Toyota Motor North America, Inc.
1588 Woodridge Ave
Ann Arbor, Michigan 48105

December 2, 2019

Mr. Linc Wehrly
Compliance Division
Light-Duty Vehicle Center
U.S. Environmental Protection Agency
2000 Traverwood Dr.
Ann Arbor, MI 48105

Subject: Request for 2016-2019 Model Year and later Off-Cycle Credits related to application of the Dual Layer HVAC Technology

This correspondence represents Toyota's application for Off-Cycle credit of 0.6 grams CO_2 per mile for the use of the Dual Layer HVAC Technology. The credit amount has been determined using the alternative methodology outlined in 40 CFR §86.1869-12(d), details of which can be found on the following pages of this correspondence.

Per 40 CFR §86.1869-12, vehicle manufacturers may obtain off-cycle credits for the use of a CO_2-reducing technology whose benefits are not adequately captured on the Federal Test Procedure and/or the Highway Fuel Economy Test. This application is submitted in accordance with the provisions of subsection (d), which enables manufacturers to earn credits by demonstrating that the applicable technology provides GHG reduction benefits via an alternative EPA-approved methodology.

If you have any questions regarding this matter, please contact Mr. Arvon Mitcham of my staff at (734) 995-5587 or email: arvon.mitcham@toyota.com at your earliest convenience.

Sincerely,

William Meschievitz
Group Manager
Powertrain Certification and Compliance

Attachment(s): [2]
Dual Layer HVAC Application (CBI and FOIA versions)

December, 2, 2019

Mr. Linc Wehrly, Director
Light Duty Vehicle Center
Compliance Division
Office of Transportation and Air Quality
2000 Traverwood Drive
Ann Arbor, Michigan, 48105

Request for GHG Off-Cycle Credit for Dual Layer HVAC Technology

Introduction

Pursuant to 40 CFR § 86.1869-12(d), 49 CFR 531.6(b), 49 CFR 533.6(c) Toyota Motor Corporation (herein referred to as "Toyota") requests a credit of 0.6 grams CO_2 per mile Greenhouse Gas (GHG) off-cycle CO_2 credits for Toyota vehicles that use Dual Layer (or 2-Layer) HVAC Technology.

Toyota and DENSO International America (DIAM) contracted with Argonne National Laboratory (ANL) and National Renewable Energy Laboratory (NREL) to confirm the nationalized CO_2 reduction benefit for the 2-Layer HVAC system. The testing, modeling, and simulation work outlined in this document was conducted by ANL and NREL. ANL completed the testing and created the vehicle models which were entered into NREL's simulation and databases to calculate the fuel economy improvement potential. Benefit evaluation followed the methodology outlined in SAE2015-01-0342[1] by ANL and NREL which demonstrates the use of vehicle drive cycle testing to create thermal models that feed into a simulation of real world data to determine off cycle fuel economy benefits. The methodology described in that paper was modified to capture the Dual Layer technology benefit in a Toyota vehicle and is detailed in SAE Technical Paper 2018-01-1368[2]. Toyota used the fuel economy benefit from this joint project to calculate the requested 0.6 grams CO_2 per mile credit amount.

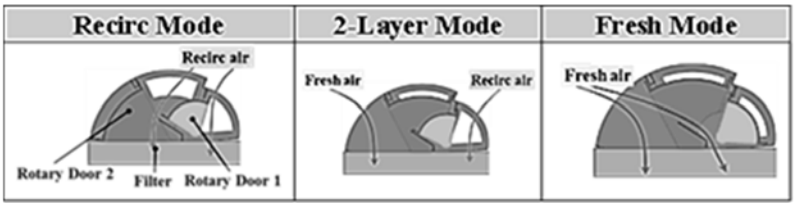
Per the recommendation in 40 CFR § 86.1869-12(d)(1), Toyota met with the EPA for informal discussions on four separate occasions (4/20/2017, 6/25/2018, 9/21/2018, 4/17/2019) to review the proposed plan and confirm application direction from the EPA. In each of the meetings the EPA was agreeable with the Toyota proposed method and the EPA's comments were reflected in the process presented here.

Description of Technology

Ventilation and heat transfer losses between the cabin and outside ambient are the key HVAC thermal losses during warmup. Ventilation losses can be reduced by recirculating the cabin air but has the adverse effect of building up cabin humidity which is a safety hazard due to increased

windshield fogging. Dual Layer HVAC uses two separate layers and a two-stage fan that can recirculate air through the lower outlets while flowing fresh, low humidity air through the upper ducts (includes the windshield defroster). The module has a door that selects full fresh, full recirculate, or dual layer mode based on logic parameters.

Table 1 Mode Positions for Air Intake



Low humidity air is needed to better defog the windshield and recirculated air improves warm up performance. With the use of recirculated air less engine heat is needed to warm the cabin and both the cabin and the engine warms up faster. Faster engine warmup improves vehicle efficiency as engine Qout is reduced.

Rationale for Using Alternative Methodology Demonstration

The off-cycle credit program was created to support the creation and adoption of fuel saving technologies which reduce real world greenhouse gas emissions but cannot be accurately captured in the traditional two cycle tests. Two cycle tests, City and Highway, could not capture the Dual Layer benefit as they do not utilize the HVAC system and operate at temperatures above the main benefit conditions. Dual Layer HVAC technology is not currently available as a credit on the EPA's pre-approved off-cycle credit technology menu. This list was developed during 2010 prior to full development and deployment of dual layer technology.

Two other methods could be used to quantify the CO_2 reduction benefit: 5-cycle testing or alternative application. The benefit of Dual Layer technology is most pronounced in colder temperatures occurring below 0°C ambient temperature where the compressor is not operating to reduce the risk of fogging (above 0°C the compressor is operating, and the fuel consumption benefit of Dual Layer is negated). Standard 5-Cycle testing is normally conducted at a higher ambient temperature than the dual layer operating conditions. In the EPA`s five cycle tests only the SC03 and Cold FTP the use of the HVAC. Cold FTP is run at -7°C which does not capture the full Dual Layer operating range and the use of the defroster in Cold FTP would have forced the vehicle into fresh mode which would cancel Dual Layer mode.

With the above restrictions, it was necessary to pursue off cycle credits under the alternative demonstration methodology pursuant to 40CFR §86.1869-12(d). This alternative method modified

EPA 5 Cycle testing to account for Dual Layer operation and used NREL's Future Automotive Systems Technology Simulator (FASTSim) to quantify the real-world CO_2 reduction benefit.

Proposed Alternative Demonstration Method

The EPA 5-Cycle testing was modified by using colder ambient conditions and setting the HVAC system to the center point of 72°F Auto to reflect Dual Layer operation conditions. Argonne National Laboratory used the vehicle data from the drive cycles to create thermal models. Those models, climate data, elevation, and grade data were input into NREL's Future Automotive Systems Technology Simulator (FASTSim) to determine the real-world benefit of this technology. The output of FASTSim was used for credit calculation. The process as well as the CO_2 off cycle credit calculation is detailed below. For further detail on the testing and modeling please see SAE 2018-01-1368 from which the summary is cited.

A. Vehicle and System Selection

To create the models that could be input to the FASTSim program and to confirm benefit in testing it was necessary to complete vehicle testing. Testing was completed on a 2016 Lexus RX due to dual layer availability and the RX engine efficiency.

This vehicle was selected as it is one of the current Toyota vehicles with the Dual Layer HVAC module. At the time of vehicle selection, only the Lexus RX and Prius were in mass production. Since adoption on the 2016 Lexus RX, many other Toyota and Lexus vehicles have adopted this technology including the 2019 Lexus LS, 2018 Toyota Avalon, 2018 Toyota Avalon Hybrid, 2018 Toyota Camry, 2018 Toyota Camry HV, and the 2016 Toyota Prius among others. Of the all the current Toyota and Lexus vehicles equipped with Dual Layer technology, the 2016 Lexus RX has the worst engine efficiency and, consequently, the lowest benefit.

Of the two available vehicles at the time of this application's start, the RX's lower engine efficiency makes it the worst-case vehicle. Vehicles with lower engine efficiency have more waste heat which lowers the impact of Dual Layer technology as there is less opportunity to accelerate the engine warmup. Dual Layer fuel economy benefit is higher for vehicles with higher efficiency. This relationship is described in more detail in the credit grouping section.

B. Vehicle Testing Methodology and Results

1. Vehicle Testing Methodology

Testing was conducted at Argonne National Laboratory and operated by ANL engineers and technicians. Table 2 shows an outline of the test cases that were run. The Urban Dynamometer Driving Schedule (UDDS or "city test"), Highway Fuel Economy Driving Schedule (HWFET), US06 (Supplemental FTP), and SC03 (Air Conditioning Supplemental FTP) were performed in standard EPA conditions in addition to the modified 5 Cycle testing.

Table 2 Dual Layer Test Matrix

Test Name	EPA Tests					Modified 5 Cycle					
	Temp (C)	5-Cycle	2-Cycle	Engine Start	HVAC	Temp (C)	Engine Start	HVAC Intake Mode			
								Auto (2 Layer)	Fresh	Rec*	Off
UDDS (Cold FTP)	-7	○		Cold & Hot	○	-7	Cold& Hot	●	●	●	
HWFET	25	●	●	Hot		25	Hot				
US06	25	●		Hot		-7,-18, 25, 35	Cold& Hot	●	●	●	●
SCO3	35	●		Hot	●	35	Hot				
FTP UDDS	25	●	●	Cold & Hot		-18, 25, 35	Cold & Hot	●	●	●	●

● = Tested ○ = Applicable Rec= Recirculated Air

As mentioned above standard 5 Cycle testing would not have captured the benefit of the Dual Layer technology due to the ambient test temperatures and the lack of HVAC usage. Therefore, ANL worked to modify the 5 Cycle tests to capture real world conditions and the Dual Layer usage conditions. Testing showed that engine loading in UDDS, HWY, and US06 overlapped, demonstrating that running only UDDS and US06 in many ambient conditions could capture a wide range of driving conditions while reducing test burden. UDDS and US06 were performed at the modified ambient temperatures of 35°C, -7°C, and -18°C conditions. For -7°C and -18°C conditions the HVAC was set to 72°F Auto. Those colder ambient temperatures were used to capture the boundary temperatures in North America.

Each cycle was started at cold and hot start conditions to capture varying powertrain operation effects. These cycles were done with the HVAC module in 2-Layer off (Full Fresh), Auto (2 Layer on based on parameters), and Full Recirculation positions. By doing all three positions the fuel consumption could be compared for each mode. The vehicle's positive temperature coefficient (PTC) was disabled to avoid interaction of the two technologies.

2. Vehicle Test Results

Table 4 shows the result for the city and highway fuel economy in full fresh condition and in 2 Layer mode. ANL's testing showed no benefit for highway and 0.34% benefit for city, leading to a on cycle benefit of 0.18% for 5-Cycle. This fuel economy benefit was used as a comparison point for the final FASTSim result, but was not used for calculating the credit amount.

Table 3 Fuel Consumption Result of Modified 5 Cycle Testing

Fuel Consumption	Full Fresh (2 Layer Disabled)	2 Layer Mode	Delta	Overall Result
Hwy [l/100km]	9.97	9.97	-	0.18%
City [l/100km]	12.39	12.35	0.34%	

C. Simulation Methodology and Results

1. Simulation Methodology

Argonne used the data from the drive cycles to create thermal models. Thermal component models were made for engine oil, engine coolant, cabin, exhaust catalyst, and engine fueling. These models were compared to the experimental data to confirm accuracy. The final model showed good correlation with vehicle testing as outlined in SAE 2018-01-1368.

NREL input the models, climate data, elevation, and grade data into FASTSim. FASTSim can evaluate the impact of a technology by calculating the engine power needed to meet a speed trace, overcome road loads, and overcome component limitations. FASTSim has been used by NREL in studies with other OEMs and is discussed in their recent Validation Report[3]. For simulation, NREL uses the Transportation Secure Data Center (TSDC), which has real world drive cycle data from 1 million miles and 146,000 unique trips from various locations across The United States of America. Data from across US TSDC includes various start times and soak times. The data is iterative, where the starting temperature of a drive is a function of the previous drive's temperature and the time between drives. Based on these cabin soak conditions, the vehicle behavior and powertrain characteristics from the models are then evaluated and the engine fuel use is calculated. The fuel use is calculated with Dual Layer and without Dual Layer and the delta gives the technology benefit. To account for nationwide ambient temperatures the simulation is run over a range of ambient temperatures and

weighting of ambient temperature to Vehicle Miles Traveled (VMT) from the EPA and NHTSA's final rulemaking for emission and CAFE standards, EPA-420-R-12-901[4], was applied.

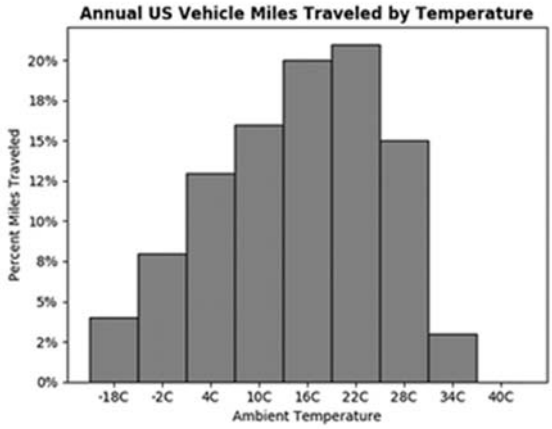


Figure 1 Weighted Percent VMT by Ambient Temperature

2. Simulation Results

The benefit of the technology was analyzed over various ambient temperatures. Benefits were greater in colder temperatures ranging from 1.36% improvement at -20°C to 0.64% at 0°C. The weighted impact was calculated by applying the frequency of miles traveled by temperature from Figure 1 and multiplying each temperature by the fuel economy benefit in Figure 2. From this a fuel economy benefit of 0.16% for Dual Layer technology was determined. This result is lower than the result of the vehicle testing (0.18%) showing that simulating the benefit over a wider range resulted in a more conservative saving amount.

