



**Emission
Solutions**

Advanced Compact Aftertreatment Architectures – Cummins Emission Solution Readiness for Global VII

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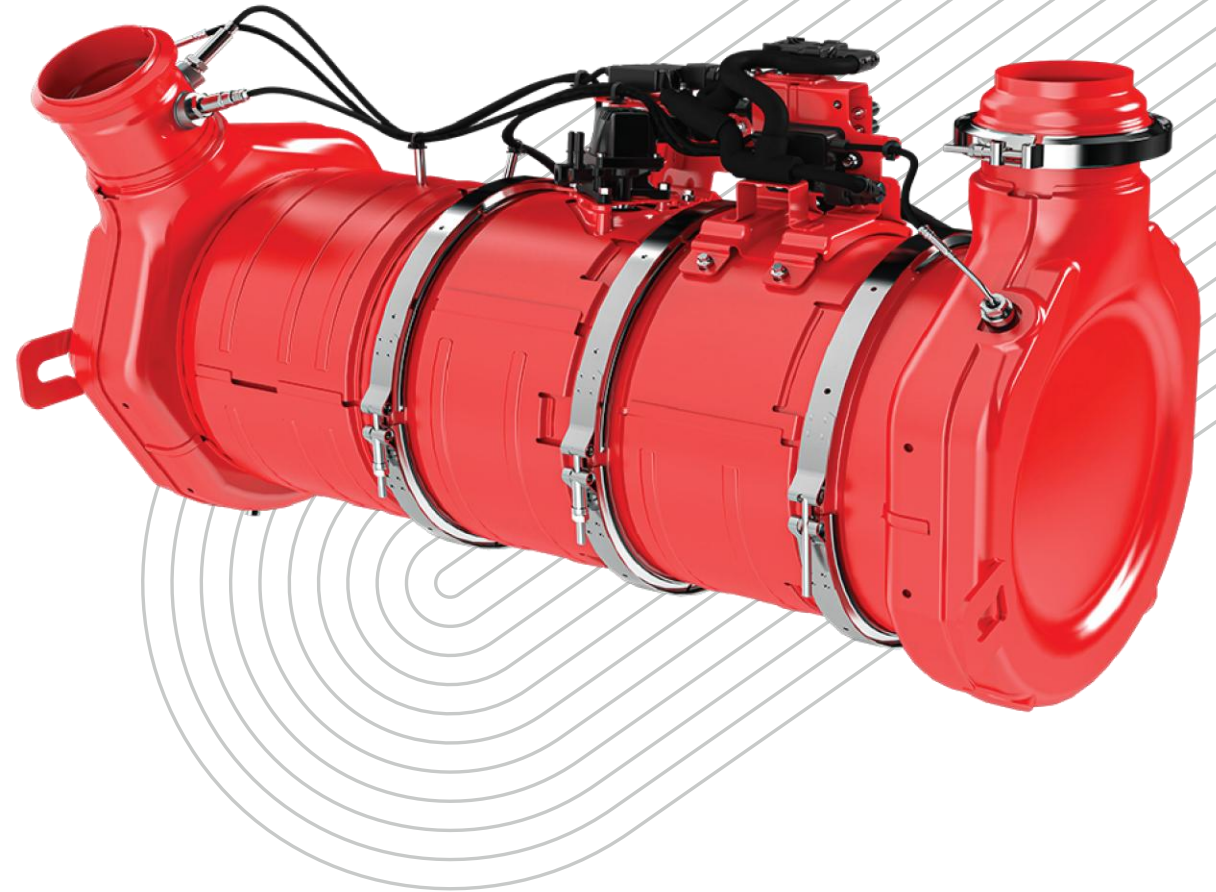
Group Lead – Decomp Reactor Development

CTCI, Pune

ECMA Conference 2026

(22-23 Oct 2026)

Cummins Confidential

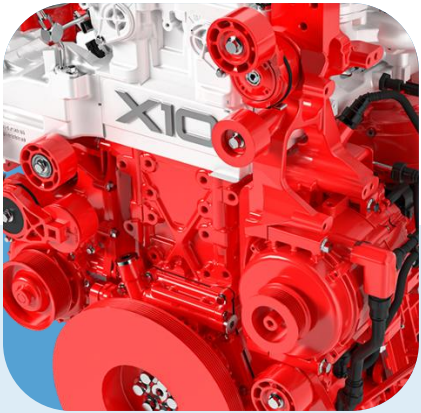


Acronyms

- Aftertreatment System (ATS)
- Diesel Oxidation Catalyst (DOC)
- Diesel particulate Filter (DPF)
- Selective Catalytic Reduction (SCR)
- Ammonia Slip Catalyst (ASC)
- Ammonia to NO_x Ratio (ANR)
- Diesel Exhaust Fluid (DEF or AdBlue)

Five operating segments

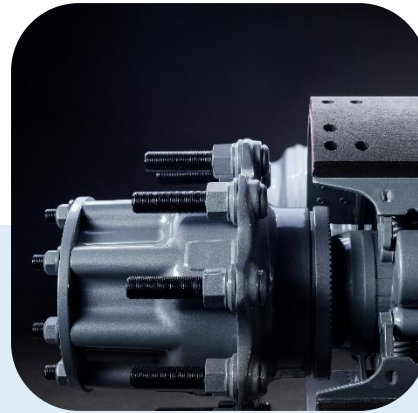
Cummins has a long track record of delivering leading power solutions. As we look ahead, we know our industries and regions will continue to change, and we are committed to bringing our customers the right technology at the right time.



