

EPA Workshop

Craig Brewster

Chief Engineer

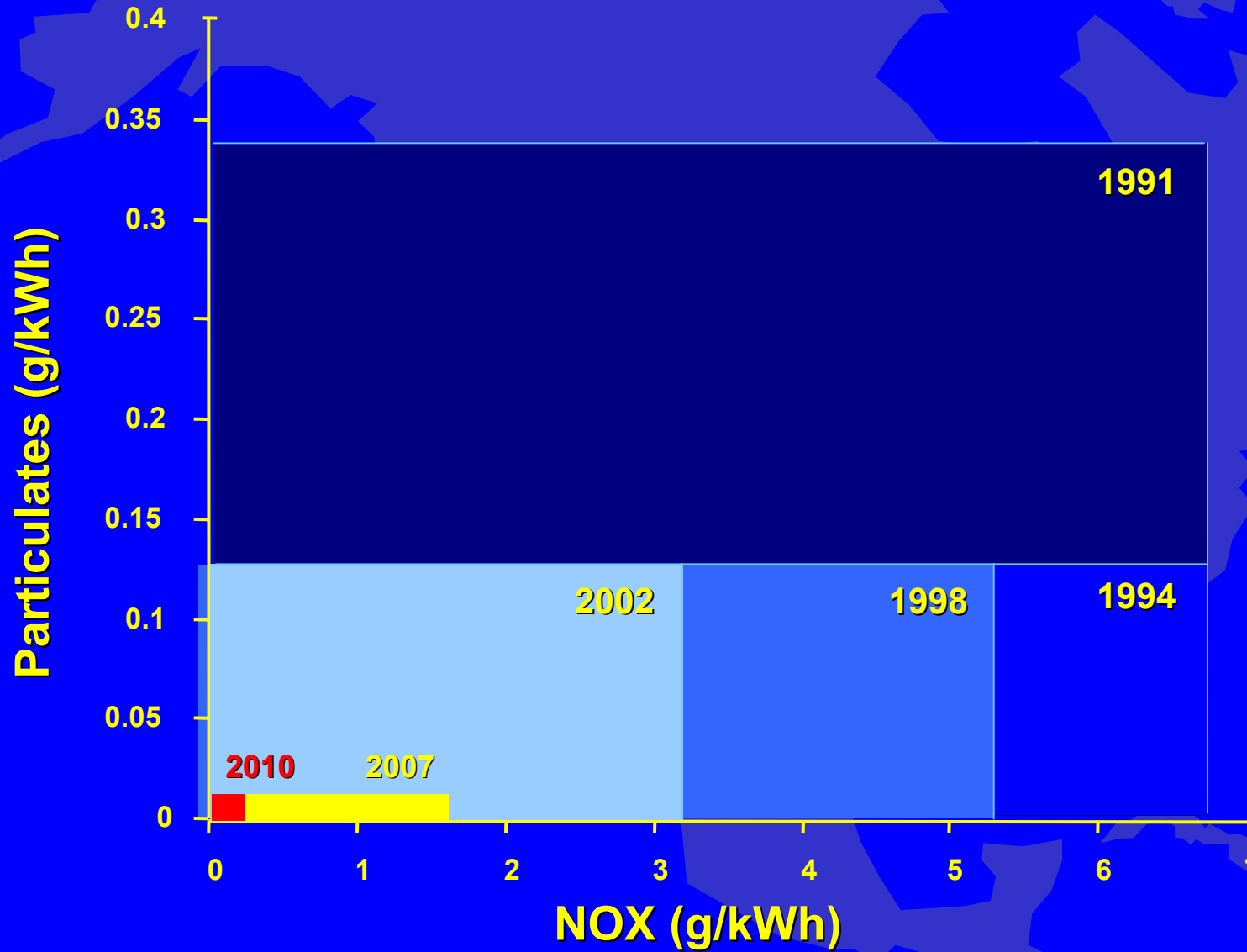
Peterbilt Motors Company

August 7, 2003

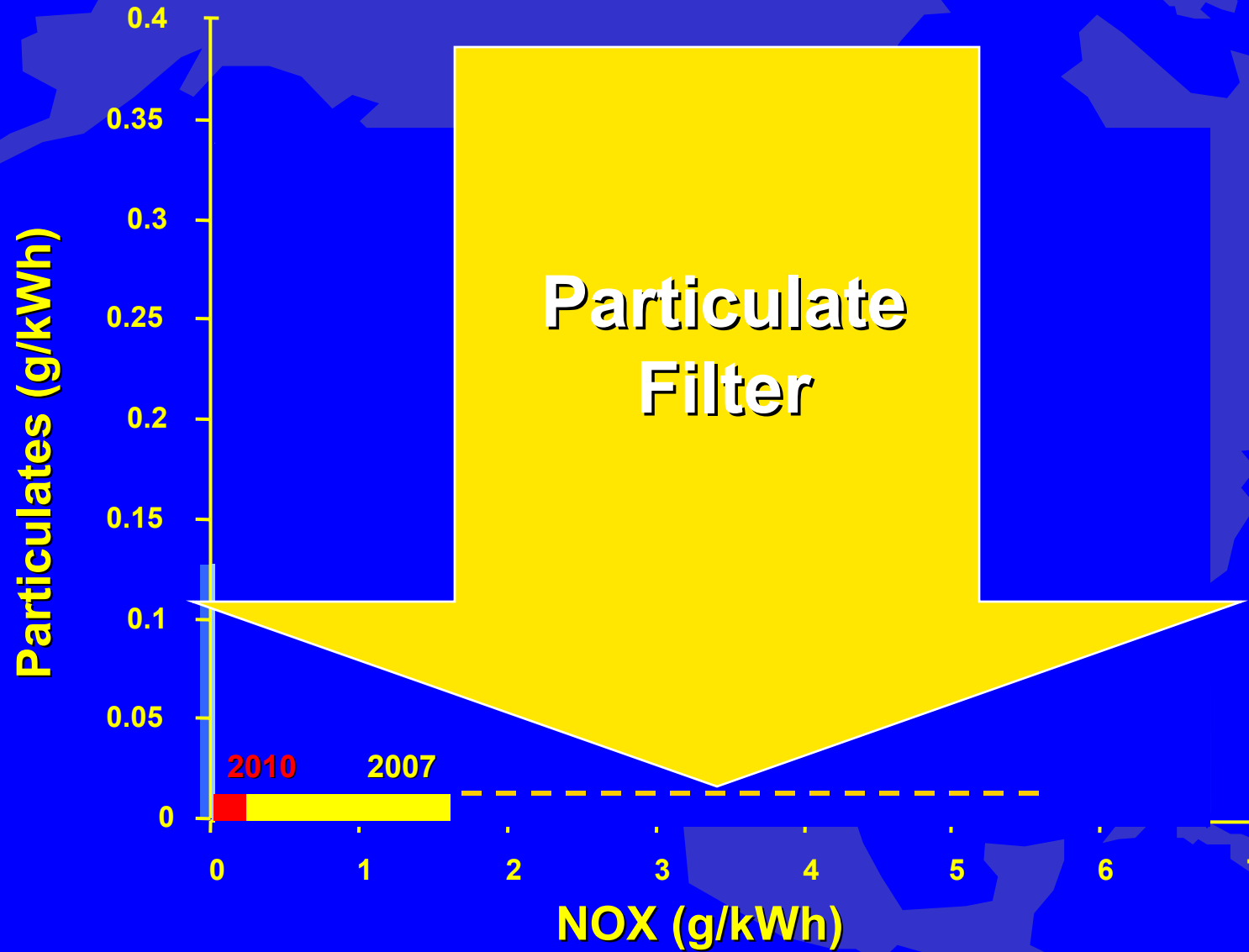
Agenda

- Vehicle Integration Challenges
- Timing Challenges

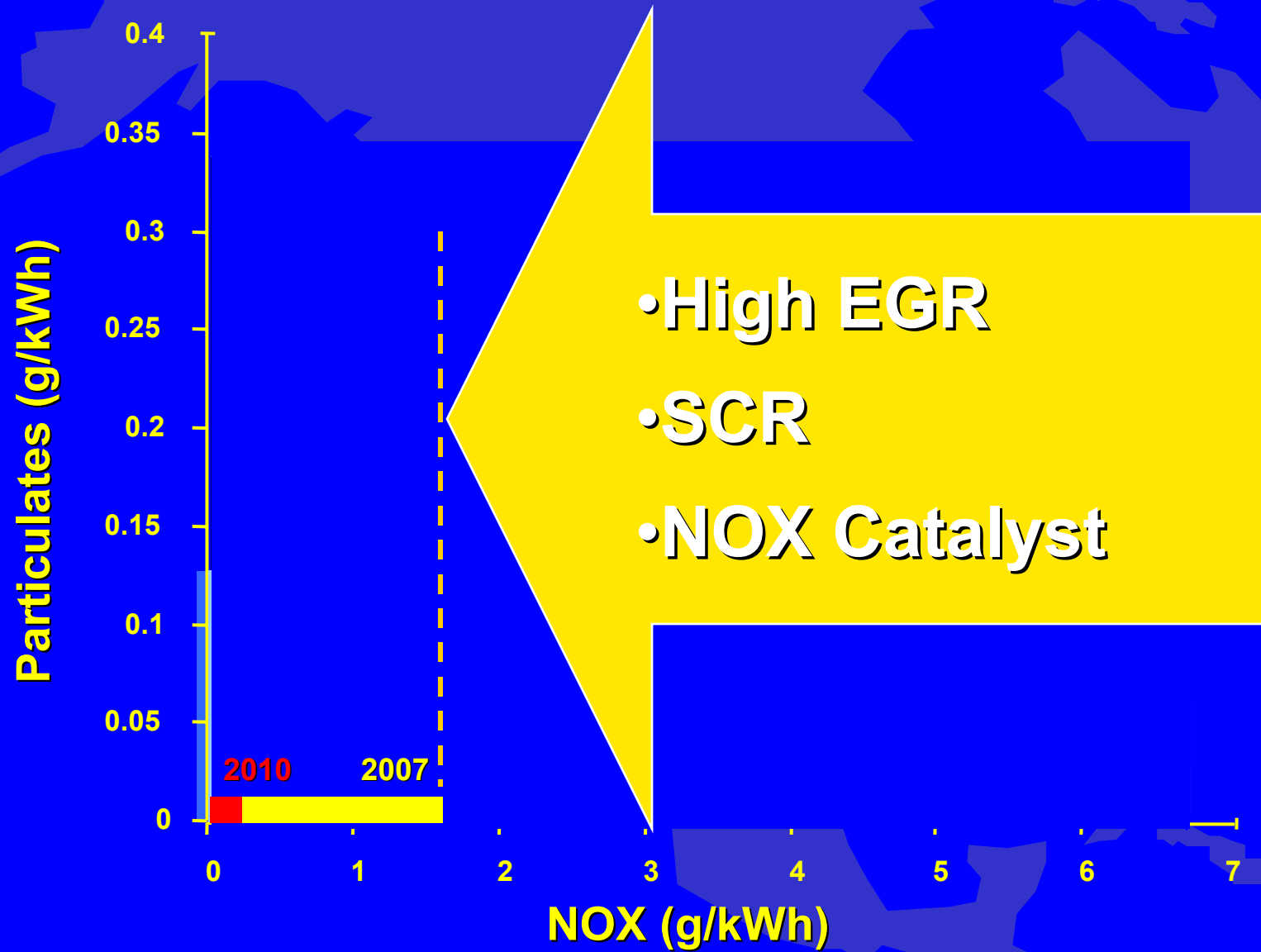
Emissions Standards



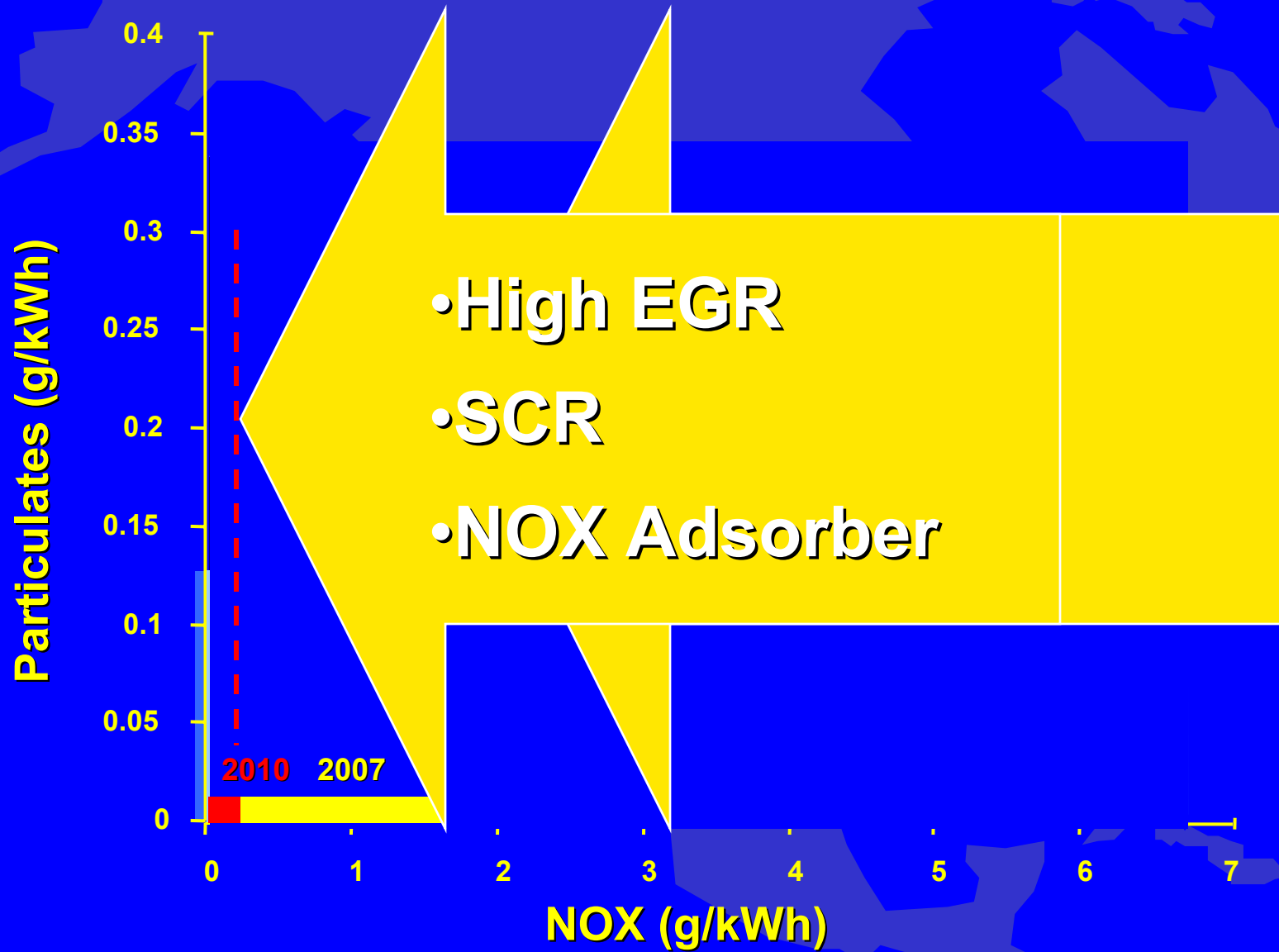
New Technologies



New Technologies

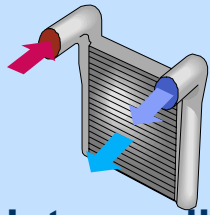