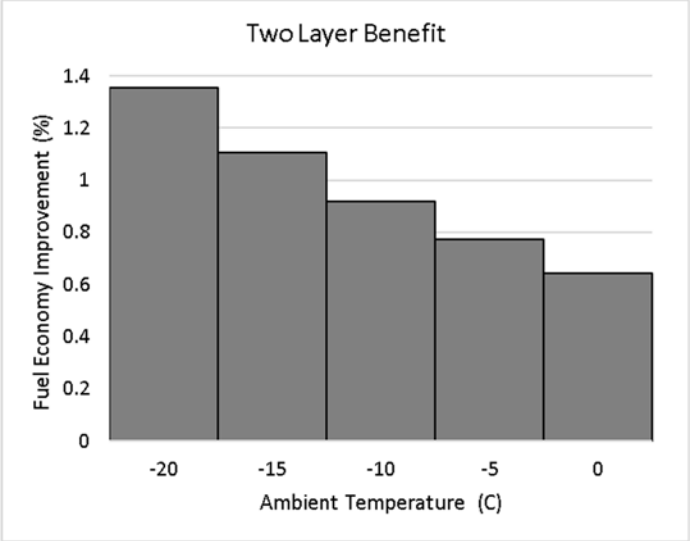


Figure 2 Fuel Economy Effect of 2 Layer System Over Various Ambient Temperatures

NREL used FASTSim to model vehicles with different engine efficiencies to confirm the effect of engine efficiency on the Dual Layer benefit. NREL ran the simulation for vehicles with 10% lower and 10% higher engine efficiency. The 10% lower engine efficiency result was a 0.141% improvement (compared to 0.161% baseline). With a 10% higher engine efficiency there was a 0.186% improvement. This confirms that vehicles with a worse efficiency than the RX will have a lower benefit due to reduced opportunity for the Dual Layer technology to speed up engine warmup. Therefore, Toyota believes the RX can capture the benefit of vehicles with higher engine efficiency since its improvement is more conservative.

Table 4 2 Layer Fuel Efficiency Benefit at Varying Engine Efficiencies

10% Lower	Base	10% Higher
0.14	0.16	0.18

D. Benefit Calculation Methodology and Result

1. Benefit Calculation Methodology

EPA-420-F-14-040, Greenhouse Gas Emissions from a Typical Passenger Vehicle[5], outlines the calculation for how much carbon dioxide is emitted from a typical passenger vehicle. The following outlines the CO_2 benefit calculation for Dual Layer technology based on the EPA calculation:

$$CO_2\ emission\ per\ mile = \frac{CO_2\ per\ gallon}{MPG} = \frac{8887}{MPG} \quad (1)$$

$$\Delta CO_2 = CO_2 \text{ emissions without technology} - CO_2 \text{emissions with technology} \quad (2)$$

$$\Delta CO_2 = \frac{8887}{MPG} - \frac{8887}{MPG \times \left(1 + \frac{FE\ improvement}{100}\right)} \quad (3)$$

$$\Delta CO_2 = \frac{8887 \times \frac{FE\ improvement}{100}}{MPG \times (1 + \frac{FE\ improvement}{100})} \quad (4)$$

Where:

$$FE\ improvement = 0.16\ \%$$
$$MPG = 21.6\ mpg$$
$$CO_2\ per\ gallon = 8887\ CO_2\ per\ gallon$$

As mentioned above the RX Dual Layer fuel economy improvement (0.16%) is used as the RX has a lower engine efficiency. The other values used in the equation were taken from EPA-420-F-14-040 which used data from the Federal Highway Administration Highway 2012 Statistics.

2. Benefit Calculation Result

The result of equation is shown below.

$$\Delta CO_2 = \frac{8887 \frac{CO_2}{gallon} \times \frac{0.16}{100}}{21.6 \frac{miles}{gallon} \times (1 + \frac{0.16}{100})} = 0.66 \frac{grams\ CO_2}{mile} \quad (5)$$

3. 2-Layer Cancelation Consideration

The use of the defroster mode cancels the function of the 2-Layer and as such needs to be quantified to adjust the final grams CO_2 per mile benefit of the technology. To determine this usage factor Toyota used real world customer usage across a twelve-month period from eight different Toyota and Lexus models that totaled 417,936 hours of drive time across all 50 US states. From this the average Toyota defroster usage rate was determined to be 5.89%. The resulting impact to the total credit value is shown in the equation below.

$$\Delta CO_2 = 0.66 \frac{grams\ CO_2}{mile}\ x\ (100\% - 5.89\%) = 0.62 \frac{grams\ CO_2}{mile} \quad (6)$$

4. Credit Grouping Strategy

The fuel economy improvement of the RX simulation was used to calculate the final credit value. Since the RX engine efficiency shows the worst-case

improvement of this benefit is worst case for Dual Layer impact Toyota including other more efficient fuel economy vehicles which would in turn better percent improvement with dual layer. Technologies like Hybrid powertrains and Start and Stop systems would see even larger benefits due to reduced time to allow hybrid and engine start/stop mode. Based on this Toyota will use the RX result as a conservative representation of the CO_2 reduction potential for all current Toyota and Lexus vehicles equipped with Dual Layer technology. Final credit amount of 0.6 grams of CO_2 per mile captures the technology benefit.

Durability Assessment

Toyota Mobile Air-Conditioning (MAC) systems including the condenser, compressor, evaporator, thermal expansion valve and HVAC module are required to pass stringent durability requirements to ensure a useful life time of the components. Testing includes meeting the rigorous 10 years/120,000 mile requirements to achieve the CO_2 related efficiency menu credits for both refrigerant-leakage and high efficiency air conditioning technology. Further durability testing on the HVAC module include door operation durability, vibration durability, thermal shock, high temperature durability, servo motor lock durability, dust durability and oil return.

Based on meeting these internal and EPA MAC durability requirements Toyota is confident that the Dual Layer HVAC can meet the requirements for the vehicle lifetime durability with no degradation in the CO_2 reduction benefit of the Dual Layer HVAC. Detailed results of the durability testing are included in the appendix.

Conclusion

Based on the above results Toyota hereby requests the EPA to approve a greenhouse gas credit of 0.6 grams CO_2 per mile for Dual Layer HVAC for all vehicles equipped with this technology.

These credits have been conservatively based on the worst-case vehicle and real-world simulation. Detailed model year, results, and the requested Dual Layer HVAC credit are included in the appendices. Thank you in advance for your consideration.

Toyota Motor Engineering and Manufacturing North America

Supporting Materials and Documentation

Attachment A: Vehicle Test Data
Attachment B: Simulation Test Data
Attachment C: Technology Description
Attachment D: SAE Paper 2018-01-1368 (Confidential)
Attachment E: Durability Tests (Confidential)
Attachment F: Big Data Result (Confidential)

References

[1] Jehlik, F., Wood, E., Gonder, J., and Lopp, S., "Simulated Real-World Energy Impacts of a Thermally Sensitive Powertrain Considering Viscous Losses and Enrichment," SAE Int. J. Mater. Manf. 8(2):239-250, 2015, https://doi.org/10.4271/2015-01-0342

[2] Jehlik, F., Chevers, N., Moniot, M., Song, Y. et al., "Determining Off-cycle Fuel Economy Benefits of 2-Layer HVAC Technology," SAE Technical Paper 2018-01-1368, 2018, doi:10.4271/2018-01-1368

[3] Gonder, Jeffrey, Aaron Brooker, Eric Wood, and Matthew Moniot. Year. Future Automotive Systems Technology Simulator (FASTSim) Validation Report. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5400-71168. https://www.nrel.gov/docs/fy18osti/71168.pdf

[4] Environmental Protection Agency, "Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards," 2012.

[5] United States Environmental Protection Agency, "Greenhouse Gas Emissions from a Typical Passenger Vehicle", EPA-420-F-14-040a, May 2014.

CS	Cold Start
HS	Hot Start

Fresh	18C	-7C	0C	25C	35C
UDDSx2, CS	61708021	61707018	61708034	61707007	
US06x2, HS	61708022	61707020		61707009	61707014
UDDSx2, HS	61708024	61707022		61707011	61707016
US06x3, CS	61708023	61707021		61707010	61707015
HWYx2				61707008	
SC03					61707013

2 Layer	18C	-7C		25C	35C
UDDSx2, CS	61708016	61708011	61708032		
US06x2, HS	61708017	61708010			
UDDSx2, HS	61708019	61708014			
US06x3, CS	61708018	61708015			

Recirc	18C	-7C		25C	35C
UDDSx2, CS	61708026	61708002	61708031		
US06x2, HS	61708027	61708004			
UDDSx2, HS	61708029	61708006			
US06x3, CS	61708028	61708005			

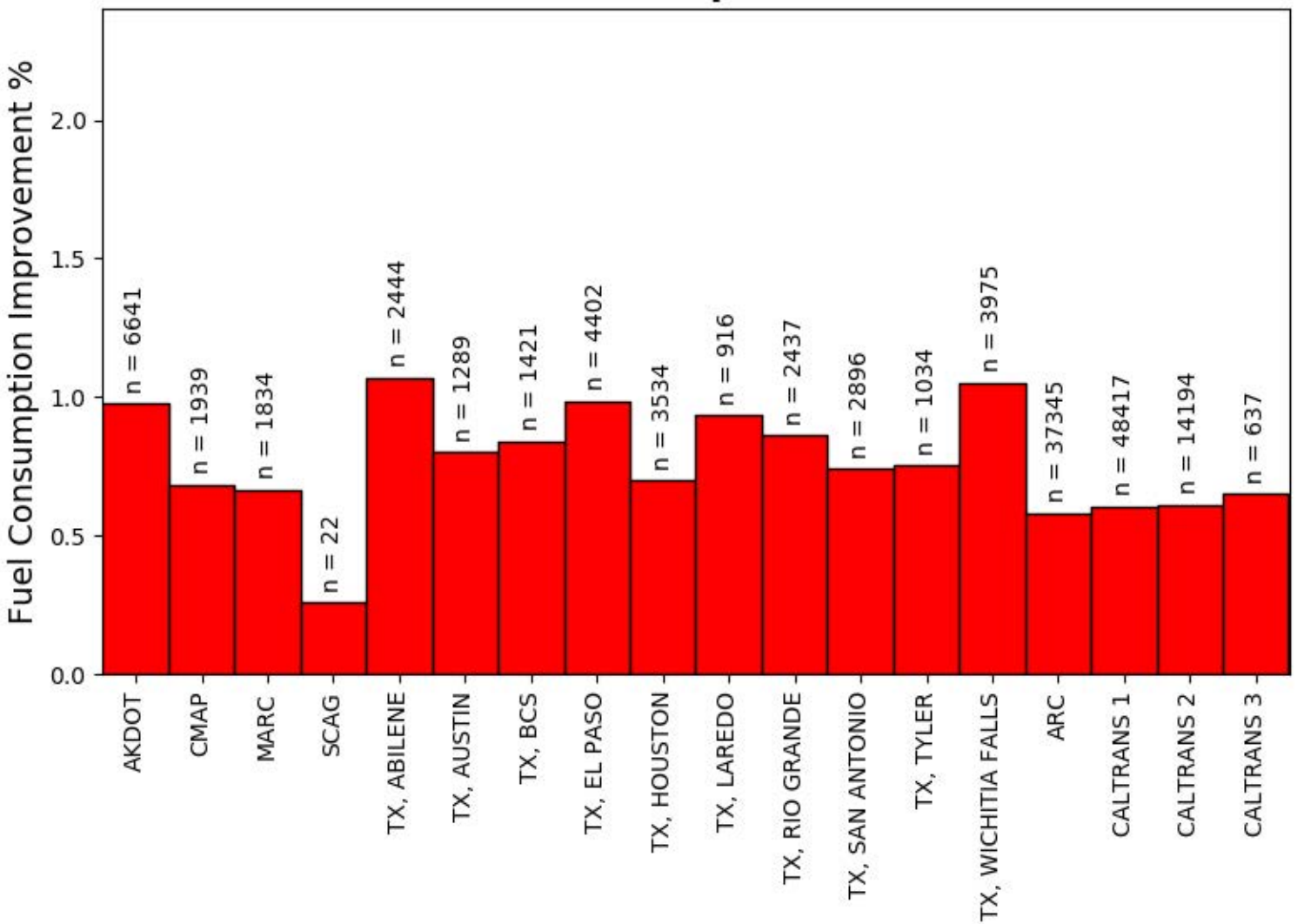
cooldown curve	61708020	61708007		61707012	61707017

Vehicle	**2016 Lexus Rx350**	**Location**		Density	0.742	[g/ml]
Test purpose	**WFO**	Orginial		Net HV:	18539	[BTU/lbm]
Principal Investigator	f jehlik	Print date		Fuel CWF	0.8616	
VIN	2T2BZMCA3GC010110					

