COMMENTS OF THE MANUFACTURERS OF EMISSION CONTROLS ASSOCIATION ON THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S RECONSIDERATION OF THE FINAL DETERMINATION OF THE MID-TERM EVALUATION OF GREENHOUSE GAS STANDARDS FOR MODEL YEAR 2022-2025 LIGHT-DUTY VEHICLES; MODEL YEAR 2021 GREENHOUSE GAS EMISSIONS STANDARDS

DOCKET ID NO. EPA–HQ– OAR–2015–0827

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The Manufacturers of Emission Controls Association (MECA) is pleased to provide comments in response to the U.S. EPA's reconsideration of the final determination of the mid-term evaluation of greenhouse gas (GHG) standards for model year 2022-2025 light-duty vehicles and model year 2021 greenhouse gas emission standards. We believe that EPA's original conclusions were well thought out, comprehensive and remain valid today. The two years since the analysis in the draft Technology Assessment Report have allowed suppliers to continue to innovate and introduce new technologies that should be included as part of this reconsideration. The pace of efficiency technology introduction and the breadth of available efficiency technology options have grown beyond early projections. Well known technologies will be applied across the light-duty vehicle fleet to meet the 2025 standards. Several new technologies, which were originally not considered in the draft TAR, are expected to be in production prior to 2021. Our industry continues to respond to the need for cleaner, more efficient vehicles by innovating and commercializing the technologies that will help our customers meet the 2022-2025 GHG requirements.

MECA is a non-profit association of the world's leading manufacturers of emission control, combustion efficiency and GHG reduction technology for mobile sources. Our members have over 40 years of experience and a proven track record in developing and manufacturing technologies for reducing criteria emissions and improving engine efficiency for a wide variety of on-road and off-road vehicles and equipment, including extensive experience in developing GHG reducing emission controls for gasoline and diesel light-duty vehicles in all world markets. Our industry has played an important role in the emissions success story associated with light-duty vehicles in the United States and has continually supported efforts to develop innovative, technology-forcing, emissions programs to mitigate air quality problems and minimize the impacts of climate change.

MECA estimates that the North American emission control market will grow to about $23 billion by 2020. Our industry exists largely because the Federal government, California and the Section 177 states have required pollution reductions from vehicles and fuels to achieve health-based air quality standards to achieve their public health and environmental goals. Today there are now close to 300,000 people employed by U.S. suppliers of emissions control and efficiency technology products and equipment to the car and truck manufacturers. MECA supported the Agency when it finalized the Mid-term Evaluation because it provided clear market value and the long term regulatory certainty necessary for our member companies to continue to invest in technologies to meet the goals of the regulation out to 2025. In 2017, the emission control industry is expected to invest over $3 billion in research and development to develop the technologies needed to meet future emission standards. MECA and our member companies supported the experts at OTAQ to inform the preparation of the draft Technical Assessment Report. Suppliers have been working with their customers to integrate technologies and reduce costs below those estimated in the draft TAR.

The Administration's decision to reopen and reconsider the final determination, the 2022-2025 standards and also the model year 2021 standard has injected uncertainty that may ultimately strand current investments, as well as jeopardize new investments in American manufacturing of advanced clean car technologies, if the standards are substantially weakened. If that uncertainty persists or serious weakening of the standards occurs, investments that would have been made in the U.S. are likely to go to China, Europe, or elsewhere where the standards will continue to be progressively tightened. Besides the loss of U.S. manufacturing jobs to other countries, due to substantially weaker GHG standards, there will likely be the corresponding increases in vehicle fuel consumption that will erode the consumer's return on their vehicle investments. Furthermore, delays or weakening of the GHG standards would disrupt the long-negotiated one national program that is in place now through 2025, as California and Section 177 states have threatened to exit the program, potentially resulting in litigation that would take years to resolve. This extended period of uncertainty would only provide additional impetus for suppliers to look at other countries, where tighter GHG regulations continue to advance, for making new manufacturing investments instead of the U.S.

MECA urges EPA to remain on course for the current MY2021 standard as this was the target industry committed to in 2012. A shift from the MY2021 standard currently in place would significantly increase the level of risk and uncertainty for the supplier industry at a time when OEMs are beginning to make their technology decisions for model year 2021 platforms in 2018. If EPA does evaluate revising the GHG standard for MY2021, the agency must consider the potential detrimental economic impact on automotive suppliers – the largest sector of manufacturing jobs in the nation. Suppliers have made long-term investment decisions based on the MY 2017-2021 standards set in the previous rulemaking that was completed in 2012. In fact, automotive suppliers have seen an overall 23 percent increase in employment since 2012, which can partly be attributed to advanced technology development spurred by the 2012 rulemaking. While supplier direct employment in the U.S. is highest in Michigan, Ohio, and Indiana, the highest growth over the past few years has been seen in the Southeast region (https://www.mema.org/sites/default/files/resource/MEMA_ImpactBook.pdf). Relaxing the stringency of the MY2021 standard would cause adverse economic impacts, including loss of jobs and increased risk to the substantial investment levels to which suppliers committed in 2012. These investments include research and development, human capital, and manufacturing equipment and facilities to satisfy customer GHG emissions requirements. Suppliers have made substantial investments to bring these emissions reducing technologies to commercialization, and therefore, MECA urges EPA to stay on course for the MY2021 standard and instead focus on the originally agreed upon goal of evaluating the GHG standards for MY 2022-2025.

