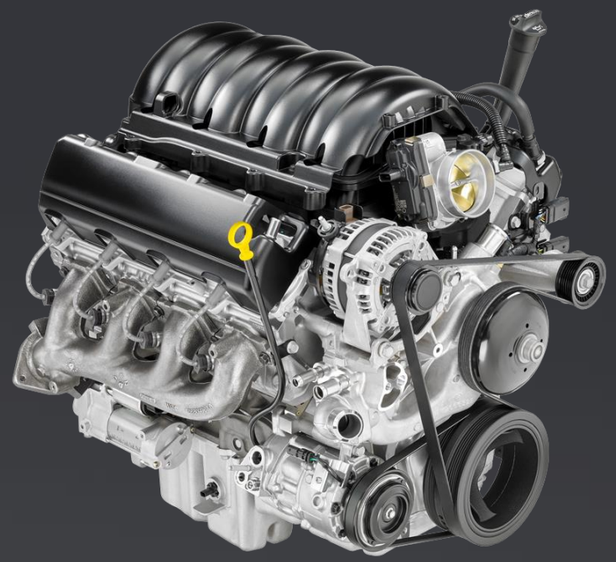


JORDAN LEE

CHIEF ENGINEER
SMALL BLOCK ENGINES

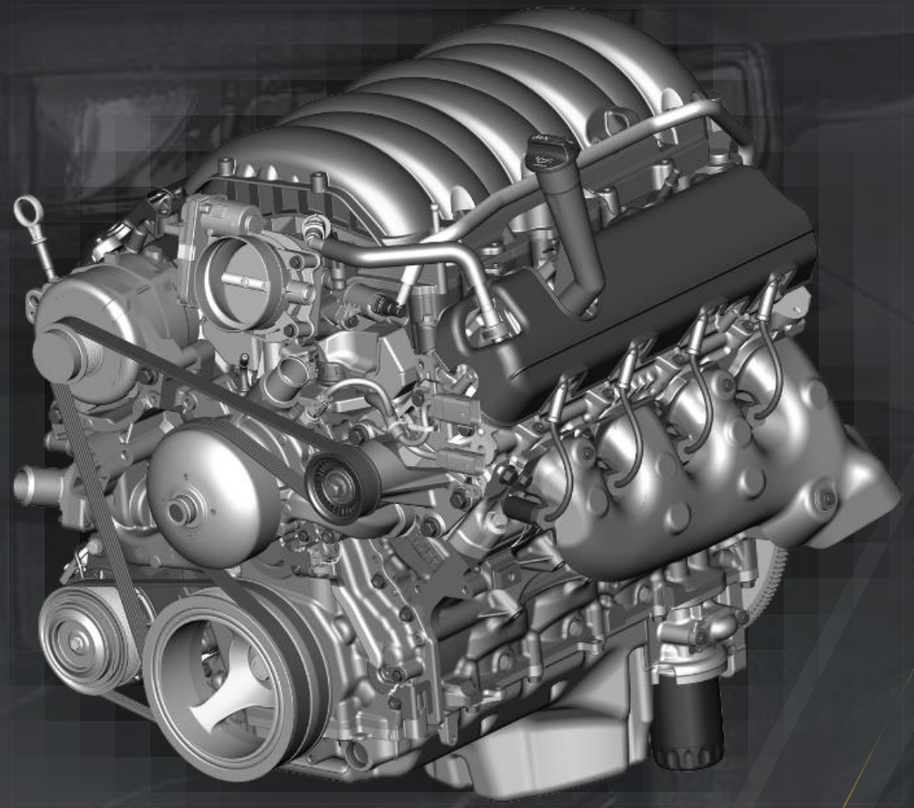
SILVERADO'S UPGRADED 5.3L AND 6.2L V8

PROGRAM OBJECTIVES:

- EVOLVE **PROVEN SMALL BLOCK ARCHITECTURE**
- EXPAND **CYLINDER DEACTIVATION**
- IMPROVE **OPERATING EFFICIENCY** FOR GREATER PERFORMANCE WITHOUT SACRIFICES
- MAINTAIN LEGENDARY **SMALL BLOCK PERFORMANCE & DURABILITY**

INTRODUCING THE WORLD'S FIRST APPLICATION OF DYNAMIC FUEL MANAGEMENT

- AFM IS A PROVEN METHOD TO REDUCE PUMPING WORK & IMPROVE FUEL ECONOMY
- DFM ADDS CYLINDER DEACTIVATION CAPABILITY ON EVERY CYLINDER
- ONLY USE THE CYLINDERS YOU NEED
  - OPTIMIZES EFFICIENCY
- 17 DISTINCT FIRING FRACTIONS
- REFINED N&V