Engine



Power Systems



Components



Distribution



**Accelerator™ by
Cummins**

Our global manufacturing and distribution footprint

ENGINE *U.S., Brazil, India and U.K.*

COMPONENTS *U.S., Australia, Brazil, China, France, Germany, India, Mexico, South Korea and U.K.*

POWER SYSTEMS *U.S., Brazil, China, India, Mexico, Nigeria, Romania and U.K.*

DISTRIBUTION *U.S., Australia, Canada, China, India, South Africa and U.K.*

**ACCELERA™ BY
CUMMINS** *U.S., Belgium, Canada, China and Germany*

**The above reflects principal manufacturing facilities for each segment. In addition, engines and engine components are manufactured by joint ventures or independent licensees at manufacturing plants in the U.S., China, India, Japan, Mexico, Sweden and U.K.*

Aftertreatment solutions

CUMMINS EMISSIONS SOLUTIONS

Leading

Global designer, integrator, manufacturer and distributor of exhaust aftertreatment systems and components

20+

Years of
aftertreatment
experience

13

Manufacturing
facilities

AND

7

Technical centers
around the globe

CORE TECHNOLOGIES



Diesel Oxidation
Catalyst (DOC)



Diesel Particulate
(DPF) Filter



Selective Catalytic
Reduction (SCR)
System



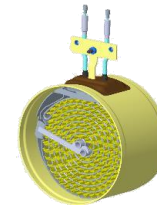
Doser Technology



Ammonia delivery
system



Controls



Thermal
Management

Multiple **integration programs** with non-Cummins OEMs and engine manufacturers

Aftertreatment Components

Urea Dosing Systems

Electronic control technology that Provides urea injection in front of the catalyst

Catalyst Technology

Provides catalyst for flow-through and wall-flow reactions

Hydrocarbon Dosing System

Provides enhanced injection and heat management capabilities

Urea Tank System

Urea quality sensor detects and monitors the correct urea liquid composition

Engine & Aftertreatment Control Modules

Provides logic between engine and aftertreatment to maintain emissions

Temperature, Pressure & NOx Sensors

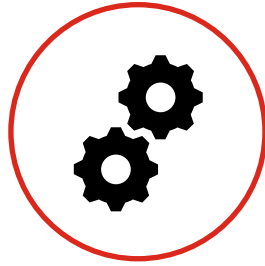
Enables logic for dosing, regeneration, warning lamps, wiring harness, etc.



Destination Zero



**Lower
emissions today**



**Advance low-carbon
technologies**



**Drive wide-scale
customer adoption**



**Reduce well-to-
wheel emissions**

Agenda

Introduction

- EURO VII Emission Norms and Its Challenges
- DEF driven PN10 watchout
- Role of efficient mixing device

