

# WVU EMISSIONS RESEARCH and the VW SAGA “Dieselgate”

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# Who is CAFEE?

- Founded in 1989 with US DOE Funding
- Examine the Impact of Alternative-fueled Engine and Vehicle Technology
- 25 Years of Research, Development and Innovation
- \$100 Million in Revenue with Limited State Support
- Maintain Unbiased, Scientific-based Findings
  - Mix of Federal Government, State Government, and Industrial/Commercial Sponsors
  - Commitment to “Getting it Right”
- Significant Field Work,
  - Core Faculty and Staff, Graduate Students, Temporary Staff and Undergraduate Students



# CAFEE Relationships

- Over 250 CAFEE Alumni in Heavy and Light-Duty Engine and Vehicle Manufacturers and Regulatory Agencies
- Direct and Indirect Involvement with Manufacturers
- Previous Work with Heavy-duty Industry has Resulted in Voluntary Recalls



Johnson Matthey  
Catalysts

CORNING



# CAFEE Relationships

- CAFEE Alumni With A Variety of NGO and Regulatory Agencies
- Help Define Future Policy and Technology Pathways
- Provide an Unbiased Viewpoint of Real-World Challenges





**WVU Transportable Chassis Laboratory**



**WVU Transportable Emissions Measurement System**



**WVU Full-Scale Environmental Wind Tunnel**



**WVU Engine Research and Emissions Certification Laboratory**

# INTERESTING PROJECTS FROM THE PAST

- Cross country emission measurement study
  - Over 2500 miles of real-world heavy-duty emissions measurement data
  - Covering various geography, ambient conditions, grade etc...
- A comprehensive evaluation of modern HD vehicles in California-Chassis dynamometer
- Cross California emissions measurement study
  - Assess real-world emissions performance of HD trucks operating in California
  - 7 vehicles from different OEM
  - More than 1500 miles/vehicle in California
- LD duty diesel passenger car emissions measurement
  - VOLKSWAGEN emissions excursion



# VW WORK-TIMELINE



Increased on-road (i.e. off-cycle) NOx emissions measured in EU



Nov. 7<sup>th</sup> 2012  
RFP by ICCT

March – May 2013  
Testing of three vehicles (on-road and laboratory)



May 15<sup>th</sup> 2014  
Submission of final report to ICCT



Sept. 3<sup>rd</sup> 2015  
VW Engineers admit to CARB of use of “defeat device”

ICCT wants to test Diesel LDVs sold in US to demonstrate EU legislator the feasibility of low NOx emissions



Dec. 2014  
Notification of voluntary recall by VW

Sept. 18<sup>th</sup> 2015  
Official letters by U.S. EPA and CARB to VW regarding violation of Clean Air Act

# CREATIVE VW ADVERTISEMENTS



## Volkswagen Turbo Diesel Injection.

Less fuel consumption with added engine power.



## This ain't your daddy's diesel.

Stinky, smoky, and sluggish. Those old diesel realities no longer apply. Enter TDI Clean Diesel. Ultra-low-sulfur fuel, direct injection technology, and extreme efficiency. We've ushered in a new era of diesel.

- Engineered to burn low-sulfur diesel fuel
- "Common Rail" direct injection system

[View key fuel efficiency info](#)



## Diesel has really cleaned up its act.

Find out how clean diesel technology impacts fuel efficiency and performance, while also being a more eco-conscious choice.

[Go to cleanbetterdiesel.org](#)



Ultra low emissions. Jetta TDI Clean Diesel.



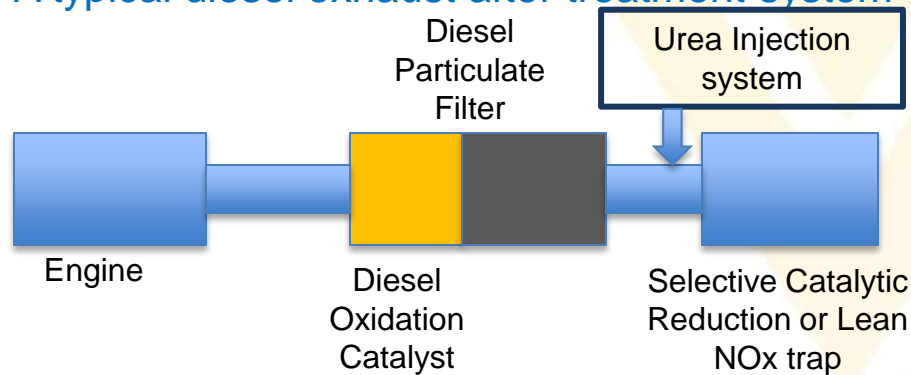
Dax Auto.