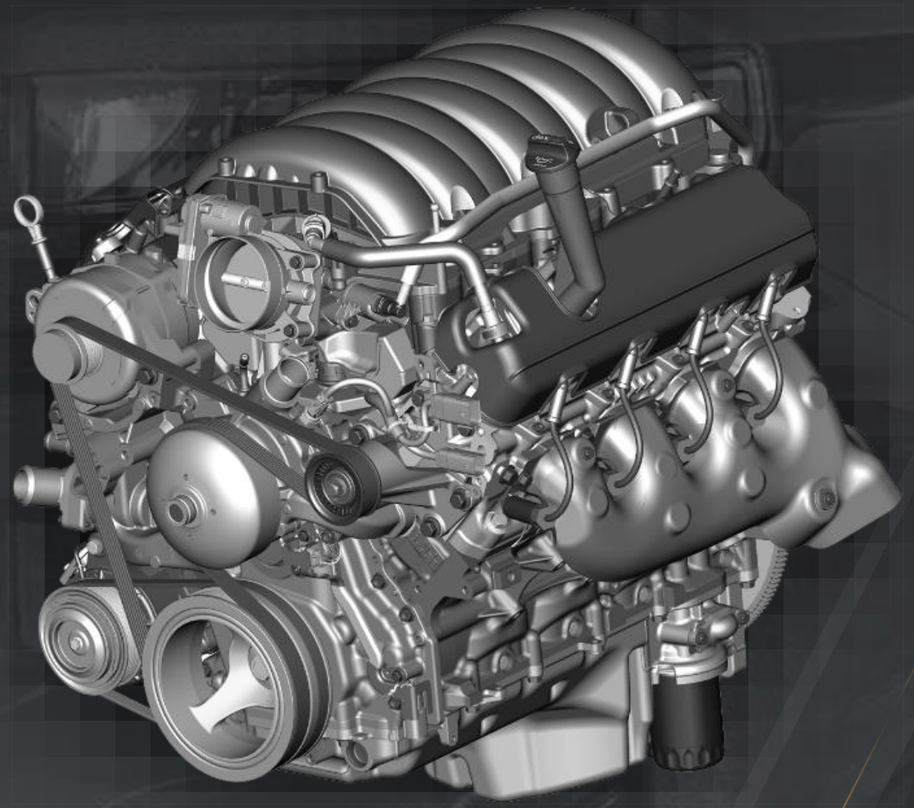
ANALYSIS TIME

INTENSELY ANALYZED, DEVELOPED AND OPTIMIZED SYSTEM

64 DIFFERENT FUNCTIONAL ASPECTS OF SYSTEMS ANALYZED DUE TO INTRODUCTION OF DFM TECHNOLOGY

12.4 MILLION CPU HOURS OF ANALYSIS FOR 5.3L AND 6.2L WITH DFM

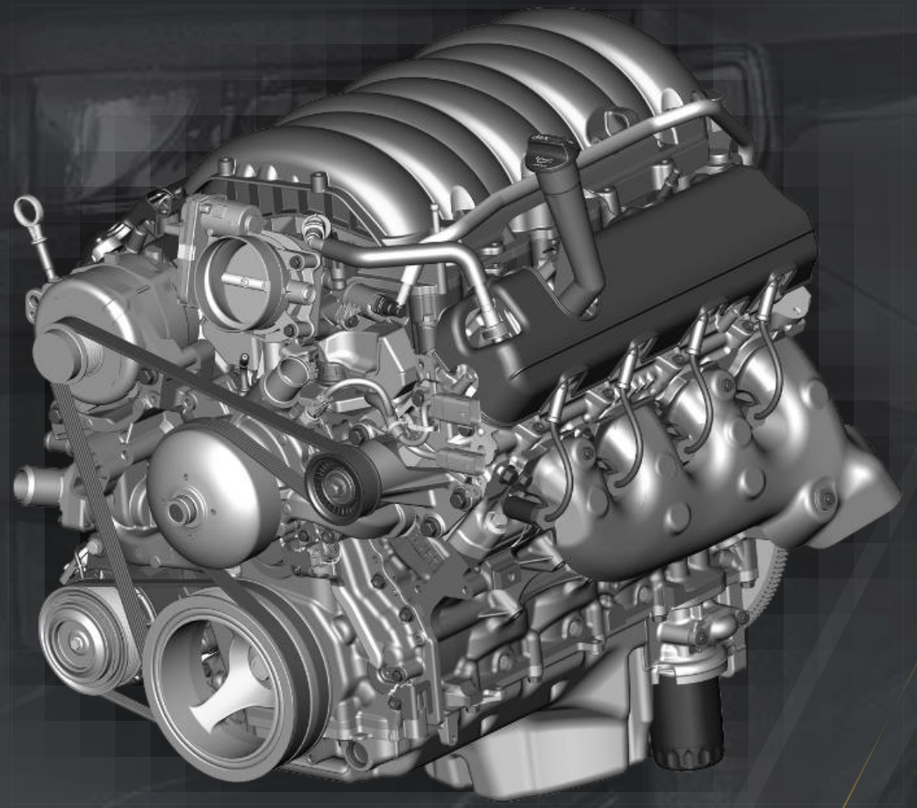
*SO **ADVANCED** THAT A PRESENTATION WAS REQUESTED AT THE **VIENNA MOTOR SYMPOSIUM***



