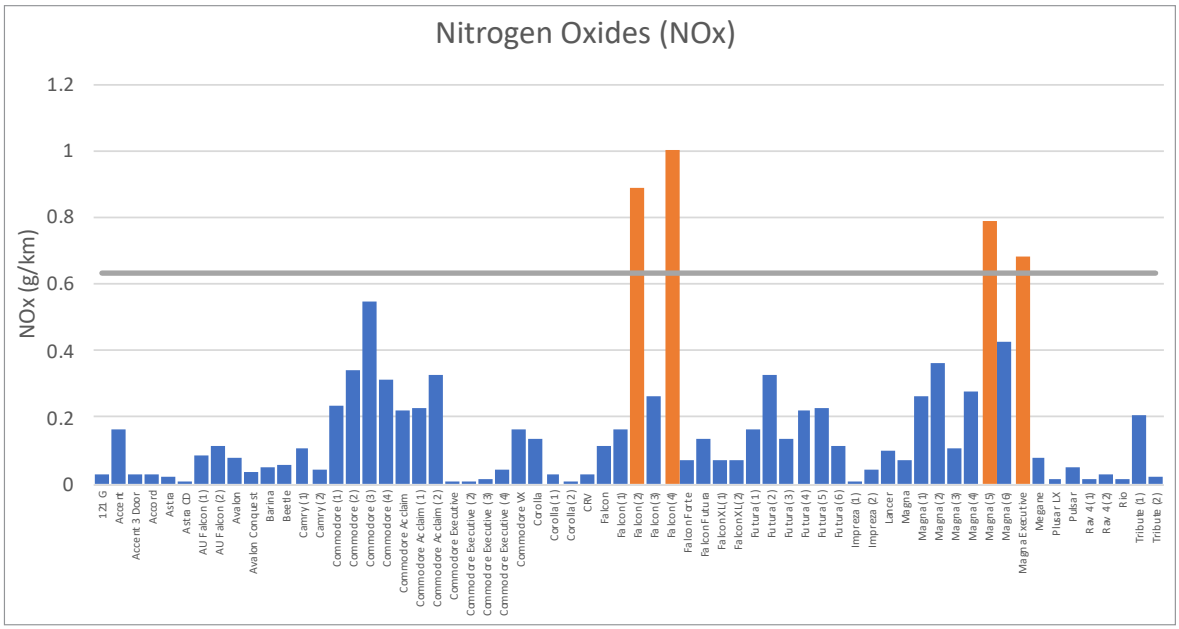

Figure 13 - NOx results

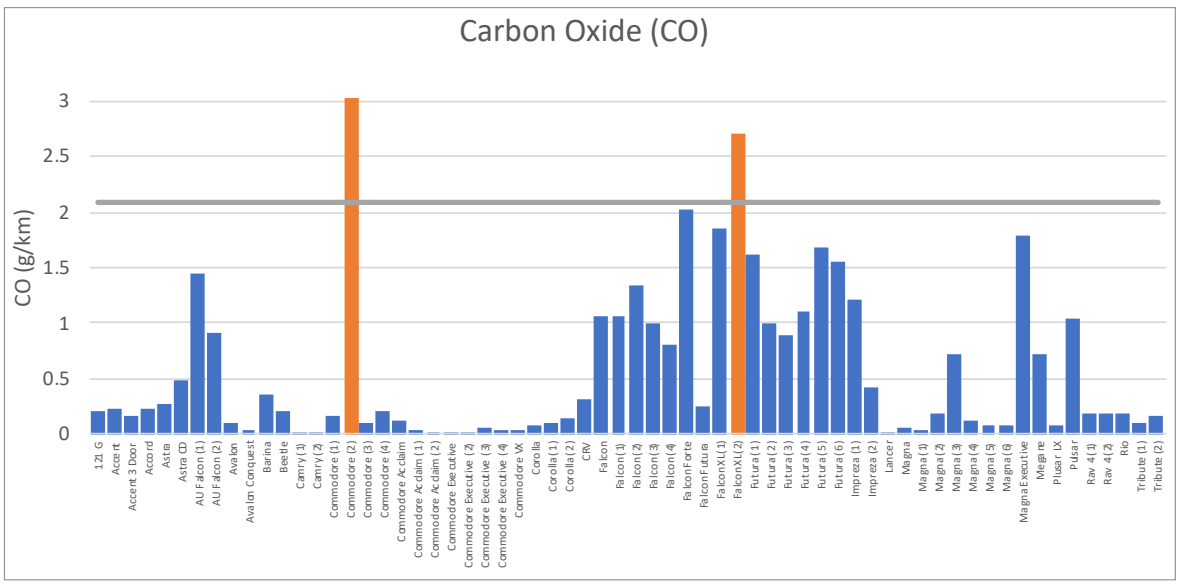

Figure 14 - CO result

Based on these results, seven out of the 64 vehicles failed the test (~11 per cent). The average milage of the failed vehicles was ~5,400km.

If these results were extrapolated out, 11 per cent of people, who are driving a low milage, unmodified vehicle would FAIL an IM240 test.

The second issue with the report relates to a conclusion drawn in a referenced report. This conclusion of good correlation between IM240 and 37/00 has been used as supporting evidence as the justification of the using 37/01 number for ICV's / modified vehicles.

5.2. National In-Service Vehicle Emissions (NISE) Study

Commencing in May 1994 the then Federal Office of Road Safety undertook a comprehensive study on the emissions performance of Australia's passenger car fleet. 640 in-service vehicles manufactured between 1970 and 1993 were selected at random from the fleet and subjected to a range of emissions tests before and after tune. Of the 640 vehicles tested 361 were ADR37/00 vehicles built after July 1986.

The NISE study established good correlation between the ADR37/00 test method and the IM240 test method with a correlation of better than 0.9 on all three regulated pollutants.

Figure 15 - Exert from RTA report

To gain better understanding, the data used to make this comment was studied.[ix] As per the RTA report comment, the report studied 361 ADR37/01 vehicles, comparing IM240 performance to ADR 37/00 result (Federal Test Procedure - FTP). Graphs for the three gases are included below, along with a 1:1 correlation line.

The comparison data from the report shows some trends that have not been considered. Dots below the red line indicate vehicles that have a higher IM240 result when compared to the ADR 37/00 drive cycle result (FTP), while vehicles above the line have the opposite, and the further away from the line, the larger the variation.