New Technologies

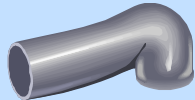


Emission Compliance Technologies

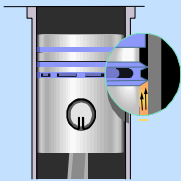
Pre-Combustion



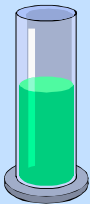
Intercooling



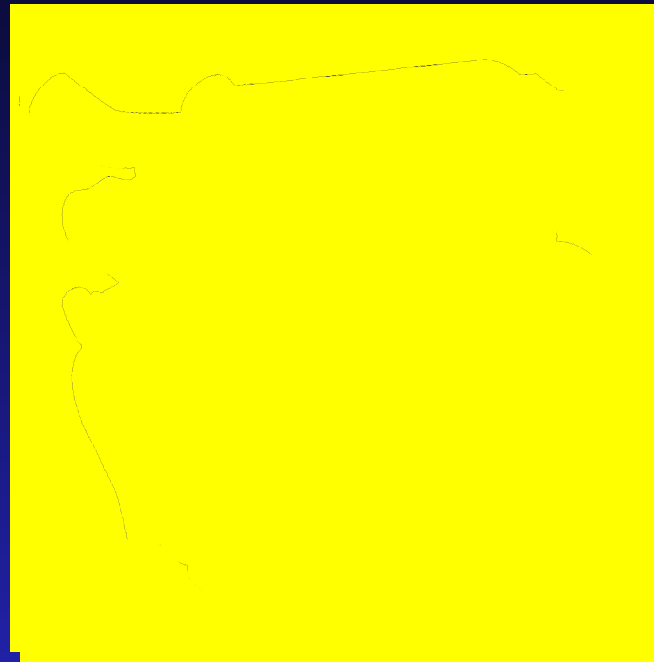
Low Swirl



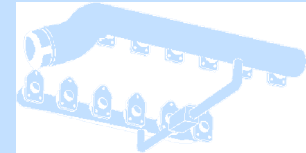
Low Oil Consumption



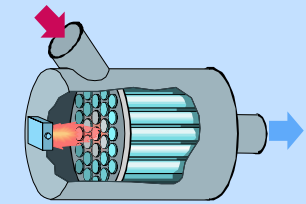
Fuel Quality



After-Combustion

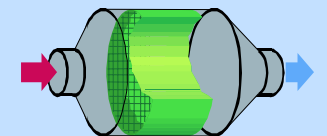