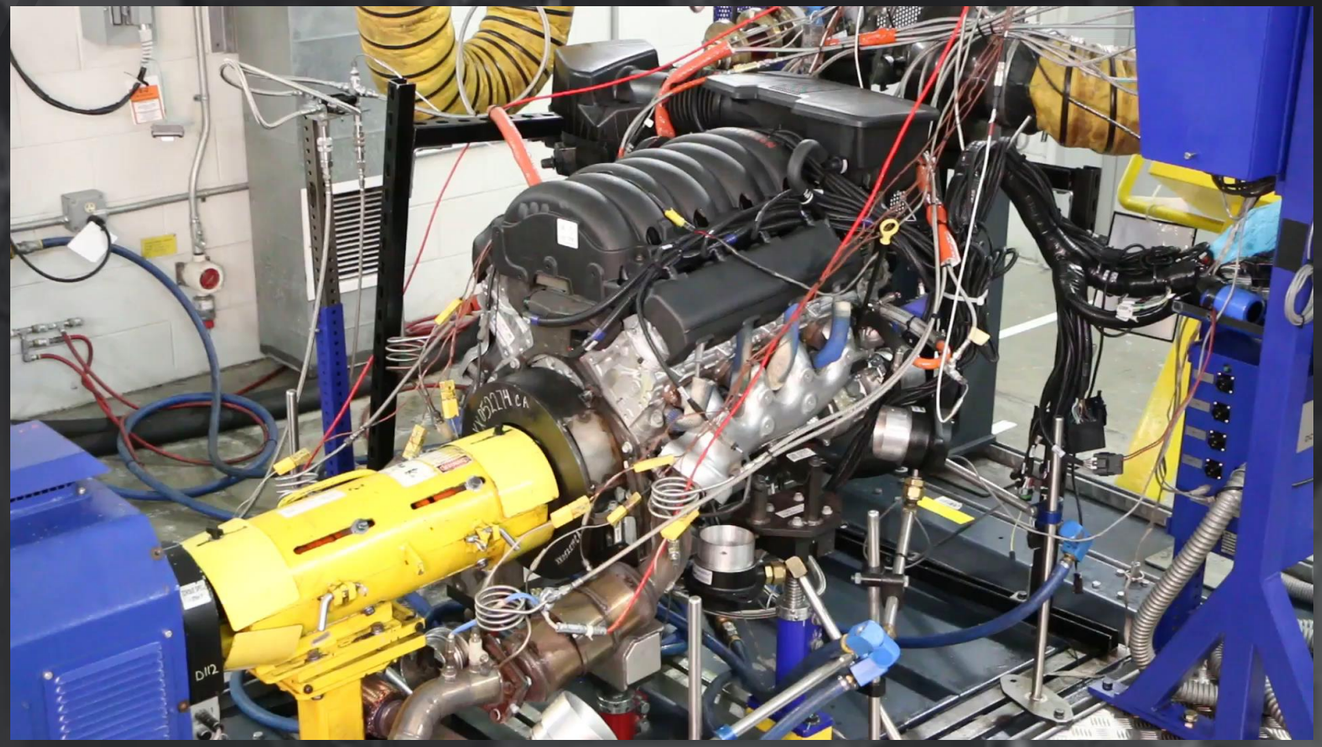
ALGORITHM DEVELOPMENT

INTENSELY ANALYZED, DEVELOPED AND OPTIMIZED SYSTEM

- **2,896,246** LINES OF CODE
- 65,904 LINES OF **DFM-SPECIFIC CODE**
- OVER **29,000** CALIBRATION VARIABLES
- DFM CYLINDER PATTERNS ARE DETERMINED UP TO **80 DECISIONS PER SECOND** (EVERY 12.5 MSEC)



