

BIODIESEL TIER I HEALTH EFFECTS

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OVERVIEW

→ PROGRAM DESCRIPTION

- ♣ TEST ENGINES
- ♣ TEST FUELS
- ♣ TEST PROCEDURES

→ REGULATED EMISSIONS

- ♣ HC, CO, NO_x, PARTICULATES

→ TOXIC AND REACTIVE HC EMISSIONS

- ♣ SPECIATED HYDROCARBONS (C₁ - C₂₂)
- ♣ POLYCYCLIC AROMATIC HYDROCARBONS (PAH)

Tier 1 Speciation Papers

- SAE 2000-01-1967
- SAE 2000-01-1968

TEST ENGINES

- 1997 CUMMINS N14
 - ♣ 14L, INLINE-6 CYLINDER
 - ♣ ELECTRONIC UNIT INJECTORS
 - ♣ 370 HP @ 1800 RPM

- 1997 DETROIT DIESEL SERIES 50 COACH
 - ♣ 8.5L, INLINE-4 CYLINDER
 - ♣ ELECTRONIC UNIT INJECTORS
 - ♣ 275 HP @ 2100 RPM
 - ♣ CATALYST

- 1995 CUMMINS B5.9
 - ♣ 5.9L, INLINE-6 CYLINDER
 - ♣ BOSCH MECHANICAL INLINE FUEL PUMP
 - ♣ 160 HP @ 2500 RPM
 - ♣ CATALYST

TEST FUELS

- **BASE DIESEL FUEL (2D) - LOW-SULFUR 2D DIESEL FUEL BLENDED TO MEET 211(b) TEST SPECIFICATIONS**
- **NEAT BIODIESEL FUEL (B100) - 100% METHYL ESTER MEETING NBB AND DRAFT ASTM SPECIFICATIONS**
- **BLENDED FUEL (B20) - 20% BIODIESEL IN THE BASE DIESEL FUEL BY VOLUME**

TEST FUEL PROPERTIES

	2-D	B100	B20
CETANE NUMBER	43.3	51.2	46.0
SPECIFIC GRAVITY	0.856	0.886	0.862
SULFUR, WT%	0.048	0.000	0.037
OXYGEN, WT%	0.0	11.0	2.1
HEAT OF COMB., BTU/LB	18290	16004	17764
VISCOSITY, cSt	2.8	4.1	2.9

TEST PROCEDURES

- EXHAUST EMISSIONS EVALUATED OVER THE HEAVY-DUTY TRANSIENT FTP (COLD AND HOT START)
- EVALUATED WITH AND WITHOUT CATALYST IF ONE WAS PRESENT
- TRIPLICATE TEST DAYS FOR N14 ON NEAT FUELS
- SINGLE TEST DAYS FOR ALL OTHER ENGINES (EXCEPT NEAT BIODIESEL DUPLICATE RUNS)