# A LOOK AT MODERN DIESEL TECHNOLOGY

- Gasoline Vs Diesel
  - Diesel engines by nature are more efficient and robust than gasoline engines
  - Emissions control in gasoline technology much more cost effective than diesel
- A typical diesel exhaust after treatment system

**Gasoline engine are equipped only with a three-way catalyst**

**Challenge: Balance between meeting emissions, lowering operational cost, lowering engine cost, avoiding extensive warranty claims**



- NOx from diesel engines cannot be removed by a simple technology such as three-way catalyst
  - Real-world NOx reductions from diesel engine is a challenge (influence of exhaust temperature is very critical)
  - Fuel consumption increases with NOx control strategy
  - Engine durability concerns arise
  - SCR uses a aqueous urea for NOx reduction (a critical consumable for diesel vehicle owners)

# In-Use Emissions Testing of Light-Duty Diesel Vehicles in the United States

- Initial request by ICCT
  - Identify European-based diesel engines sold in the United States meeting at least Tier 2 Bin 5, LEV II emissions
  - Proposed a plan to evaluate the in-use emissions from a representative selection of suggested vehicles – request specified two SCR-equipped and one lean NOx trapped-equipped vehicles
  - Proposed budget ~\$193,662 with multiple options
  - Project award ~ \$69,387
- Serendipity played a **major role**
- ICCT initiated, WVU investigated, **CARB “carried the torch”**



# Test Vehicles

=> **Three** test vehicles, **two** after-treatment technologies

Vehicle		A (VW Jetta)	B (VW Passat)	C (BMW X5)
Mileage at test start [miles]		4,710	15,226	15,031
Fuel		ULSD	ULSD	ULSD
Engine displacement [L]		2.0	2.0	3.0
Emission after-treatment technology		<b>OC, DPF, LNT</b>	<b>OC, DPF, urea-SCR</b>	<b>OC, DPF, urea-SCR</b>
Drive train		2-wheel drive, front	2-wheel drive, front	4-wheel drive
Applicable emissions limit	<i>U.S. EPA</i>	<b>Tier2 - Bin5 (LDV)</b>	<b>Tier2 - Bin5 (LDV)</b>	<b>Tier2 - Bin5 (LDV)</b>
	<i>CARB</i>	<b>LEV-II, ULEV</b>	<b>LEV-II, ULEV</b>	<b>LEV-II, LEV</b>
EPA Fuel Economy Values [mpg] <sup>1)</sup>	<i>City</i>	29	30	19
	<i>Highway</i>	39	40	26
	<i>Combined</i>	33	34	22
EPA CO <sub>2</sub> Values [g/km] <sup>1)</sup>		193	186	288
Actual Test Weight [kg]		1855	1884	2903
Payload [kg]		305	314	533

<sup>1)</sup> EPA advertised fuel economy and CO<sub>2</sub> emissions values for new vehicles in the US ([www.fueleconomy.gov](http://www.fueleconomy.gov))