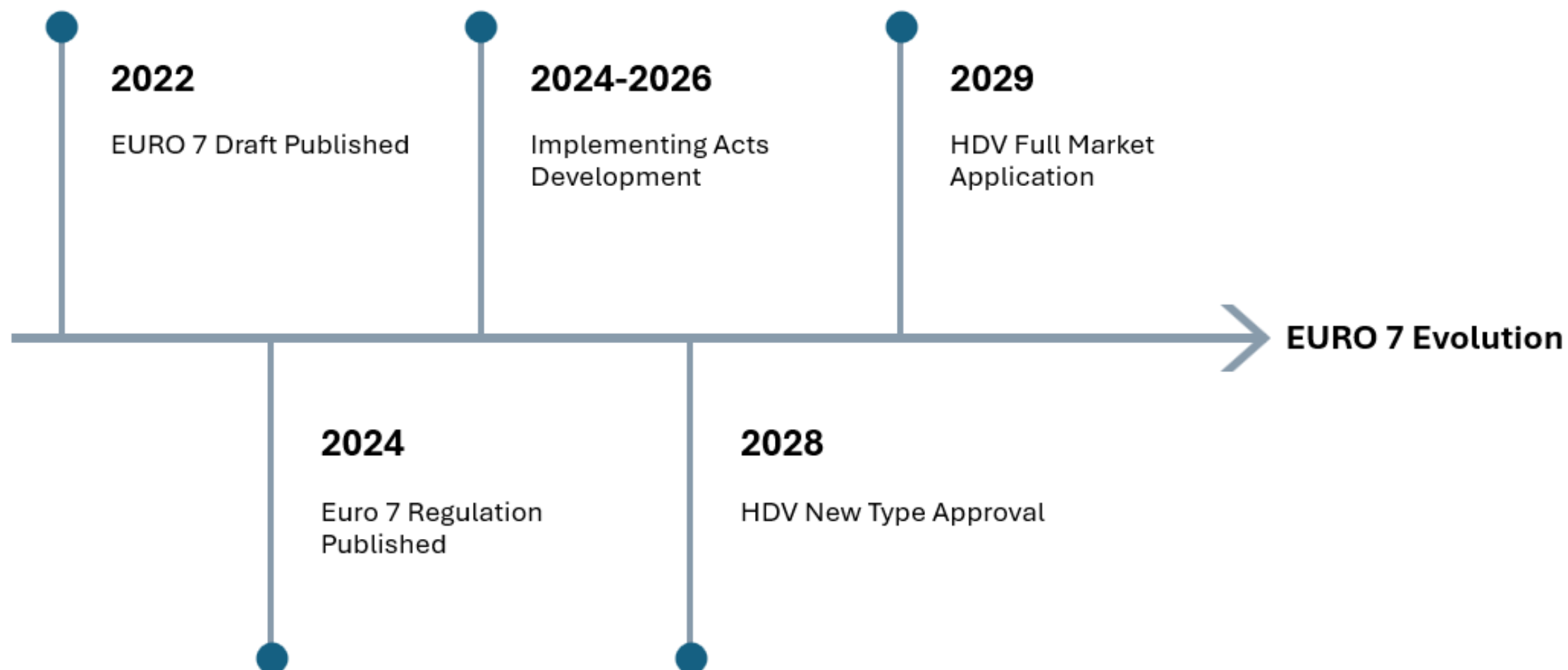
System Architecture Readiness

- Brief outline of combination of ATS – Single Module, Switchback configuration
- Performance comparison of Global VII systems

Summary

- Conclusion

EURO 7 - TIMELINE



EURO 7 – EMISSION NORM DETAILS

Euro VI Phase E (Diesel)		
Species	WHTC & (WHSC)	RDE
NO _x	460 (400)	690
PM	10 (10)	-
PN23* (#/kWh)	6E11 (8E11)	9.78E11
CO	4000 (1500)	6000
NH ₃ (ppm)	10 (10)	-
CH ₄	-	-
N ₂ O	-	-
HCHO	-	-
THC**	160 (130)	240

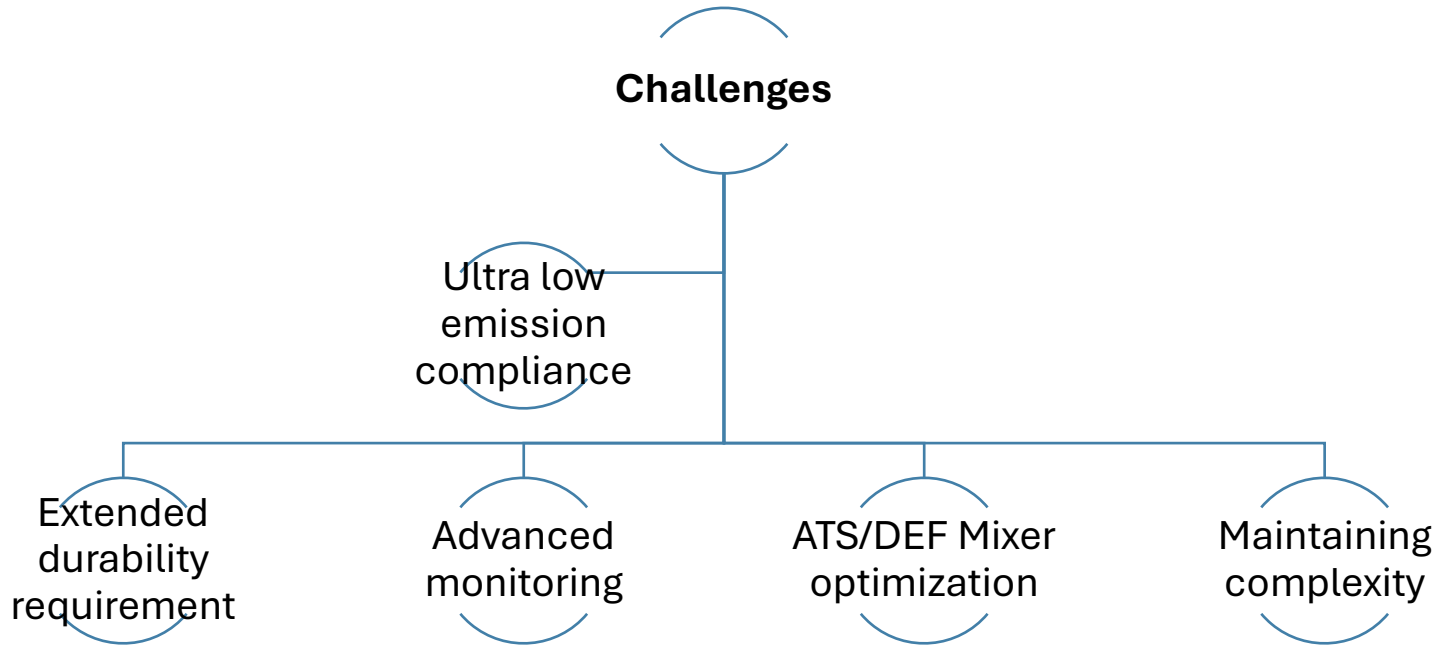
*PN23 assessed instead of more stringent PN10 in Euro 7
 **THC split and expanded into CH₄ and NMOG in Euro 7