Test ID [#]	Cycle	Phase Number	Test Time	Test Cell Temp [C]	Test Cell RH [%]	Test Cell Baro [in/Hg]	Test weight [lb]	Dyno Target A:	Dyno Target B:	Dyno Target C:	Cycle Distance [mi]	Fuel used Scale [gal]	Fuel Economy Scale [mpg]	Fuel Consumption Scale [l/100km]
Day 0 Coastdowns, Channel Check and Prep														
61707003	Blank 1Bag 1400	1p	07/21/17, 09:50:04 AM	23	46	29	4750	36.77	0.31411	0.026615	1.50	0.11	13.84	16.99
61707004	Phase1 UDDS 1Bag	1p	07/21/17, 02:36:10 PM	22	47	29	4750	36.77	0.31411	0.026615	3.58	0.14	25.14	9.36
61707005	Blank 1Bag 1400	1p	07/24/17, 10:54:12 AM	24	42	29	4750	36.42	0.3186	0.027185	5.68	0.33	17.11	13.75
61707006	Hwyx2 + coastdown	1p	07/24/17, 02:40:36 PM	25	39	29	4750	36.42	0.3186	0.027185	10.25	0.27	37.81	6.22
61707006	Hwyx2 + coastdown	2p	07/24/17, 02:40:36 PM	25	38	29	4750	36.42	0.3186	0.027185	10.25	0.27	38.00	6.19
61707007	UDDSx2, 4 bag	1p	07/25/17, 08:46:14 AM	26	37	29	4750	36.42	0.3186	0.027185	3.59	0.16	21.96	10.71
61707007	UDDSx2, 4 bag	2p	07/25/17, 08:46:14 AM	24	42	29	4750	36.42	0.3186	0.027185	3.85	0.15	25.81	9.11
61707007	UDDSx2, 4 bag	c1+2p	07/25/17, 08:46:14 AM	**25**	**39**	**29**					**7.44**	**0.31**	**23.80**	**9.88**
61707007	UDDSx2, 4 bag	3p	07/25/17, 08:46:14 AM	26	35	29	4750	36.42	0.3186	0.027185	3.60	0.13	26.91	8.74
61707007	UDDSx2, 4 bag	4p	07/25/17, 08:46:14 AM	24	40	29	4750	36.42	0.3186	0.027185	3.87	0.15	26.14	9.00
61707007	UDDSx2, 4 bag	c3+4p	07/25/17, 08:46:14 AM	**25**	**38**	**29**					**7.46**	**0.28**	**26.51**	**8.87**
61707008	HWYx2, 2 bag	1p	07/25/17, 10:07:14 AM	28	31	29	4750	36.42	0.3186	0.027185	10.25	0.29	35.51	6.62
61707008	HWYx2, 2 bag	2p	07/25/17, 10:07:14 AM	28	32	29	4750	36.42	0.3186	0.027185	10.25	0.28	36.10	6.52
61707009	US06x2, 4 bag	s1p	07/25/17, 10:47:47 AM	24	42	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.53	17.38
61707009	US06x2, 4 bag	2p	07/25/17, 10:47:47 AM	28	32	29	4750	36.42	0.3186	0.027185	6.24	0.25	25.21	9.33
61707009	US06x2, 4 bag	c1+2p	07/25/17, 10:47:47 AM	**26**	**37**	**29**					**8.02**	**0.38**	**21.16**	**11.12**
61707009	US06x2, 4 bag	s3p	07/25/17, 10:47:47 AM	25	38	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.62	17.27
61707009	US06x2, 4 bag	4p	07/25/17, 10:47:47 AM	29	31	29	4750	36.42	0.3186	0.027185	6.25	0.25	25.31	9.29
61707009	US06x2, 4 bag	c3+4p	07/25/17, 10:47:47 AM	**27**	**34**	**29**					**8.03**	**0.38**	**21.26**	**11.06**
61707010	US06x2, 4 bag	s1p	07/25/17, 01:34:57 PM	24	41	29	4750	36.42	0.3186	0.027185	1.78	0.15	12.10	19.45
61707010	US06x2, 4 bag	2p	07/25/17, 01:34:57 PM	28	31	29	4750	36.42	0.3186	0.027185	6.24	0.26	24.15	9.74
61707010	US06x2, 4 bag	c1+2p	07/25/17, 01:34:57 PM	**26**	**36**	**29**					**8.02**	**0.41**	**19.78**	**11.89**
61707010	US06x2, 4 bag	s3p	07/25/17, 01:34:57 PM	25	38	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.90	16.92
61707010	US06x2, 4 bag	4p	07/25/17, 01:34:57 PM	29	31	29	4750	36.42	0.3186	0.027185	6.24	0.25	25.21	9.33
61707010	US06x2, 4 bag	c3+4p	07/25/17, 01:34:57 PM	**27**	**34**	**29**					**8.02**	**0.38**	**21.35**	**11.02**
61707011	UDDSx2, 4 bag	1p	07/25/17, 02:16:42 PM	25	40	29	4750	36.42	0.3186	0.027185	3.59	0.14	25.79	9.12
61707011	UDDSx2, 4 bag	2p	07/25/17, 02:16:42 PM	24	41	29	4750	36.42	0.3186	0.027185	3.87	0.16	23.70	9.92
61707011	UDDSx2, 4 bag	c1+2p	07/25/17, 02:16:42 PM	**24**	**40**	**29**					**7.47**	**0.30**	**24.67**	**9.54**
61707011	UDDSx2, 4 bag	3p	07/25/17, 02:16:42 PM	27	34	29	4750	36.42	0.3186	0.027185	3.60	0.14	25.50	9.22
61707011	UDDSx2, 4 bag	4p	07/25/17, 02:16:42 PM	25	39	29	4750	36.42	0.3186	0.027185	3.87	0.17	23.39	10.06
61707011	UDDSx2, 4 bag	c3+4p	07/25/17, 02:16:42 PM	**26**	**37**	**29**					**7.47**	**0.31**	**24.36**	**9.66**
61707012	Blank 1Bag 10800	1p	07/25/17, 03:28:39 PM	NaN	NaN	NaN	4750	36.42	0.3186	0.027185	CHANNEL NOT	#VALUE!		#DIV/0!
61707013	SC03, 3 bag	1p	07/26/17, 09:06:17 AM	36	42	29	4750	36.42	0.3186	0.027185	3.59	0.21	17.13	13.73
61707013	SC03, 3 bag	2p	07/26/17, 09:06:17 AM	35	43	29	4750	36.42	0.3186	0.027185	3.58	0.19	19.07	12.34
61707013	SC03, 3 bag	3p	07/26/17, 09:06:17 AM	36	41	29	4750	36.42	0.3186	0.027185	3.58	0.19	18.48	12.73
61707014	US06x2, 4 bag	s1p	07/26/17, 10:15:11 AM	37	39	29	4750	36.42	0.3186	0.027185	1.78	0.15	11.59	20.30
61707014	US06x2, 4 bag	2p	07/26/17, 10:15:11 AM	40	31	29	4750	36.42	0.3186	0.027185	6.24	0.27	22.75	10.34
61707014	US06x2, 4 bag	c1+2p	07/26/17, 10:15:11 AM	**38**	**35**	**29**					**8.03**	**0.43**	**18.74**	**12.55**
61707014	US06x2, 4 bag	s3p	07/26/17, 10:15:11 AM	37	36	29	4750	36.42	0.3186	0.027185	1.78	0.15	12.26	19.19
61707014	US06x2, 4 bag	4p	07/26/17, 10:15:11 AM	40	30	29	4750	36.42	0.3186	0.027185	6.24	0.27	23.09	10.19
61707014	US06x2, 4 bag	c3+4p	07/26/17, 10:15:11 AM	**38**	**33**	**29**					**8.02**	**0.42**	**19.30**	**12.19**
61707015	US06x2, 4 bag	s1p	07/26/17, 01:04:06 PM	34	52	29	4750	36.42	0.3186	0.027185	1.79	0.15	12.27	19.18
61707015	US06x2, 4 bag	2p	07/26/17, 01:04:06 PM	38	35	29	4750	36.42	0.3186	0.027185	6.24	0.26	24.31	9.67
61707015	US06x2, 4 bag	c1+2p	07/26/17, 01:04:06 PM	**36**	**43**	**29**					**8.03**	**0.40**	**19.95**	**11.79**
61707015	US06x2, 4 bag	s3p	07/26/17, 01:04:06 PM	35	41	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.30	17.69
61707015	US06x2, 4 bag	4p	07/26/17, 01:04:06 PM	38	32	29	4750	36.42	0.3186	0.027185	6.24	0.25	24.76	9.50
61707015	US06x2, 4 bag	c3+4p	07/26/17, 01:04:06 PM	**37**	**37**	**29**					**8.02**	**0.39**	**20.79**	**11.32**
61707016	UDDSx2, 4 bag	1p	07/26/17, 01:48:26 PM	35	41	29	4750	36.42	0.3186	0.027185	3.60	0.14	25.06	9.39
61707016	UDDSx2, 4 bag	2p	07/26/17, 01:48:26 PM	34	45	29	4750	36.42	0.3186	0.027185	3.88	0.17	23.22	10.13
61707016	UDDSx2, 4 bag	c1+2p	07/26/17, 01:48:26 PM	**34**	**43**	**29**					**7.48**	**0.31**	**24.07**	**9.77**
61707016	UDDSx2, 4 bag	3p	07/26/17, 01:48:26 PM	36	39	29	4750	36.42	0.3186	0.027185	3.60	0.14	25.28	9.31
61707016	UDDSx2, 4 bag	4p	07/26/17, 01:48:26 PM	34	47	29	4750	36.42	0.3186	0.027185	3.88	0.17	23.13	10.17
61707016	UDDSx2, 4 bag	c3+4p	07/26/17, 01:48:26 PM	**35**	**43**	**29**					**7.48**	**0.31**	**24.12**	**9.75**
61707017	Blank 1Bag 10800	1p	07/26/17, 03:03:32 PM	NaN	NaN	NaN	4750	36.42	0.3186	0.027185	CHANNEL NOT	#VALUE!		#DIV/0!
61707018	UDDSx2, 4 bag	1p	07/27/17, 08:43:45 AM	-6	12	29	4750	36.42	0.3186	0.027185	3.59	0.21	16.82	13.98
61707018	UDDSx2, 4 bag	2p	07/27/17, 08:43:45 AM	-7	15	29	4750	36.42	0.3186	0.027185	3.86	0.19	20.09	11.71
61707018	UDDSx2, 4 bag	c1+2p	07/27/17, 08:43:45 AM	**-6**	**13**	**29**					**7.45**	**0.41**	**18.37**	**12.81**
61707018	UDDSx2, 4 bag	3p	07/27/17, 08:43:45 AM	-5	13	29	4750	36.42	0.3186	0.027185	3.59	0.15	23.52	10.00
61707018	UDDSx2, 4 bag	4p	07/27/17, 08:43:45 AM	-7	15	29	4750	36.42	0.3186	0.027185	3.85	0.17	22.86	10.29
61707018	UDDSx2, 4 bag	c3+4p	07/27/17, 08:43:45 AM	**-6**	**14**	**29**					**7.44**	**0.32**	**23.17**	**10.15**
61707019	UDDSx1, 2 bag	1p	07/27/17, 10:13:41 AM	-9	18	29	4750	36.42	0.3186	0.027185	3.59	0.15	23.38	10.06
61707019	UDDSx1, 2 bag	2p	07/27/17, 10:13:41 AM	-7	15	29	4750	36.42	0.3186	0.027185	3.85	0.17	22.79	10.32
61707020	US06x2, 4 bag	s1p	07/27/17, 10:51:29 AM	-4	12	29	4750	36.42	0.3186	0.027185	1.77	0.13	13.57	17.33
61707020	US06x2, 4 bag	2p	07/27/17, 10:51:29 AM	0	9	29	4750	36.42	0.3186	0.027185	6.24	0.26	24.23	9.71
61707020	US06x2, 4 bag	c1+2p	07/27/17, 10:51:29 AM	**-2**	**10**	**29**					**8.01**	**0.39**	**20.64**	**11.40**
61707020	US06x2, 4 bag	s3p	07/27/17, 10:51:29 AM	-5	13	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.91	16.91
61707020	US06x2, 4 bag	4p	07/27/17, 10:51:29 AM	-2	10	29	4750	36.42	0.3186	0.027185	6.24	0.25	24.65	9.54
61707020	US06x2, 4 bag	c3+4p	07/27/17, 10:51:29 AM	**-3**	**11**	**29**					**8.01**	**0.38**	**21.05**	**11.18**
61707021	US06x3, 3 bag	1p	07/27/17, 01:14:14 PM	-2	10	29	4750	36.42	0.3186	0.027185	8.00	0.45	17.86	13.17
61707021	US06x3, 3 bag	2p	07/27/17, 01:14:14 PM	-2	11	29	4750	36.42	0.3186	0.027185	7.99	0.38	21.19	11.10
61707021	US06x3, 3 bag	3p	07/27/17, 01:14:14 PM	-3	11	29	4750	36.42	0.3186	0.027185	8.00	0.37	21.37	11.01
61707022	UDDSx2, 4 bag	1p	07/27/17, 02:05:38 PM	-6	16	29	4750	36.42	0.3186	0.027185	3.59	0.14	25.32	9.29
61707022	UDDSx2, 4 bag	2p	07/27/17, 02:05:38 PM	-7	15	29	4750	36.42	0.3186	0.027185	3.85	0.17	23.04	10.21
61707022	UDDSx2, 4 bag	c1+2p	07/27/17, 02:05:38 PM	**-7**	**15**	**29**					**7.44**	**0.31**	**24.09**	**9.76**
61707022	UDDSx2, 4 bag	3p	07/27/17, 02:05:38 PM	-6	13	29	4750	36.42	0.3186	0.027185	3.59	0.15	24.61	9.56
61707022	UDDSx2, 4 bag	4p	07/27/17, 02:05:38 PM	-7	15	29	4750	36.42	0.3186	0.027185	3.85	0.17	22.76	10.33
61707022	UDDSx2, 4 bag	c3+4p	07/27/17, 02:05:38 PM	**-6**	**14**	**29**					**7.44**	**0.32**	**23.62**	**9.96**
61707023	UDDSx2, 4 bag	1p	07/28/17, 09:59:57 AM	25	38	29	4750	36.42	0.3186	0.027185	3.60	0.17	21.56	10.91
61707023	UDDSx2, 4 bag	2p	07/28/17, 09:59:57 AM	24	41	29	4750	36.42	0.3186	0.027185	3.85	0.17	22.95	10.25
61707023	UDDSx2, 4 bag	c1+2p	07/28/17, 09:59:57 AM	**25**	**39**	**29**					**7.45**	**0.33**	**22.26**	**10.57**
61707023	UDDSx2, 4 bag	3p	07/28/17, 09:59:57 AM	27	35	29	4750	36.42	0.3186	0.027185	3.59	0.14	25.46	9.24
61707023	UDDSx2, 4 bag	4p	07/28/17, 09:59:57 AM	24	40	29	4750	36.42	0.3186	0.027185	3.85	0.17	23.07	10.20
61707023	UDDSx2, 4 bag	c3+4p	07/28/17, 09:59:57 AM	**25**	**37**	**29**					**7.44**	**0.31**	**24.16**	**9.74**
61708001	UDDSx2, 4 bag	1p	08/02/17, 10:17:24 AM	25	39	29	4750	36.42	0.3186	0.027185	3.59	0.17	20.55	11.45
61708001	UDDSx2, 4 bag	2p	08/02/17, 10:17:24 AM	24	42	29	4750	36.42	0.3186	0.027185	3.85	0.17	22.38	10.51
61708001	UDDSx2, 4 bag	c1+2p	08/02/17, 10:17:24 AM	**25**	**40**	**29**					**7.45**	**0.35**	**21.46**	**10.96**
61708001	UDDSx2, 4 bag	3p	08/02/17, 10:17:24 AM	27	34	29	4750	36.42	0.3186	0.027185	3.60	0.14	25.25	9.32
61708001	UDDSx2, 4 bag	4p	08/02/17, 10:17:24 AM	24	40	29	4750	36.42	0.3186	0.027185	3.86	0.17	22.86	10.29