LEGENDARY DURABILITY



- TESTED IN ONE OF THE LARGEST, MOST ADVANCED AUTOMOTIVE PROPULSION LABORATORIES LOCATED IN PONTIAC, MI
- TESTED AND DEVELOPED TO GM'S PROPRIETARY ENGINE DURABILITY STANDARDS

LEGENDARY V8 DURABILITY

- THE 2019 SILVERADO TRUCK ENGINES WILL HAVE ACCUMULATED AN EQUIVALENT OF OVER **5 MILLION MILES** OF VALIDATION TESTING
- REPEATED CYCLING BETWEEN APPROXIMATELY -13˚F (-25˚C) TO 239˚F (115˚C) **COOLANT TEMPERATURE** WHILE RUNNING THE ENGINE UNDER MAX POWER CONDITIONS CONTINUOUSLY FOR MONTHS
- DURABILITY OF GM'S DEACTIVATION SYSTEMS HAVE BEEN TESTED FOR **TENS OF MILLIONS** OF CYCLES

SUMMARY

ONE OF THE MOST TECHNOLOGICALLY ADVANCED GASOLINE V8 ENGINES

- SUCCESSFULLY INCORPORATED THE WORLD'S FIRST DYNAMIC FUEL MANAGEMENT SYSTEM
- IMPROVED EFFICIENCY
- REFINED N&V
- PROVEN POWER & TORQUE

JOE FOLK

ASSISTANT CHIEF ENGINEER
SMALL BLOCK ENGINES

GM'S HISTORY WITH CYLINDER DEACTIVATION

2005 5.3L V8
with DoD

INTRODUCED IN 2005 ON 5.3L V8 GEN IV ENGINES IN MID-SIZE UTILITY VEHICLES UNDER NAME 'DISPLACEMENT ON DEMAND'

4 ENGINE FAMILIES WITH
7 DISPLACEMENTS

MILLIONS OF V6, V8, OHV, OHC ENGINES WITH AFM PRODUCED, MORE THAN ANY OTHER COMPETITOR

2007 3.9L V6
with AFM

2015 4.3L V6
with AFM

FULL-SIZE AND MID-SIZE SUVS AND TRUCKS, SMALL TO LARGE SEDANS AND SPORTS CARS TOO

OVER 80 UNIQUE PATENTS

2016 3.6L V6
with AFM

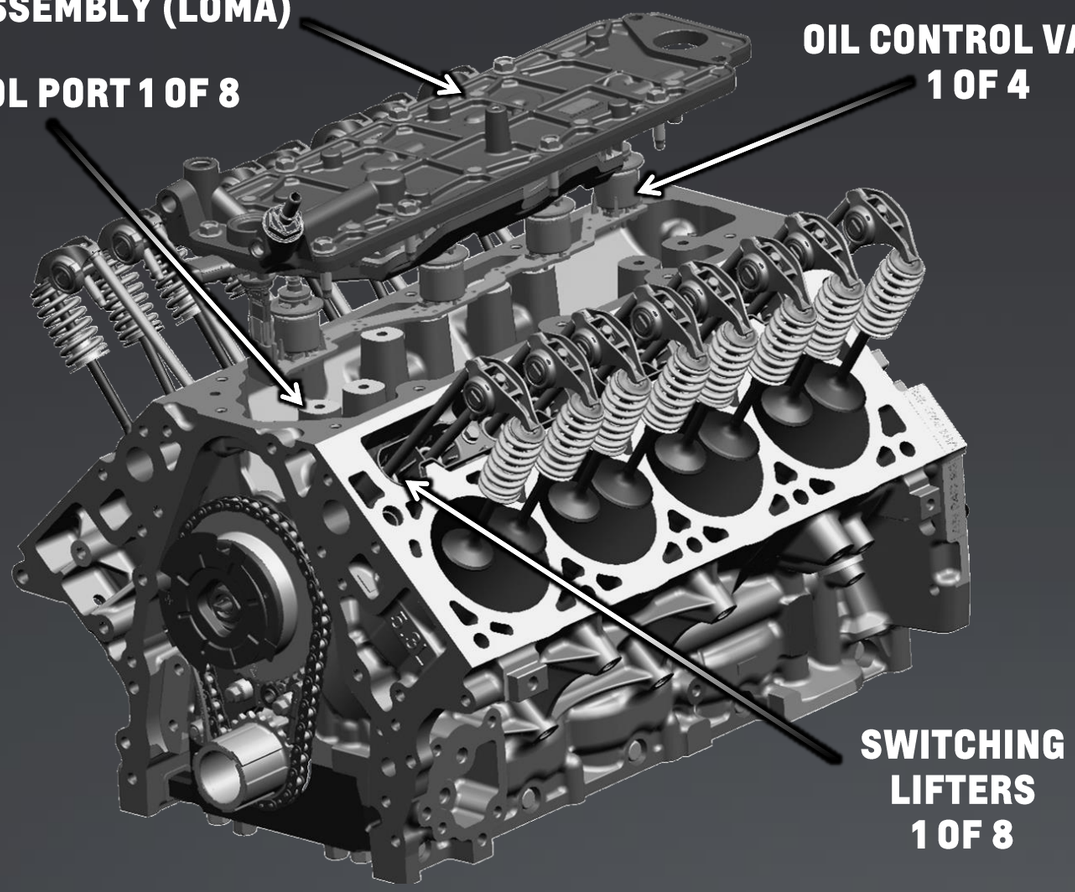
GENERAL MOTORS LEADS THE INDUSTRY IN CYLINDER DEACTIVATION