Euro 7 May 2024 Published		
Species	WHTC & WHSC	RDE
NO _x	200	260
PM	8	-
PN10 (#/kWh)	6E11	9E11
CO	1500	1950
NH ₃	60	85
CH ₄	500	650
N ₂ O	200	260
HCHO	-	-
NMOG	80	105

New Introductions

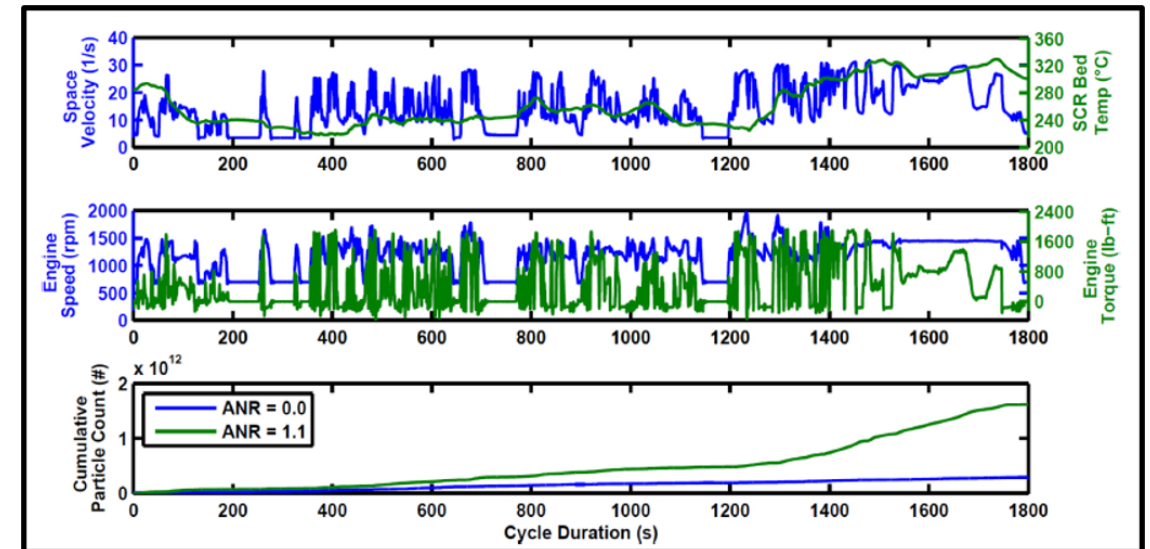
- NO_x and PM stringent.
- Introduction of PN10 and N₂O.