61708001	UDDSx2, 4 bag	c3+4p	08/02/17, 10:17:24 AM	**26**	**37**	**29**					**7.45**	**0.31**	**23.95**	**9.82**
61708002	UDDSx2, 4 bag	1p	08/03/17, 08:31:18 AM	-6	14	29	4750	36.42	0.3186	0.027185	3.59	0.22	16.49	14.27
61708002	UDDSx2, 4 bag	2p	08/03/17, 08:31:18 AM	-7	15	29	4750	36.42	0.3186	0.027185	3.86	0.19	20.17	11.66
61708002	UDDSx2, 4 bag	c1+2p	08/03/17, 08:31:18 AM	**-7**	**14**	**29**					**7.46**	**0.41**	**18.21**	**12.92**
61708002	UDDSx2, 4 bag	3p	08/03/17, 08:31:18 AM	-5	13	29	4750	36.42	0.3186	0.027185	3.60	0.15	24.69	9.53
61708002	UDDSx2, 4 bag	4p	08/03/17, 08:31:18 AM	-7	15	29	4750	36.42	0.3186	0.027185	3.88	0.17	22.62	10.40
61708002	UDDSx2, 4 bag	c3+4p	08/03/17, 08:31:18 AM	**-6**	**14**	**29**					**7.48**	**0.32**	**23.57**	**9.98**
61708003	US06x2, 4 bag	s1p	08/03/17, 09:53:39 AM	-5	13	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.41	17.53
61708003	US06x2, 4 bag	2p	08/03/17, 09:53:39 AM	-1	9	29	4750	36.42	0.3186	0.027185	6.24	0.25	24.47	9.61
61708003	US06x2, 4 bag	c1+2p	08/03/17, 09:53:39 AM	**-3**	**11**	**29**					**8.02**	**0.39**	**20.68**	**11.37**
61708003	US06x2, 4 bag	s3p	08/03/17, 09:53:39 AM	-5	14	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.99	16.81
61708003	US06x2, 4 bag	4p	08/03/17, 09:53:39 AM	-2	12	29	4750	36.42	0.3186	0.027185	6.24	0.25	25.22	9.33
61708003	US06x2, 4 bag	c3+4p	08/03/17, 09:53:39 AM	**-4**	**13**	**29**					**8.02**	**0.37**	**21.41**	**10.99**
61708004	US06x2, 4 bag	s1p	08/03/17, 10:50:03 AM	-6	15	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.77	17.08
61708004	US06x2, 4 bag	2p	08/03/17, 10:50:03 AM	-3	12	29	4750	36.42	0.3186	0.027185	6.24	0.25	24.57	9.57
61708004	US06x2, 4 bag	c1+2p	08/03/17, 10:50:03 AM	**-4**	**13**	**29**					**8.03**	**0.38**	**20.93**	**11.24**
61708004	US06x2, 4 bag	s3p	08/03/17, 10:50:03 AM	-6	14	29	4750	36.42	0.3186	0.027185	1.79	0.13	13.95	16.87
61708004	US06x2, 4 bag	4p	08/03/17, 10:50:03 AM	-3	11	29	4750	36.42	0.3186	0.027185	6.24	0.25	24.90	9.45
61708004	US06x2, 4 bag	c3+4p	08/03/17, 10:50:03 AM	**-4**	**12**	**29**					**8.02**	**0.38**	**21.19**	**11.10**
61708005	US06x3, 3 bag	1p	08/03/17, 02:06:25 PM	-3	10	29	4750	36.42	0.3186	0.027185	8.01	0.45	17.65	13.33
61708005	US06x3, 3 bag	2p	08/03/17, 02:06:25 PM	-4	12	29	4750	36.42	0.3186	0.027185	8.00	0.38	20.97	11.22
61708005	US06x3, 3 bag	3p	08/03/17, 02:06:25 PM	-5	11	29	4750	36.42	0.3186	0.027185	8.00	0.37	21.34	11.02
61708006	UDDSx2, 4 bag	1p	08/03/17, 02:59:12 PM	-6	12	29	4750	36.42	0.3186	0.027185	3.59	0.14	25.16	9.35
61708006	UDDSx2, 4 bag	2p	08/03/17, 02:59:12 PM	-7	14	29	4750	36.42	0.3186	0.027185	3.85	0.17	22.79	10.32
61708006	UDDSx2, 4 bag	c1+2p	08/03/17, 02:59:12 PM	**-7**	**13**	**29**					**7.44**	**0.31**	**23.87**	**9.85**
61708006	UDDSx2, 4 bag	3p	08/03/17, 02:59:12 PM	-6	12	29	4750	36.42	0.3186	0.027185	3.59	0.15	24.76	9.50
61708006	UDDSx2, 4 bag	4p	08/03/17, 02:59:12 PM	-7	14	29	4750	36.42	0.3186	0.027185	3.86	0.17	22.83	10.30
61708006	UDDSx2, 4 bag	c3+4p	08/03/17, 02:59:12 PM	**-6**	**13**	**29**					**7.45**	**0.31**	**23.73**	**9.91**
61708007	Blank 1Bag 10800	1p	08/03/17, 04:07:07 PM	NaN	NaN	NaN	4750	36.42	0.3186	0.027185	CHANNEL NO	#VALUE!		#DIV/0!
61708008		1p	08/04/17, 08:44:43 AM	-6	10	29	4750	36.42	0.3186	0.027185	3.60	0.22	16.60	14.17
61708008		2p	08/04/17, 08:44:43 AM	-8	13	29	4750	36.42	0.3186	0.027185	1.68	0.10	16.09	14.62
61708009	UDDSx2, 4 bag	1p	08/04/17, 12:42:33 PM	-6	11	29	4750	36.42	0.3186	0.027185	3.60	0.21	16.86	13.95
61708009	UDDSx2, 4 bag	2p	08/04/17, 12:42:33 PM	-7	12	29	4750	36.42	0.3186	0.027185	3.86	0.19	20.63	11.40
61708009	UDDSx2, 4 bag	c1+2p	08/04/17, 12:42:33 PM	**-7**	**11**	**29**					**7.46**	**0.40**	**18.62**	**12.63**
61708009	UDDSx2, 4 bag	3p	08/04/17, 12:42:33 PM	-5	10	29	4750	36.42	0.3186	0.027185	3.58	0.15	24.52	9.59
61708009	UDDSx2, 4 bag	4p	08/04/17, 12:42:33 PM	-7	12	29	4750	36.42	0.3186	0.027185	3.86	0.17	22.92	10.26
61708009	UDDSx2, 4 bag	c3+4p	08/04/17, 12:42:33 PM	**-6**	**11**	**29**					**7.45**	**0.31**	**23.66**	**9.94**
61708010	US06x2, 4 bag	s1p	08/04/17, 02:01:00 PM	-5	10	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.46	17.47
61708010	US06x2, 4 bag	2p	08/04/17, 02:01:00 PM	-1	7	29	4750	36.42	0.3186	0.027185	6.24	0.26	24.29	9.68
61708010	US06x2, 4 bag	c1+2p	08/04/17, 02:01:00 PM	**-3**	**9**	**29**					**8.02**	**0.39**	**20.62**	**11.41**
61708010	US06x2, 4 bag	s3p	08/04/17, 02:01:00 PM	-6	12	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.98	16.83
61708010	US06x2, 4 bag	4p	08/04/17, 02:01:00 PM	-3	9	29	4750	36.42	0.3186	0.027185	6.23	0.25	24.75	9.50
61708010	US06x2, 4 bag	c3+4p	08/04/17, 02:01:00 PM	**-4**	**11**	**29**					**8.02**	**0.38**	**21.13**	**11.13**
61708011	UDDSx2, 4 bag	1p	08/07/17, 08:15:15 AM	-6	11	29	4750	36.42	0.3186	0.027185	3.59	0.22	16.64	14.13
61708011	UDDSx2, 4 bag	2p	08/07/17, 08:15:15 AM	-7	13	29	4750	36.42	0.3186	0.027185	3.86	0.19	20.29	11.59
61708011	UDDSx2, 4 bag	c1+2p	08/07/17, 08:15:15 AM	**-6**	**12**	**29**					**7.45**	**0.41**	**18.35**	**12.82**
61708011	UDDSx2, 4 bag	3p	08/07/17, 08:15:15 AM	-5	11	29	4750	36.42	0.3186	0.027185	3.59	0.15	24.36	9.66
61708011	UDDSx2, 4 bag	4p	08/07/17, 08:15:15 AM	-7	13	29	4750	36.42	0.3186	0.027185	3.86	0.17	22.66	10.38
61708011	UDDSx2, 4 bag	c3+4p	08/07/17, 08:15:15 AM	**-6**	**12**	**29**					**7.46**	**0.32**	**23.45**	**10.03**
61708012	US06x2, 4 bag	s1p	08/07/17, 09:33:31 AM	-5	11	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.37	17.59
61708012	US06x2, 4 bag	2p	08/07/17, 09:33:31 AM	-1	8	29	4750	36.42	0.3186	0.027185	6.24	0.26	24.14	9.75
61708012	US06x2, 4 bag	c1+2p	08/07/17, 09:33:31 AM	**-3**	**9**	**29**					**8.02**	**0.39**	**20.48**	**11.49**
61708012	US06x2, 4 bag	s3p	08/07/17, 09:33:31 AM	-5	13	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.99	16.82
61708012	US06x2, 4 bag	4p	08/07/17, 09:33:31 AM	-2	10	29	4750	36.42	0.3186	0.027185	6.24	0.25	24.72	9.52
61708012	US06x2, 4 bag	c3+4p	08/07/17, 09:33:31 AM	**-4**	**11**	**29**					**8.02**	**0.38**	**21.12**	**11.14**
61708013	US06x3, 3 bag	1p	08/07/17, 01:09:45 PM	-7	11	29	4750	36.42	0.3186	0.027185	8.01	0.44	18.06	13.02
61708013	US06x3, 3 bag	2p	08/07/17, 01:09:45 PM	-7	11	29	4750	36.42	0.3186	0.027185	8.02	0.36	22.13	10.63
61708013	US06x3, 3 bag	3p	08/07/17, 01:09:45 PM	-7	12	29	4750	36.42	0.3186	0.027185	8.02	0.37	21.71	10.83
61708014	UDDSx2, 4 bag	1p	08/07/17, 02:01:36 PM	-6	10	29	4750	36.42	0.3186	0.027185	3.59	0.14	25.29	9.30
61708014	UDDSx2, 4 bag	2p	08/07/17, 02:01:36 PM	-7	12	29	4750	36.42	0.3186	0.027185	3.86	0.17	23.05	10.20
61708014	UDDSx2, 4 bag	c1+2p	08/07/17, 02:01:36 PM	**-6**	**11**	**29**					**7.46**	**0.31**	**24.08**	**9.77**
61708014	UDDSx2, 4 bag	3p	08/07/17, 02:01:36 PM	-6	10	29	4750	36.42	0.3186	0.027185	3.59	0.15	24.70	9.52
61708014	UDDSx2, 4 bag	4p	08/07/17, 02:01:36 PM	-7	12	29	4750	36.42	0.3186	0.027185	3.86	0.17	22.69	10.36
61708014	UDDSx2, 4 bag	c3+4p	08/07/17, 02:01:36 PM	**-6**	**11**	**29**					**7.46**	**0.32**	**23.62**	**9.96**
61708015	US06x3, 3 bag	1p	08/07/17, 04:29:22 PM	-3	9	29	4750	36.42	0.3186	0.027185	8.02	0.45	17.89	13.15
61708015	US06x3, 3 bag	2p	08/07/17, 04:29:22 PM	-5	11	29	4750	36.42	0.3186	0.027185	8.02	0.38	21.11	11.14
61708015	US06x3, 3 bag	3p	08/07/17, 04:29:22 PM	-4	11	29	4750	36.42	0.3186	0.027185	8.03	0.38	21.17	11.11
61708016	UDDSx2, 4 bag	1p	08/08/17, 09:56:01 AM	-17	25	29	4750	36.42	0.3186	0.027185	3.59	0.24	15.12	15.56
61708016	UDDSx2, 4 bag	2p	08/08/17, 09:56:01 AM	-18	25	29	4750	36.42	0.3186	0.027185	3.85	0.21	18.77	12.53
61708016	UDDSx2, 4 bag	c1+2p	08/08/17, 09:56:01 AM	**-17**	**25**	**29**					**7.45**	**0.44**	**16.81**	**13.99**
61708016	UDDSx2, 4 bag	3p	08/08/17, 09:56:01 AM	-17	24	29	4750	36.42	0.3186	0.027185	3.60	0.16	22.40	10.50
61708016	UDDSx2, 4 bag	4p	08/08/17, 09:56:01 AM	-18	26	29	4750	36.42	0.3186	0.027185	3.87	0.17	22.34	10.53
61708016	UDDSx2, 4 bag	c3+4p	08/08/17, 09:56:01 AM	**-17**	**25**	**29**					**7.46**	**0.33**	**22.37**	**10.52**
61708017	US06x2, 4 bag	s1p	08/08/17, 11:13:12 AM	-15	22	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.25	17.76
61708017	US06x2, 4 bag	2p	08/08/17, 11:13:12 AM	-11	16	29	4750	36.42	0.3186	0.027185	6.24	0.27	23.37	10.07
61708017	US06x2, 4 bag	c1+2p	08/08/17, 11:13:12 AM	**-13**	**19**	**29**					**8.02**	**0.40**	**19.98**	**11.77**
61708017	US06x2, 4 bag	s3p	08/08/17, 11:13:12 AM	-13	17	29	4750	36.42	0.3186	0.027185	1.78	0.13	13.81	17.03
61708017	US06x2, 4 bag	4p	08/08/17, 11:13:12 AM	-9	13	29	4750	36.42	0.3186	0.027185	6.24	0.25	24.53	9.59
61708017	US06x2, 4 bag	c3+4p	08/08/17, 11:13:12 AM	**-11**	**15**	**29**					**8.03**	**0.38**	**20.92**	**11.24**
61708018	US06x3, 3 bag	1p	08/08/17, 01:38:25 PM	-13	19	29	4750	36.42	0.3186	0.027185	8.00	0.47	17.12	13.74
61708018	US06x3, 3 bag	2p	08/08/17, 01:38:25 PM	-11	14	29	4750	36.42	0.3186	0.027185	7.99	0.38	20.91	11.25
61708018	US06x3, 3 bag	3p	08/08/17, 01:38:25 PM	-10	13	29	4750	36.42	0.3186	0.027185	8.00	0.38	21.19	11.10
61708019	UDDSx2, 4 bag	1p	08/08/17, 02:29:03 PM	-16	18	29	4750	36.42	0.3186	0.027185	3.59	0.15	24.18	9.73
61708019	UDDSx2, 4 bag	2p	08/08/17, 02:29:03 PM	-17	21	29	4750	36.42	0.3186	0.027185	3.87	0.17	22.70	10.36
61708019	UDDSx2, 4 bag	c1+2p	08/08/17, 02:29:03 PM	**-17**	**19**	**29**					**7.46**	**0.32**	**23.39**	**10.06**
61708019	UDDSx2, 4 bag	3p	08/08/17, 02:29:03 PM	-17	22	29	4750	36.42	0.3186	0.027185	3.59	0.15	23.90	9.84
61708019	UDDSx2, 4 bag	4p	08/08/17, 02:29:03 PM	-18	23	29	4750	36.42	0.3186	0.027185	3.86	0.17	22.37	10.51
61708019	UDDSx2, 4 bag	c3+4p	08/08/17, 02:29:03 PM	**-18**	**22**	**29**					**7.45**	**0.32**	**23.08**	**10.19**
61708020	Blank 1Bag 10800	1p	08/08/17, 03:36:42 PM	NaN	NaN	NaN	4750	36.42	0.3186	0.027185	CHANNEL NO	#VALUE!		#DIV/0!
61708021	UDDSx2, 4 bag	1p	08/09/17, 07:51:51 AM	-17	27	29	4750	36.42	0.3186	0.027185	3.59	0.24	15.01	15.67
61708021	UDDSx2, 4 bag	2p	08/09/17, 07:51:51 AM	-18	30	29	4750	36.42	0.3186	0.027185	3.86	0.21	18.16	12.95
61708021	UDDSx2, 4 bag	c1+2p	08/09/17, 07:51:51 AM	**-17**	**28**	**29**					**7.45**	**0.45**	**16.49**	**14.26**
61708021	UDDSx2, 4 bag	3p	08/09/17, 07:51:51 AM	-17	28	29	4750	36.42	0.3186	0.027185	3.60	0.16	22.13	10.63
61708021	UDDSx2, 4 bag	4p	08/09/17, 07:51:51 AM	-18	28	29	4750	36.42	0.3186	0.027185	3.86	0.18	21.89	10.75
61708021	UDDSx2, 4 bag	c3+4p	08/09/17, 07:51:51 AM	**-17**	**28**	**29**					**7.45**	**0.34**	**22.00**	**10.69**
61708022	US06x2, 4 bag	s1p	08/09/17, 09:10:48 AM	-15	25	29	4750	36.42	0.3186	0.027185	1.78	0.14	13.06	18.01
61708022	US06x2, 4 bag	2p	08/09/17, 09:10:48 AM	-11	18	29	4750	36.42	0.3186	0.027185	6.24	0.26	24.01	9.80