Vehicle manufacturers will rely on a systems approach to meeting future tailpipe emission standards that will likely include fuels as well as technologies. Some manufacturers may choose higher compression ratio engines requiring higher octane fuels. MECA supports fuel neutral standards and clean fuels, including ultra-low sulfur gasolines at several octane levels and ultra-low sulfur diesel. As detailed in EPA's final determination and draft Technical Assessment Report (TAR), there is a large set of technology combinations available to reduce greenhouse gas emissions from passenger vehicles and light-duty trucks, including fuel efficient advanced gasoline and diesel powertrains. The vast majority of technologies being deployed across the light-duty fleet represent technologies that have existed for decades and are just now being designed into conventional internal combustion diesel and gasoline engines. MECA members are committed to provide the emission control technologies that allow all of these fuel efficient powertrains to meet the corresponding Tier 3 criteria pollutant standards. As the conventional technologies are deployed, suppliers will continue to innovate new technologies to reduce vehicle CO_2 and GHG emissions to help their customers meet future standards. For the next several decades, there are likely to be numerous cost-effective ways to improve fuel economy without extensive use of strong hybridization or full electrification. We urge the agencies to focus on setting performance based policies that drive innovation in all areas of vehicle fuel efficiency technologies.

The final determination is based on the draft TAR, which discusses a range of powertrain technologies that manufacturers are deploying to improve the efficiency of their engines. The rapid introduction of innovative GHG technologies is due in part to advances in computing power that is available on today's vehicles. Well known technologies such as turbochargers, exhaust gas recirculation (EGR) systems, advanced fuel injectors, variable valve actuation technology, 48V mild hybrid systems, advanced exhaust controls and powertrain control modules will be applied to both light-duty gasoline and diesel powertrains to meet the 2025 standards. Auto manufacturers will take advantage of the synergies between advanced emission control technologies and advanced powertrains to optimize their performance with respect to both GHGs and criteria pollutant emissions. MECA members offer a large portfolio of technologies for reducing both GHGs and criteria pollutants from advanced gasoline and diesel engines (see MECA's Tier 3 technology report: http://www.meca.org/resources/LEV_III-Tier_3_white_paper_0215_rev.pdf). By retaining the 2022-2025 GHG standards, the agencies offer the supplier industry the regulatory stability on which they rely to make long-term investments that ensure technologies to simultaneously reduce criteria and GHG pollutants are available to provide their customers a cost-effective way to meet CO_2 and fuel economy targets. In fact, the presence of the most stringent standards in the U.S. has provided domestic suppliers and vehicle manufacturers with a competitive advantage over their foreign competitors through the early adoption and optimization of technologies on vehicles.

The pace of efficiency technology introduction and the breadth of technology options available for compliance have grown beyond those early projections, and in just the past 2 years, new technologies have been announced for commercialization before 2020 that were not previously considered in the draft TAR or proposed determination. *Automotive News* recently reported that automakers have announced plans to adopt 48V mild hybrids at a faster rate than originally planned. The more stringent CO_2 standards in Europe have led one industry group to project that by 2020, 48V cars will outpace European sales of full hybrids, including plug-ins that can be recharged with a cable and driven in electric-only mode. By 2025, the group predicts 55 percent of all cars sold in Europe will be equipped with 48V technology (http://europe.autonews.com/article/20170923/ANE/170929892/). A recent analysis by ICCT, with input from MECA members and other suppliers, projects an 8-10% greater CO_2 reduction benefit at a 36% lower cost of technologies to meet the 2025 standards than originally estimated by EPA in its final determination. While the original rule anticipated fuel prices being higher than they are currently, the rule and TAR both overestimated the cost of technologies. This will result in lower technology costs offsetting the lower than anticipated fuel prices, so that consumers will still see a three-year payback. ICCT's analysis can be found at http://www.theicct.org/US-2030-technology-cost-assessment.

Some of the new technologies that will be in production prior to 2021 but were not considered in the TAR include dynamic cylinder deactivation, variable compression ratio and electric boost. Dynamic cylinder deactivation utilizes high speed computing to electronically control the deactivation and firing fraction of any cylinder independently of the others depending on the load at each engine rotation as a way to further optimize efficiency. This technology has the potential to improve fuel economy by 10-17% and up to 20% when combined with 48V mild hybrid technology. At least one automaker has plans to introduce dynamic cylinder deactivation in a MY 2019 U.S. vehicle. Variable compression ratio (VCR) is another fuel saving technology that has been introduced since the finalization of the draft TAR. Several design approaches for variable compression have been discussed in the literature as a way to optimize compression ratio and combustion efficiency inside the cylinder based on the power demand. This technology is expected to achieve approximately 10% improved fuel economy. Nissan has announced that it will begin offering vehicles equipped with its "Multi-Link" VCR system starting with MY 2018 (http://articles.sae.org/15040/). Electric boost is a third technology not considered in the draft TAR. Electric boost is used in combination with a main power turbo and often as part of a 48V mild hybrid system on a vehicle. Electric boost technology can quickly deliver boost as the power turbine comes up to full boost power in order to reduce turbo-lag and enable engine downsizing and down-speeding. Electric boost has been reported to yield as much as a 5% fuel savings over the test cycle.

MECA continues to recognize the benefit to real-world CO_2 reductions via the off-cycle credit program as a policy to expand the available technologies that vehicle manufacturers can deploy to meet the goals of the regulation. The existing off-cycle methodology allows suppliers to partner with their customers to apply for off-cycle credits. After several years of implementation, suppliers have found it difficult to convince vehicle manufacturers to commit the full complement of resources needed to evaluate technologies on fully integrated vehicles without compelling data and indication that the Agency believes a technology shows promise. Even a conservative estimate of the amount of credit a technology may offer would justify deployment of resources to fully demonstrate a technology. We continue to believe that a parallel supplier pathway to contingent pre-certification would greatly expand the available technologies and resources for full demonstration across a fleet of integrated vehicles by the OEM to ultimately confirm the real world CO_2 reductions of a given technology. Expanding the off-cycle credit process to include EPA, NHTSA and the California Air Resources Board may be one consideration in the future to allow for resource sharing among the agencies for reviewing data and evaluating off-cycle technology pathways. The European Eco-Innovation program is an example of how a supplier based credit program might work. MECA looks forward to working with EPA to explore the potential for certification flexibilities to be used to incentivize early market introduction of advanced off-cycle technologies.