COMPARISON OF V8 DFM TO AFM

ITEM	MY 2018 AFM	MY 2019 DFM
NUMBER OF CYLINDERS WITH DEACTIVATION HARDWARE	4 (CYLS 1, 4, 6, 7) 8 DEACTIVATING LIFTERS	8 (ALL CYLINDERS) 16 DEACTIVATING LIFTERS
SIZE OF SWITCHING WINDOW	480° CRANK	240° CRANK
LOCATION OF OIL CONTROL VALVES	4 INTEGRATED INTO VALLEY COVER LOMA	8 INTEGRATED INTO ENGINE BLOCK NO LOMA
NUMBER OF STEADY-STATE CYLINDER DEACTIVATION FRACTIONS	V8 & V4	17

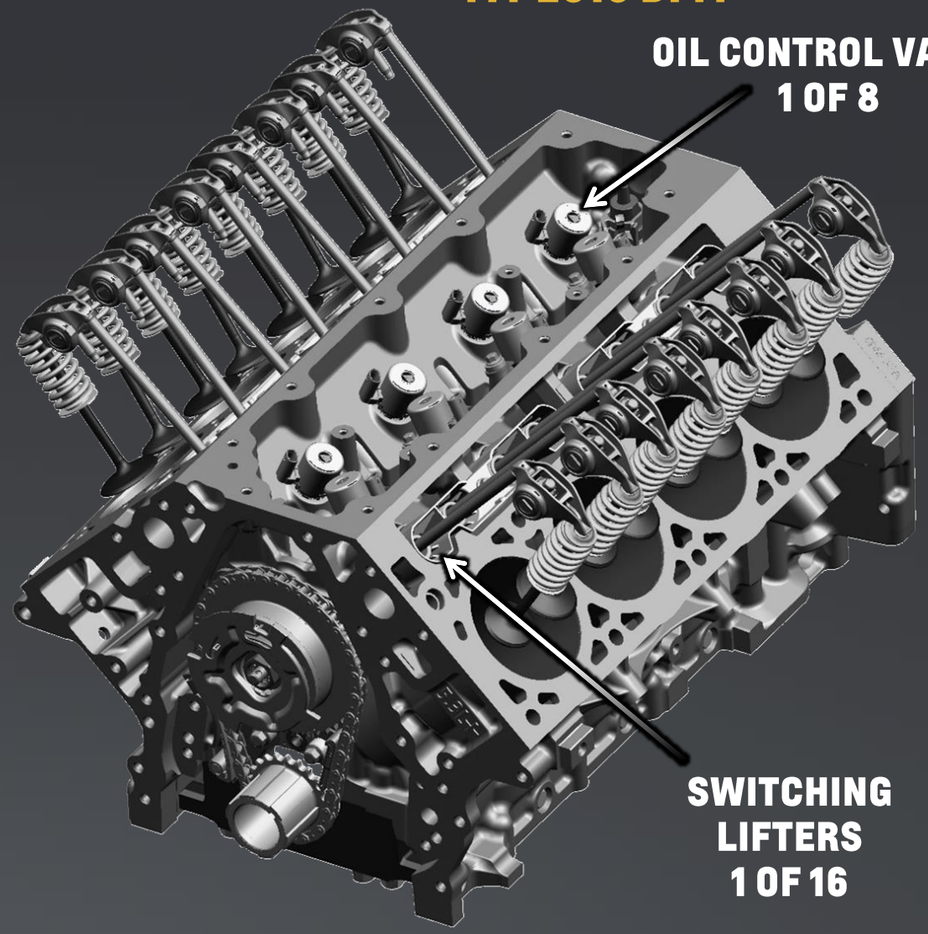
COMPARISON OF V8 AFM TO DFM

MY 2018 AFM



AFM OIL CONTROL VALVES IN LOMA / VALLEY COVER

MY 2019 DFM



DFM OIL CONTROL VALVES IN ENGINE BLOCK

DYNAMIC FUEL MANAGEMENT FIRING FRACTIONS

- UP TO 17 FIRING FRACTIONS OR PATTERNS
- ROWS ARE ENGINE CYCLES AND COLUMNS ARE CYLINDERS IN FIRING ORDER
- GREEN INDICATES THE CYLINDER IS ACTIVE

DYNAMIC FUEL MANAGEMENT FIRING FRACTIONS

- FIXED PATTERN EXAMPLE, 1/2 FIRING FRACTION
- 4 CYLINDERS ACTIVE OUT OF 8 FIRING OPPORTUNITIES (AFM'S V4 MODE)
- THE SAME CYLINDERS ARE ACTIVE EVERY ENGINE CYCLE

1/2 FIRING FRACTION IN DFM (V4 MODE IN AFM)

0 = DEAC | 1 = FIRING

FIRING ORDER	A	B	C	D	E	F	G	H
CYLINDER NUMBER	1	8	7	2	6	5	4	3
	0	1	0	1	0	1	0	1

DYNAMIC FUEL MANAGEMENT FIRING FRACTIONS

- ROTATING DEACTIVATION PATTERN EXAMPLE, 1/3 FIRING FRACTION
- 1 CYLINDER ACTIVE OUT OF 3 FIRING OPPORTUNITIES
- THE FULL PATTERN REPEATS EVERY 3 ENGINE CYCLES