61708022	US06x2, 4 bag	c1+2p	08/09/17, 09:10:48 AM	**-13**	**21**	**29**					**8.02**	**0.40**	**20.24**	**11.62**
61708022	US06x2, 4 bag	s3p	08/09/17, 09:10:48 AM	-12	16	29	4750	36.42	0.3186	0.027185	1.79	0.13	13.86	16.97
61708022	US06x2, 4 bag	4p	08/09/17, 09:10:48 AM	-9	13	29	4750	36.42	0.3186	0.027185	6.24	0.25	24.78	9.49
61708022	US06x2, 4 bag	c3+4p	08/09/17, 09:10:48 AM	**-11**	**14**	**29**					**8.03**	**0.38**	**21.08**	**11.16**
61708023	US06x3, 3 bag	1p	08/09/17, 12:46:19 PM	-13	18	29	4750	36.42	0.3186	0.027185	8.02	0.47	17.02	13.82
61708023	US06x3, 3 bag	2p	08/09/17, 12:46:19 PM	-11	15	29	4750	36.42	0.3186	0.027185	8.03	0.38	20.99	11.20
61708023	US06x3, 3 bag	3p	08/09/17, 12:46:19 PM	-10	14	29	4750	36.42	0.3186	0.027185	8.02	0.38	21.11	11.14
61708024	UDDSx2, 4 bag	1p	08/09/17, 01:39:11 PM	-16	19	29	4750	36.42	0.3186	0.027185	3.60	0.15	24.17	9.73
61708024	UDDSx2, 4 bag	2p	08/09/17, 01:39:11 PM	-17	21	29	4750	36.42	0.3186	0.027185	3.88	0.17	22.77	10.33
61708024	UDDSx2, 4 bag	c1+2p	08/09/17, 01:39:11 PM	**-17**	**20**	**29**					**7.48**	**0.32**	**23.43**	**10.04**
61708024	UDDSx2, 4 bag	3p	08/09/17, 01:39:11 PM	-17	22	29	4750	36.42	0.3186	0.027185	3.60	0.15	24.11	9.76
61708024	UDDSx2, 4 bag	4p	08/09/17, 01:39:11 PM	-18	22	29	4750	36.42	0.3186	0.027185	3.88	0.17	22.33	10.53
61708024	UDDSx2, 4 bag	c3+4p	08/09/17, 01:39:11 PM	**-18**	**22**	**29**					**7.48**	**0.32**	**23.15**	**10.16**
61708025	Blank 1Bag 10800	1p	08/09/17, 02:47:42 PM	NaN	NaN	NaN	4750	36.42	0.3186	0.027185	)T FOUND CH	#VALUE!		#DIV/0!
61708026	UDDSx2, 4 bag	1p	08/10/17, 07:54:14 AM	-17	25	29	4750	36.42	0.3186	0.027185	3.60	0.24	15.03	15.65
61708026	UDDSx2, 4 bag	2p	08/10/17, 07:54:14 AM	-18	27	29	4750	36.42	0.3186	0.027185	3.86	0.20	19.19	12.26
61708026	UDDSx2, 4 bag	c1+2p	08/10/17, 07:54:14 AM	**-17**	**26**	**29**					**7.45**	**0.44**	**16.93**	**13.89**
61708026	UDDSx2, 4 bag	3p	08/10/17, 07:54:14 AM	-17	26	29	4750	36.42	0.3186	0.027185	3.60	0.16	22.86	10.29
61708026	UDDSx2, 4 bag	4p	08/10/17, 07:54:14 AM	-18	27	29	4750	36.42	0.3186	0.027185	3.86	0.17	22.29	10.55
61708026	UDDSx2, 4 bag	c3+4p	08/10/17, 07:54:14 AM	**-17**	**26**	**29**					**7.45**	**0.33**	**22.56**	**10.42**
61708027	US06x2, 4 bag	s1p	08/10/17, 09:12:55 AM	-14	22	29	4750	36.42	0.3186	0.027185	1.78	0.14	13.17	17.86
61708027	US06x2, 4 bag	2p	08/10/17, 09:12:55 AM	-11	15	29	4750	36.42	0.3186	0.027185	6.24	0.26	24.01	9.79
61708027	US06x2, 4 bag	c1+2p	08/10/17, 09:12:55 AM	**-13**	**19**	**29**					**8.02**	**0.39**	**20.30**	**11.58**
61708027	US06x2, 4 bag	s3p	08/10/17, 09:12:55 AM	-12	16	29	4750	36.42	0.3186	0.027185	1.78	0.13	14.07	16.72
61708027	US06x2, 4 bag	4p	08/10/17, 09:12:55 AM	-9	13	29	4750	36.42	0.3186	0.027185	6.24	0.25	24.75	9.50
61708027	US06x2, 4 bag	c3+4p	08/10/17, 09:12:55 AM	**-11**	**14**	**29**					**8.02**	**0.38**	**21.18**	**11.11**
61708028	US06x3, 3 bag	1p	08/10/17, 12:47:39 PM	-13	19	29	4750	36.42	0.3186	0.027185	8.01	0.46	17.23	13.65
61708028	US06x3, 3 bag	2p	08/10/17, 12:47:39 PM	-12	15	29	4750	36.42	0.3186	0.027185	8.02	0.38	21.03	11.18
61708028	US06x3, 3 bag	3p	08/10/17, 12:47:39 PM	-10	13	29	4750	36.42	0.3186	0.027185	8.02	0.38	21.38	11.00
61708029	UDDSx2, 4 bag	1p	08/10/17, 01:38:27 PM	-16	19	29	4750	36.42	0.3186	0.027185	3.60	0.15	24.59	9.56
61708029	UDDSx2, 4 bag	2p	08/10/17, 01:38:27 PM	-17	21	29	4750	36.42	0.3186	0.027185	3.86	0.17	22.83	10.30
61708029	UDDSx2, 4 bag	c1+2p	08/10/17, 01:38:27 PM	**-16**	**20**	**29**					**7.46**	**0.32**	**23.65**	**9.95**
61708029	UDDSx2, 4 bag	3p	08/10/17, 01:38:27 PM	-17	22	29	4750	36.42	0.3186	0.027185	3.59	0.15	23.92	9.83
61708029	UDDSx2, 4 bag	4p	08/10/17, 01:38:27 PM	-18	22	29	4750	36.42	0.3186	0.027185	3.87	0.17	22.18	10.60
61708029	UDDSx2, 4 bag	c3+4p	08/10/17, 01:38:27 PM	**-18**	**22**	**29**					**7.46**	**0.32**	**22.99**	**10.23**
61708030	UDDSx2, 4 bag	1p	08/14/17, 02:34:28 PM	-2	12	29	4750	36.42	0.3186	0.027185	3.59	#DIV/0!		#DIV/0!
61708030	UDDSx2, 4 bag	2p	08/14/17, 02:34:28 PM	-3	12	29	4750	36.42	0.3186	0.027185	3.86	#DIV/0!		#DIV/0!
61708031	UDDSx2, 4 bag	1p	08/15/17, 12:43:32 PM	0	12	29	4750	36.42	0.3186	0.027185	3.59	0.21	17.13	13.73
61708031	UDDSx2, 4 bag	2p	08/15/17, 12:43:32 PM	-2	14	29	4750	36.42	0.3186	0.027185	3.85	0.20	19.51	12.05
61708031	UDDSx2, 4 bag	c1+2p	08/15/17, 12:43:32 PM	**-1**	**13**	**29**					**7.44**	**0.41**	**18.29**	**12.86**
61708031	UDDSx2, 4 bag	3p	08/15/17, 12:43:32 PM	0	12	29	4750	36.42	0.3186	0.027185	3.59	0.16	22.21	10.59
61708031	UDDSx2, 4 bag	4p	08/15/17, 12:43:32 PM	-2	13	29	4750	36.42	0.3186	0.027185	3.87	0.19	20.90	11.26
61708031	UDDSx2, 4 bag	c3+4p	08/15/17, 12:43:32 PM	**-1**	**13**	**29**					**7.47**	**0.35**	**21.51**	**10.93**
61708032	UDDSx2, 4 bag	1p	08/16/17, 08:31:18 AM	-1	9	29	4750	36.42	0.3186	0.027185	3.60	0.21	17.29	13.61
61708032	UDDSx2, 4 bag	2p	08/16/17, 08:31:18 AM	-3	10	29	4750	36.42	0.3186	0.027185	3.86	0.18	21.06	11.17
61708032	UDDSx2, 4 bag	c1+2p	08/16/17, 08:31:18 AM	**-2**	**9**	**29**					**7.46**	**0.39**	**19.06**	**12.34**
61708032	UDDSx2, 4 bag	3p	08/16/17, 08:31:18 AM	0	9	29	4750	36.42	0.3186	0.027185	3.59	0.15	23.38	10.06
61708032	UDDSx2, 4 bag	4p	08/16/17, 08:31:18 AM	-2	10	29	4750	36.42	0.3186	0.027185	3.87	0.17	22.74	10.34
61708032	UDDSx2, 4 bag	c3+4p	08/16/17, 08:31:18 AM	**-1**	**9**	**29**					**7.46**	**0.32**	**23.04**	**10.21**
61708033	UDDSx2, 4 bag	1p	08/16/17, 01:21:17 PM	-1	9	29	4750	36.42	0.3186	0.027185	3.60	0.21	17.17	13.70
61708033	UDDSx2, 4 bag	2p	08/16/17, 01:21:17 PM	-3	10	29	4750	36.42	0.3186	0.027185	3.87	0.19	20.63	11.40
61708033	UDDSx2, 4 bag	c1+2p	08/16/17, 01:21:17 PM	**-2**	**9**	**29**					**7.47**	**0.40**	**18.80**	**12.51**
61708033	UDDSx2, 4 bag	3p	08/16/17, 01:21:17 PM	0	8	29	4750	36.42	0.3186	0.027185	3.60	0.16	23.16	10.15
61708033	UDDSx2, 4 bag	4p	08/16/17, 01:21:17 PM	-2	9	29	4750	36.42	0.3186	0.027185	3.85	0.18	21.41	10.99
61708033	UDDSx2, 4 bag	c3+4p	08/16/17, 01:21:17 PM	**-1**	**9**	**29**					**7.45**	**0.34**	**22.22**	**10.58**
61708034	UDDSx2, 4 bag	1p	08/17/17, 08:35:16 AM	0	8	29	4750	36.42	0.3186	0.027185	3.59	0.20	17.70	13.29
61708034	UDDSx2, 4 bag	2p	08/17/17, 08:35:16 AM	-2	9	29	4750	36.42	0.3186	0.027185	3.87	0.18	21.26	11.07
61708034	UDDSx2, 4 bag	c1+2p	08/17/17, 08:35:16 AM	**-1**	**9**	**29**					**7.46**	**0.38**	**19.38**	**12.14**
61708034	UDDSx2, 4 bag	3p	08/17/17, 08:35:16 AM	1	8	29	4750	36.42	0.3186	0.027185	3.59	0.15	23.48	10.02
61708034	UDDSx2, 4 bag	4p	08/17/17, 08:35:16 AM	-2	10	29	4750	36.42	0.3186	0.027185	3.86	0.17	22.95	10.25
61708034	UDDSx2, 4 bag	c3+4p	08/17/17, 08:35:16 AM	**-1**	**9**	**29**					**7.46**	**0.32**	**23.20**	**10.14**
61708035	UDDSx2, 4 bag	1p	08/17/17, 12:31:50 PM	0	10	29	4750	36.42	0.3186	0.027185	3.59	0.21	17.24	13.64
61708035	UDDSx2, 4 bag	2p	08/17/17, 12:31:50 PM	-2	11	29	4750	36.42	0.3186	0.027185	3.86	0.20	19.76	11.90
61708035	UDDSx2, 4 bag	c1+2p	08/17/17, 12:31:50 PM	**-1**	**10**	**29**					**7.46**	**0.40**	**18.46**	**12.74**
61708035	UDDSx2, 4 bag	3p	08/17/17, 12:31:50 PM	1	9	29	4750	36.42	0.3186	0.027185	3.59	0.16	22.47	10.47
61708035	UDDSx2, 4 bag	4p	08/17/17, 12:31:50 PM	-2	11	29	4750	36.42	0.3186	0.027185	3.85	0.18	21.54	10.92
61708035	UDDSx2, 4 bag	c3+4p	08/17/17, 12:31:50 PM	**0**	**10**	**29**					**7.45**	**0.34**	**21.98**	**10.70**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CMAP
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SCAG
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TX, AUSTIN
TX, BCS
TX, EL PASO
TX, HOUSTON
TX, LAREDO
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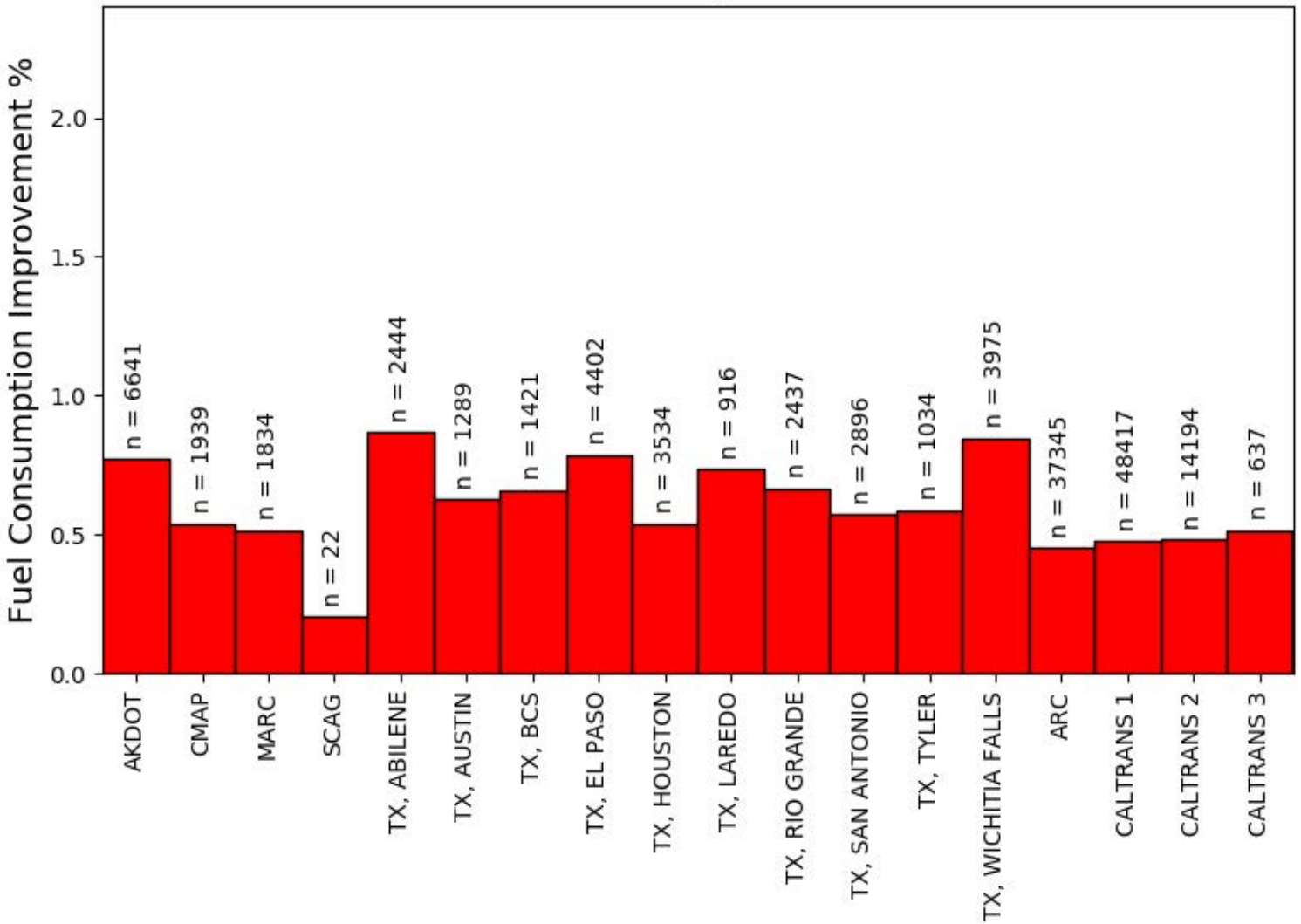
TX, WICHITIA FALLS
ARC
CALTRANS 1
CALTRANS 2
CALTRANS 3