For gasoline vehicles, direct injection technology has been deployed at a rapid pace, enabling gasoline engines to achieve greater fuel efficiency. Although significant advances have also occurred in improving the efficiency of naturally aspirated engines, GDI is expected to continue as the dominant pathway to meeting 2022-2025 light-duty greenhouse gas emission standards with an estimated 90% utilization across new engines sold in 2025. Modern GDI engines emit more particulate matter in the form of black carbon than traditional port fuel injected (PFI) engines. Certain driving conditions, such as hybrid engine starts during high load conditions can also lead to higher PM emissions. Emissions controls, such as advanced fuel injectors and gasoline particulate filters (GPF) can ensure that these more fuel-efficient gasoline engines meet and exceed tough EPA and California criteria emission regulations. Most European, Chinese and Indian cars will employ advanced technologies to meet more stringent particle number emission standards, but the same cars will be sold in the U.S. where a 3 mg/mile PM limit will not demand the best emission control technologies. MECA recommends that EPA consider offering automakers CO_2 equivalent black carbon credits for substantially outperforming PM emission standards. EPA should also consider aligning the Tier 3 PM standard with LEV 3 beyond 2025.

EPA also requested comment on the impact of the GHG standards on other air quality standards. In comments MECA submitted to EPA on the proposed determination (please refer to MECA's comments submitted to this docket on December 28, 2016), we provided information describing the potential for elevated evaporative emissions from plug-in hybrid electric vehicles (PHEV). We still have concerns that EPA's response to our comments on the draft TAR and proposed determination with regard to evaporative emission impacts does not consider the 2012 final rule language regarding the "holistic" nature of the MTE (discussed at 77 FR 62652) and the assertion in 77 FR 62816 that: "Focusing on vehicle tailpipe emissions has not raised any issues for criteria pollutants…." The fact that the draft TAR and Proposed Determination do not take these evaporative emission issues into consideration highlights the need to develop comprehensive emission standards beyond 2025 that harmonize all emissions from vehicles under one regulation and promote the optimization of GHG and criteria pollutant reductions in parallel. While the percentage of vehicles using PHEV technology to meet the 2022-2025 model year GHG standards remains to be seen, they are present in the fleet today and their penetration is expected to increase. PHEVs typically use pressurized fuel systems to reduce evaporative emissions from the fuel tank. This decreases vapor generation and in-use canister purge requirements. MECA still contends that an increase in PHEV sales related to the 2022 and later model year GHG and fuel economy rules may lead to an unintended increase in the VOC inventory. This potential increase can be remedied with appropriate test procedures and emission standards for vehicles with sealed tanks and NIRCOS evaporative control system designs.

MECA provided comments on the draft TAR indicating that Tier 3 evaporative emission and OBD requirements did not address potential increases in fuel vapor emissions related to pressurized fuel systems. As discussed in the comments, the first concern was related to fuel cap removal emissions (puff loss). These emissions could be relatively large in pressurized fuel systems, especially as the fuel in the tank falls below 20 percent of nominal volume and, as is common, the vehicle has experienced a series of sequential driving and diurnal events before refueling. The current Tier 3 requirements do not address this emission source through either a test procedure or emission standard. The only somewhat related provisions, which pre-date the development of PHEVs, are general requirements that fuel tanks must vent to the canister prior to cap removal if the fuel tank pressure exceeds 10 inches water (2.5 kPa) during the running loss test or during the development of the fuel tank temperature profile (40 CFR §§86.129-94(d)(6) and 86.134-96-(g)(1)(xvi) and (g)(2)(xii)). There is no specific regulatory prohibition requiring venting to the canister in-use for systems whose pressure exceeds a fixed kPa value. In a related section of the regulations, there is a provision that fuel tanks are not permitted to vent to atmosphere at any time (except for emergencies), but no implementing language regarding a definition of emergency is given (40 CFR §§86.096-8(b)(4) and 86.096-9(b)(4)). Today we see PHEV fuel tank pressures ranging between 18 and 30 kPa. More definition on requirements is needed in this area. Finally, as discussed in the EPA Tier 3 rulemaking documents, there is a concern that the OBD evaporative system leak detection threshold is too lax for pressurized fuel systems. Data provided in the MECA comments on the draft TAR and discussed in the EPA Tier 3 rulemaking documents indicate that fuel system vapor leak emissions would be much greater in pressurized fuel systems even at leak diameters much smaller than the present 0.020" detection threshold. We have attached a Microsoft PowerPoint presentation as an appendix to these comments to further illustrate the issues outlined herein on the potential to inadvertently increase evaporative emissions from an increasingly electrified fleet utilizing sealed tanks and NIRCOS refueling emission controls (see Appendix 1).