EURO 7 – CHALLENGES



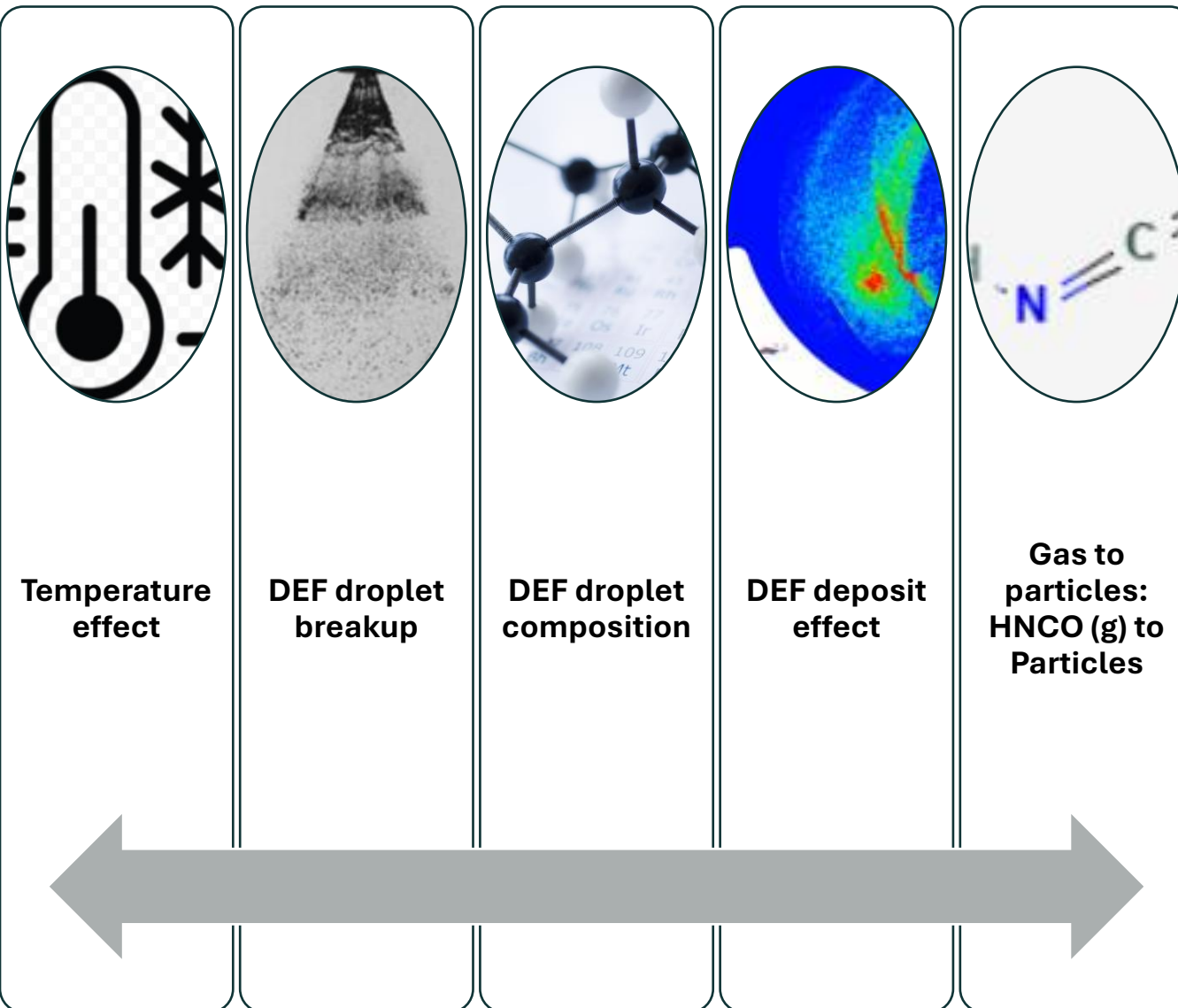
DEF DRIVEN – PN10 WATCHOUT

- PN = Particle Number, number of solid particles emitted.
- Euro 5/ Euro 6 larger than 23 nm called PN23, were measured.
- Euro 7 extends to larger than 10 nm called as PN10.
- PN10 can increase due to secondary DEF particles induced.



Robinson, M., Backhaus, J., Foley, R., and Liu, Z., "The Effect of Diesel Exhaust Fluid Dosing on Tailpipe Particle Number Emissions," SAE Technical Paper 2016-01-0995, 2016, doi:10.4271/2016-01-0995