REGULATED EMISSIONS

HC, CO, NO_x, PARTICULATES

CONCLUSIONS

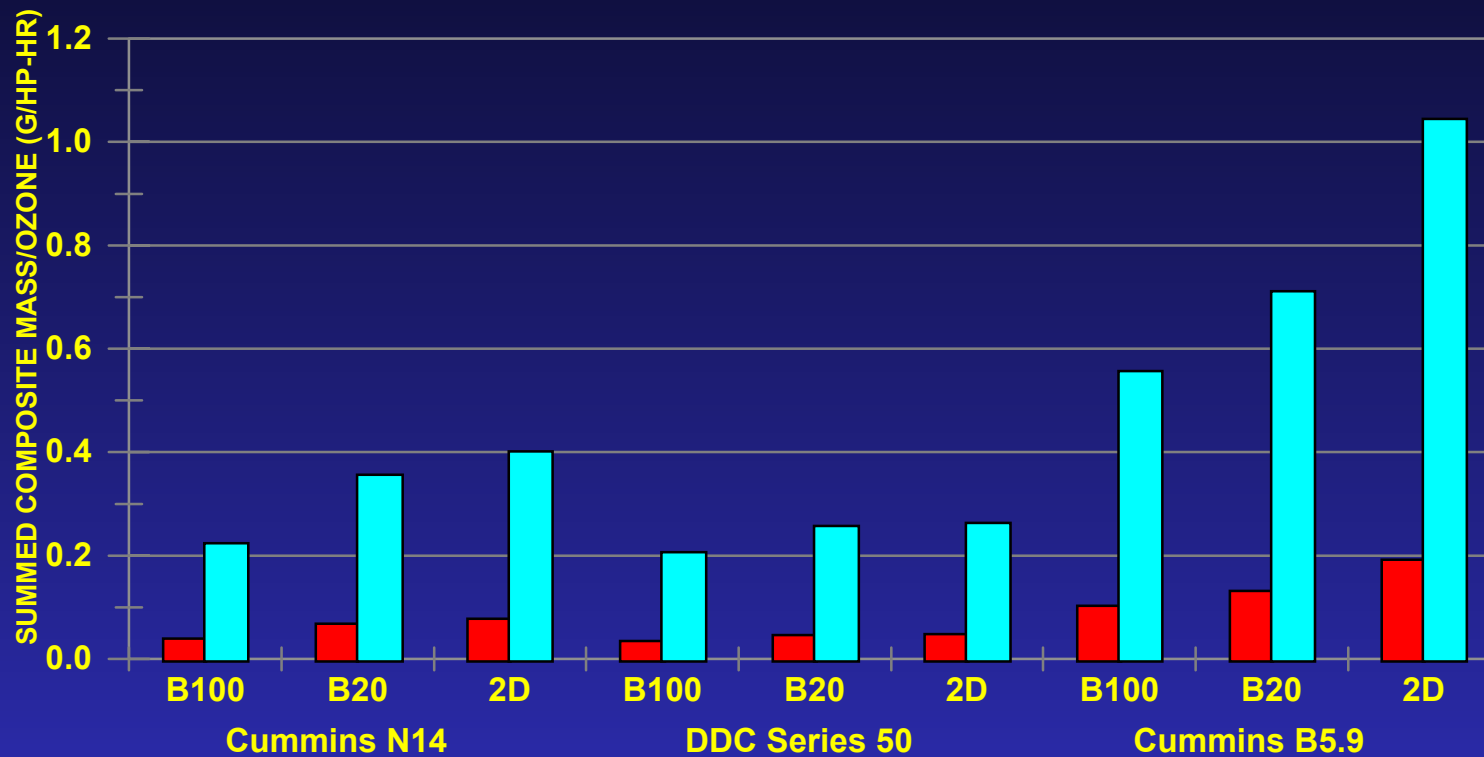
BIODIESEL AND REGULATED EMISSIONS

POLLUTANT	B100 vs 2D	B20 vs 2D
HC	-80% to -90%	-20% to -30%
CO	-40%	-10% to -20%
PM	-30% to -50%	-5% to -15%
PM w/ Catalyst	-50% to -60%	-10% to -22%
NOx	+12% (+4% B5.9)	+4% (+2% B5.9)