In summary, MECA believes that EPA's original final determination was well thought out, thorough and comprehensive. In addition, we believe that MY 2021 standards should remain in place in order to provide certainty to the automotive supplier industry. The uncertainty associated with revising standards that have already been incorporated into suppliers' short and long term planning is likely to strand current investments, as well as jeopardize new investments in American manufacturing of advanced clean car technologies supporting nearly 300,000 U.S. jobs. The pace of efficiency technology introduction and the breadth of available efficiency technology options have accelerated beyond early projections, including new technologies that were not originally considered in the TAR but are expected to be introduced into production prior to 2021. The latest suite of technology options expected to be applied across the light-duty vehicle fleet to meet the 2025 standards should be included in EPA's analysis to support its reconsideration. Our industry continues to respond to the need for cleaner, more efficient vehicles by innovating and commercializing the technologies that will help our customers meet the 2022-2025 GHG requirements.

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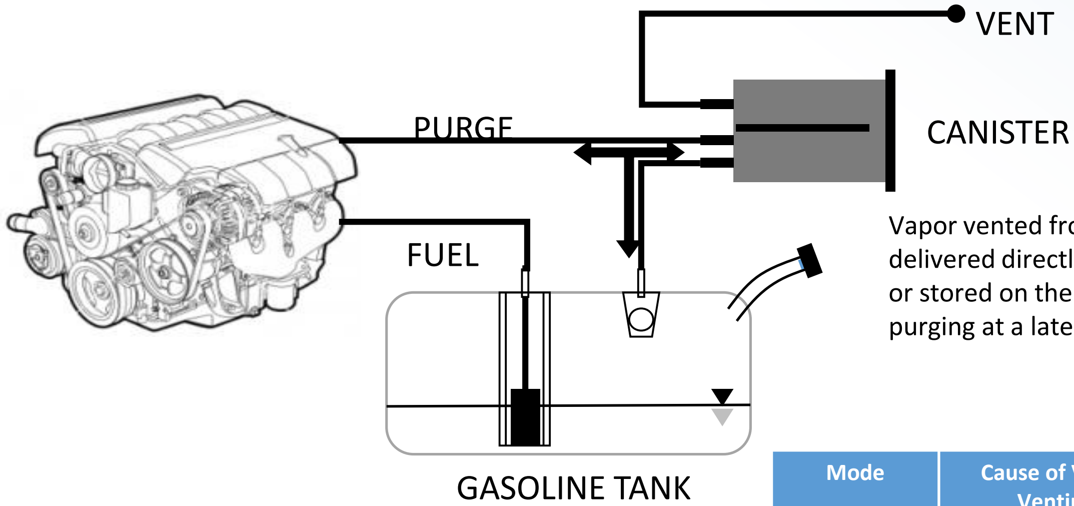
Appendix 1: Emission and Pressure Issues with Sealed Tanks

CONVENTIONAL FUEL SYSTEMS: Effective vapor management relies upon a working balance between canister and purge



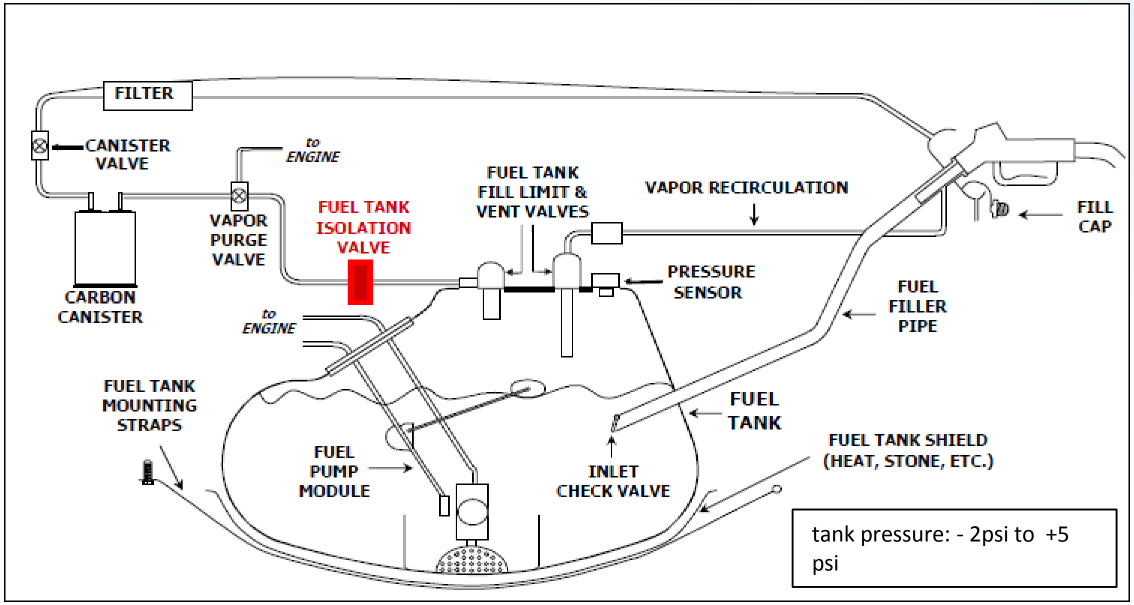
Vapor vented from the tank can be delivered directly to the engine with purge or stored on the canister for purging at a later time

Mode	Cause of Vapor Venting	Vapor Generation Factor
Parking	Daytime Temp	2 grams/gallon
Running Loss	Engine, exhaust, and road surface heat	13 grams/gallon with ΔT of 25°F
Refueling	Volume displacement	5 grams/gallon

NIRCOS Background

- Demands for fuel economy improvements on vehicles has led to the introduction and growth of hybrid technology.
  - These vehicles generally have less opportunity for purge.
- LEVII&LEVIII/ORVR evaporative control requirements coupled with reduced purge opportunity has led to the development and use of NIRCOS.
- Expect use of hybrids/NIRCOS to increase as fuel economy standards become more stringent.
- Hybrids and NIRCOS are not a US only technology.
  - Issues for China 6
  - Europe

NIRCOS Normally Closed Hybrid System



Relevant Definitions

- ARB Evap TP

1.1. “Non-integrated refueling canister-only system” means a subclass of a non-integrated refueling emission control system, where other non-refueling related evaporative emissions from the vehicle are stored in the fuel tank, instead of in a vapor storage unit(s).