CRITICAL FACTOR AFFECTING SECONDARY PN



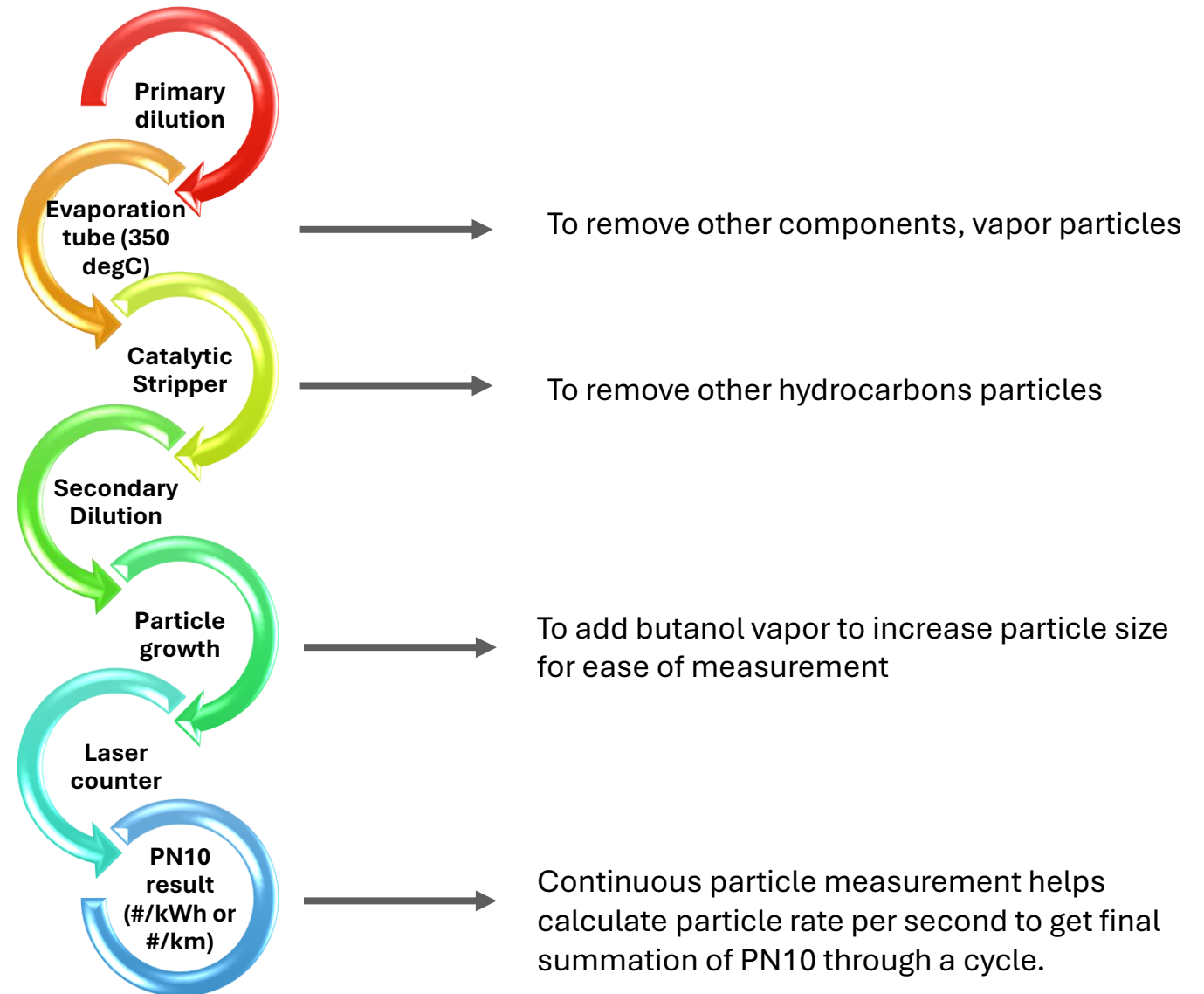
How DEF dosing impacts PN10

- Un-utilized DEF particles which pass through the SCR during transient cycle.
- Atomized DEF can get attached to particles present in exhaust gases.
- Deposit formation inside mixer may impact PN10 formation.
- Decomposition of DEF inside mixer may impact.

PN10 MEASUREMENT

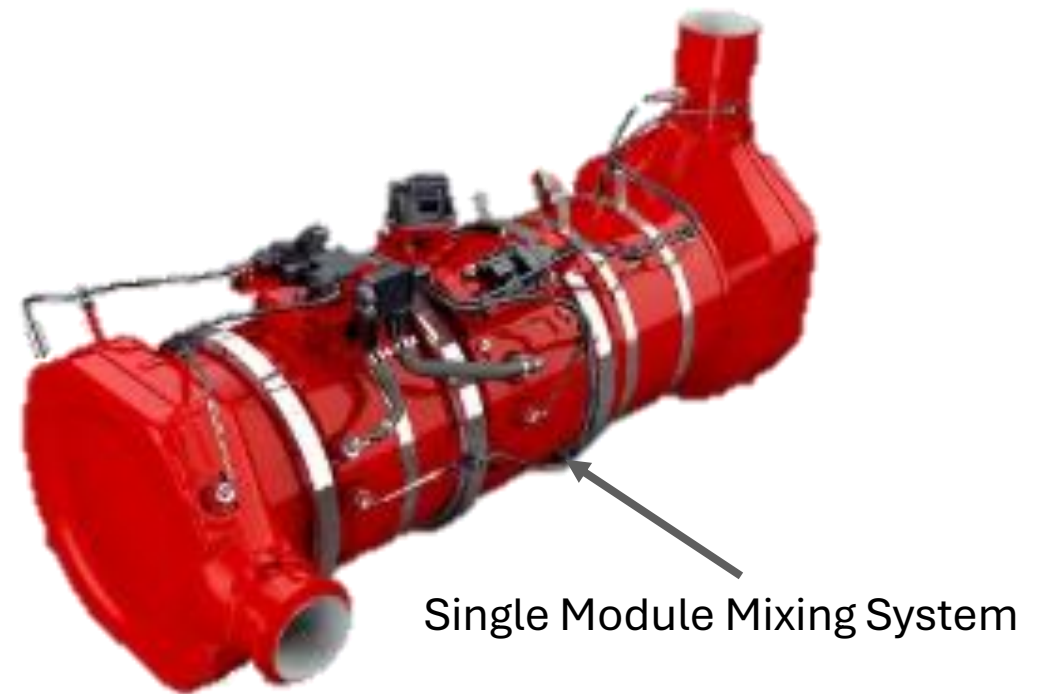
PN10 measurement system consists of:

1. Exhaust sampling
2. Dilution
3. Volatile removal
4. Particle counting



ROLE OF DEF MIXING DEVICE

- Mixer prime function - To ensure DEF particles are decomposed and mixed with exhaust.
- Longer the length better is mixing, also known as Decomposition Reactor Tube.
- Need of efficient mixing device
 - Regulate DEF particles mixing and injection
 - Regulate distribution of ammonia on face of SCR
 - Regulate DEF deposit risk during low temperature
 - Regulate **PN10 formation** due to DEF particles
 - Thermal management during low temperature cycles
 - Achieve all above function in minimum length, compact design