EGR



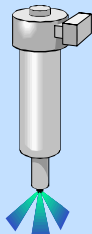
Particulate Trap

SCR

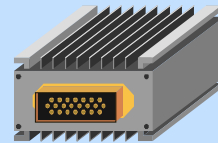


Denox Cat

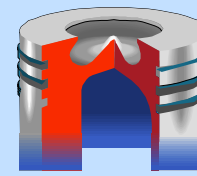
During Combustion



Injection



Electronics

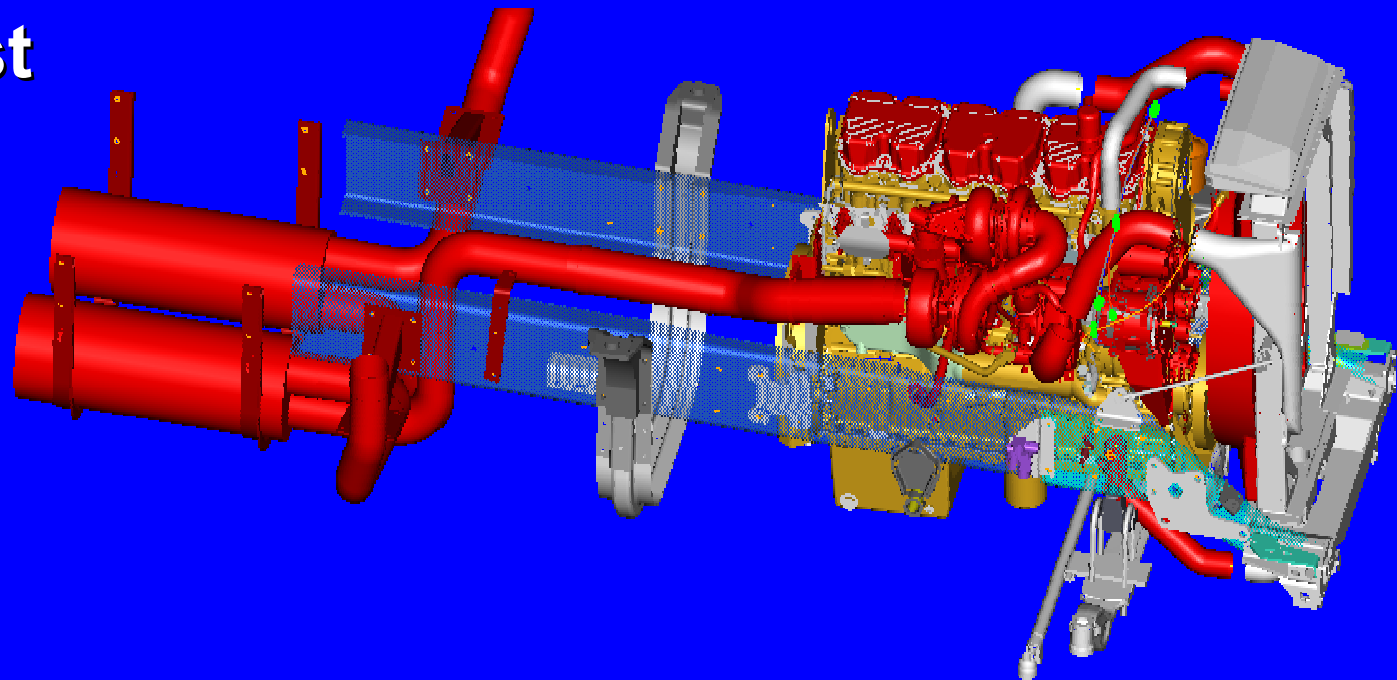


Combustion Chamber



Chassis Systems Integration

- **Jacket Water Cooling**
- **Intake Air Cooling**
- **Electrical / Electronic**
- **Exhaust**



