

**DAIMLERCHRYSLER**  
DaimlerChrysler Powersystems

***Catalyst Performance Maps  
For Aftertreatment Simulation***

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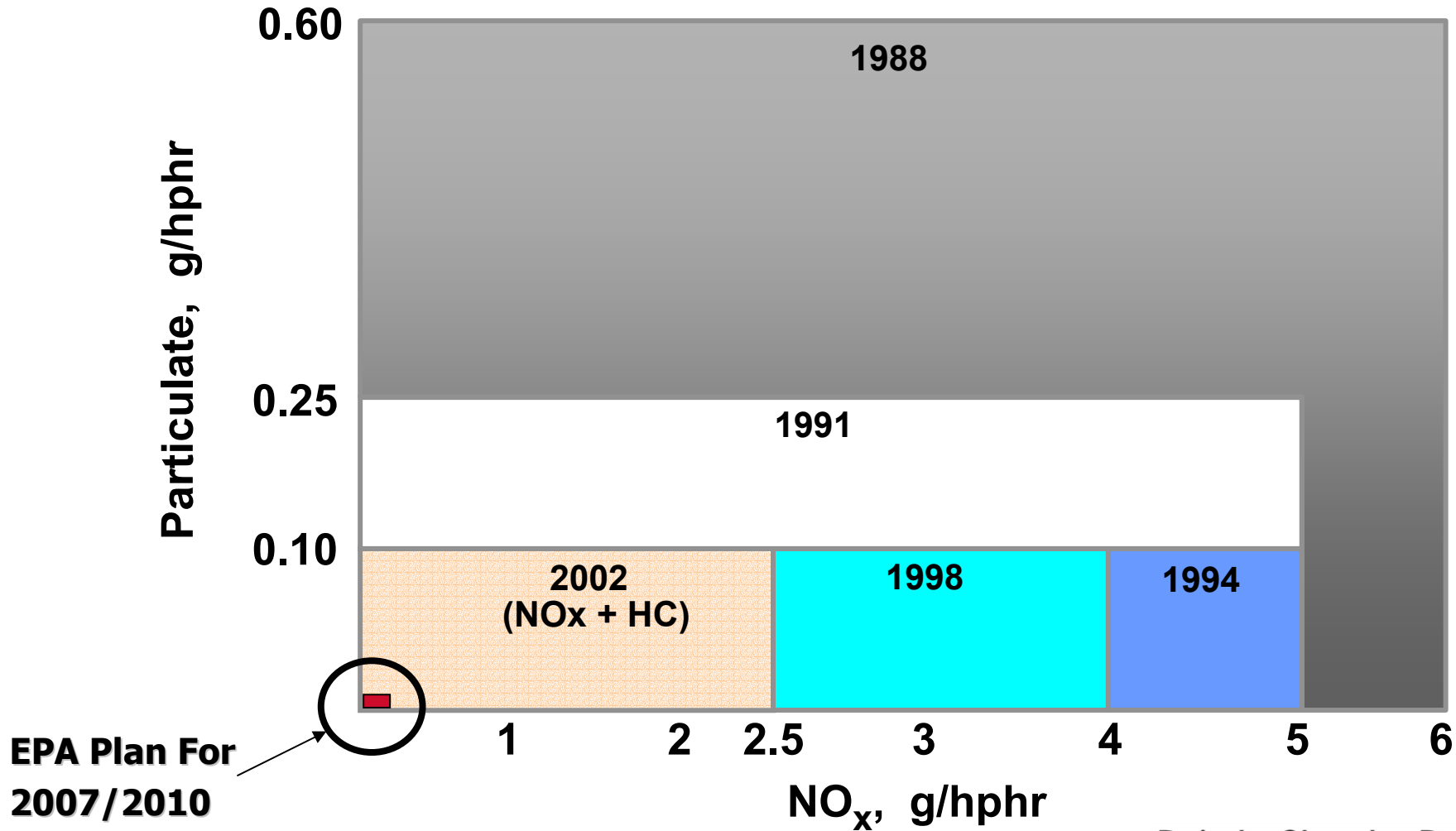


# To Meet 2007/2010 Standards

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- **Aftertreatment (AT) Will Be an Integral Part of the Emissions Strategy**
  - Diesel Particulate Filters (0.01 g/hphr)
  - NOx Device (0.2 g/hphr)
- **Aftertreatment Must Be Integrated and Optimized**
  - Conversion Efficiencies >90% Are Desired
- **Simulation Tools Are Vital For Engine Integration**

# Heavy Duty Emissions Regulation



# Simulation Tools

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- **Diesel Engine Industry Uses Simulation Extensively**
  - Used Today For Optimizing Overall Engine Performance
  - Also Used for Component Optimization
    - » From 3-D CFD to 1-D Cycle Simulation
    - » Turbochargers, Injectors, EGR System, Camshafts, etc.
- **These Tools WILL Be Used For Aftertreatment Optimization**
- **Cross-Cut Lean Exhaust Emissions Reduction Simulations**