1.2. “Sealed fuel system” means a non-liquid phase fuel system, on-board a vehicle, that stores, delivers, and meters the fuel under a very high pressure, and which inherently has no evaporative-related emissions, due to design specifications that eliminate the escape of any fuel vapors, under normal vehicle operations.

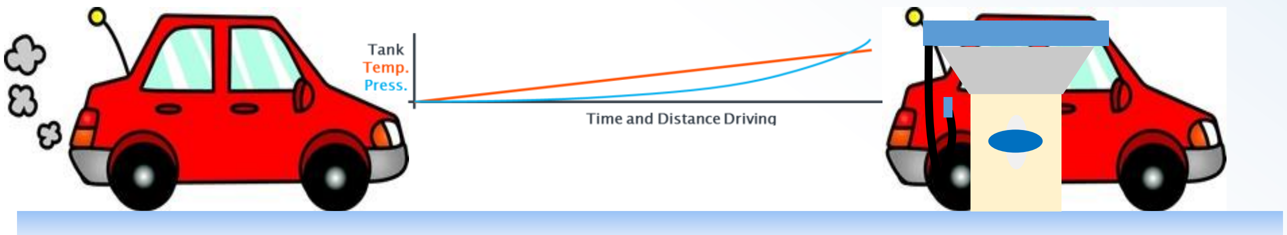
- CFR86.1803-01

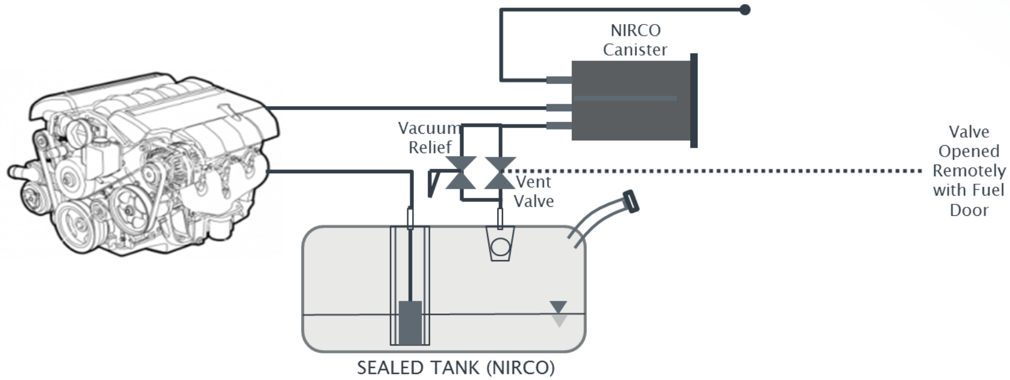
Non-integrated refueling emission control system means a system where fuel vapors from refueling are stored in a vapor storage unit assigned solely to the function of storing refueling vapors.

- Draft UNECE

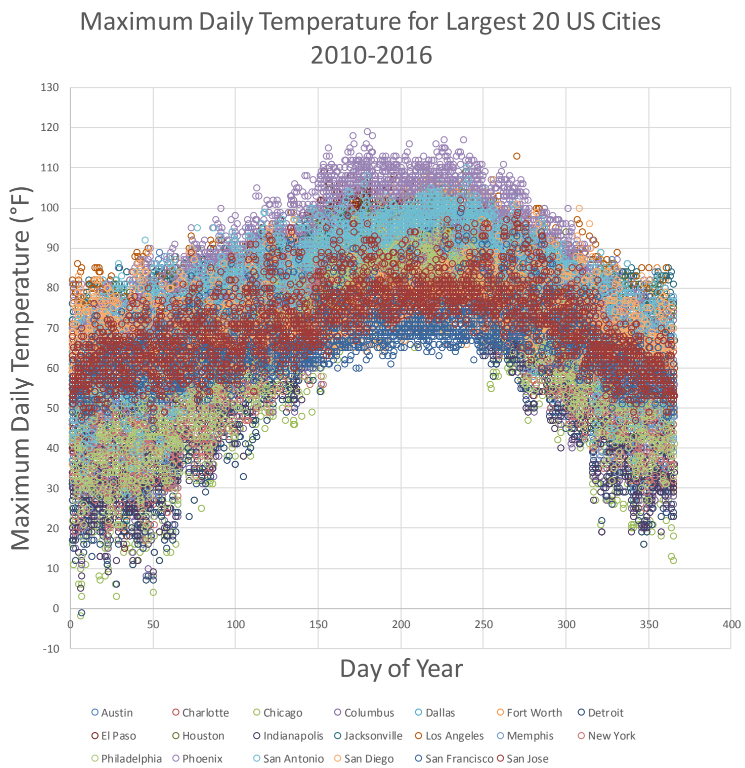
“Sealed fuel tank”: "a system where the fuel vapors from the fuel tank are stored in a tank system under normal vehicle operations, and a vapor storage unit is assigned solely to the function of storing the fuel vapor to release the tank pressure just before the fuel cap is opened for refueling.