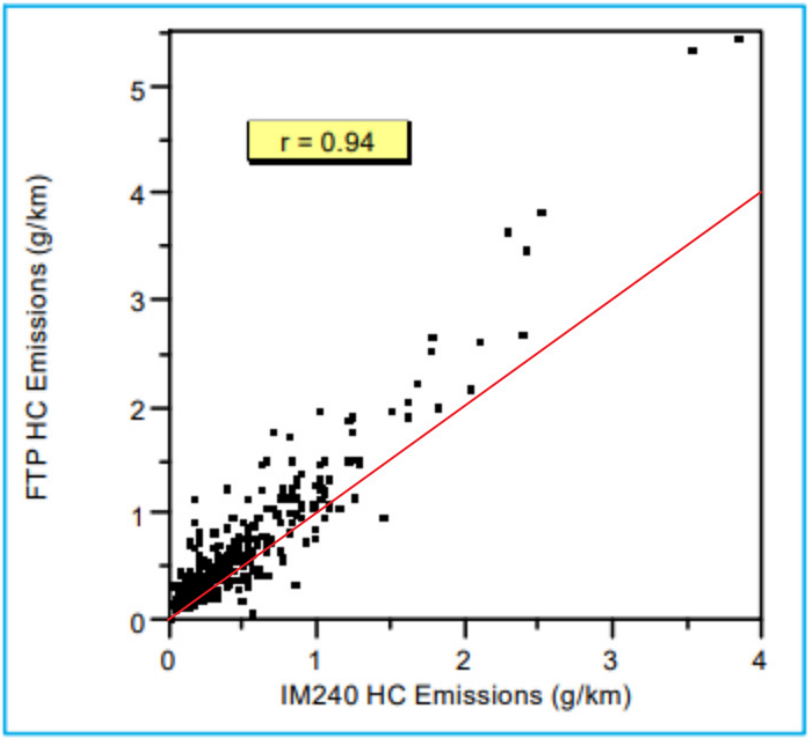

Figure 16 - IM240 vs FTP results for HC - ADR37/00 Vehicles

HC and the CO graphs show there is a large spread on both sides of the line, meaning there are differences in individual vehicle's results between the IM240 and the FTP result. This means many vehicles would fail an IM240 test at current limits, but pass a ADR 37/00 test and vice versa. Of a more disturbing trend is the NOx emissions. It is clearly visible on the graph that a vast majority of vehicles are below the line, meaning that their IM240 results are substantially higher than the ADR 37/00 result – meaning ADR 37/00 compliant vehicles would fail an IM240 test when compared to their certification requirements.

Looking at these results at a higher level, while there is a 'whole study group' trend of correlation, which has been documented at between r=0.90 and 0.94, there is insufficient data and evidence to suggest that there is a tight enough correlation to extend the same correlation trend to individual vehicles. This is due to the large spread seen on both sides of the HC and CO lines and the underside of the NOx line.

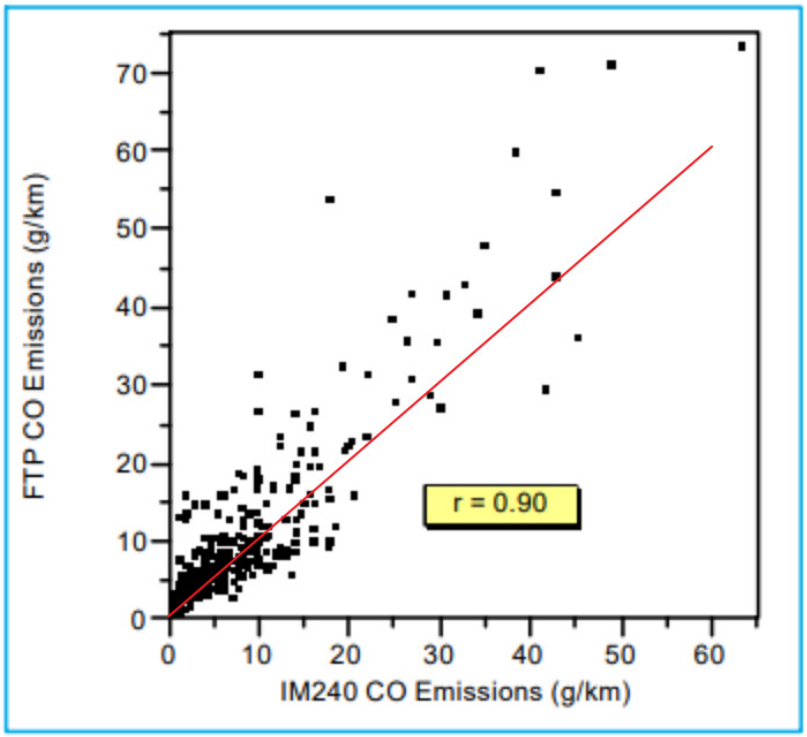

Figure 17 - IM240 vs FTP results for CO - ADR37/00 Vehicles

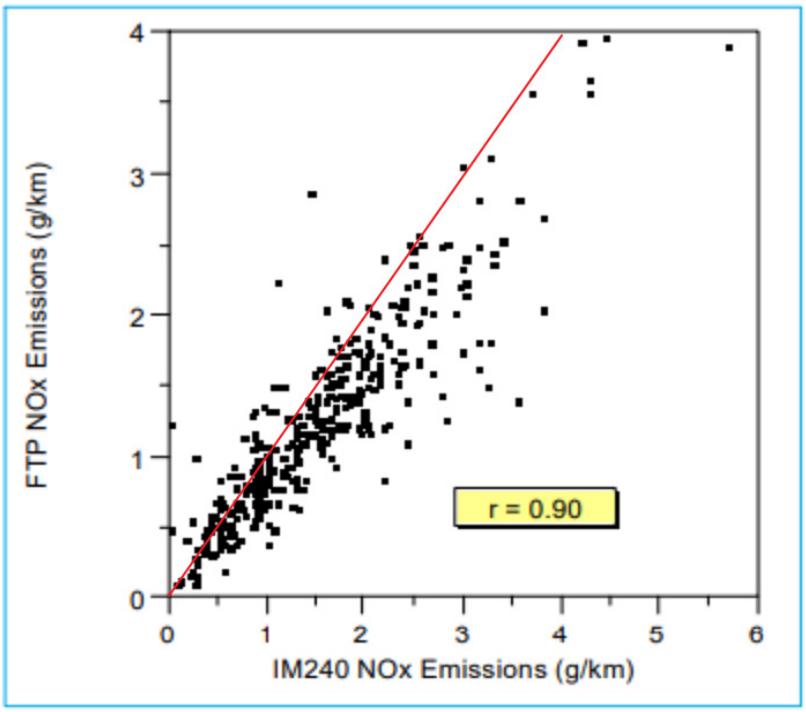

Figure 18 - IM240 vs FTP results for NOx - ADR37/00 Vehicles

7.2 ADR79/00

A TfNSW report, dated April 2003 titled 'Establishing ADR 79/00 Compliance'[x] was published to try and justify correlation between 79/00 and IM240 targets. As part of the activity a total of 25 vehicles where tested. There were three tests conducted.

- IM240
- IM240 – Cold (engine left to idle for 40 seconds prior to test)
- ADR79/00

It is noted, not all vehicles were tested to the IM240 – cold procedure and the ADR test procedure, and the testing to ADR79/00 was not completed to the full test procedure due to limitations with the dyno (not able to reach the highest speed specified in the ADR).
From the raw data several key issues were identified.

The first issue was the impact of the 40 second idle prior to the test.