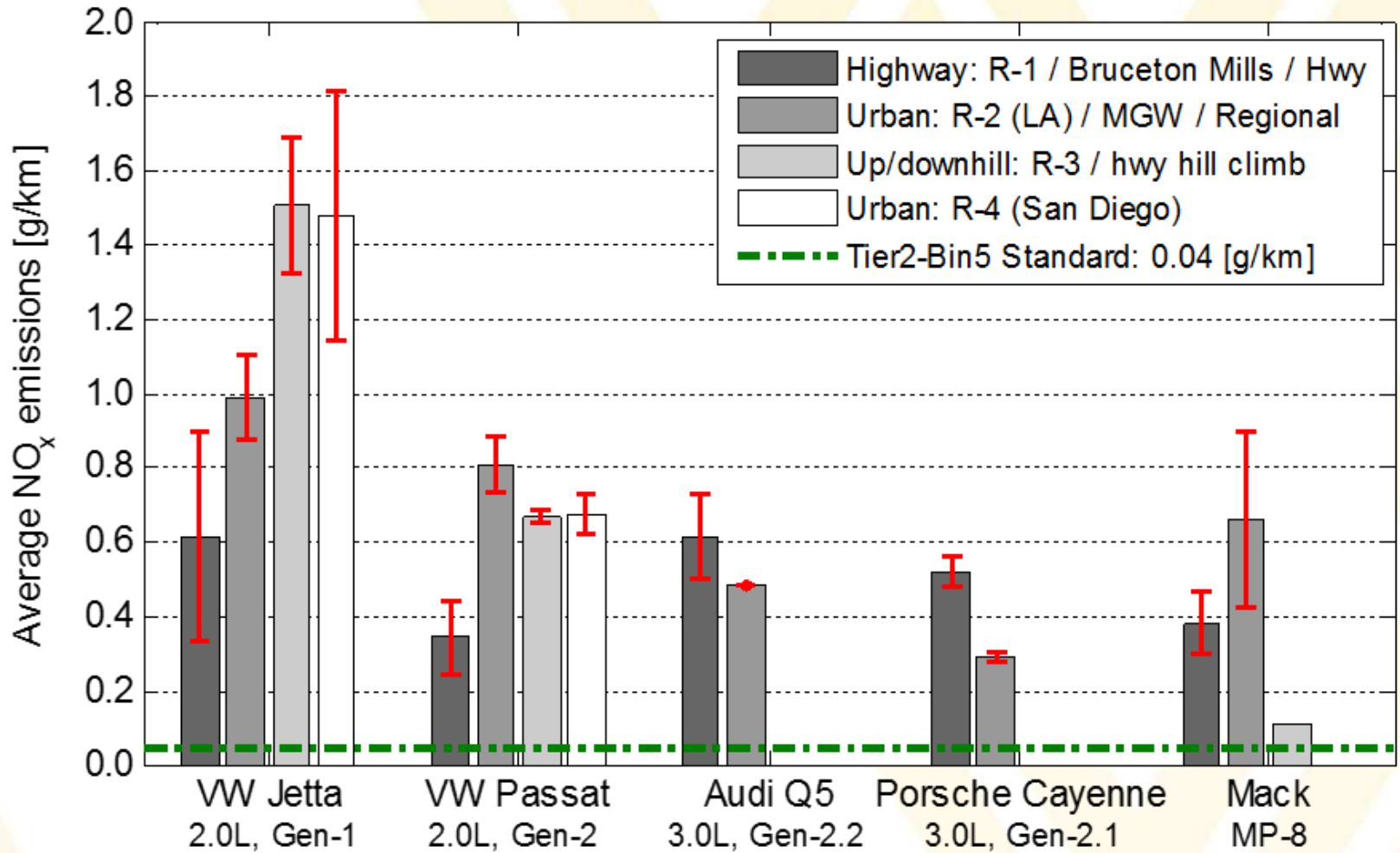
- Vehicles did not indicate any after-treatment or engine malfunction (ECU scan)
- Vehicles A and B were tested on chassis dynamometer and complied with certification standards for all regulated emissions

# METHODOLOGY - Instrumentation





# On-Road NO<sub>x</sub> Results



# VW'S RESPONSE TO WVU'S REPORT



- “It should first be decided *whether we are honest. If we are not honest, everything stays as it is.* ICCT has *stupidly* just published measurements of [North American Region] diesel off-cycle, *not good.*”
- -Oliver Schmidt, VW Chief U.S. Environmental Compliance Officer (internal email to VW colleague)

# Timeline...cont'd

Sep. 25<sup>th</sup> 2015

CEO Winterkorn resigns, VW names Müller C.E.O.

Dec. 10<sup>th</sup> 2015

Internal VW inquiry reports decision to cheat was made more than a decade ago

Jan. 12<sup>th</sup> 2016

EPA & CARB rejected VW's proposed fix

Mar. 9<sup>th</sup> 2016

Horn steps down as president and CEO of Volkswagen Group of America. Woebcken named president and CEO on an interim basis.