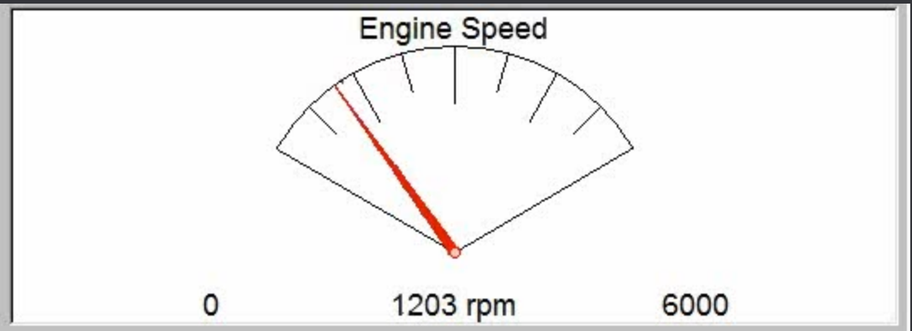
1/3 FIRING FRACTION IN DFM

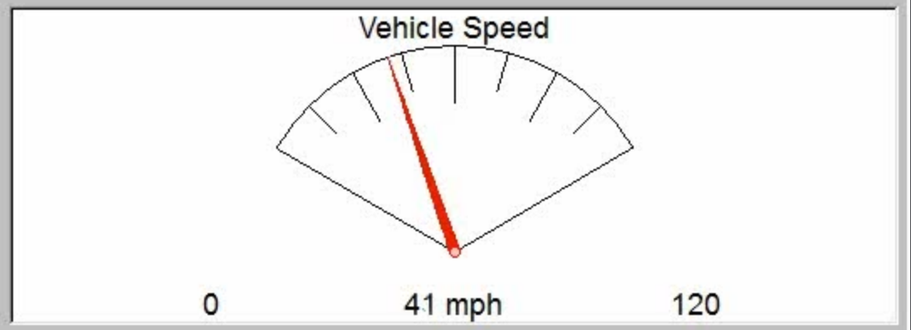
0 = DEAC | 1 = FIRING

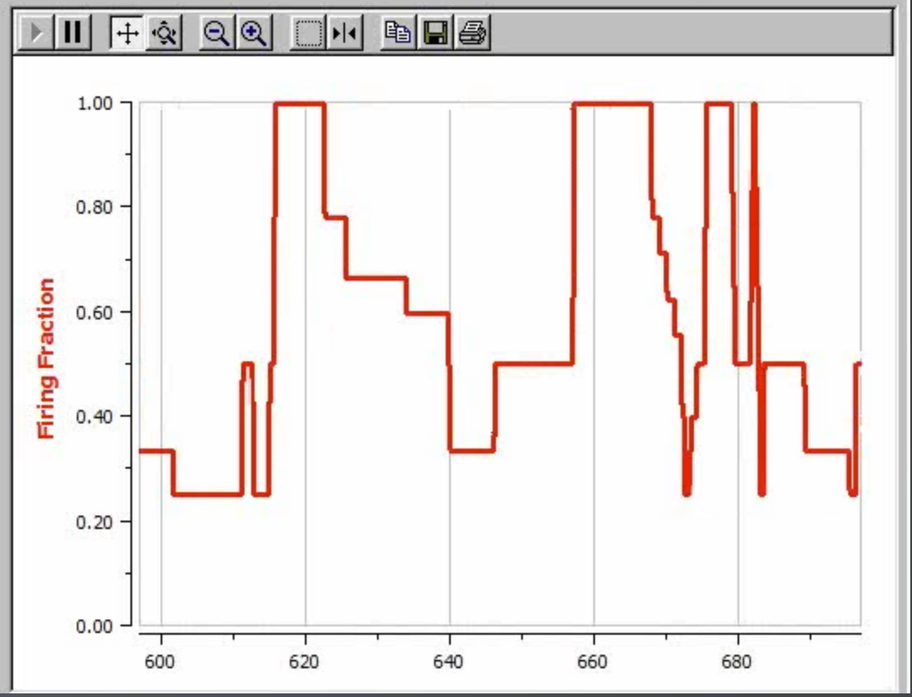
FIRING ORDER	A	B	C	D	E	F	G	H
CYLINDER NUMBER	1	8	7	2	6	5	4	3
	0	0	1	0	0	1	0	0
	1	0	0	1	0	0	1	0
	0	1	0	0	1	0	0	1

Engine Cylinder Calculated Firing Fraction
50 %

Fuel Off 11.82 %	3/5 2.77 %