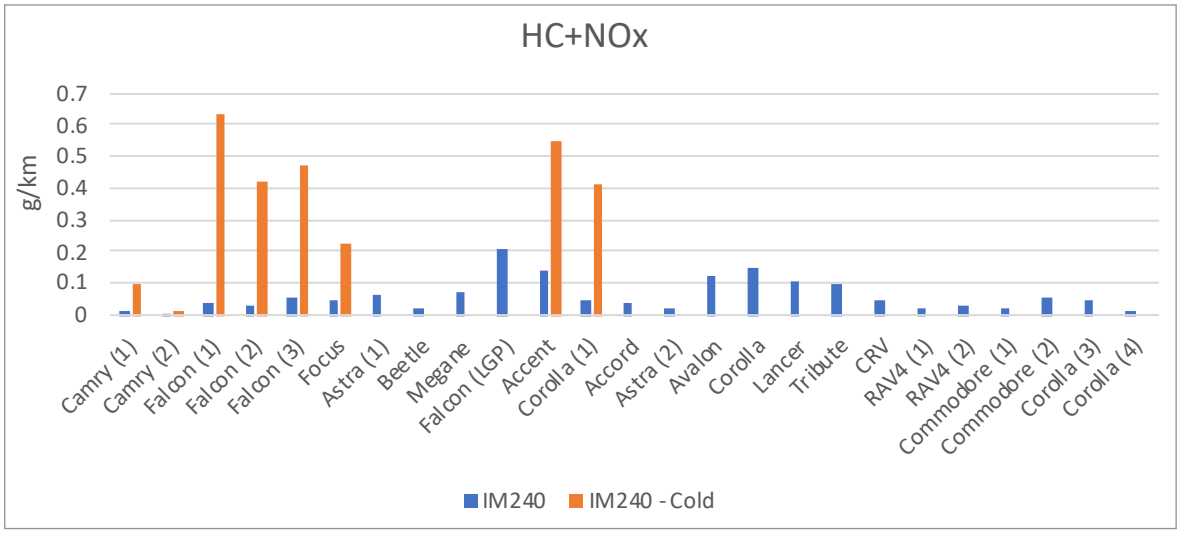

Figure 19 - Impact of idle before IM240 test on HC + NOx

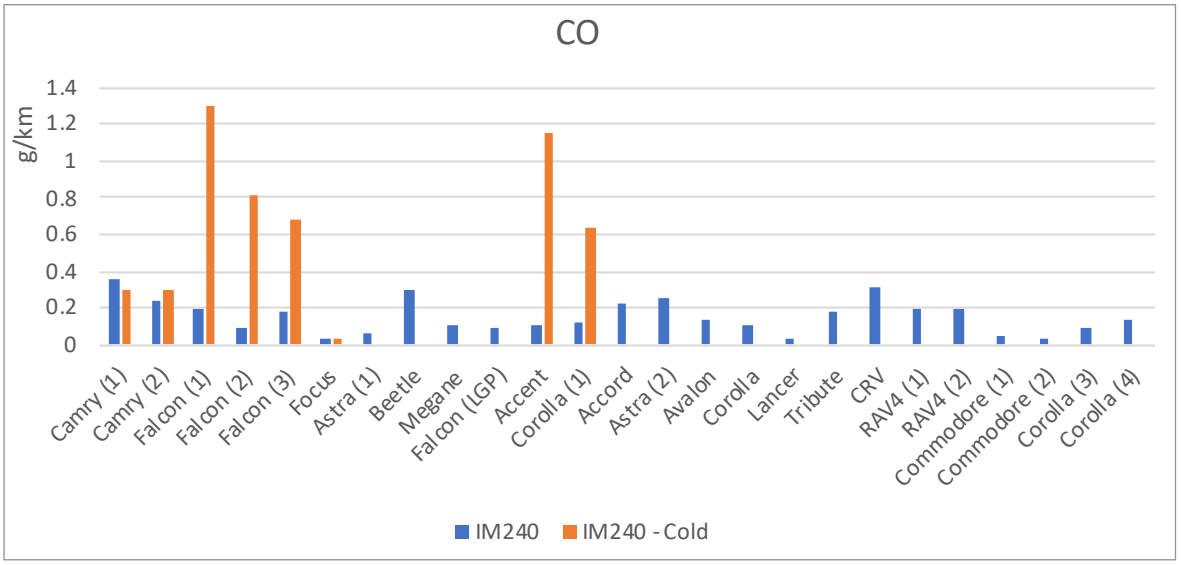

Figure 20 - Impact of idle before IM240 test on CO

From the data it can be seen that the 40 second idle time dramatically impacts the result. This data backs up the study conducted by GM as part of the 'Impact of Fuels and Ambient Conditions on IM240 Emissions', where they showed a small idle for the test impacted results.

This result clearly demonstrates the sensitivity of the result to pre-test activities and brings into question the repeatability of the test.

The second issue is the correlation between ADR 79/00 and IM240.

The issue presented here is similar to the issue presented in the ADR 37/00 vs IM240 correlation. There is a large spread of vehicles on both sides of the line, showing poor correlation on an individual basis compared to the ADR 79/00 result.