TOXIC AND REACTIVE HYDROCARBONS

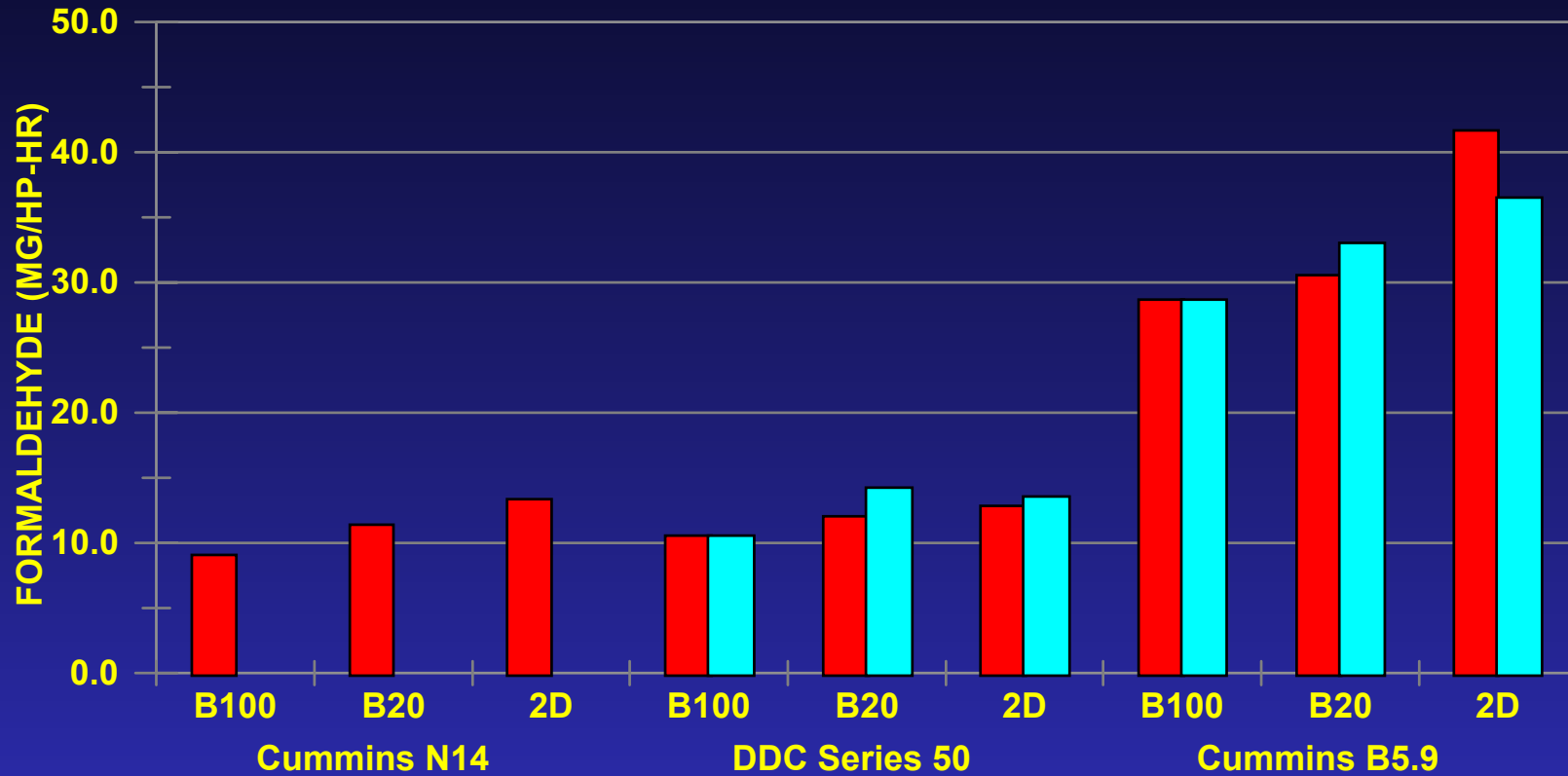
SPECIATED HYDROCARBONS
PAH/NPAH