# Component Optimization

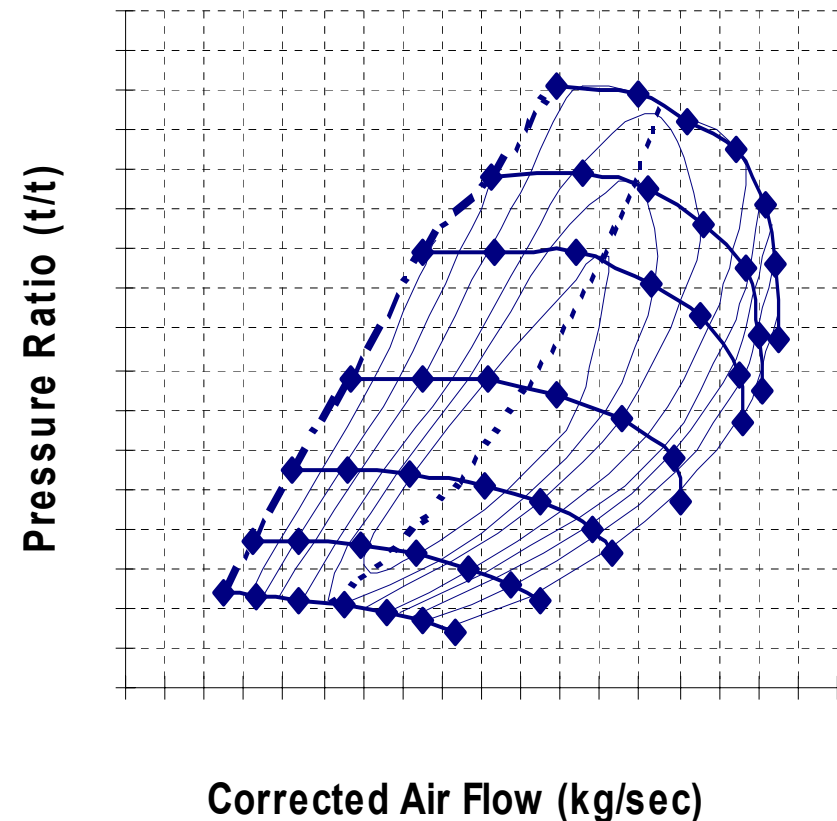
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- **Turbochargers – A Good Example**
- **Before Testing a Turbocharger – It is Modeled**
  - **Turbocharger Supplier Provides Performance Data**
    - » Compressor Map, Turbine Map
  - **Other Data Can Be Supplied As Well**
    - » Rotating Inertia, Mass, Critical Geometric Data, Etc.
  - **Based On The Modeling:**
    - » Turbocharger Match Is Iterated and Refined
    - » Innovative Designs Can Be Studied
    - » Control Strategies Can Be Defined

# Compressor Map

- **Supplier Provides Performance Map**
  - Standardized Format
  - They Know It Is Required
  - Covers Speed, Flow, Pressure, Efficiency, Surge, Choke
- **I Don't Get or Need Design Details**
  - Number of Blades, Curvature Data, Etc.

Typical Compressor Performance Map



# Engine Is Modeled ...

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- **Engines Will Continue To Be Studied Via Simulation**
  - Turbocharger Maps Are Only One Example
  - Camshafts, Head Flow, Heat Exchangers, Friction, etc.
- **Aftertreatment Devices Will Be No Different**
  - OEM's Creating Models and Performance Data
  - AT Suppliers Creating Models and Data
  - National Labs, Universities, etc., Creating Models and Data
- **What Can CLEERS Do To Help?**

# CLEERS Continues To Evolve

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- **Started Out Considering Creation of Models**
  - Could Not Agree on Approach
  - Everyone Wanted Their Own Model
  - Too Competitive
- **Continues as a Forum For Information Exchange**
  - Workshops, Web Site Data Base, etc.
- **CLEERS Uniquely Suited To Define Catalyst Maps**



# Catalyst Performance Maps (1)

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## The Vision Statement

- **Catalyst Performance Map(s) Summarize the Global Performance Criteria That Are Critical To Engine Performance and Integration Onto A Diesel Engine.**
  - **Flow/Mass Transfer, Thermal, Kinetics (w/ Aging)**
- **The Catalyst Maps May Be Performance Curves, Calibrated Global Equations, Simplified Chemical Kinetic Equations, Etc.**
- **Each AT Technology (LNT, SCR, DPF) Will Have Its Unique Criteria.**

# Catalyst Performance Maps (2)

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## The Vision Statement

- **Ideally, The Maps Convey The Information Needed By OEM's Without Revealing Detailed, Confidential AT Formulations.**
- **Once The "Map Requirements" Are Quantified, We Will Define A Standard Format.**
- **The CLEERS Focus Groups (LNT, SCR, DPF) Will Determine What Should Be Included In These Maps.**

# CLEERS Focus Groups

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- **Currently, There Are Three Focus Groups**
  - LNT, SCR, DPF
- **The CLEERS Focus Groups Are Composed Primarily of OEM's and National Labs**
- **Catalyst Suppliers Have Been Added**
  - Catalyst Supplier's Input Is Critical
- **In General, Focus Groups Are Kept Small So Consensus Can Be Reached**
- **Members Must All Contribute**

# What To Include In The “Maps”

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- **This Is The #1 Task Of Each Focus Group**
  - **Must Cover Mass Transfer, Thermal, and Kinetic Issues**
  - **Ideally, Suitable For Various Level of Simulation (1-D, 3-D)**
  - **Ideally, Easy Data For Supplier To Generate**
- **A Methodology Has Been Decided To Quantify Needed Catalyst Map Data**
  - **Study One Catalyst (per Focus Group) In Detail**
  - **Group Members Will Model That Catalyst**
  - **Results Will Be Shared**
  - **The “Critical Input” Will Be Quantified**

# Catalyst Map Summary

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- **A “Catalyst Map Vision” Has Evolved.**
- **Catalyst Maps Should Be Good Method For Communicating Global Performance Data Between Supplier and OEM.**
- **Each of The Focus Groups Will Investigate What Should Be On Their Map(s).**
- **Potentially, Great Value To Industry.**
  - **Ease of Information Transfer Between Supplier and OEM**
  - **A Good Step Forward In AT Modeling**