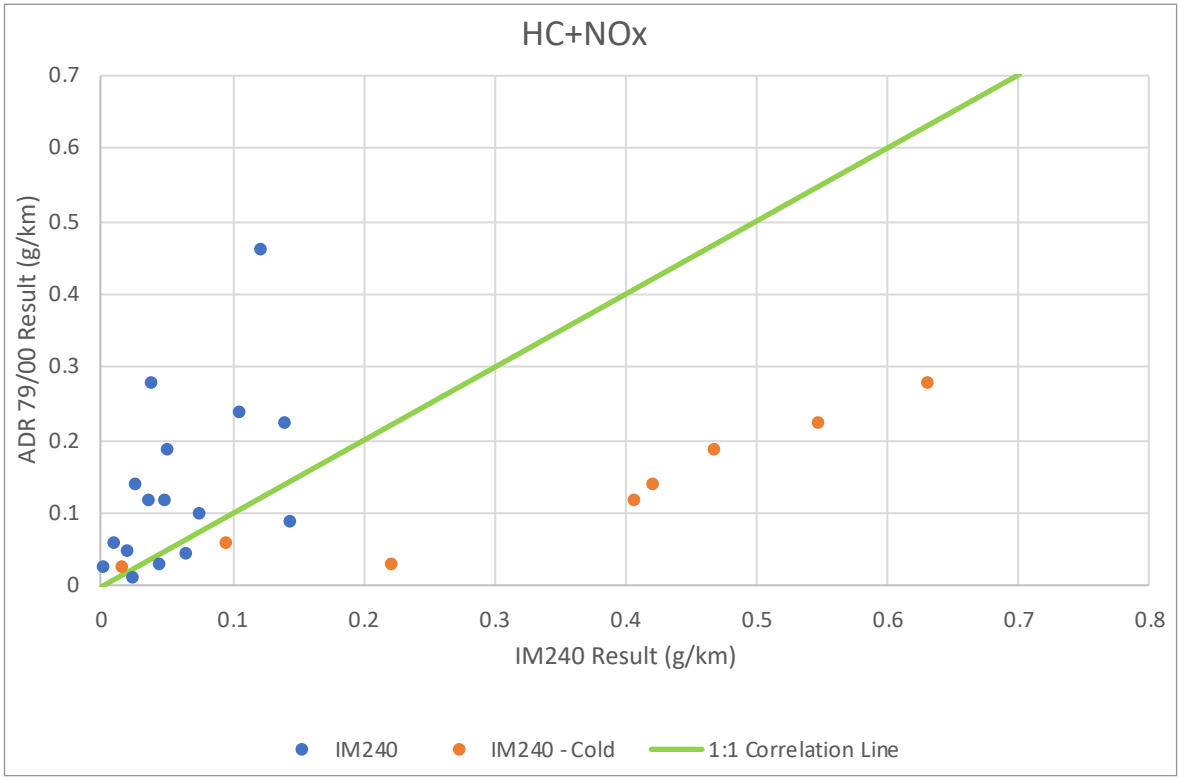

Figure 21 - IM240 vs ADR 79/00 - HC+NOx

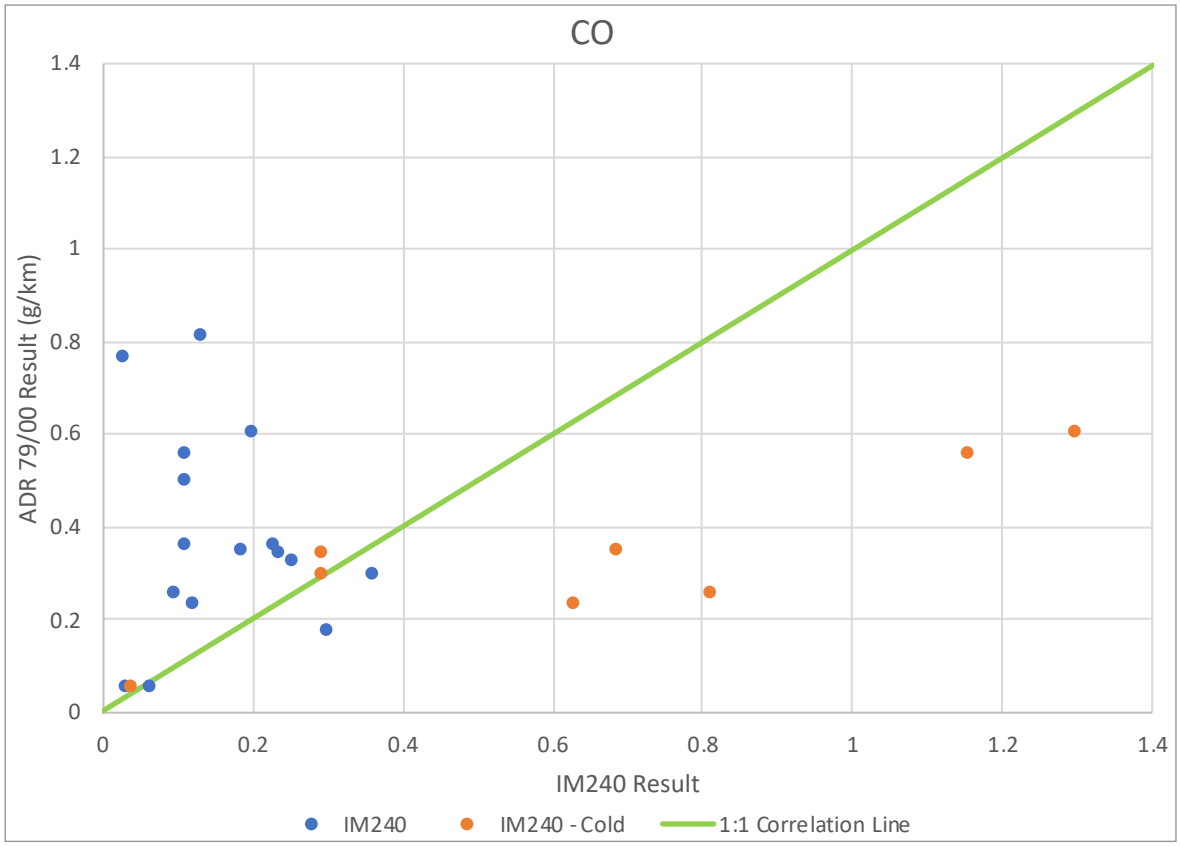

Figure 22 - IM240 vs ADR 79/00 – CO

Another issue with this report is only using a sample size of 16 vehicles of unknown condition, age or kms to make a correct assessment of correlation.

7.3 Euro 4 and 5

A study was found that comparative data between Euro 4 & 5 diesel vehicles was included in the A review of the European passenger car regulations – Real driving emissions vs local air quality – prepared by the Electrotechnical Engineering and Energy Technology, MOBI Research Group, Vrije Universiteit Brussels.[xi]

The data presented shows NOx levels of Euro 4 and Euro 5 vehicles, measured during an IM240 drive cycle compared against the Euro 5 limit.

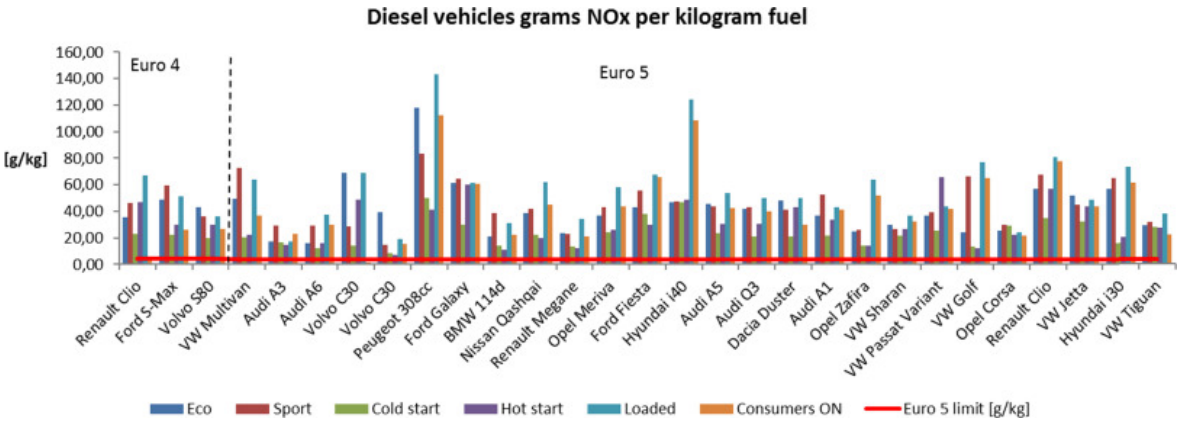

Figure 23 - Exert from report

This result clearly shows the complete inadequacy of the IM240 drive cycle and methodology for diesel engine emissions test correlation to IM240, and by extension, other modern drive cycles.

Based on the evidence presented, there is poor correlation, on an individual vehicle bases between the certification drive cycles and IM240 result. There are instances of both vehicles performing better and worse on an IM240 test compared to full certification emissions tests. Therefore, comments say there is good correlation is false and cannot be used.

8. Expectation of the Vehicle Builder / Modifier

Below is a table that outlines the items that go into the emissions testing process. The process for the ICV builder or vehicle modifier, is compared against an original equipment / vehicle manufacturer.