C₁ TO C₁₂ SPECIATION TOTAL MASS AND OZONE POTENTIAL



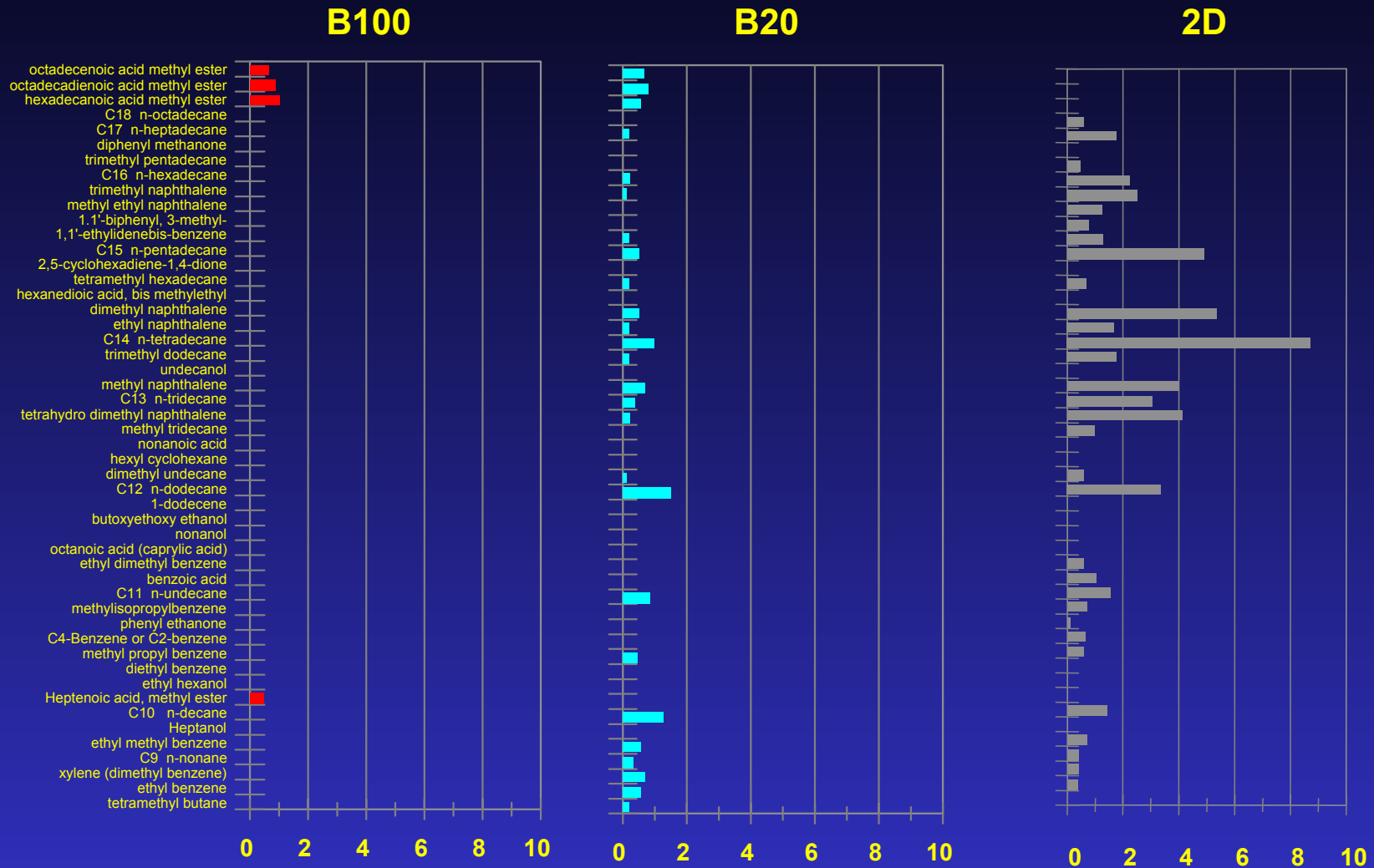
■ MASS ■ OZONE POTENTIAL