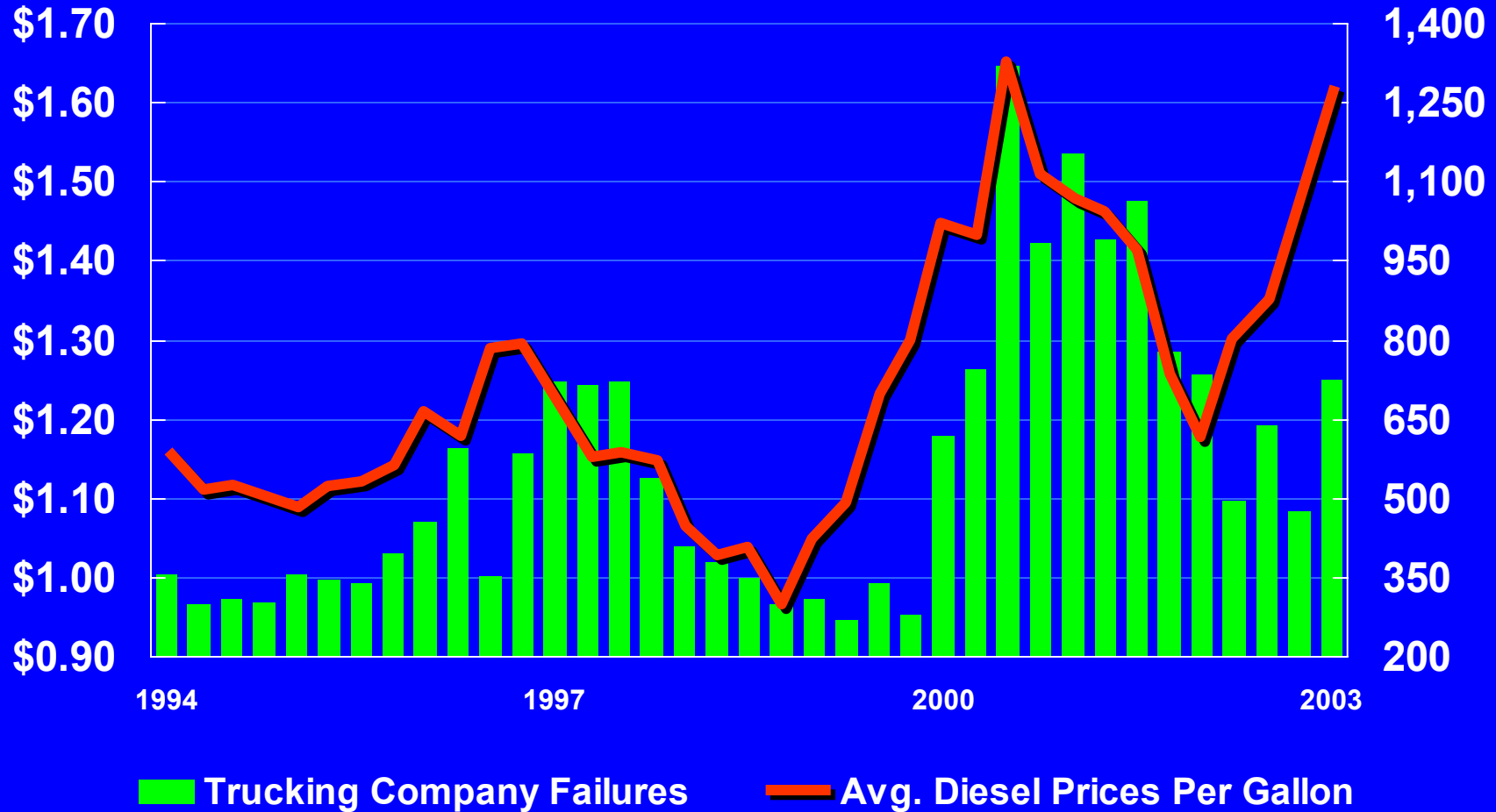
Customer Expectations

- Purchase Price
- Operating Costs
- Reliability
- Predictable Performance

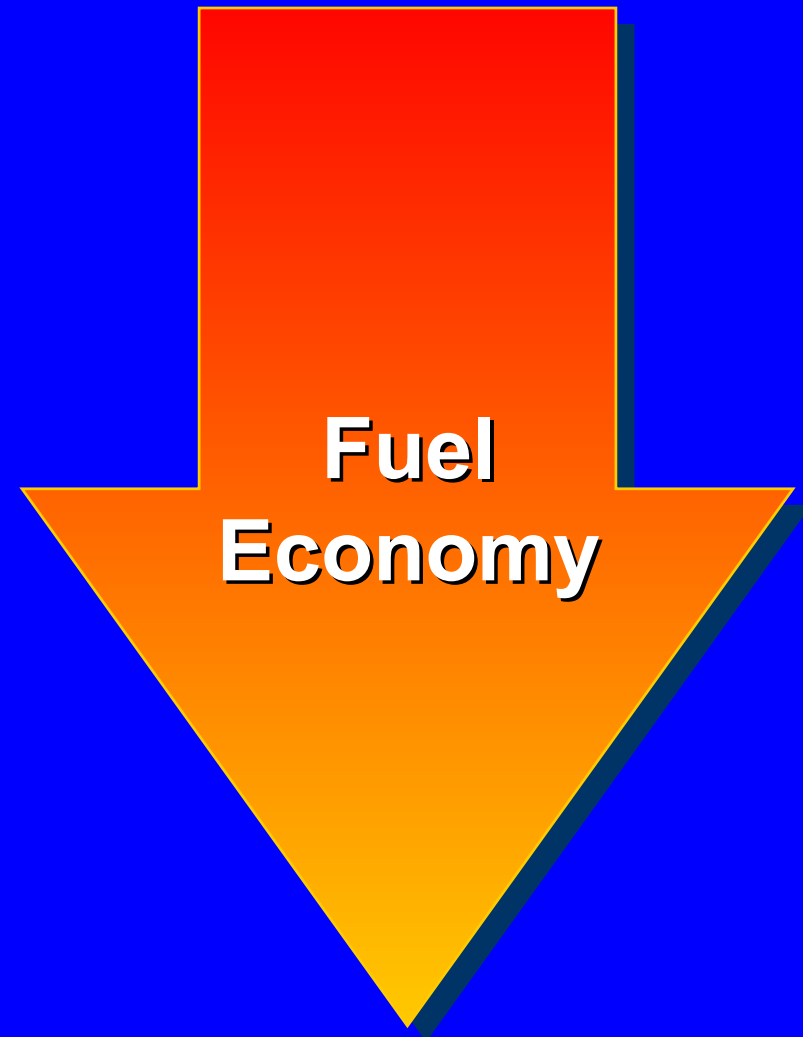
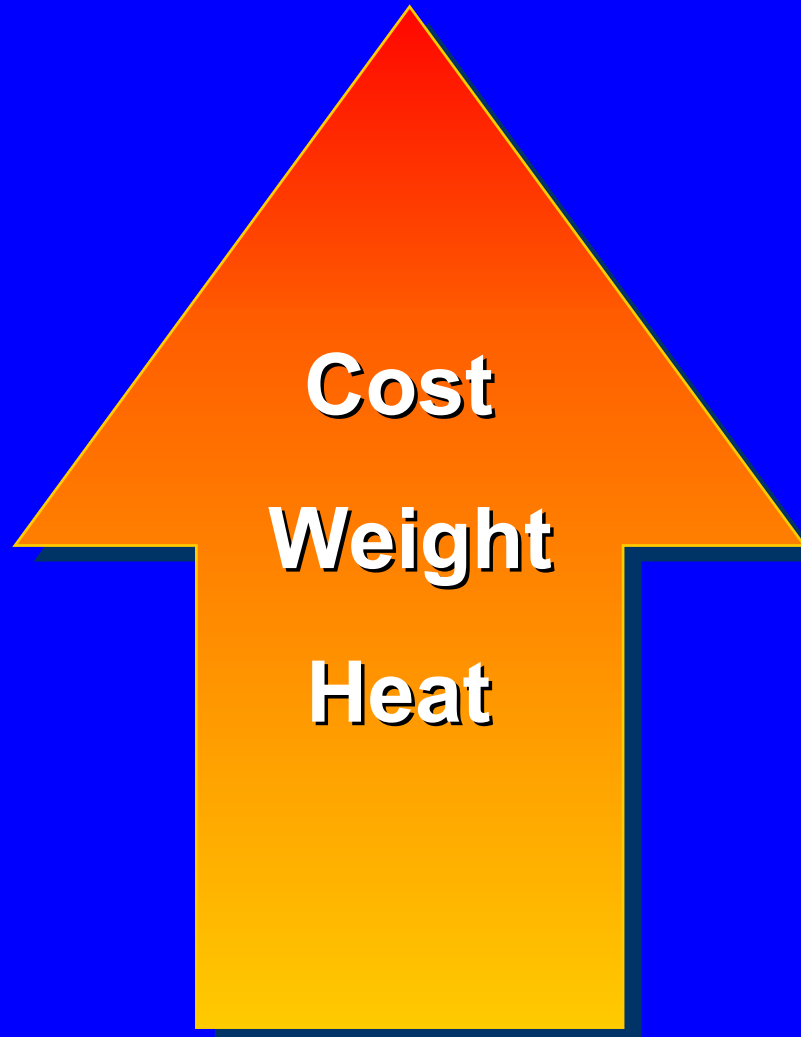
Operating Cost Sensitivity