	OEM	Home Builder / Modifier	Likely to achieve a better result
Testing Cycle	ADR37/01	IM240	-
Limits	ADR37/01	ADR37/01	-
Correlation to ADR 37/01	-	Large spread of values for HC and CO. Trend of higher Nox values	OEM
Fuel	Controlled fuel	Fuel purchased - unknow composition	OEM
Temperature	Full climate-controlled facility	Climate control unknow - temperature and humidity dependant on ambient conditions	OEM
Tyres	Controlled sample tyres and pressures choose to maximise rolling efficiency	Generic tyres purchased from shop	OEM
Engine	Newly built engine conditioned for testing	Usually, 2nd hand from a donor vehicle that has exceed the ADR emissions service life (5 years, 100,000km)	OEM
Emissions components	Handpicked to provide best possible result	Either purchased second hand or from 3rd party manufacturer due to original parts not being available – performance unknow Note second-hand components from 2nd hand from a donor vehicle that has exceed the ADR emissions service life (5 years, 100,000km)	OEM
Emissions experience	- Full departments with large experience to maximise performance. - Full knowledge of subsystems and their effect on performance	No emissions experience - comments from community	OEM
Tuning	Tune of vehicle specifically design to suit the test cycle and the components used	What has been created on a performance dyno to ensure correct vehicle operations (usually correct combustion under load)	OEM

Engine / Component Run IN	Run in conducted under controlled conditions in a specific way to maximise emissions component performance	Due to vehicles not being registered / certified. Road run in is not possible. Can only be done on dyno's or closed roads. In many cases it in is not possible	OEM
Passing Emissions Test	- As many runs as required to pass to test. - Test operators given a huge amount of time to learn vehicle and optimise technique to achieve best result - Huge amount of data logging to rectify any issue. - Very experienced staff that can steer tuning and technique during test	- No access to test. - 2 valid runs only - No time for operator to families themselves with vehicle to optimise result - No information given on day (pass / fail only) - Addition report showing traces and 'possible' cause of failure (due to no experience with that particular vehicle and continuation - $600	OEM
Test Past Confidence	- Huge IP knowledge detailing what is required. - Bench testing prior to full vehicle testing to increase confidence. - Individual component testing to ensure all parts are at optimal spec	- Minimal / no confidence of passing the test prior to, due to the huge amount of variables, including both test, operator, conditions and individual component performance - Vehicle must be finished (huge investment) prior to testing - large gamble for builder	OEM
Costing	All part of vehicle program	$2,500 per test, Detailed report based on results $600	OEM
Timing	Tests can be repeated one after another, tuning to occur on dyno until a pass is achieved	Once a failure is recorded have to wait until detailed report (if purchased). Then find appropriate knowledge to fix problem (if known, if not guess). Then rebook a test which is dependent on other people wanting to box a test.	OEM

From this table, it can be determined that the OEM has a clear advantage when it comes to emissions testing performance, knowledge, and troubleshooting.

Therefore, the expectation of an ICV builder or vehicle modifier to operate and succeed under these conditions is completely unrealistic. The differences between what is available to the ICV builder / modifier must be taken into consideration when determining testing procedures, requirements, and limits.

9. ICV kit manufacturer case study

9.1 IM240 to ADR 37/01 & 79/XX testing

A local ICV kit manufacturer conducted emissions measurement activities as part of the ECU development for an OEM engine. As part of this development a vehicle was tested to the following ADRs at the associated facilities:

- ADR 37/01 at Ford Motor Company Emissions lab
  - six test runs with tuning required to pass test
- ADR 79/00 at Ford Motor Company Emissions lab
  - three test runs with tuning required to pass test
- ADR 79/01 at Toyota Australia Emissions lab (Altona)
  - seven test runs with tuning required to pass test

Results of the testing with comparison to the assessment criteria is below

ADR 37/01	HC g/km	CO g/km	NOx g/km
Result	0.225	1.37	0.596
Specification	0.26	2.1	0.63
% of Spec	0.865	0.652	0.94
Judgement	**Pass**	**Pass**	**Pass**

Table 5 - ADR 37/01 Result

ADR 79/00	HC + Nox g/km	CO g/km
Result	0.488	1.527
Specification	0.5	2.2
% of Spec	0.976	0.694
Judgement	**Pass**	**Pass**

Table 6 - ADR 79/00 Result

ADR 79/01	HC g/km	CO g/km	NOx g/km
Results	0.197	1.347	0.02
Specifications	0.2	2.3	0.15
% of Spec	0.985	0.586	0.13
Judgement	**Pass**	**Pass**	**Pass**

Table 7 - ADR 79/01 Result

Post the 79/01 testing, the vehicle was sent to a TfNSW facility for IM240 testing. This was to study the relationship between the ADR compliant vehicle (that meet the ADR's) and the required IM240 testing and subsequent results.

	HC g/km	CO g/km	NOx g/km
IM240	0.33	14.9	0.01
ADR79/01	0.197	1.347	0.02
Specs (37/01)	0.26	2.1	0.63
IM v ADR	**1.7X greater**	**11X greater**	**0.5**

Table 8 - IM240 test results & comparison to 79/01 results

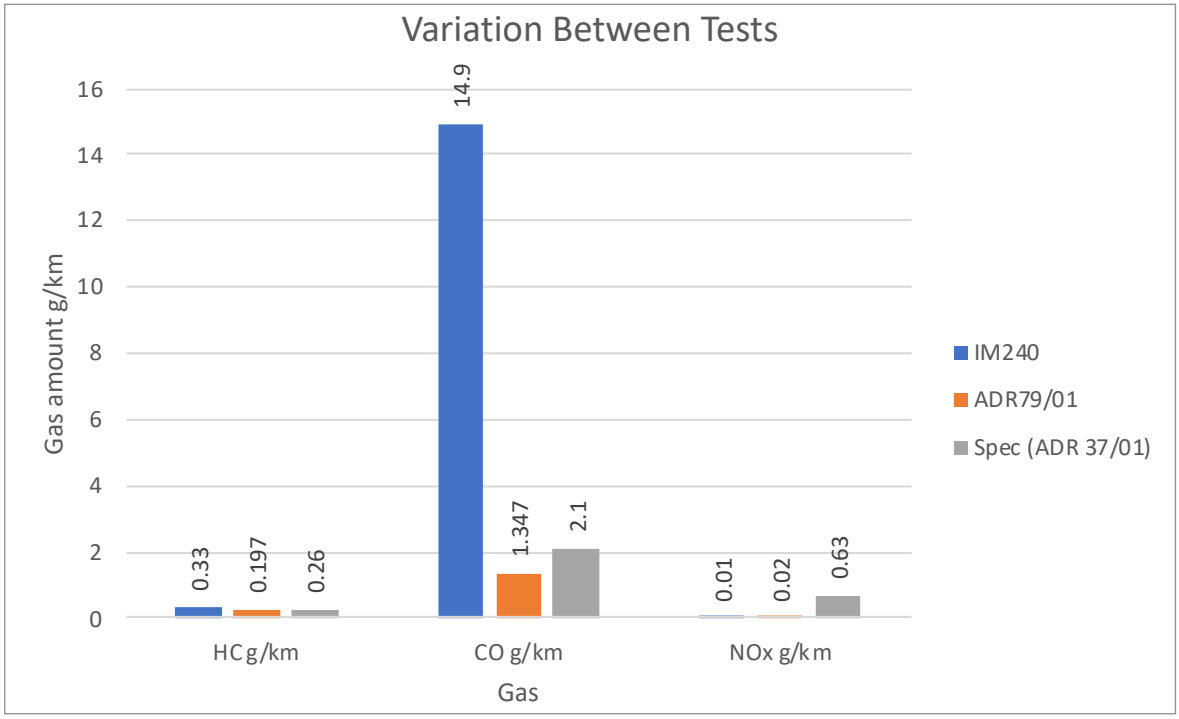

Table 9 - IM240 test results & comparison to 79/01 results

During the IM240 test, greater (than ADR79/01) levels of HC and CO were created, with slightly lower NOx production. This contradicts the assumption that an ADR79/01 complaint vehicle will produce less emission when tested to IM240.