FORMALDEHYDE EMISSIONS



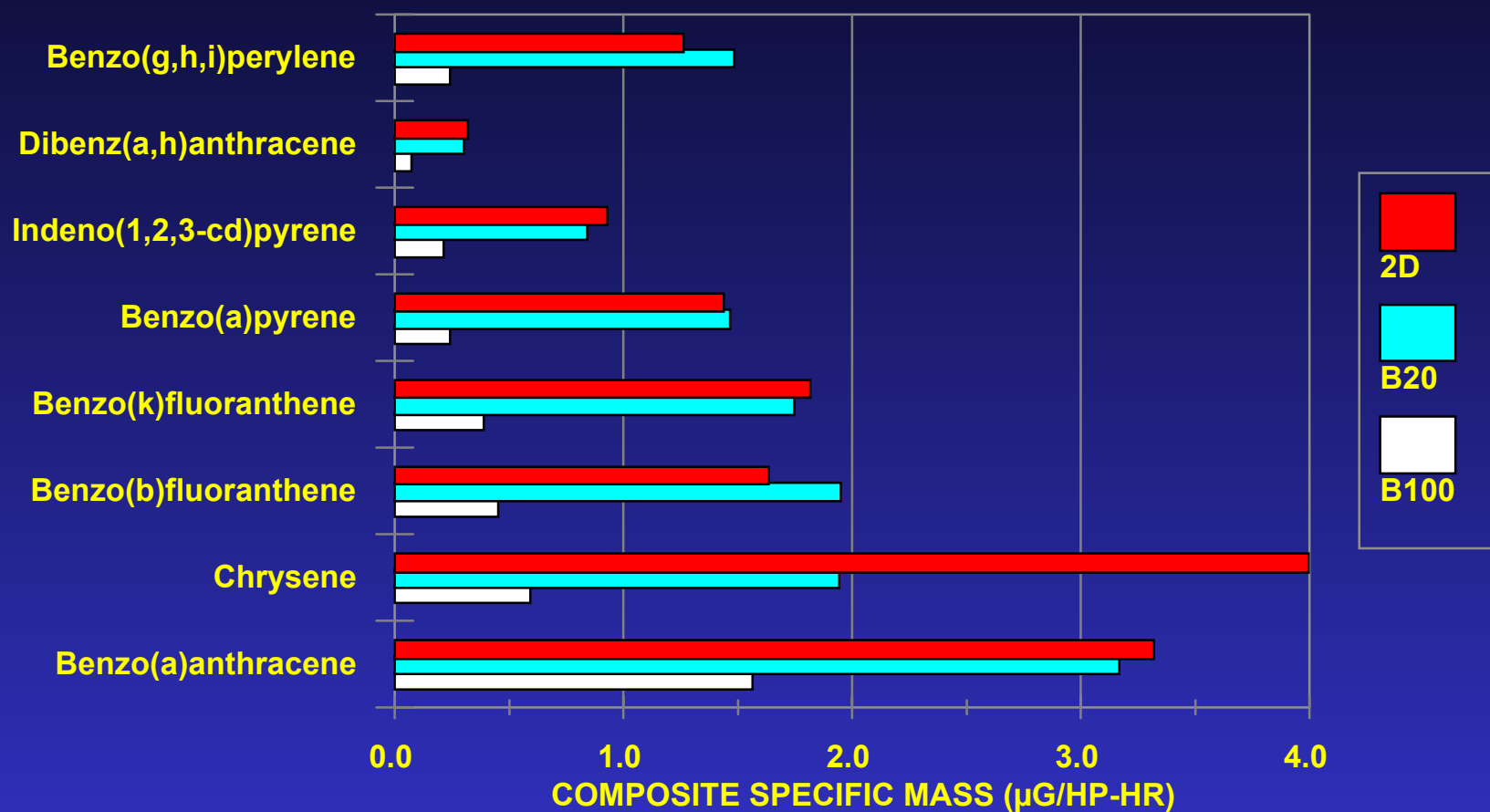
 No Catalyst  Catalyst