Decomposition Reactor Tube

CRITICAL PARAMETERS IMPACTING DEF MIXING SYSTEM

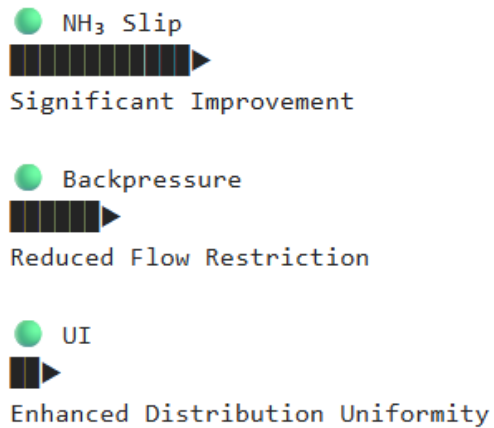


Space Availability	<ul style="list-style-type: none">• DRT vs Compact Mixing Device• Geometry before and after DEF mixing system
Droplet breakup principle	<ul style="list-style-type: none">• Swirl based• Breakup based• Length based
Type of DEF dosing system	<ul style="list-style-type: none">• Injection angle• Injection velocity• Injection diameters
Doser integration	<ul style="list-style-type: none">• Axial injection• Perpendicular injection• Angled injection• Single vs Dual Dosing