Nov. 2<sup>nd</sup> 2015

Second Notice of Violation by U.S. EPA and CARB

Jan. 4<sup>th</sup> 2016

DOJ files complaint on behalf of EPA against Volkswagen Group for alleged violations of the Clean Air Act. Fines estimated up to \$46B

Jan. 22<sup>nd</sup> 2016

Plaintiff's Steering Committee appointed

Mar. 24<sup>th</sup> 2016

U.S. District Judge Charles Breyer requests definitive answer on the status of a fix

# Timeline...still going...

Apr. 21<sup>st</sup> 2016

VW announces "substantial compensation" and buyback offers for US 2.0-litre vehicles

Jun. 15<sup>th</sup> 2016

Judge Breyer extends deadline for solution

Oct. 25<sup>th</sup> 2016

Judge Breyer signs off on \$10.03B buyback and \$4.7B in emissions remediation

Apr. 22<sup>nd</sup> 2016

VW postpones full-year financial announcement alleging a €16.2B loss

Jun. 28<sup>th</sup> 2016

VW, regulators and plaintiffs' groups announce settlement of up to \$14.7B

Nov. 22<sup>nd</sup> 2016

VW announces it will no longer sell diesel vehicles in the US

# Timeline...still going...

Dec 20<sup>th</sup> 2016

Second Consent Decree  
\$1B reimbursement for  
buyback/fix  
\$225M into  
mitigation fund  
\$25M to CARB  
for ZEV development

Jan. 11<sup>th</sup> 2017

VW agrees to plead  
guilty to three criminal  
felony counts and to pay  
a \$2.8B criminal, \$1.45B  
civil (US Customs) and  
\$50M in civil (DOJ)

Mar. 3<sup>rd</sup> 2017

MIT researchers  
estimate 1,200 or  
more premature  
deaths in Europe  
due to Dieselgate

Jan. 9<sup>th</sup> 2017

FBI arrests Oliver Schmidt, former  
Volkswagen U.S. regulatory  
compliance lead, on fraud  
conspiracy charges. Five more  
are indicted but believed to be  
outside the U.S.

Jan. 23<sup>rd</sup> 2017

VW settles  
Franchise  
Dealer  
Approval –  
\$1.2B to  
dealers

Apr. 21<sup>st</sup> 2017

Regulators give final  
approval to a criminal  
fine of \$2.8 billion and  
appoint an independent  
compliance monitor and  
auditor for three years..

# Timeline...still going...

January 30, 2018

Volkswagen suspends chief lobbyist Thomas Steg following WHO reports VW studied effects of diesel emissions on monkeys and humans

February 27, 2018

One of Germany's top courts opens door for diesel bans in German cities

March 2018

ICCT study finds declining diesel sales do not threaten EU's emission reduction targets

April 2018

German environment minister calls for retrofitting all manipulated cars

April 12, 2018

Volkswagen appoints Herbert Diess as new CEO after Matthias Mueller is ousted by board of directors

May 30, 2018

Hamburg becomes first German city to impose diesel driving bans in city center. EU Commission sues VW for excessive air pollution levels.

May 3, 2018

Former VW CEO Winterkorn is indicted on fraud and conspiracy charges in the United States

June 13, 2018

VW is fined one billion euros by German prosecutors; City of Stuttgart says it will introduce diesel driving bans by 2019

# TIMELINE...STILL GOING...

July 27, 2018

German transport minister Andreas Scheuer says he is opposed to so-called “blue badges” for older diesel cars to facilitate driving bans

September 5, 2018

Germany’s Federal Administrative Court rules Frankfurt must ban older diesel cars

September 10, 2018

Town of Braunschweig begins hearings regarding 4,000 Volkswagen shareholders

December 5, 2018

Volkswagen says last generation of combustion engines to be launched in 2026

August 21, 2018

Report says new VW CEO Diess knew about fraud software earlier than he conceded

September 8, 2018

VW diesel cheating bill expected to top 30 billion euros as legal battle begins

September 23, 2018

Porsche announces it will no longer make diesel automobiles.