HEAVY HC SPECIATION - CUMMINS N14 ENGINE



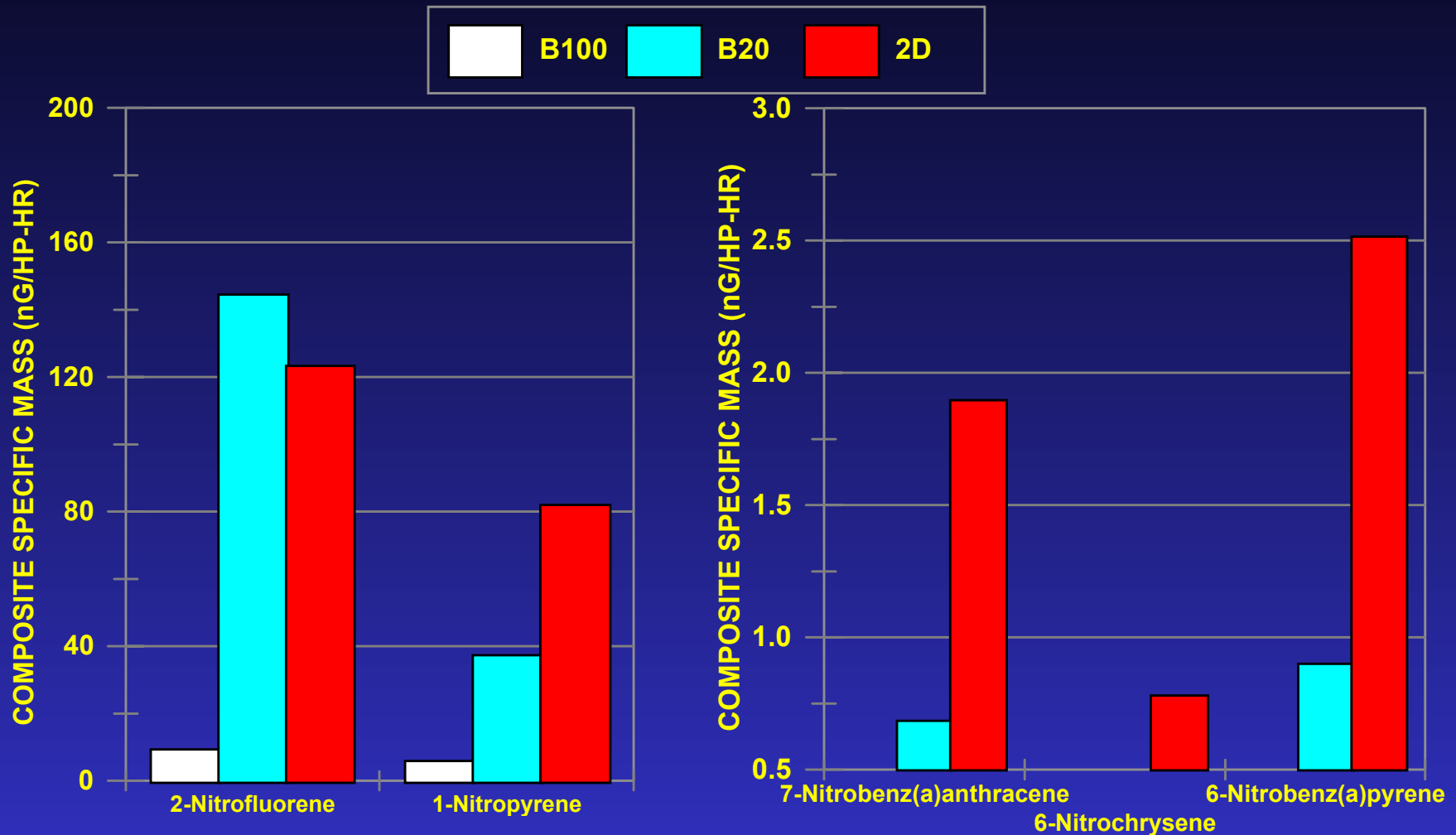
RELATIVE EMISSION RATE (MG/HP-HR)