Diesel
Prices

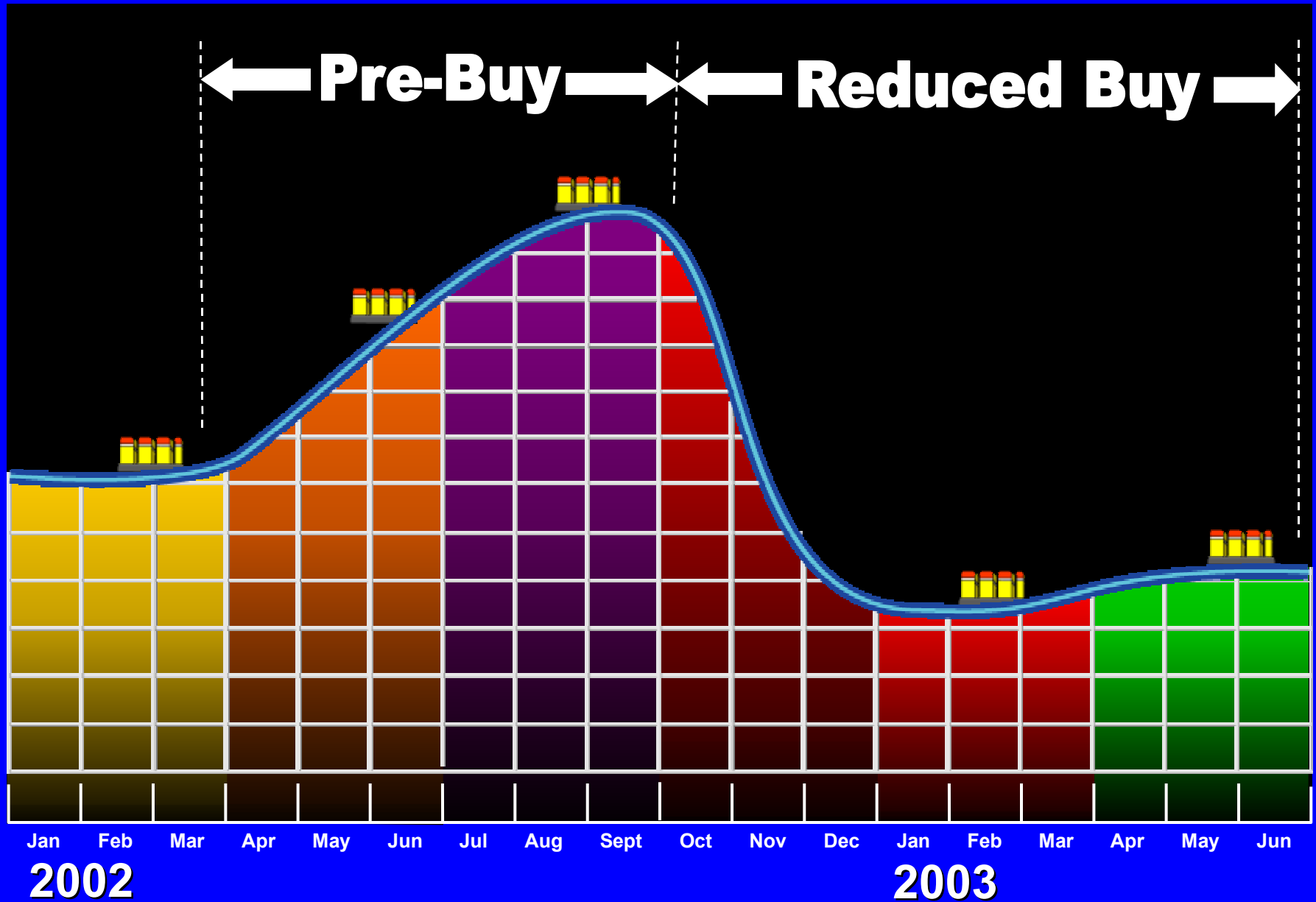
Carrier
Failures



2002/2004 Emissions



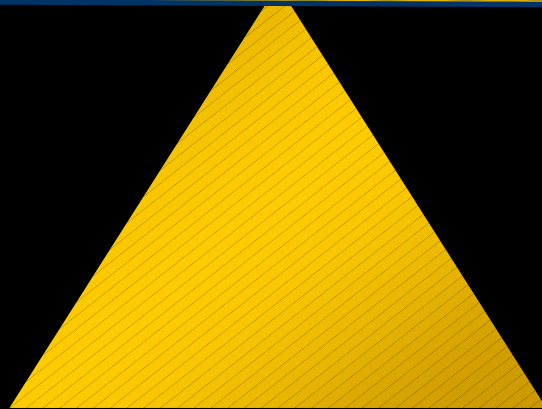
Customer Reaction






**PARTS
SERVICE
MAINTENANCE**



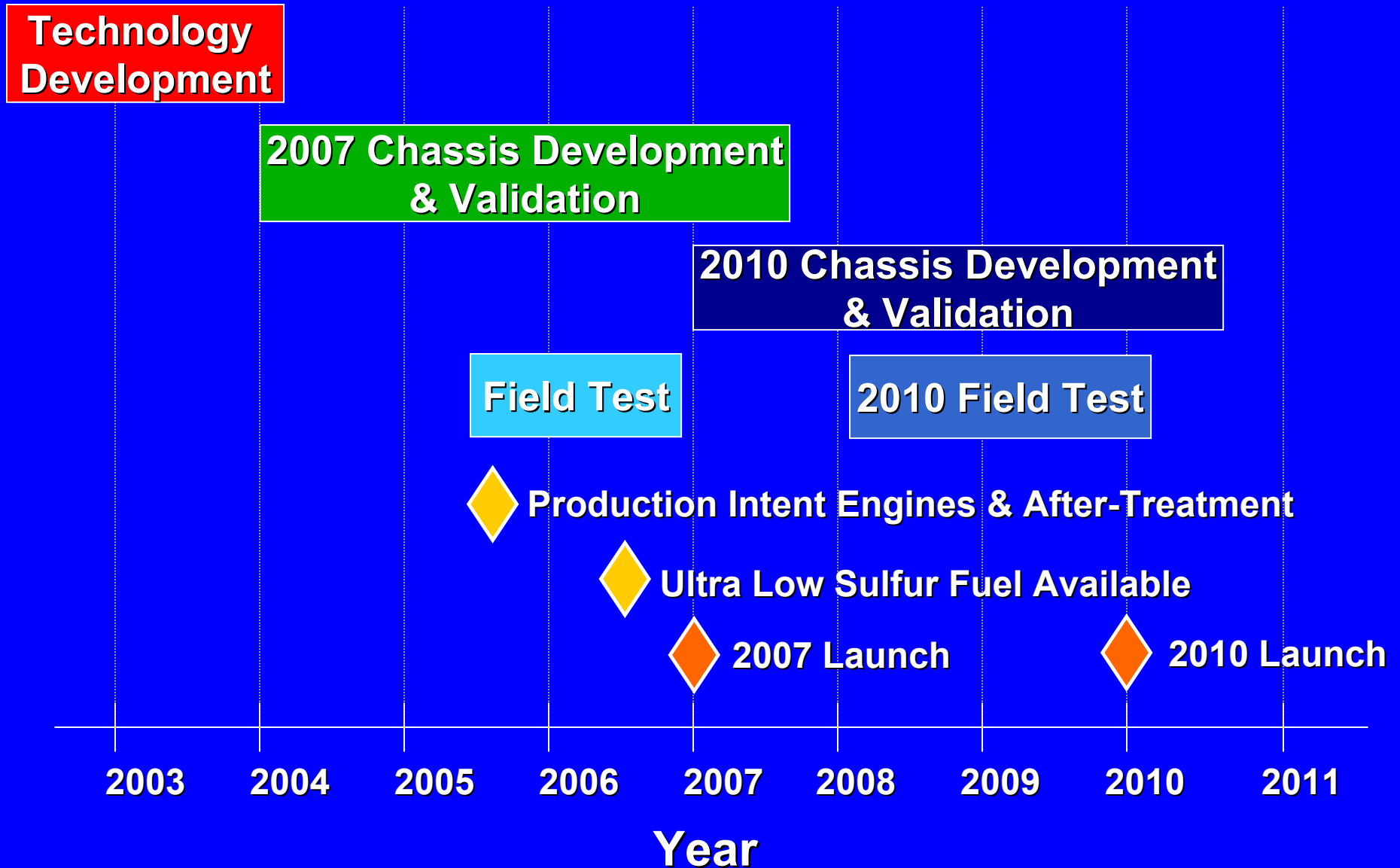
**2007
EMISSIONS**



Win-Win-Win

- **Environment**  **Lower Emissions**
- **Engine &
Truck OEM's**  **Reliable & Efficient
Products**
- **Truck Owners**  **Cost Effective
Truck**