By this testing methodology and limits, a tested ADR79/01 vehicle is non-compliant.

This demonstrates the real-world lack of correlation between the IM240 testing methodology and limits vs ADR compliant vehicles.

During further development work in NSW, further IM240 back-to-back runs were conducted at the Penrith facility.

	HC g/km	CO g/km	NOx g/km
Test #1	0.24	11.8	0.06
Test #2	0.17	10	0.04
Variability	40%	18%	50%
Spec (ADR37/01)	0.26	2.1	0.63

Table 10 - Variability in testing

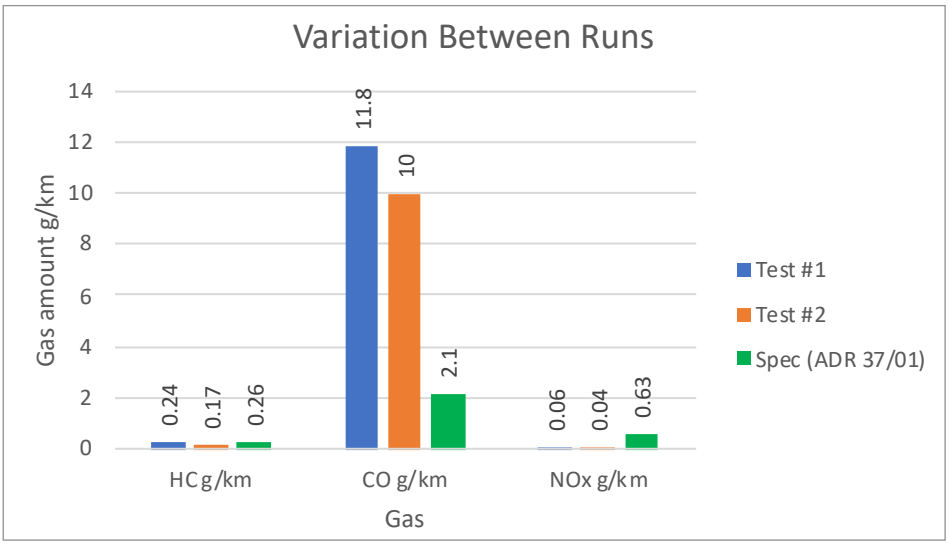

Table 11 - Variability in testing

From the testing it can be seen there is significant variability between runs. These testing results supports the data presented earlier.

From this testing, it can be seen from real world back-to-back physical testing that there is insufficient evidence of correlation between ADRs and IM240. The results here back up the large spread in FPT vs IM240 results presented earlier.

In this particular case, a vehicle that has demonstrated ADR 79/01 compliance has failed an IM240 test and would be deemed non-compliant.

9.2 Gear selection

As part of the IM240 drive cycles, shift points are determined by the number of gears the vehicle has. The manufacturer conducted testing where the number of gears was inputted into the computer manipulated to determine the impact of this on the result. This was due to the initial failure of the ADR 79/00 engine on IM240 machine, as well as the engine being tuned to be a 'higher revving engine'.

# of Gears	HC g/km	CO g/km	NOx g/km	Pass / Fail (ADR37/01)
4 Gears (trial run)	0.24	11.8	0.06	Fail
4 Gears	0.17	10	0.04	Fail
3 Gears	0.09	1.7	0.05	**Pass**

Table 12 - Gear change manipulation result

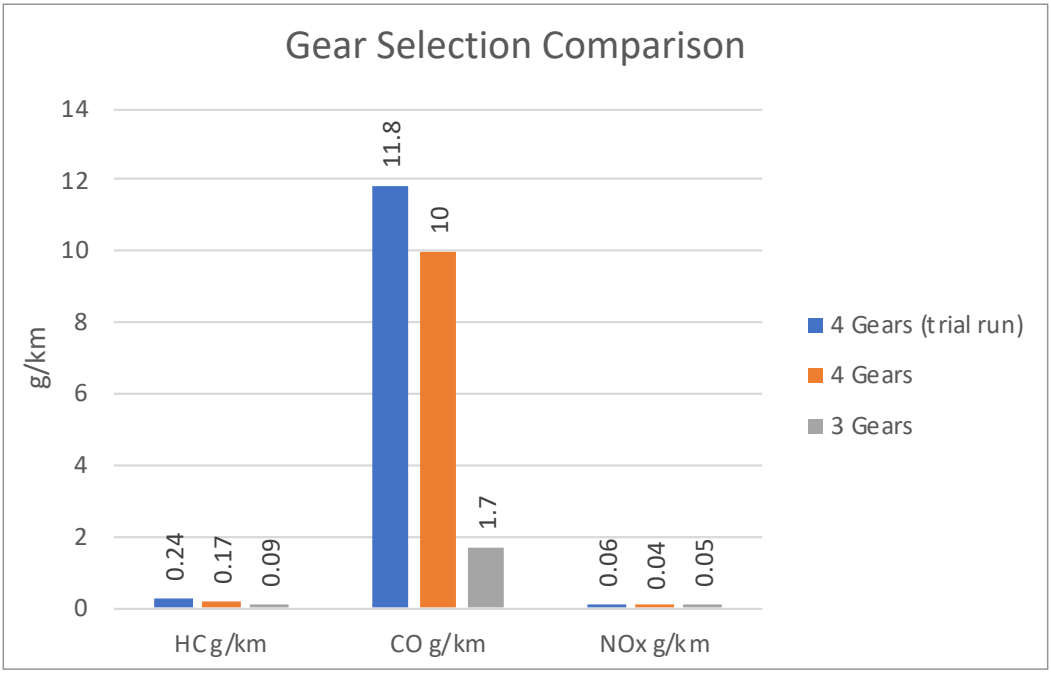

Table 13 - Gear change manipulation result (graphed)

From the data, manipulating the gears used has a dramatic impact on results. When the number of gears used was changed from 4 to 3, the CO levels dramatically reduced. It went from a FAIL result to a PASS. This is due to the engine now operating in its designed rev range.

This shows that the base parameters of the IM240 test is not appropriate for all engine configurations. Certain engines are disadvantaged due to their setup.

Under the current arrangement, consideration of this shown variability is not considered and hence, vehicles that would normally receive a pass if they were to operate in their designed rev range are failing.