Ambient Temperature 5C
Fuel Consumption Improvement %
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0.5
1.0
1.5
2.0
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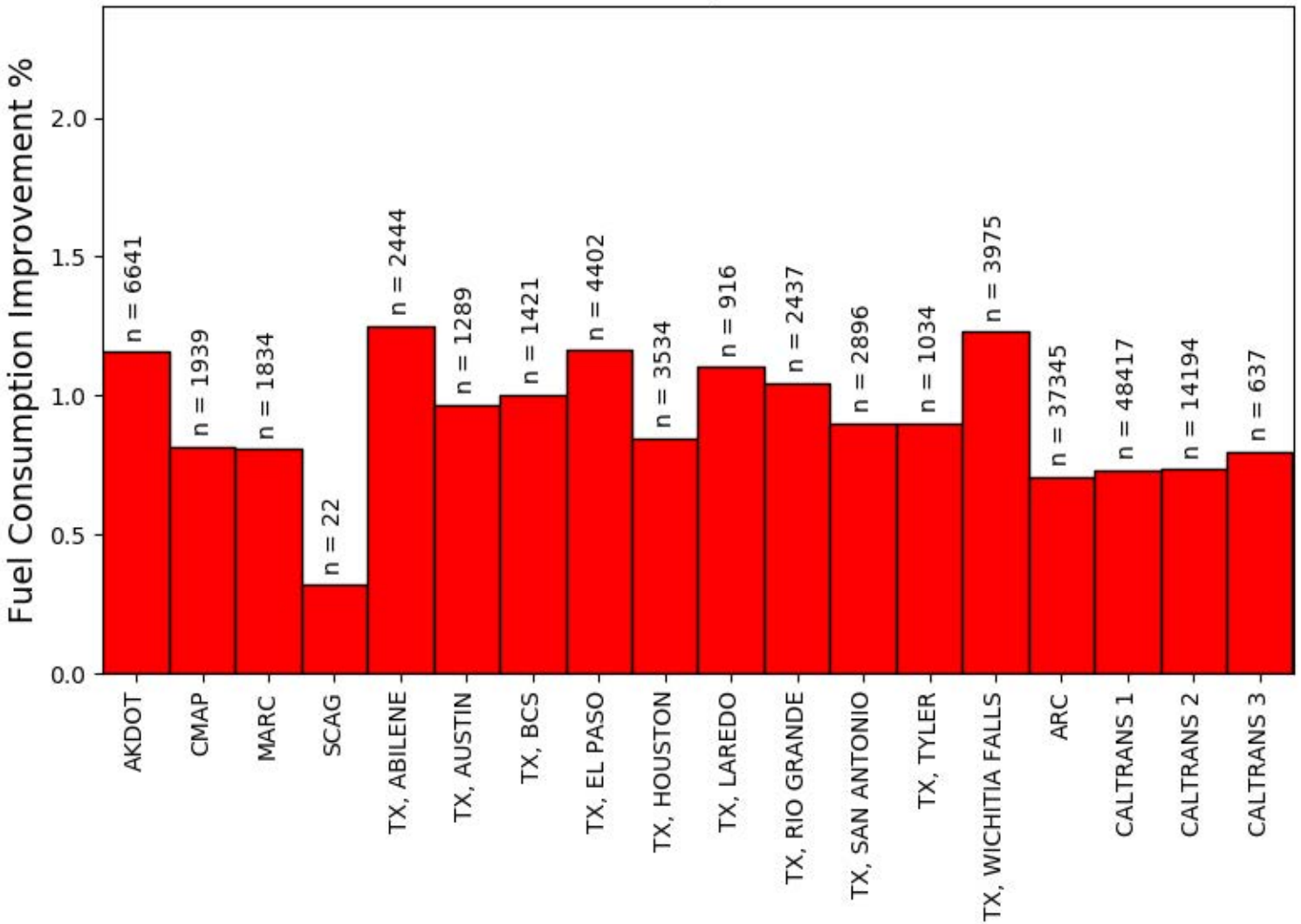
TX, EL PASO
TX, HOUSTON
TX, LAREDO
TX, RIO GRANDE
TX, SAN ANTONIO
TX, TYLER
TX, WICHITIA FALLS
ARC
CALTRANS 1
CALTRANS 2
CALTRANS 3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2.0
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n = 3975
n = 37345
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AKDOT
CMAP
MARC
SCAG
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TX, AUSTIN
TX, BCS
TX, EL PASO
TX, HOUSTON
TX, LAREDO
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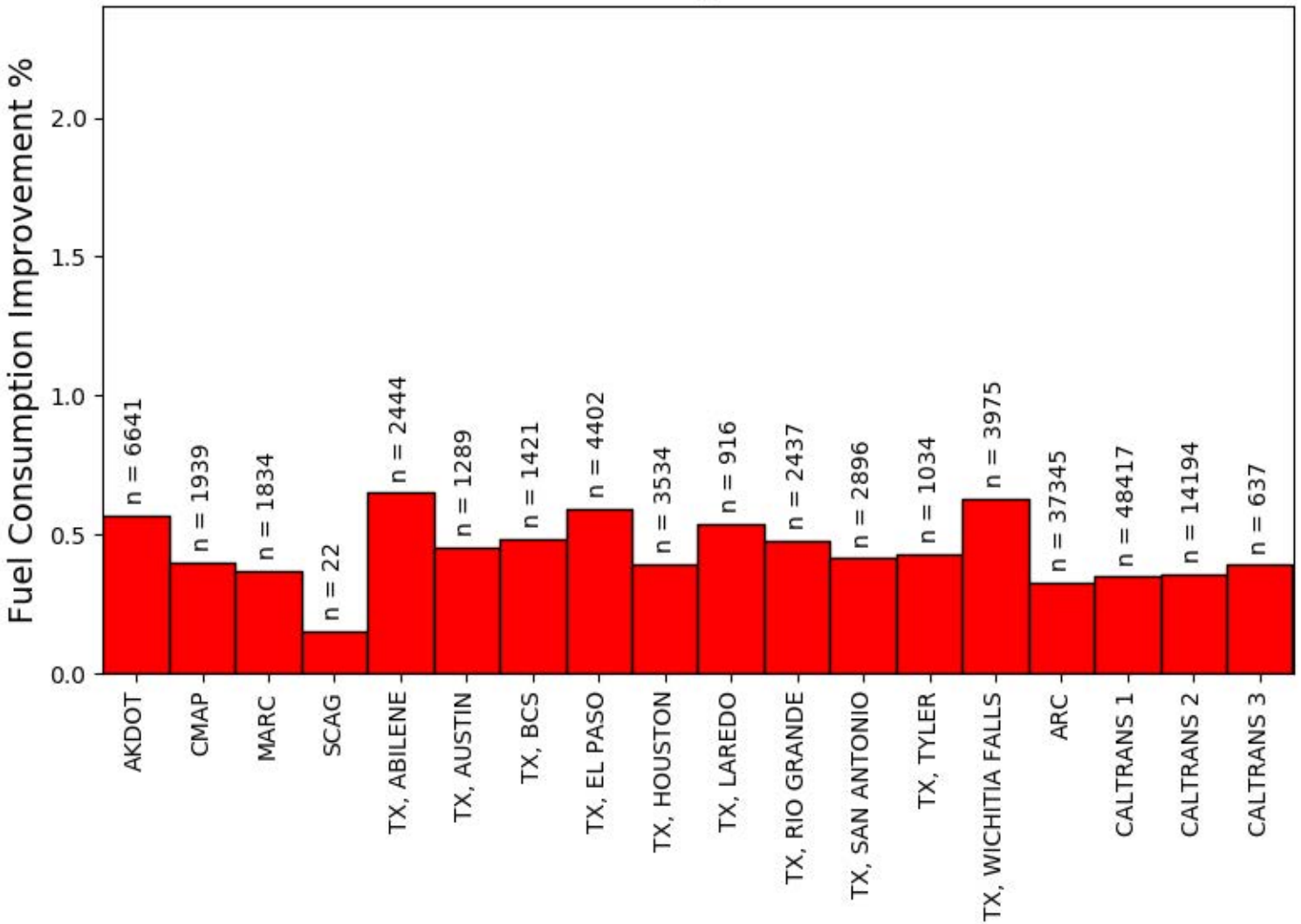
TX, WICHITIA FALLS
ARC
CALTRANS 1
CALTRANS 2
CALTRANS 3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2.0
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n = 1421
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n = 916
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AKDOT
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SCAG
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TX, AUSTIN
TX, BCS
TX, EL PASO
TX, HOUSTON
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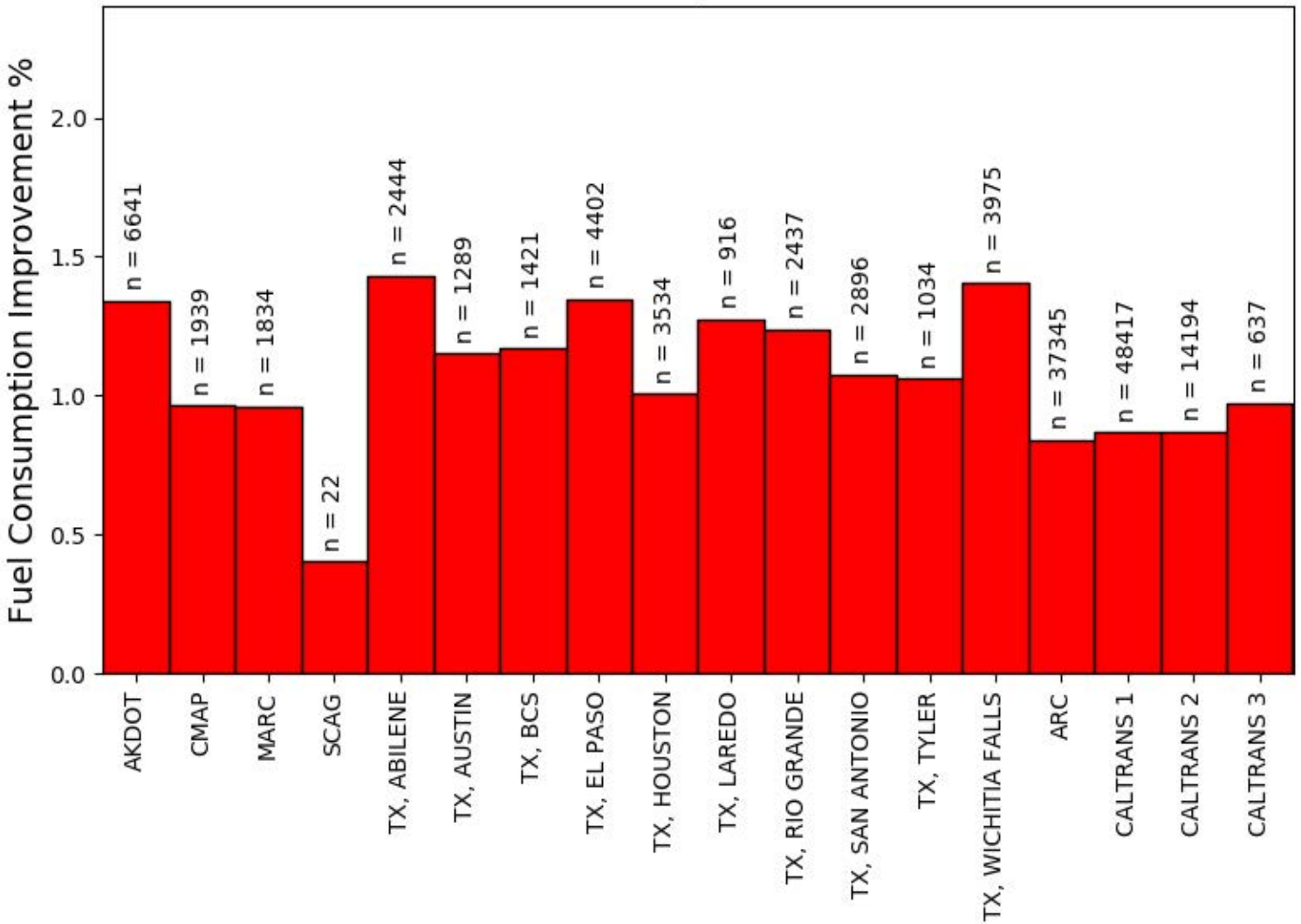
TX, WICHITIA FALLS
ARC
CALTRANS 1
CALTRANS 2
CALTRANS 3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2.0
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n = 2444
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n = 1421
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n = 3975
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AKDOT
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TX, LAREDO
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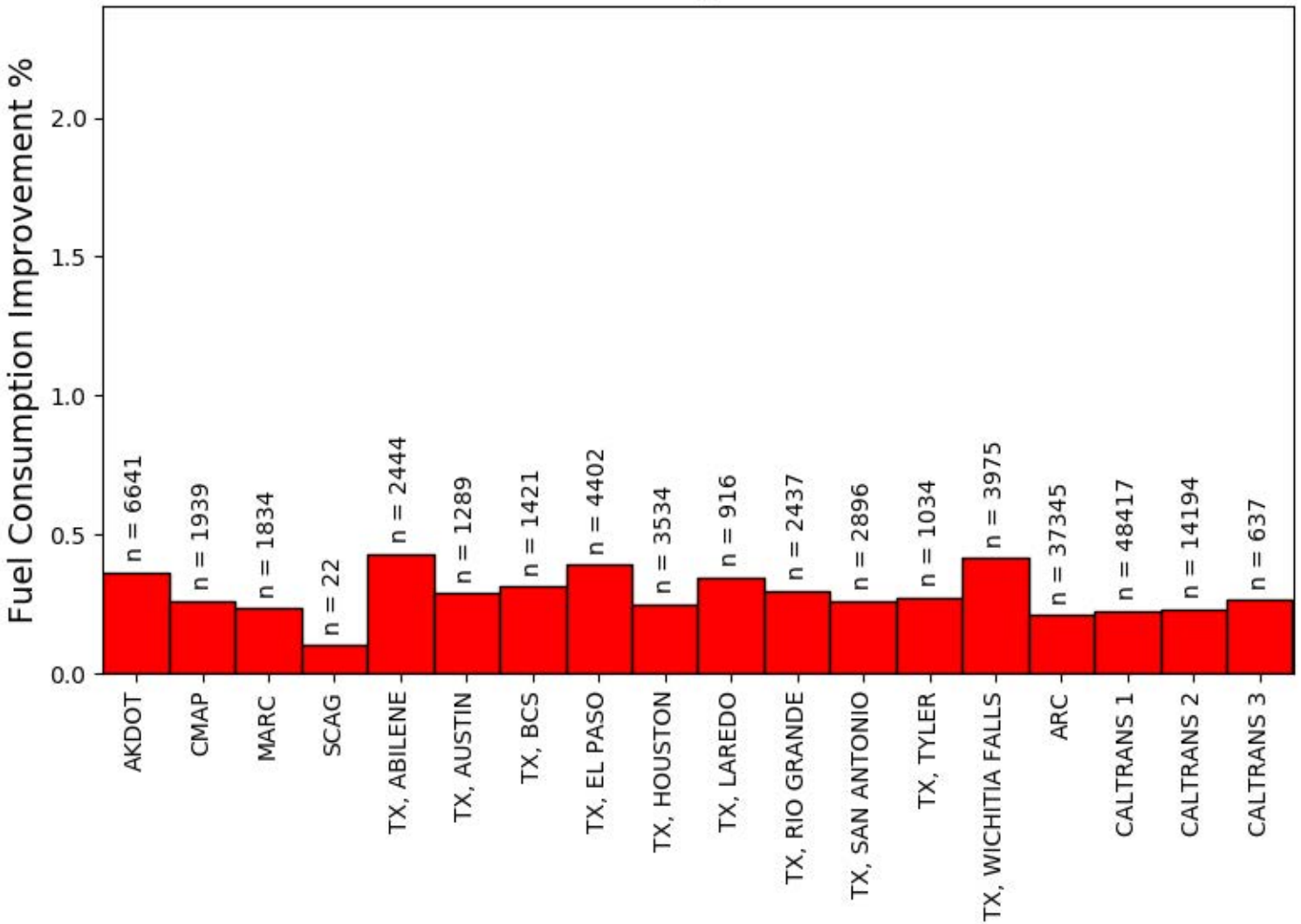
TX, WICHITIA FALLS
ARC
CALTRANS 1
CALTRANS 2
CALTRANS 3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AKDOT
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MARC
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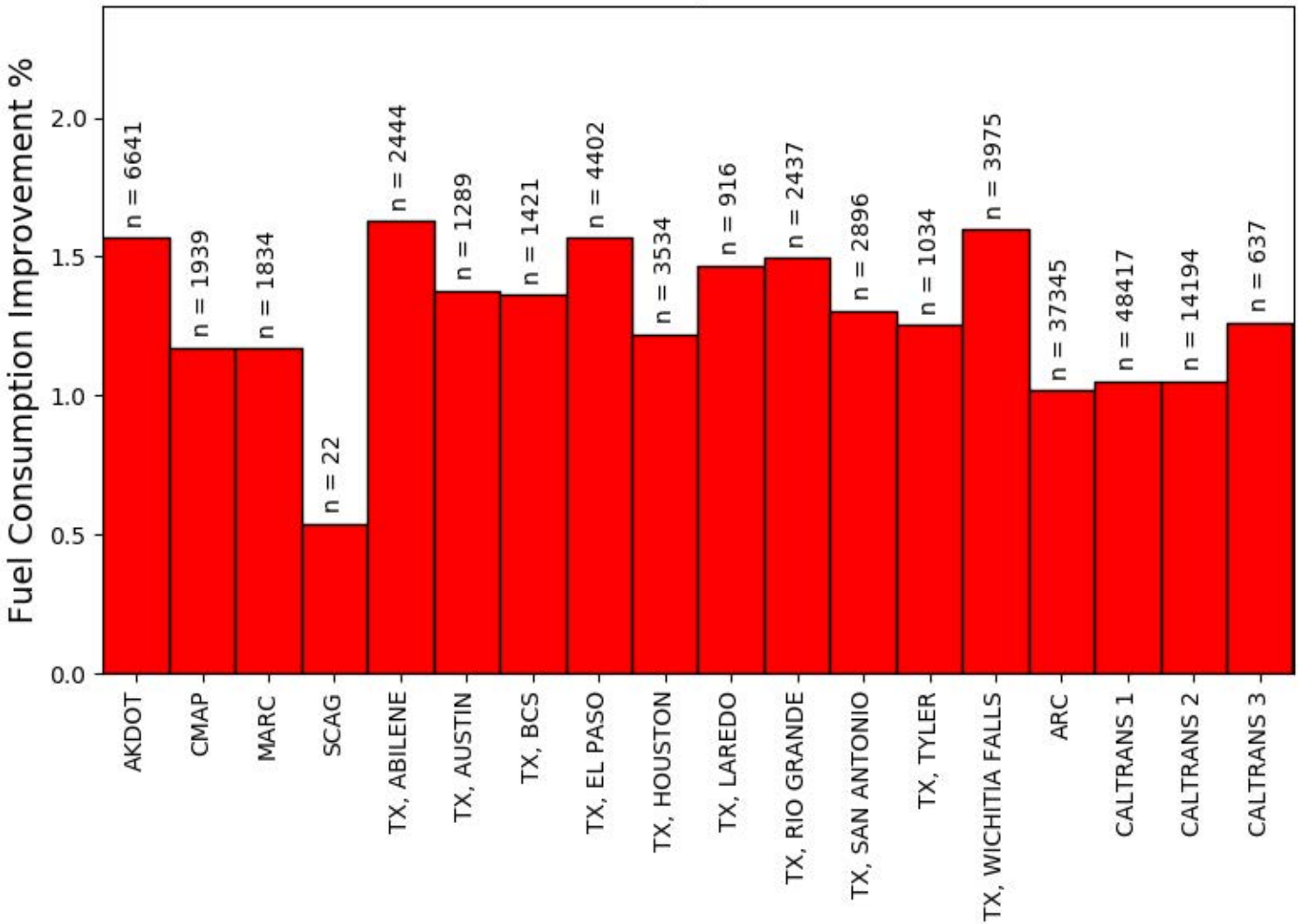
TX, TYLER
TX, WICHITIA FALLS
ARC
CALTRANS 1
CALTRANS 2
CALTRANS 3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Fuel Consumption Improvement %
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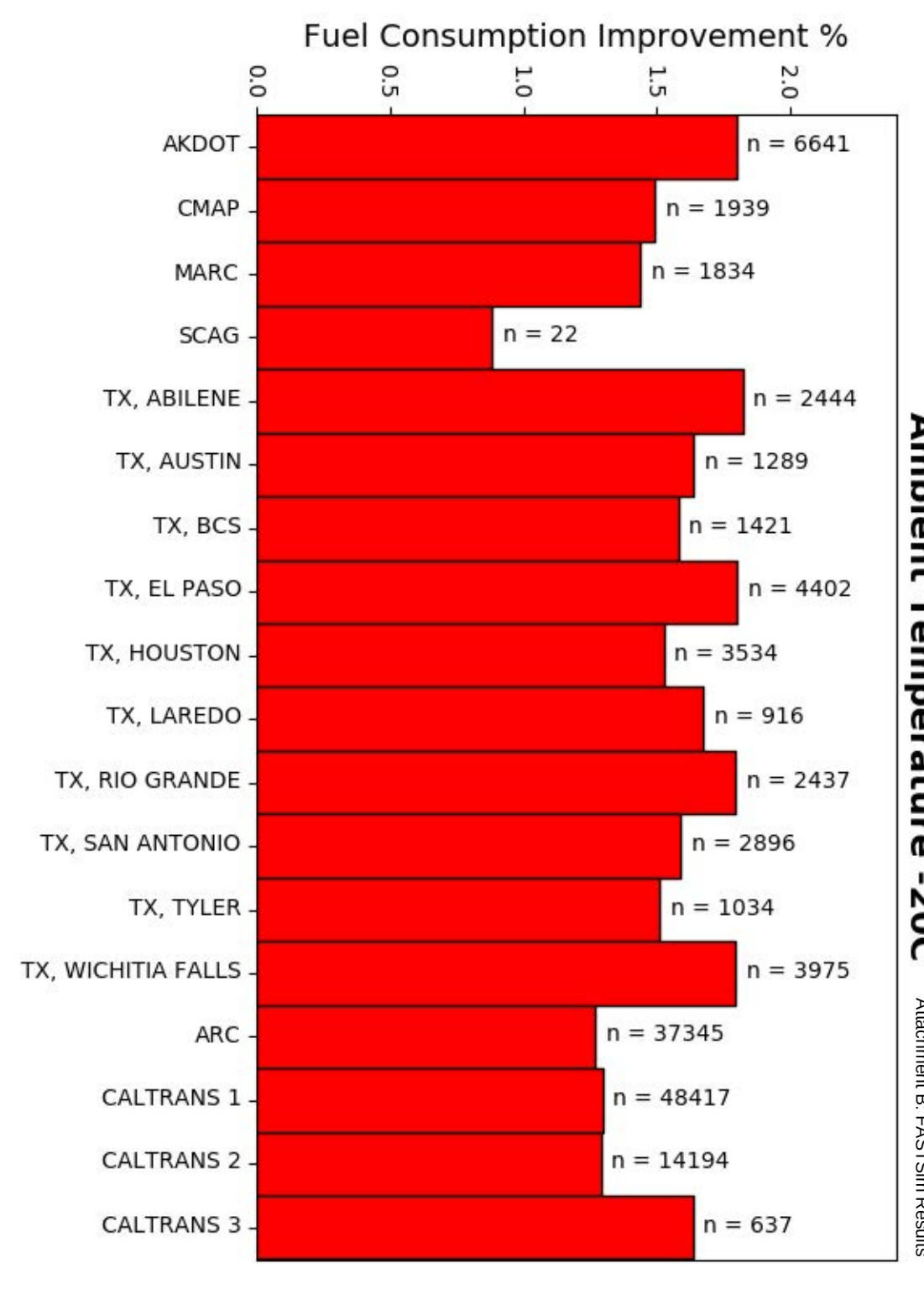
TX, SAN ANTONIO
TX, TYLER
TX, WICHITIA FALLS
ARC
CALTRANS 1
CALTRANS 2
CALTRANS 3