Timing



Timing

Technology Development

2007 Chassis Development & Validation

2010 Chassis Development & Validation

Field Test

2010 Field Test

Production Intent Engines & After-Treatment

Ultra Low Sulfur Fuel Available

2007 Launch

2010 Launch

2003

2004

2005

2006

2007

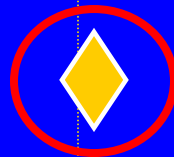
2008

2009

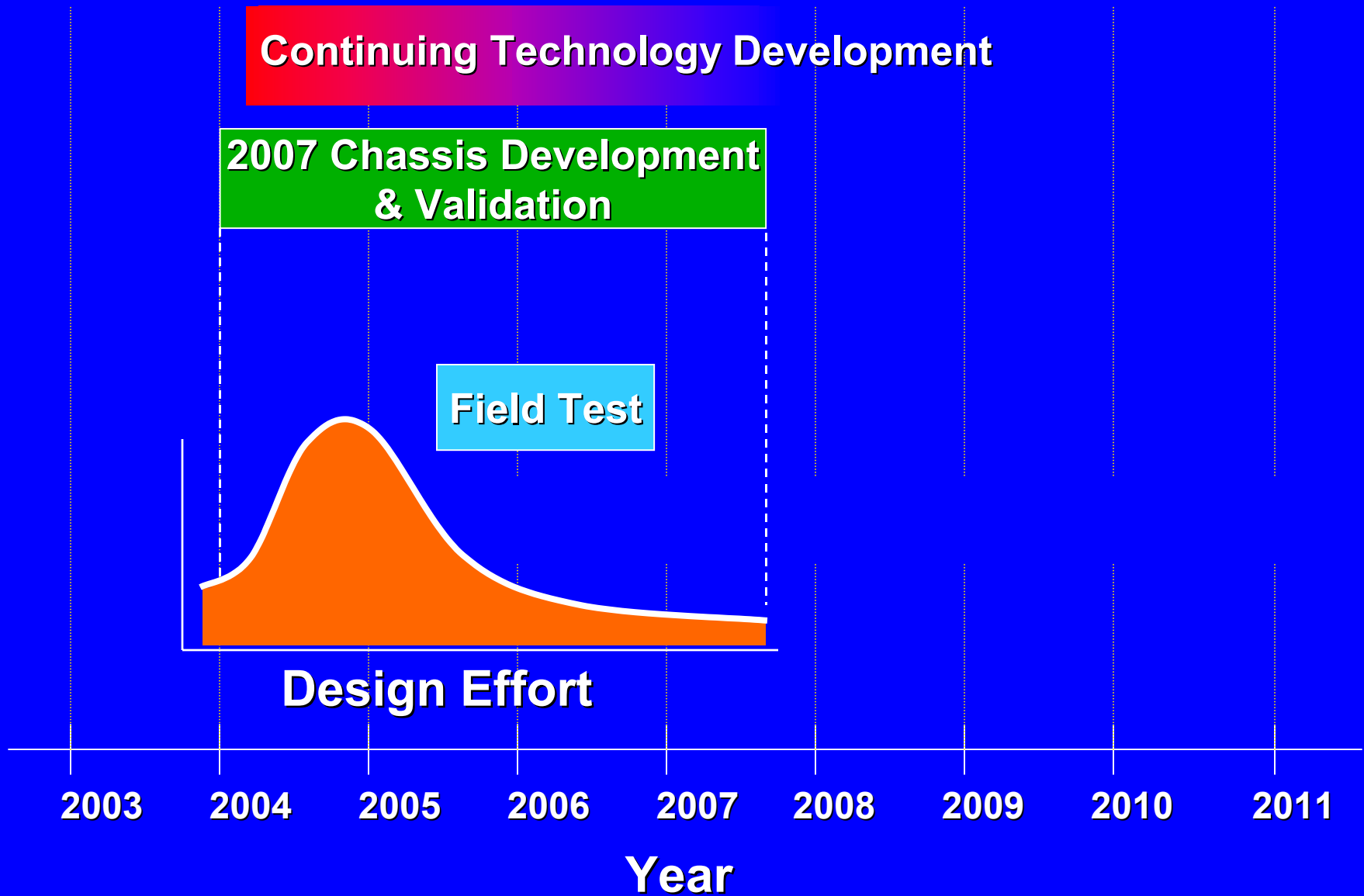
2010

2011

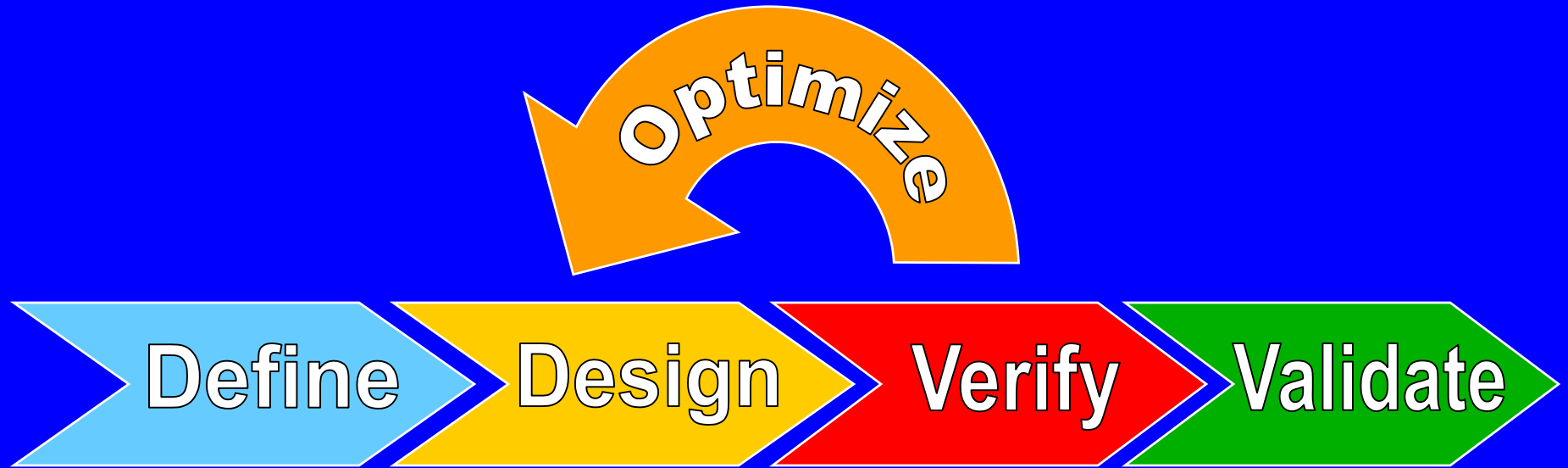
Year



Timing

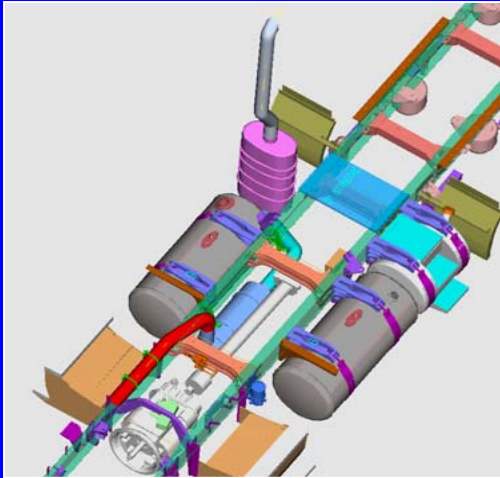


Design Process



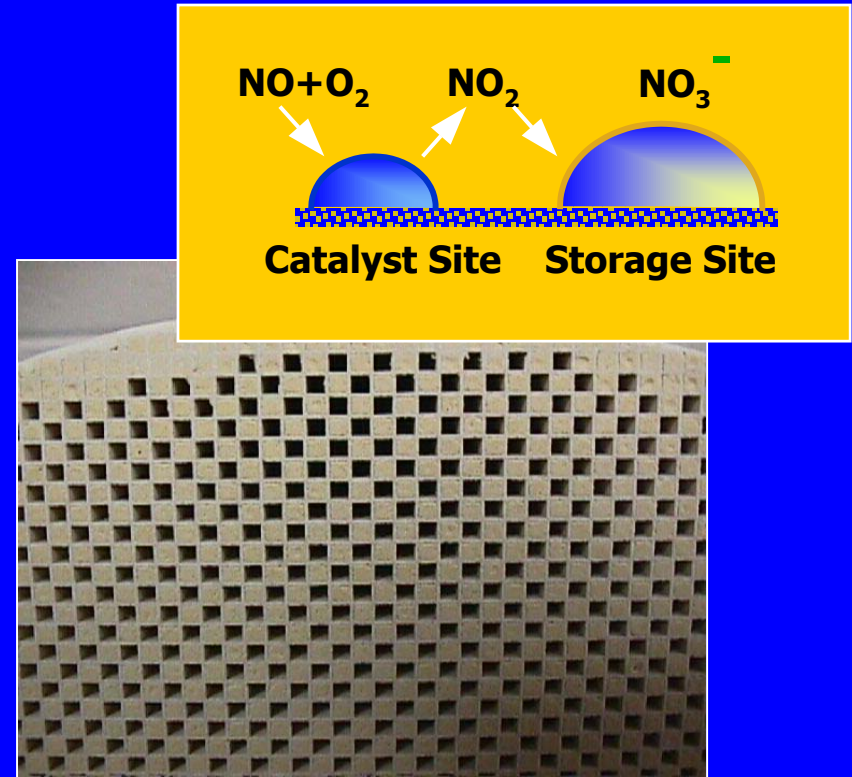
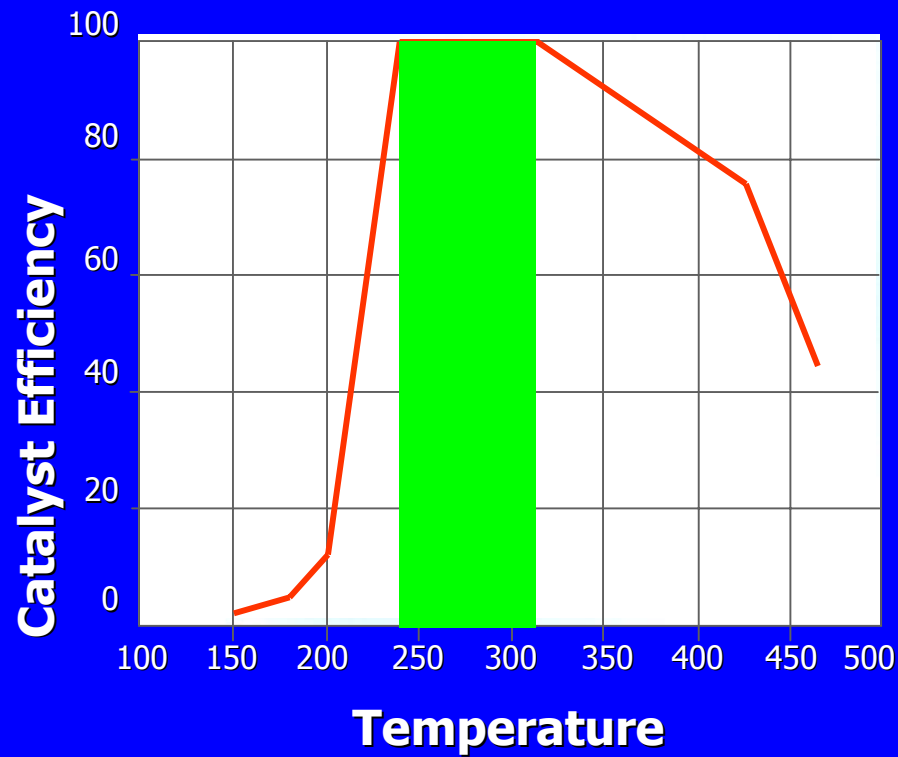
Vehicle Variations