# U.S. Settlements

- October 25, 2016 (2.0L Settlement, Consumer) :
  - \$10B Consumer Recovery (Plaintiff and FTC)
  - \$2.7B (over 3yrs) into a mitigation fund
  - **\$2B (over 10 yrs) into zero emission development**
  - Additional fines to be levied if VW does not achieve 95% participation by June 2019
- December 20, 2016 (3.0L DOJ announcement, Consumer)
  - \$1B reimbursement for buyback/fix
  - \$225M into the mitigation fund
  - **\$25M to Ca. for zero emission development**
- April 21, 2017 (DOJ Settlement of Criminal and Civil Penalties)
  - \$2.8B for Criminal Penalties
  - \$1.45B in civil penalties to US Customs
  - \$50M in civil penalties to DOJ
- January 23, 2017 (Franchise Dealer Approval)
  - \$1.2 B to dealers

# SOME CLARIFICATION

- WVU CAFEE did not find any defeat devices
  - 3 vehicle dataset cannot identify defeat device issues
  - We INITIATED the discovery
  - Years of experience helped us reach conclusions and reputation caused others to listen
- Enforcement action takes time
  - Detailed investigation by ARB. Time consuming to identify the real-issue behind the high off-cycle emissions



The New York Times

Ap Associated Press

THE HUFFINGTON POST



nature



PITTSBURGH TRIBUNE-REVIEW

## Media Coverage of CAFEE Research/ VW Diesel Emissions (Jan. 2016)

### Global locations of note:

- / Dohar, Qatar
- / Brisbane, Australia
- / Jakarta, Indonesia
- / London, England
- / Alberta & Toronto, Canada
- / Mumbai, India
- / Norway
- / Germany
- / France
- / Portugal
- / Japan
- / Italy

### Television interviews:

- / I-View
- / NPR-DC
- / MSNBC
- / All In With Chris Hayes/ MSNBC
- / Bloomberg TV
- / German TV ARD
- / The State Journal's Decision Makers with Bray Cary
- / Danish Broadcast Corporation
- / TF-1 French Television
- / La Repubblica
- / NHK Japan Broadcasting Corporation
- / RTS Swiss Public Broadcasting

### National publications of note:

- / The New York Times
- / The Washington Post
- / CBS News
- / ABC News
- / NBC & MSNBC
- / CNN & CNN International
- / The Discovery Channel
- / NPR (Los Angeles and Washington, D.C.)
- / Associated Press
- / Reuters
- / Al Jazeera (America and UK)
- / USA Today
- / Huffington Post
- / AOL
- / Bloomberg
- / TIME

### State/local publications of note:

- / The Dominion Post
- / WV MetroNews
- / Charleston Gazette-Mail
- / WV Public Broadcasting
- / WBOY-TV
- / The State Journal
- / Pittsburgh-Tribune Review

**150+ DIRECT MEDIA INQUIRIES**

since the story broke from international, national, state and local media outlets.



**100+ INTERVIEWS CONDUCTED (AND COUNTING)**

in person, by phone, satellite uplink, radio and Skype, and continue with today's scheduled in-person live interview on NBC's Today Show.



Thousands of **SOCIAL MEDIA IMPRESSIONS**



**WV Public News** (@wvpublicnews) · Sep 21  
WVU Researchers Help Bust Volkswagen for Pollution Violations  
[wvpublic.org/post/wvu-resea...](http://wvpublic.org/post/wvu-resea...)

**WVU LIVE** (@wvu\_live) · Sep 21  
West Virginia University uncovers VW's emission rigging plot. <https://t.co/1458C8U>  
[/1458C8U](https://t.co/1458C8U)



Over **3,500 STORIES**

appeared in news outlets from as far away as Qatar, Australia, Indonesia, England, Canada, India, South Korea, Norway, Germany, France and Japan.

The Washington Post



Japan Broadcasting Corporation



THOMSON REUTERS



ABC



LJAZEERA

GESTIONARADIO <sup>G</sup>

Los Angeles Times



GERMAN TV

# Lessons Learned

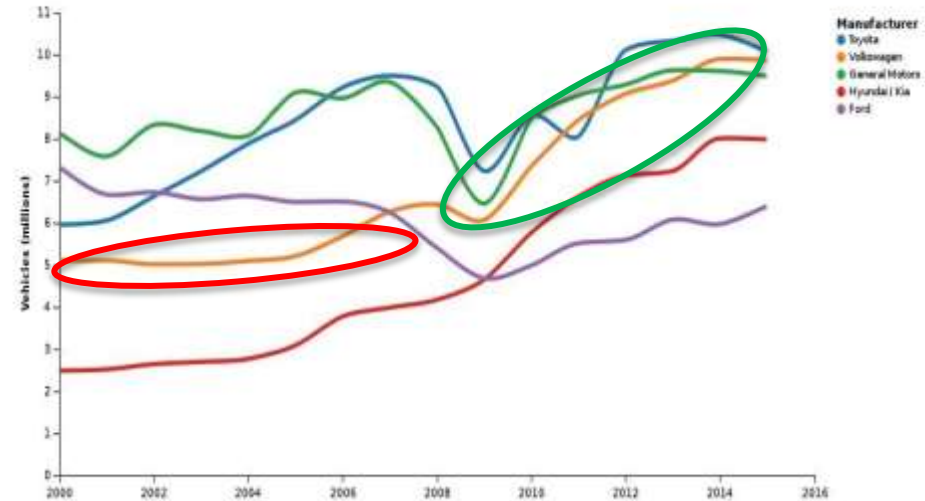
**Di\*sel**  
it's no longer a dirty word.