PAH EMISSIONS - CUMMINS N14 ENGINE



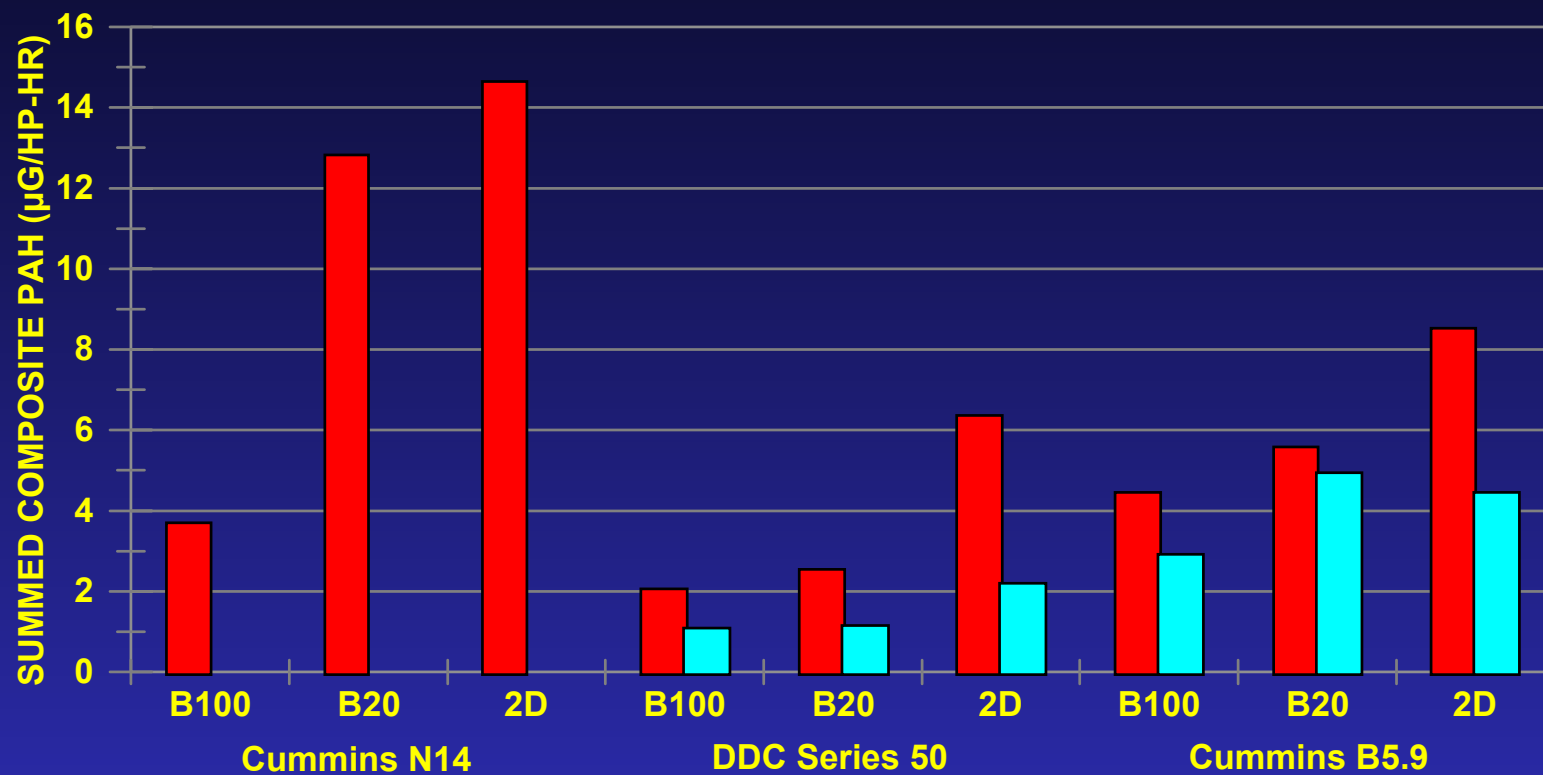
Note: 2D & B100 values are 3 repetitions, B20 is one repeat