- Packaging
- Duty-Cycle



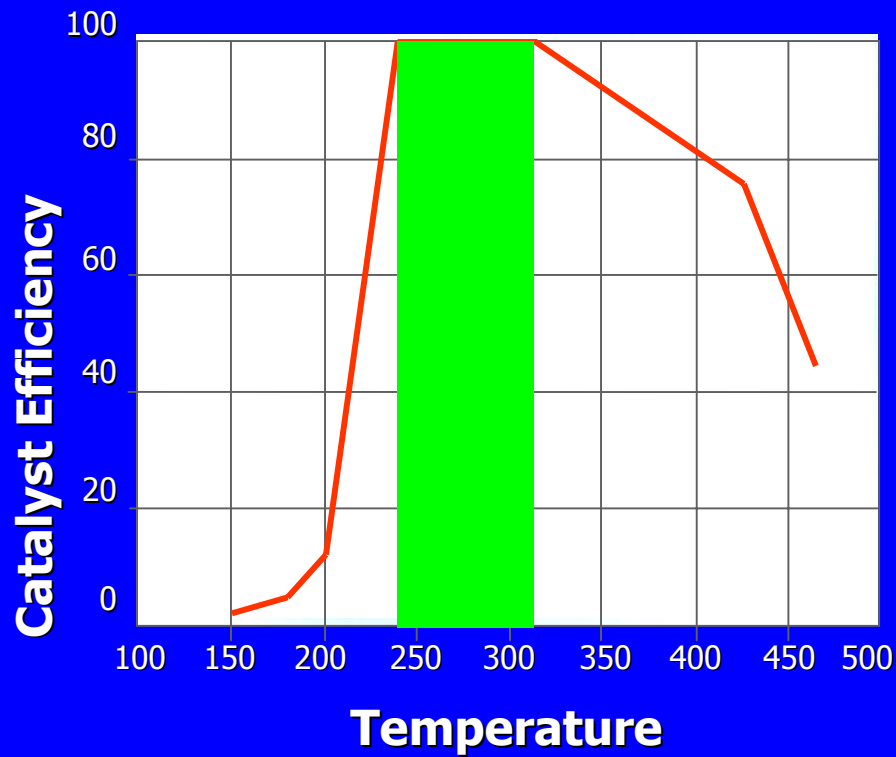
System Optimization

Desired

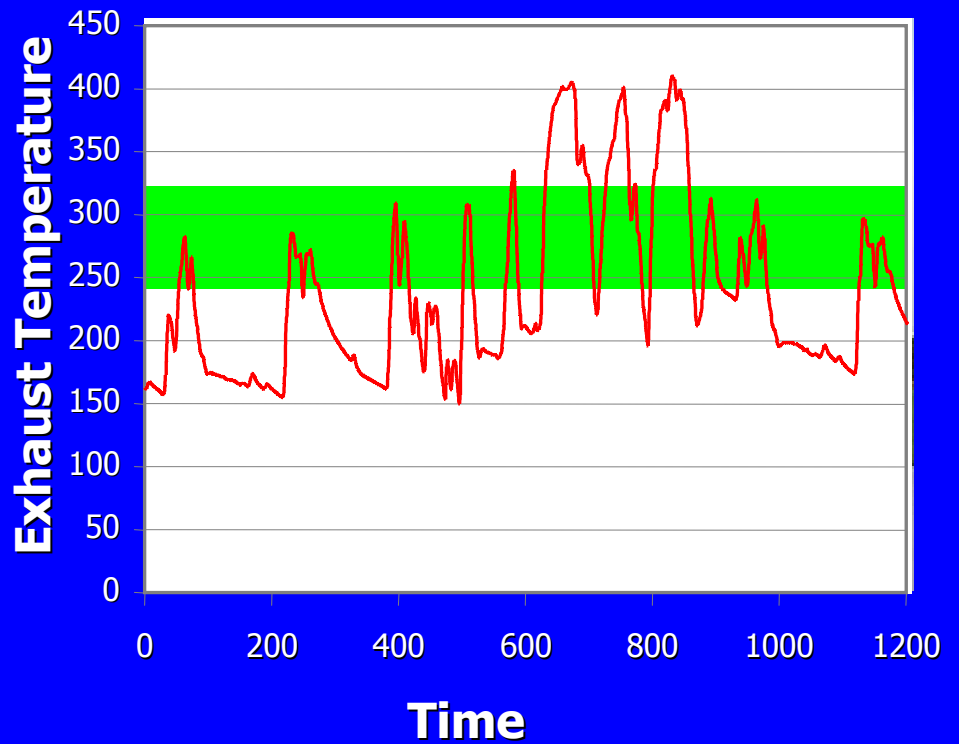


System Optimization

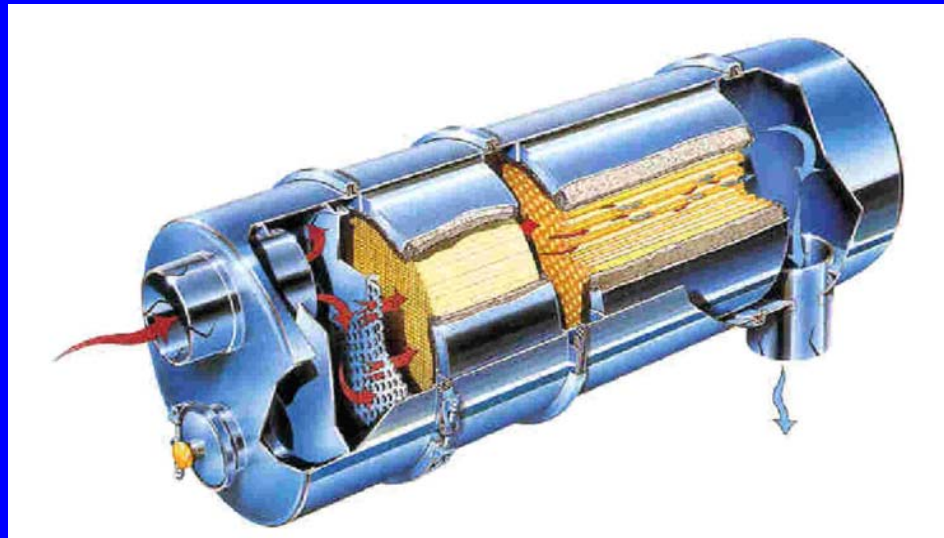
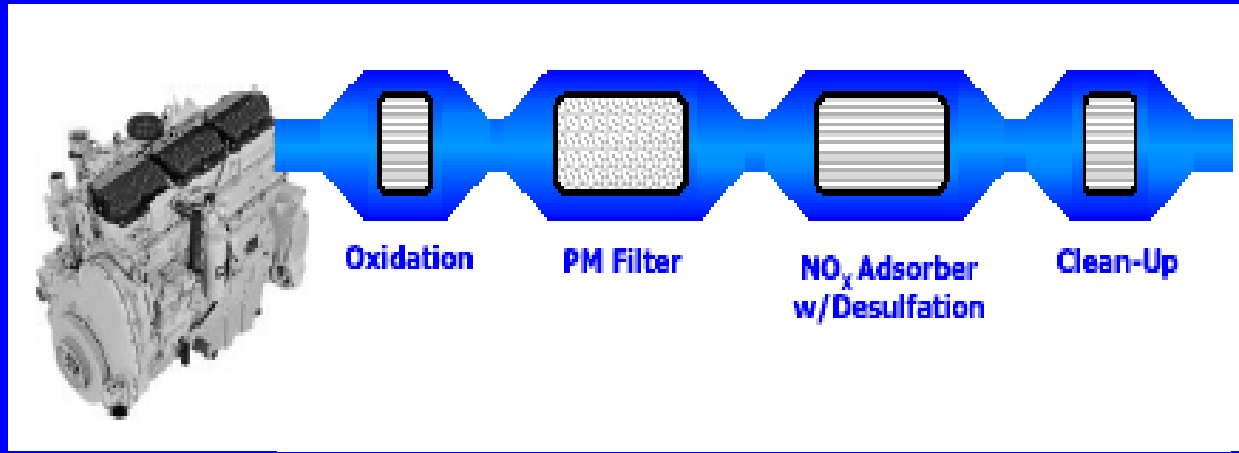
Desired



Actual



2007/2010 Emissions Technologies



Development Timing Challenges

- **Experience With Technologies**
- **Availability Of Off-the Shelf Commercial Components**
- **High Product Durability Requirements**
- **Criticality of Systems &/or Components**

“Uncertainty” Risk Factors

- **Technology**

- Acceptability Of SCR By The EPA
- Lack Of Common Approach By Engine Manufacturers
- Availability Of An Adequate Infrastructure In 2007

- **Chassis Integration**

- Heat Rejection Water/Air
- CAC Pressure
- Electrical/Electronic/Software Demand

- **Development**

- Availability Of Commercial “Prototype” Components
- Representative Product For Testing
- Adequate Time For Validation By Vehicle OEM & Customer

Time is of the Essence

- **Remove Uncertainties**
- **Generate Consumer Confidence**

Win

Win

Win