Fuel Consumption Improvement %
0.0
0.5
1.0
1.5
2.0
AKDOT
n = 6641
CMAP
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MARC
n = 1834
SCAG
n = 22
TX, ABILENE
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TX, AUSTIN
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TX, EL PASO
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TX, HOUSTON
n = 3534
TX, LAREDO
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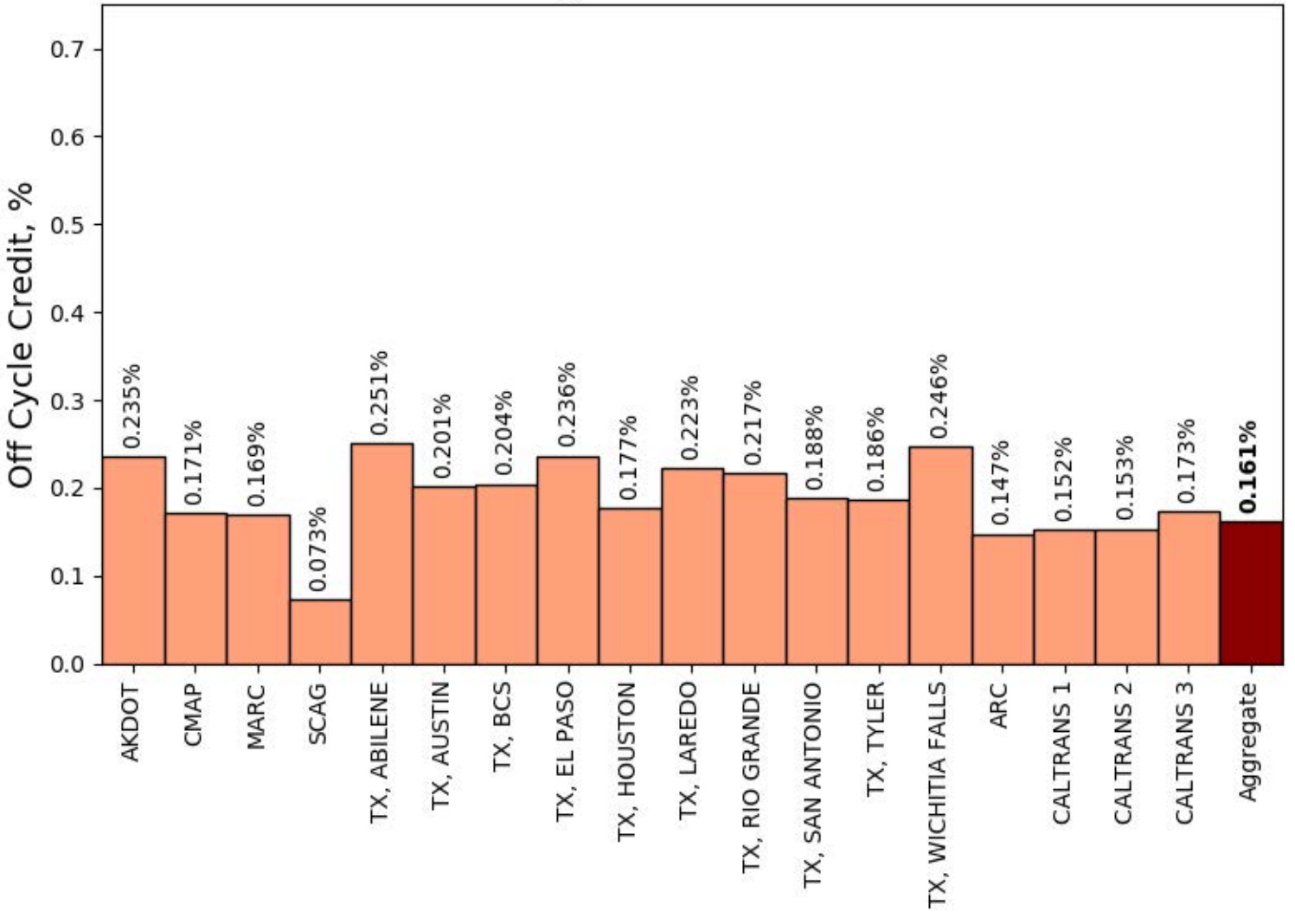
TX, RIO GRANDE
n = 2437
TX, SAN ANTONIO
n = 2896
TX, TYLER
n = 1034
TX, WICHITIA FALLS
n = 3975
ARC
n = 37345
CALTRANS 1
n = 48417
CALTRANS 2
n = 14194
CALTRANS 3
n = 637
Ambient Temperature -20C