NPAH EMISSIONS - CUMMINS N14 ENGINE

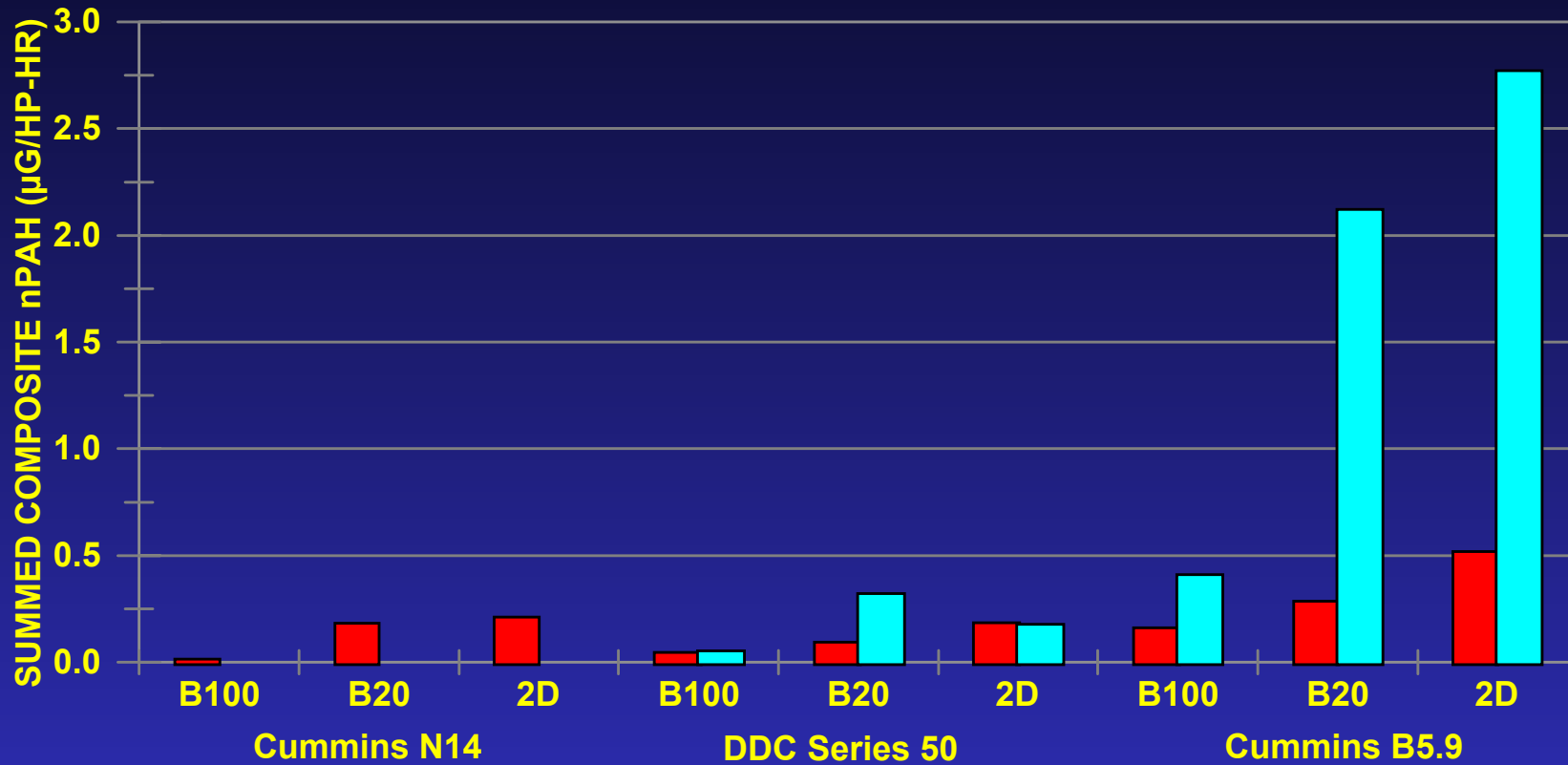


Note: 2D & B100 values are 3 repetitions, B20 is one repeat

PAH EMISSIONS SUMMARY ALL ENGINES



NPAH EMISSIONS SUMMARY ALL ENGINES



 No Catalyst  Catalyst

CONCLUSIONS

- BIODIESEL REDUCED EMISSIONS OF HC, CO, AND PARTICULATES
- BIODIESEL INCREASED NO_x SLIGHTLY

CONCLUSIONS (CONT'D)

- BIODIESEL REDUCED EMISSIONS OF TOXIC AND REACTIVE HYDROCARBON SPECIES
- BIODIESEL REDUCED PAH AND NPAH EMISSIONS
- BLENDING BIODIESEL AND DIESEL FUEL DID NOT GENERATE ANY UNEXPECTED NEW HC SPECIES