**TDI** clean diesel

The Audi A3 TDI\*      The Audi Q7 TDI\*

It's official. Diesel has made a comeback and Audi TDI clean diesel is the reason why. The proof is in the super efficient engine. 42mpg highway for the Audi A3 TDI and 25mpg highway for the Audi Q7 TDI to be exact! Combine that with powerful, off-the-line low-end torque and 20% fewer emissions than gasoline engines and you have the complete diesel package.™ Not surprising, the Audi A3 TDI has also been named "Green Car Journal's 2010 Green Car of the Year."™ Test-drive an Audi TDI clean diesel today at a dealer near you. [www.audi.com/diesel](http://www.audi.com/diesel)

Motor vehicle production by manufacturer (top five groups)



**MEANWHILE AT VW'S EMISSIONS TEST CENTER**

**THATS ANOTHER PASS** ✓

As of this morning, VW is still the #2 Car company in the world even after a \$30 billion settlement.

One of the smartest risk analysis strategy

“Our company was dishonest, with the EPA and the California Air Resources Board, and with all of you, and in my German words, *we have totally screwed up.*”

--Michael Horn, President of VW of America, September 22, 2015



# Why the defeat device pathway?

- **Make diesel vehicles appealing to a sub \$35K price range**
- **Prevent warranty issues**
- **Conceal consumables like urea**
- **US-based Entities had No/Little Design Decisions**
  - **Dealt with US Regulatory Requirements**
  - **Sales/Service/Warranty**

# CLEAN DIESEL-TRUTH OR MYTH

- Negative publicity for diesel technology
  - News cycles have focused largely on the failed VW vehicles.
  - WVU study showed a third vehicle (BMW X5) low on emissions both in laboratory and real-world

## CLEAN DIESEL IS NOT A MYTH

- Diesel vehicles are always associated with smoke
  - Modern diesel vehicles do not emit soot, in some cases cleaner than modern gasoline direct injection technology
- SCR provides the opportunity to achieve low levels of NOx emissions
  - Truth: It is a constant work in progress



Courtesy: <http://starecat.com/content/wp-content/uploads/meanwhile-at-volkswagens-emissions-test-center-thats-another-pass-smoke.jpg>



Courtesy: Marian Kamensky, [www.Politicalcartoons.com](http://www.Politicalcartoons.com)

# REGULATION, TECHNOLOGY AND RESEARCHERS

- A “NEUTRAL” approach and emphasis on science is the key
  - Credibility in a researcher entirely depends on the science behind the research
  - Unbiased interpretation of results is key
  - Class action law suits ??????????
  - WVU report to ICCT never implicated the OEM
  - Regulations cannot cover all aspects of vehicle operation
  - Differences in real-world operation and certification must be carefully interpreted
- Bridge the gap between regulators and OEM
  - Efficiency of current practices (in-use test procedures for HD engines)
  - Health impacts of advanced technology
  - Identifying inefficiencies in advanced technology
- Regulations promote technology growth
  - For instance the upcoming 2017 GHG emissions standard will lead to the introduction of state-of-the-art engine technology

# CLOSING REMARKS

## THERE IS NO SUCH THING AS BAD PUBLICITY

- Media coverage has catapulted WVU CAFEE into international visibility
- Individual careers have been positively influenced due to the visibility
- WVU CAFEE has received **“NO DOLLARS”** from settlement money from either federal or state agency
- Its business as usual in WVU CAFEE where we are actively developing proposals, researching new concepts, training the next generation work force and constant fight to be the leaders in emissions research