10. Other considerations

- VicRoads to adopt a clear and sustainable pathway towards gaining IM240 testing accreditation.
- There are heightened risks associated with having one sole service provider in the market which may lead to a previous situation when Vipac withdrew. Industry cannot afford to be placed in that position again.
- The current situation could be considered as a monopoly with significant barriers to entry for new providers.

10.1 Victoria's Reputation

- If ABMARC withdraws, Victoria will no longer be self-sufficient for vehicle emissions testing and cannot conduct testing to the requirements specified.
- Victoria is currently forfeiting legitimate revenue for Victorian businesses by forcing customers to go interstate for emissions testing.
- Victoria prides itself on being Australia's leading state for automotive engineering and manufacturing businesses, yet it has repeatedly been unable to develop viable emissions testing regulations for aftermarket, modified and ICV vehicle industry.

10.2 Recycling

The ICV and modified engine industries are one of the biggest proponents of the term 'reduce, reuse, and recycle'.

The vast majority of ICV builders use components sourced from existing vehicles, and engines are included in this. A recent survey of 139 ICVs found that 137 used recycled engine units, while only two used crate engines. That is 98.5 per cent of ICVs. Rather than send engines and transmissions to the scrap heap where they may cause environmental problems, these units are cleaned, refurbished, and reused, reducing landfill.

10.3 Low Milage of ICVs

A VACC survey was conducted in 2010, asking 126 ICV owners what their average yearly kms travelled in their vehicles. The results are shown in the table below.

KM's travelled	0-500	501-1,000	1,001-2,000	2,001-5,000	5,001-10,000	10,000-20,000	20,000+
No. ICV's	20	15	33	28	20	10	0

Table 14- ICV Survey Results

The average milage for an ICV was 3,680km. The average milage for non-ICVs Victorians obtained during the ABS - Survey of Motor Vehicle Use, Australia - June 2020 was 12,400km.

11. Recommendations

Based on the evidence presented it can be concluded that the variabilities seen in IM240 testing and the correlation between IM240 to ADR 37/xx, and other modern drive cycles means that IM240 in its current form is unsuitable for a certification test. Combined with the extremely highs costs associated with establishing and maintaining a suitable test facility, and it becomes clear that IM240 testing of modified and ICV vehicles is unreliable and commercially unviable.

Therefore, moving forward, it is recommended a testing regime do the following:

- Ensure there are multiple service operators that allow for a competitive business environment.
- Specify equipment requirements that enable sustainable business models, based on the relatively small number of vehicles that need assessment.
- Incorporate testing requirements that take into account the parts being used (i.e. out of service parts and available parts).
- Ensure there are realistic requirements that consider the industry knowledge and resources available in Australia.
- Have a testing regime with requirements that give a vehicle builder or modifier confidence in the process and outcome prior to commencing / investing in the build.
- Have testing requirements that acknowledge and consider the difference between OEM certification testing and public testing.

12. Proposals

Moving forward, four proposals are tabled as an alternative to the current IM240 situation, along with respective positives and negatives that are to be considered

12.1 Proposal 1 - Government Operated Facility

This proposal is for the Victorian government to set up and operate a fully compliant IM240 testing facility to facilitate compliance testing for the current IM240 requirements. The government owned and operated facility will be used to support local industry, support the motoring public, law enforcement and assist in maintaining a strong emissions knowledge within the community. The lab would also provide a source of environmental enforcement of vehicles deemed to be operating outside of operating conditions.

Due to the high cost of the equipment, high cost of maintenance and requirement for skilled staff, a centralised government funded operation (similar to the NSW facility) is deemed to provide the best alignment to the current IM240 requirements. Facility use costing should be set similar to NSW to encourage the use of the facility.

The limits for this testing are to be increased to reflect the challenges identified with IM240. A target of ADR 37/00 limits is proposed. These new limits are to consider:

- Variations in test results seen due to
  - Fuel
  - Ethanol content
  - Ambient temperature
- Variation between each run
- Difference pre-test operation

- Driver to vehicle unfamiliarity
- Poor single vehicle correlation between ADR37/01 and IM240
- No correlation between ADR79 drive cycle and IM240
- Higher NOx on IM240 compared to ADR 37/01
- Unknow performance of parts available to the public compared with new OEM components (many are unavailable)
- Limits in line with the original intent of IM240 by the US EPA
- Limits that consider the use of out of service components
- Limits that consider the trends seen with in-vehicle service testing / unmodified vehicles where they do not meet IM240 targets.

Potential issues associated with this proposal include:

- Substantial initial investment required to build the facility
- Substantial ongoing investment required to maintain calibration, facility costs, required staffing levels (maintain knowledgeable staff)
- Issues with lack of local support of equipment.

12.2 Proposal 2 - Simulated IM240

This proposal is to move to a simulated IM240 using dyno machines made available from companies such as Mainline and Dyno Dynamics. These machines have been used for many years as an indicator or IM240 performance. This proposal is comparable to the current operations in South Australia.

The limits for this testing are to be increased to reflect the challenges identified with IM240. A target of ADR 37/00 limits is proposed. These new limits are to consider:

- Variations in test results seen due to
  - Fuel
  - Ethanol content
  - Ambient temperature
- Variation between each run
- Difference pre-test operation
- Driver to vehicle unfamiliarity
- Poor single vehicle correlation between ADR37/01 and IM240
- No correlation between ADR79 drive cycle and IM240
- Higher NOx on IM240 compared to ADR 37/01
- Unknow performance of parts available to the public compared with new OEM components (many are unavailable)
- Limits comparable with the original intent of IM240 by the US EPA.
- Limits that consider the use of out of service components
- Limits that consider the trends seen with in-vehicle service testing / unmodified vehicles where they do not meet IM240 targets

Potential issues associated with this proposal include:

- Lack of large fleet correlation between these machines lab and lab test results – however, due to the large variation in IM240 results caused by external factors, clearly demonstrating high accuracy correlation is difficult / impossible.
- The equipment provider being used by other states (Mainline) will no longer support emissions measurement. There is a high risk that if such a proposal was endorsed there would not be equipment available to conduct such testing at some point in the future.
- The reliance of conducting emissions measurement and judging against a pass/fail number out of a full emissions lab environment still raises concerns about correlation and repeatability (as per this report). While the increasing of the values to ADR 37/00 of certification values goes some way to address this issue, the core issue will always remain.

12.3 Proposal 3 – NZ Based System

This proposal is similar to those procedures conducted in New Zealand (Low Volume Vehicle Standard 90-10(03) (Exhaust Gas Emissions)) for fuel injected engines, with the intention of ensuring the engine and emissions systems are properly installed and functioning based on known "healthy" air fuel ratios.