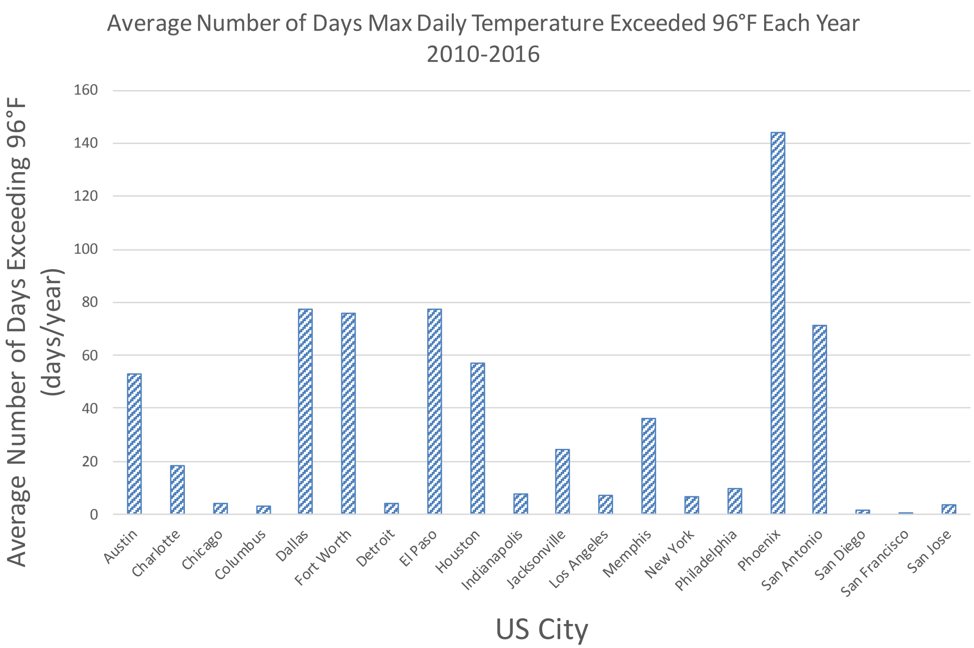
Sealed tank (NIRCOs) temperature and pressure can rise during operation, and the tank must be vented to the canister prior to refueling to relieve pressure





Large number of days across the US where temperatures exceed 96°F

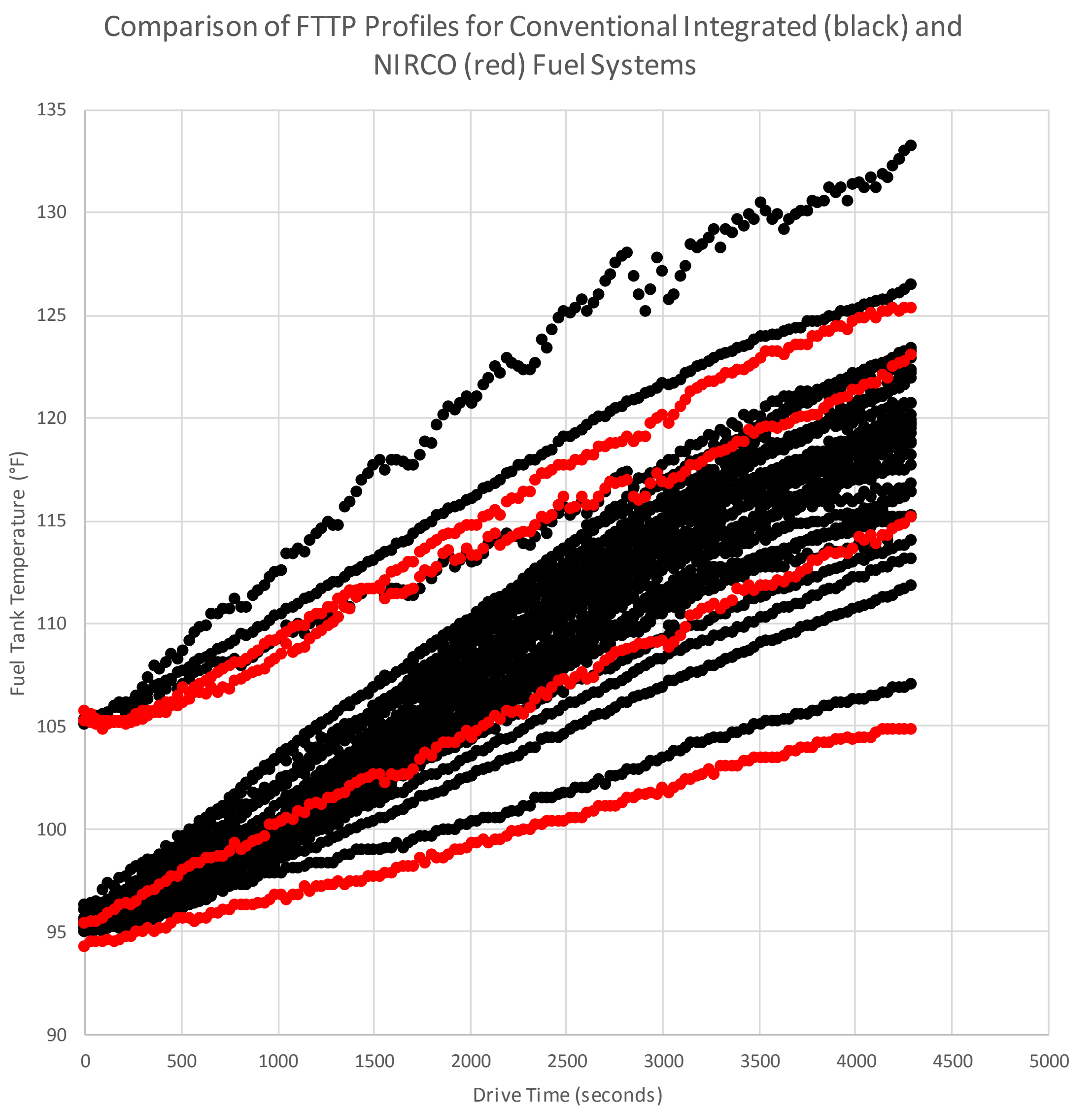




Issues to consider for NIRCOs

- "Puff" losses at refueling following hot driving conditions
- Tank pressure generation during hot driving conditions
- Leak control for pressurized fuel tanks