Logic Cutoff of 0C
Off Cycle Credit, %
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.235%
0.171%
0.169%
0.073%
0.251%
0.201%
0.204%
0.236%
0.177%
0.223%
0.217%
0.188%
0.186%
0.246%
0.147%
0.152%
0.153%
0.173%
0.161%
AKDOT
CMAP
MARC
SCAG
TX, ABILENE
TX, AUSTIN
TX, BCS
TX, EL PASO
TX, HOUSTON
TX, LAREDO
TX, RIO GRANDE
TX, SAN ANTONIO
TX, TYLER
TX, WICHITIA FALLS
ARC
CALTRANS 1
CALTRANS 2
CALTRANS 3
Aggregate

2-LAYER HVAC TECHNOLOGY: BACKGROUND AND BENEFITS

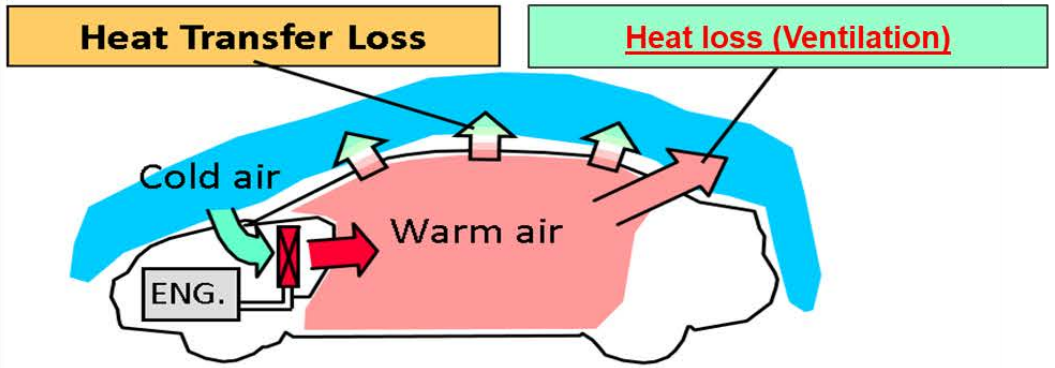
Attachment C: Technology Description

2-Layer HVAC Concept: Uses fresh air for upper ducts and recirculated air for lower ducts

Function: Maintain ventilation performance and enable recirculation to retain cabin heat

(OCC benefit only so A/C cap is not applicable)

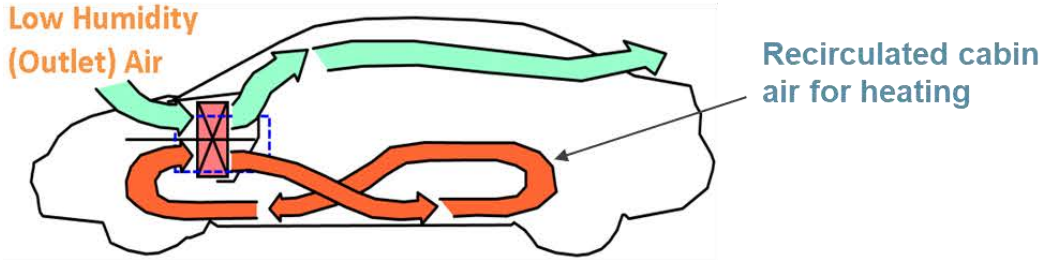
Conventional HVAC



Conventional HVAC:

- In cold ambient temperature, there is heat loss from ventilation using conventional HVAC system
- As a result, heat from engine is required to maintain cabin temperature

2 Layer HVAC



2-Layer Function:

- Maintain ventilation performance (green)
- Enable recirculation to retain cabin heat (orange)

2-Layer Benefits:

- **Decreases heat rejection from HVAC (more HVAC heat available for cabin heating)**
- **Reduces heat coming from engine for faster engine warmup**