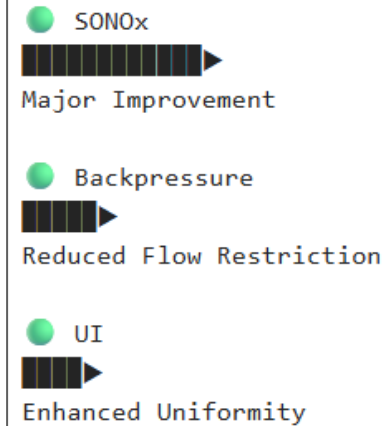
SINGLE MODULE SYSTEM PERFORMANCE



On highway

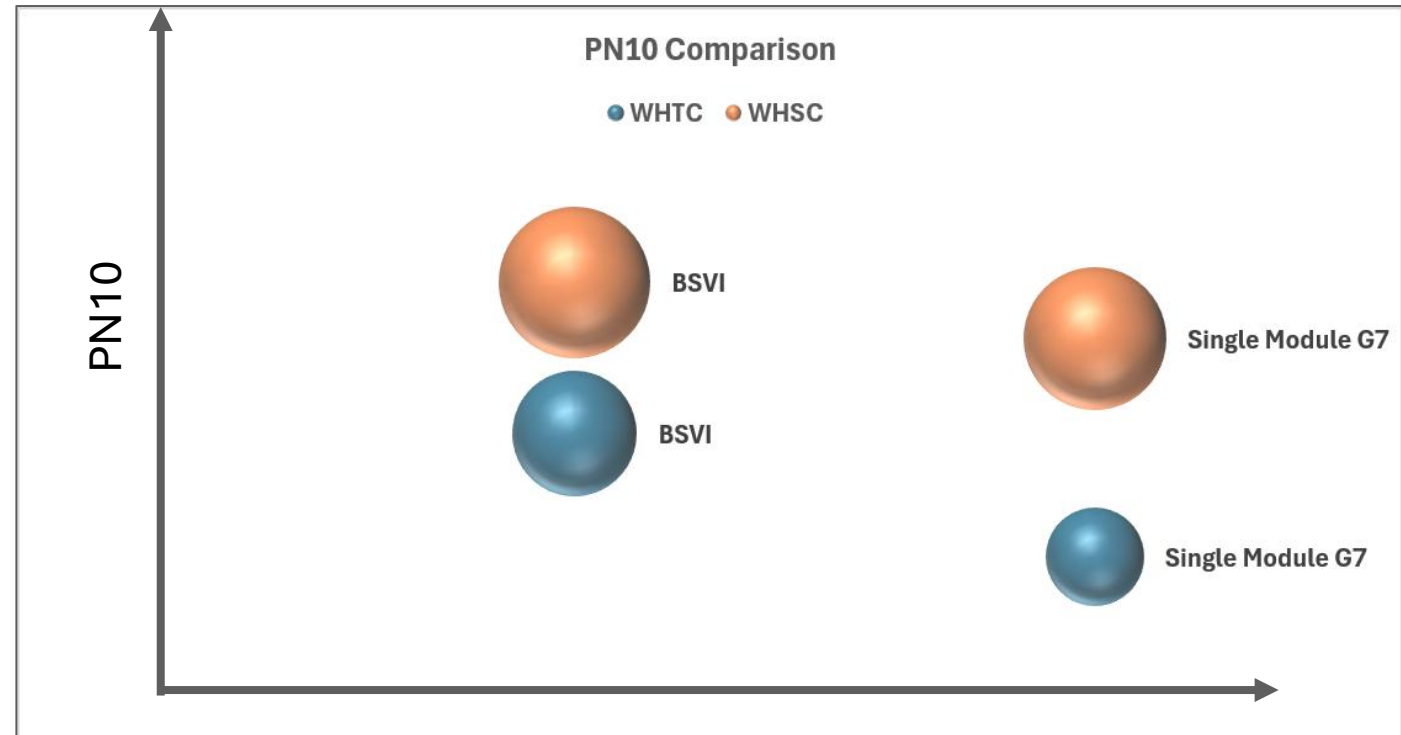


Off highway



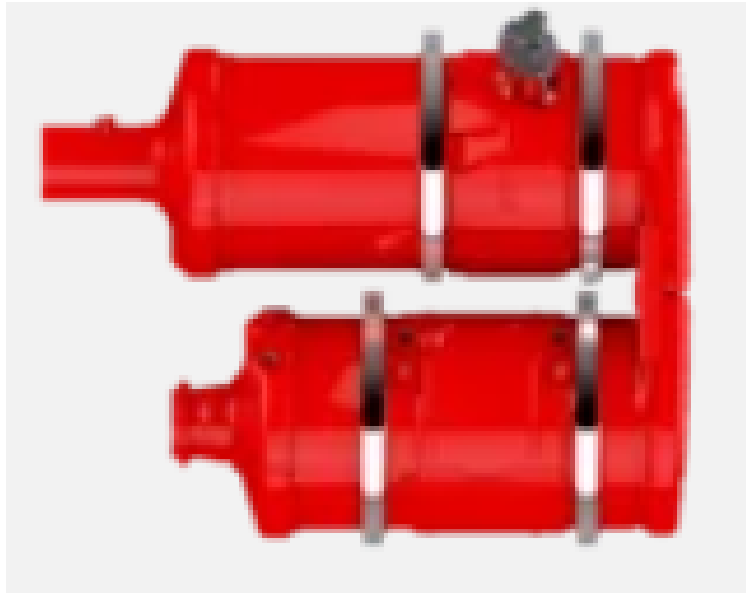
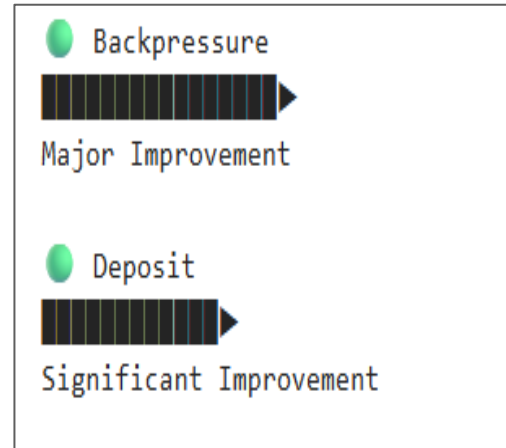
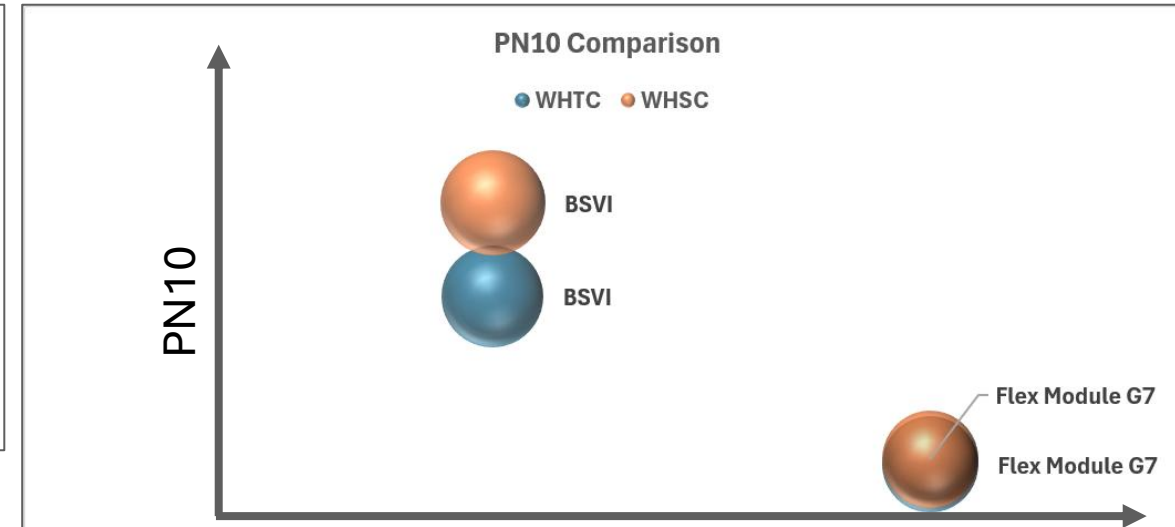
- High UI providing benefit in overall system performance for transient cycles.

SINGLE MODULE SYSTEM PN10 PERFORMANCE



- Secondary PN10 significantly improved for both steady state and transient cycles.
- Controlled droplet breakup and mixing ensured improved performance.

FLEX MODULE SYSTEM PERFORMANCE



- PN10 significantly improved
- Significant improvement in deposit formation
- Optimum doser and DEF mixer integration, controlled breakup ensured improved performance.

SUMMARY

- **Euro 7 Challenges** - Tight norms and limited spaceclaim.
- **DEF mixing device** critical for meeting system performance, low DEF deposit formation and controlled secondary DEF dominated PN10 particles.
- CES ready with **Single Module, Flex Module** type systems, superior to BSVI systems.
- DEF Mixer readiness to meet secondary **PN10 requirements**.
- Combination of doser and mixer will help to meet upcoming **tight norms** and meet **EUL requirements**.

Q+A