FTTP for NIRCOs are among lowest measured – run on battery

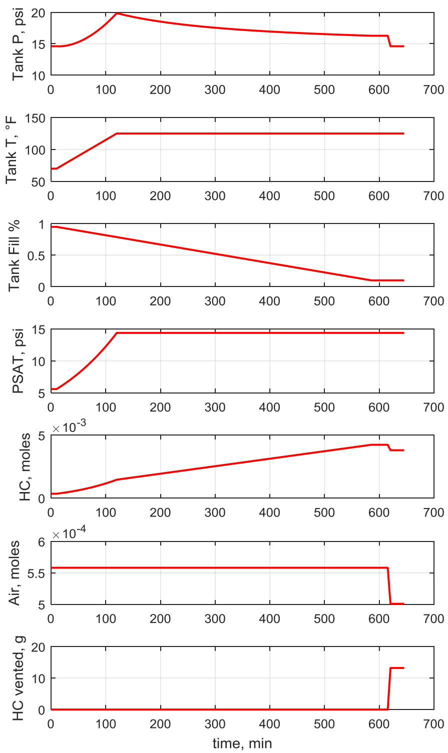


Maximum tank pressures and puff loss for a 10 gallon tank, 10% fill undergoing a Δ24°F heat build
(NOTE: ~39 grams vapor load to canister for certification ORVR test)

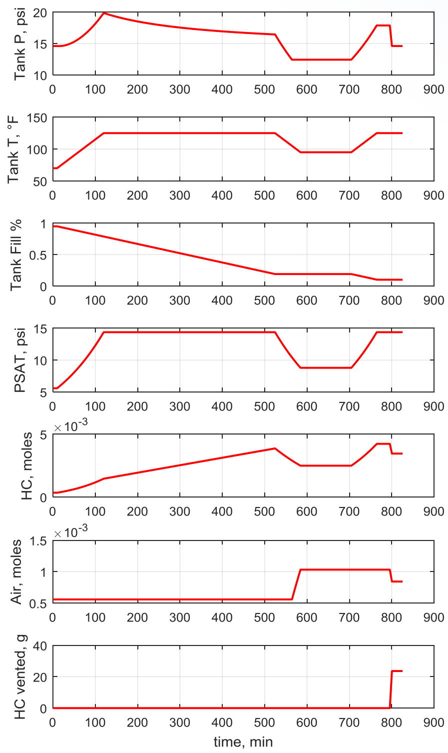
RVP, psi	Heat Build, °F	Max Tank P, psi	Puff Loss, grams
7	72 – 96°F	17.2 psi	7.6 grams
7	76 – 100°F	17.3 psi	8.5 grams
7	81 – 105°F	17.5 psi	9.8 grams
7	86 – 110°F	17.7 psi	11.2 grams
7	91 – 115°F	18.0 psi	12.8 grams
9	72 – 96°F	17.8 psi	11.7 grams
9	76 – 100°F	18.0 psi	13.0 grams
9	81 – 105°F	18.2 psi	14.8 grams
9	86 – 110°F	18.5 psi	16.9 grams
9	91 – 115°F	18.8 psi	19.2 grams

During running loss temperate conditions, sealed tank systems can generate significant vapor loading during de-pressurization for refueling (“Puff” emissions) – MODELING ANALYSIS

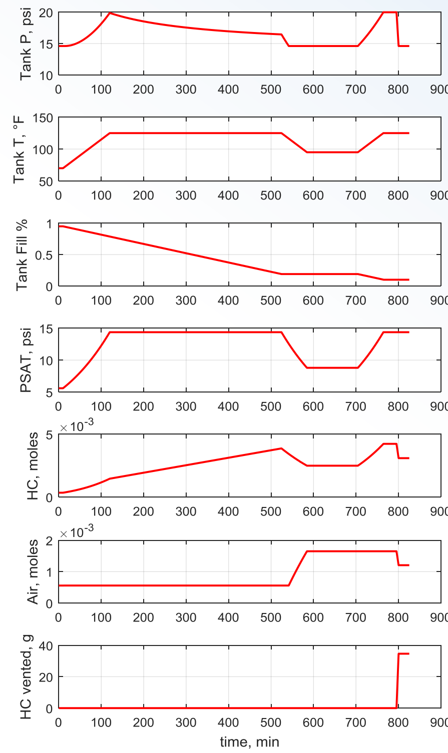
Amb T 95°F, Max T 125°F
Continuous Driving
Tank Vac Relief 15 kPa
FE 30 mpg, Range 395 mi
Puff 13 grams



Amb T 95°F, Max T 125°F
Parked at 19% Fill
Tank Vac Relief 15 kPa
FE 30 mpg, Range 395 mi
Puff 24 grams



Amb T 95°F, Max T 125°F
Parked at 19% Fill
Tank Vac Relief 0 kPa
FE 30 mpg, Range 395 mi
Puff 35 grams



Improvements for controlling puff emissions

- A “puff” can occur during two scenarios:

1. During vehicle engine operation when the tank is vented to the canister and purge system
2. Prior to a refueling event, when the tank is depressurized to the canister

At refueling, the puff load to the canister precedes the refueling event. However, the ORVR test procedures refuel the vehicle in temperature conditions in which the tank will have only a minor puff load or can even be at a vacuum level.