For this to occur the user must prove to the certifying engineer that the following has been undertaken:

- Fuel injected engine
- Installation of the following sensors
  - Mass air-flow sensor (MAF) or manifold absolute pressure sensor (MAP)
  - Temperature
  - Throttle position sensor
  - One or more oxygen sensor
- Installation of a new catalytic convertor from a suitable engine sized vehicle (for vehicles outside of ADR service life)
  - be positioned as closely as practicable to the exhaust manifolds; and
  - be oriented in the correct direction of flow.
- Checking emissions performance through OBD diagnostics – ensuring no fault codes (where applicable noting some vehicles / engines / ECU's do not have full OBD functionality)
- Demonstration of catalytic convertor working correctly through external temperature check
- Dyno data showing results of steady speed, loaded and idle air fuel ratios of –
  - at a steady and constant speed of between 90 and 100 kph, in the highest available forward gear, for a period of approximately 10 seconds
    - in the case of a turbocharged or supercharged engine, between 12.8:1 and 14.9:1;
    - in the case of an electronically fuel-injected engine, between 13.8:1 and 14.9:1; or
    - in the case of a diesel-injected engine, no richer than 18.9:1;
  - loaded condition - during moderate acceleration from approximately 70 kph to approximately 100 kph, using the highest available forward gear for the engine speed used during the acceleration period

- in the case of a turbocharged or supercharged engine, between 11.0:1 and 14.9:1; or
- in the case of an electronically fuel-injected engine, between
- 12.2:1 and 14.9:1; or
- in the case of a diesel-injected engine, no richer than 13.8:1;

- Idle
  - turbocharged or supercharged engine, no richer than 12.8:1; or
  - in the case of an electronically fuel-injected engine, between 13.3:1 and 15.5:1.

This proposal allows for confidence with the vehicle owner and VASS engineer prior to the vehicle being built. The test equipment required to demonstrate compliance with this requirement is available and accessible at a reasonable cost, allowing for quick testing / retesting and allows for testing to be done in remote areas (removes location discrimination of a central testing site). The compliance requirements associated with such a proposal reflect the proportionally small number of vehicles that require assessment. The equipment specified to conduct the assessments are commonly already available to well equipment workshops and hence no additional outlay is required, making adoption and high industry and consumer acceptance.

It will be the responsibility of the VASS engineer to ensure the dyno work is done correctly and the results are valid.

12.4 Proposal 4 – UK Based System

The below proposal is similar to those procedures conducted in the United Kingdom (UK), with the intention of ensuring the engine and emissions systems are properly installed and functioning based on known "healthy" air fuel ratios and a measured emissions using a workshop grade gas analyser. Unlike the previous proposal, this proposal measures gaseous emissions and compares that to a value.

For this to occur the user must prove to the certifying engineer that the following has been done:

- Fuel injected engine
- Installation of the following sensors
  - Mass air-flow sensor (MAF) or manifold absolute pressure sensor (MAP)
  - Temperature
  - Throttle position sensor
  - One or more oxygen sensor
- Installation of a new catalytic convertor from a suitable engine sized vehicle (for vehicles outside of ADR service life)
  - be positioned as closely as practicable to the exhaust manifolds; and
  - be oriented in the correct direction of flow.
- Checking emissions performance through OBD diagnostics – ensuring no fault codes (where applicable noting some vehicles / engines / ECU's do not have full OBD functionality)
- Demonstration of catalytic convertor working correctly through external temperature check

There are 2 requirements to this test. Fast idle test and idle test.

Fast Idle

- 2500 to 3000rpm
  - CO <= 0.2%
  - HC <= 200ppm
  - Lambda between 0.97 & 1.03

Idle

  - 450 to 1500rpm
  - CO <=0.3%

Similar to the previous proposal, it allows for confidence with the vehicle owner and VASS engineer prior to vehicle being built. The equipment required to meet this requirement is easily available and accessible allowing for allowing the VASS (or associated workshop) to conduct the measurement activities. The compliance requirements associated with such a proposal reflect the proportionally small number of vehicles that require assessment. The equipment specified to conduct the assessments are commonly already available to well equipment workshops / VASS engineers and hence no additional outlay is required, making adoption and high industry and consumer acceptance.

Unlike the previous proposal, the VASS engineer can conduct the testing, removing the need for a third party to conduct activities.

12.5 Recommended Proposal

Moving forward, VACC and SVA recommend that one of the systems based on either the UK or NZ models be considered and introduced as a method of ensuring suitable emissions performance for ICV and modified vehicles.

While the simulated IM240 proposal is seen as being the closest match to current requirements, there is still major concerns about test repeatability and the use of pass/fail values, as well as the risk of equipment required to do the testing being no longer available. This will cause issues if new workshops want to enter the market or if machines require maintenance or replacement. Hence, with a long-term outlook it is not recommended to proceed with such an option.

13. Risk Benefit Analysis

13.1Current

- Lack of easily accessible, fully compliant and cost effective IM240 test lab left in Australia
- Cost to build a lab to the current requirements is unsustainable based on the number of vehicles that require testing

13.2 Proposed system risks

- Increased number of people choosing this path putting higher workload on VASS engineers
- Potentially lower emissions performance per vehicle, however as a percentage of total Victorian fleet, any increase in emissions would be negligible, and total fleet emissions could possibly even be improved by current non-compliant and non-tested vehicles going through the testing process and reducing their emissions output

13.3 Proposed system benefits

- By having an accessible, simplified, transparent and cost-effective testing regime it will encourage those who choose non-compliance to do the right thing and undertake the required testing, which in turn will improve those vehicles emissions performance.
- Provides a very clear understanding to the builder prior to commencement what needs to be done to get their vehicle built and approved (unlike IM240 where it is not known until testing is conducted)
- Increase competition in the vehicle testing space
- Ensures a consistent environmental message
- Ensures there is not a repeat of a one supplier scenario that has repeatedly led to the current crisis.
- Equipment to conduct such activities already exist in many well-equipped workshops
- System can be introduced with no cost to VicRoads or the EPA.

References

[i] United States Environmental Protection Agency: Air. (1998). "EPA IM 240 & Evap Technical Guidance".

[ii] Dieselnet. (2007). United States: Cars and Light-Duty Trucks: Tier 1. https://dieselnet.com/standards/us/ld_t1.php

[iii] United States Environmental Protection Agency. (1995). "EPA I/M Briefing book."

[iv] Society of Automotive Engineers International. (1996). "Impact of Fuels and Ambient Conditions on IM240 Emissions." https://www.sae.org/publications/technical-papers/content/962092/

[v] Department of the Environment and Heritage. (2005). "NISE 2 Contract 2 Drive Cycle Test Development." Canberra.

[vi] AA1 Car. (date unknown). "I/M240: Load Mode Emissions Testing." www.aa1car.com/library/im240.html

[vii] Federal Office of Road Safety. (1996). "Report on the National In-Service Vehicle Emissions Study."

[viiii] (2003). "Establishing ADR 37/01 Compliance – A short test with limits."

[Ix] Federal Office of Road Safety. (1996). "Motor Vehicle Pollution in Australia: Report on the National In-Service Vehicle Emissions Study."

[x] Transport for New South Wales. (2003). "Establishing ADR 79/00 Compliance."

[xi] Hooftman, N., Messagie, M., Van Mierlo, J., and Coosemans, T. (2018). "A review of the European passenger car regulations – Real driving emissions vs local air quality." Renewable and Sustainable Energy Reviews. V 86, p 1-21.

VACC

You're in good hands

VACC House • Level 7, 464 St Kilda Road, Melbourne VIC 3004