The worst case condition is that the fuel tank is pressurized at a high temperature condition (e.g. very hot day), the vehicle is driven on battery to the gas station, and the vehicle is refueled.

ARB Cap Removal Regulatory Language

- 1.2.3. Tank pressure shall not exceed 10 inches of water 30 seconds after the start of the engine until the end of engine operation during the temperature profile determination unless a pressurized system is used and the manufacturer demonstrates in a separate test that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the running loss fuel tank temperature profile determination.
- 8.1.10. and 8.2.5 Tank pressure shall not exceed 10 inches of water during the running loss test unless a pressurized system is used and the manufacturer demonstrates in a separate test that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the test.
- For 2012 and subsequent model-year off-vehicle charge capable HEVs that are equipped with NIRCOS, a manufacturer shall demonstrate in either a separate test or an engineering evaluation, that vapor would not be vented to the atmosphere if the fuel fill pipe cap was removed at the end of the test.

EPA History with Puff Losses

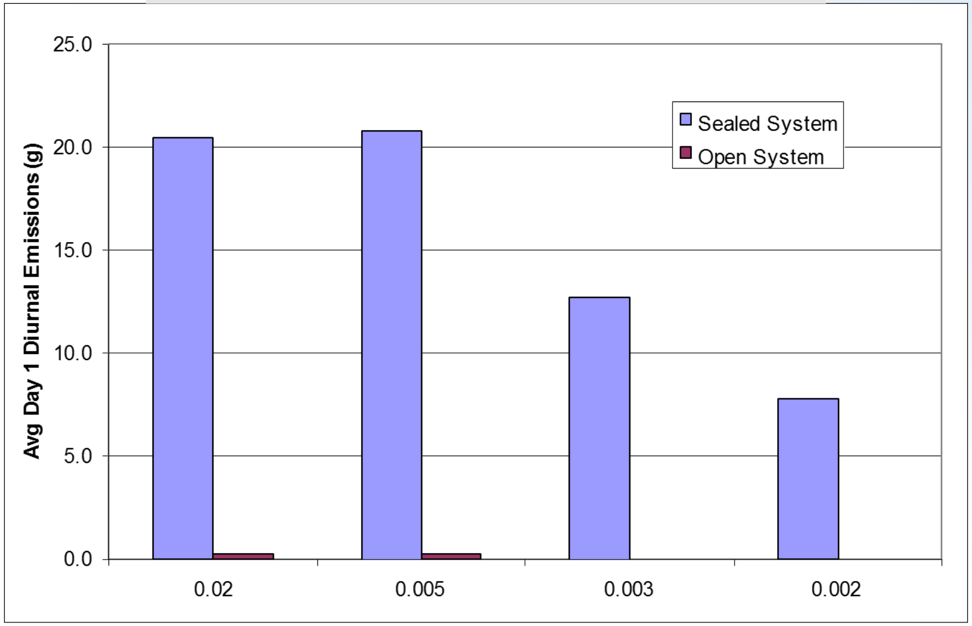
- EPA Identified cap removal emissions (AKA "puff losses") as an issue in 1980s.
  - EPA proposed specific test procedure in Enhanced Evap NPRM in Jan 1990.
  - Cap removal after FTP drive but before hot soak. Mass would be Included in HS measurement.
- March 1993 EPA Enhanced Evap Final Rule deferred action, but included:
  - "Fuel tank pressure during the running loss test may not exceed 10 inches of water (2.5 kPa), unless manufacturer shows that fuel vapors, other than refueling emissions, are vented to the evaporative canister when the fuel cap is removed."
  - There were no concrete provisions in terms of specific test procedures or standards to assess effectiveness of implementation.
  - Follow-on specific proposal and workshop promised to address pressurized systems.
- EPA proposed specific test requirement for puff losses in May 1993 ORVR Supplemental NPRM.
  - Cap removal after ORVR preconditioning drive but before refueling test.
  - Not finalized, but action promised as part of workshop discussed in Enhanced Evap rule.
- Successful rollout of Enhanced Evap & ORVR programs was more important at the time, and pressurized tanks were disappearing -- so future work on puff loss did not occur.
- Puff losses are again an issue with pressurized fuel tanks used on many HEVs/PHEVs and more to come.
  - Stage II does not address puff losses.
  - Even for non-pressurized systems, puff losses are about the same mass as what ORVR does not capture.
- Action needs to be considered in terms of test procedures and standards.
  - Puff losses may possibly be addressed with WLTP
  - Sealed tank systems are a by-product of GHG/CAFE standards. It is important to start now if this is to be included in MTE deliberations

MECA

OBD & Leaks from Fuel Systems

- A leak in a "pressurized" fuel tank NIRCOS system will allow essentially all vapor to vent to atmosphere. On a non-pressurized system much will to canister.
  - This is true at leak diameters much smaller than the 0.020" required for OBD leak detection or the Tier 3 leak standard.
  - Manufacturers expressed concern that leak detection and repair at smaller diameters is problematic.
  - There may be other remedies for pressurized systems.
- This is not directly a canister volume issue, but it is an unintended consequence of "pressurized" fuel tanks with NIRCOS.
  - There should be a level playing field for "pressurized" (NIRCOS) and non-pressurized tanks (with canisters).
- We also need to pre-emptively raise concerns with mechanical seals.

IMPACT OF LEAKS ON OPEN SYSTEM WITH CANISTER vs. SEALED SYSTEM



Orifice Diameter in Inches

A 0.001” limit on a sealed tank is equivalent to a 0.020” limit on an open system