2/9 0.00 %	5/8 0.58 %
1/4 10.55 %	2/3 4.19 %
2/7 0.19 %	5/7 0.74 %
1/3 7.69 %	3/4 0.24 %
3/8 0.30 %	7/9 0.15 %
2/5 9.58 %	4/5 1.99 %
4/9 0.34 %	5/6 0.19 %
1/2 15.26 %	6/7 0.12 %
5/9 0.74 %	1 32.62 %





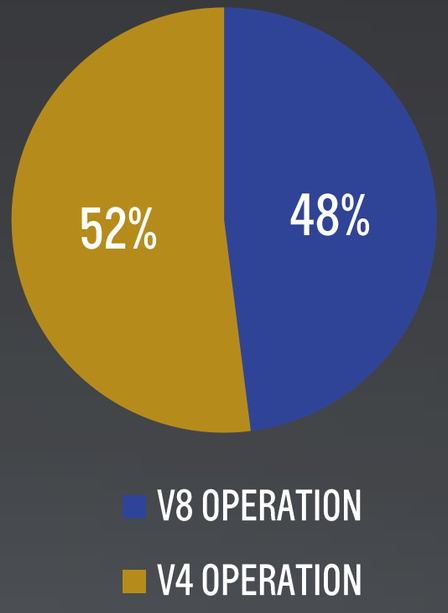


5.3L DFM
OPERATIONAL BENEFIT

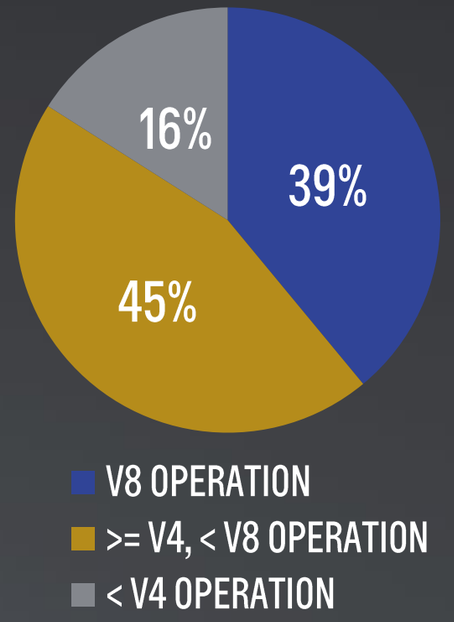
USING INDUSTRY STANDARD TEST SCHEDULES:

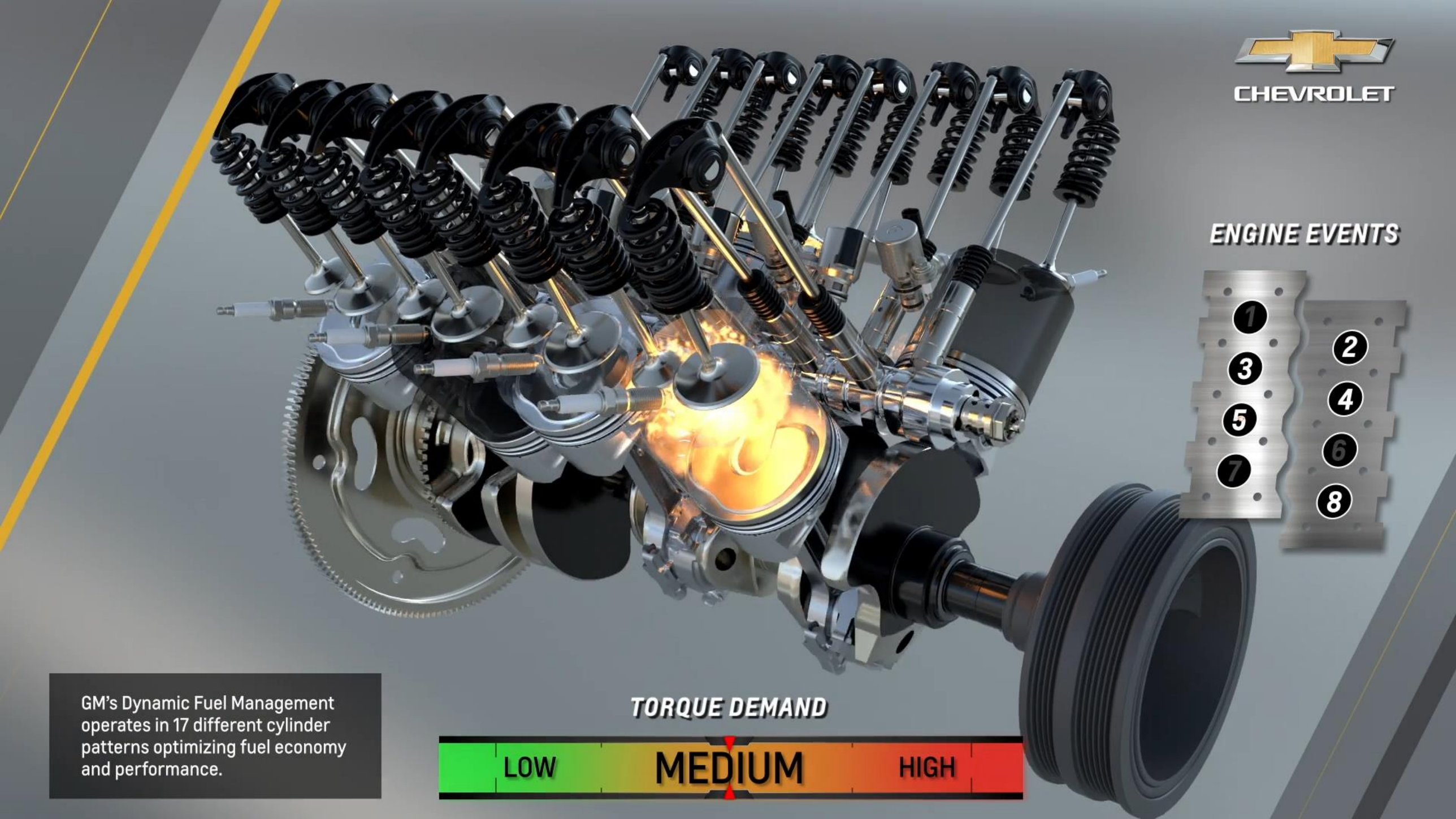
THE 2019 SILVERADO 2WD WITH 5.3L DFM OPERATED WITH LESS THAN 8 ACTIVE CYLINDERS GREATER THAN 60% OF THE TIME

5.3L AFM 2WD OPERATION ON INDUSTRY STANDARD CYCLES



5.3L DFM 2WD OPERATION ON INDUSTRY STANDARD CYCLES

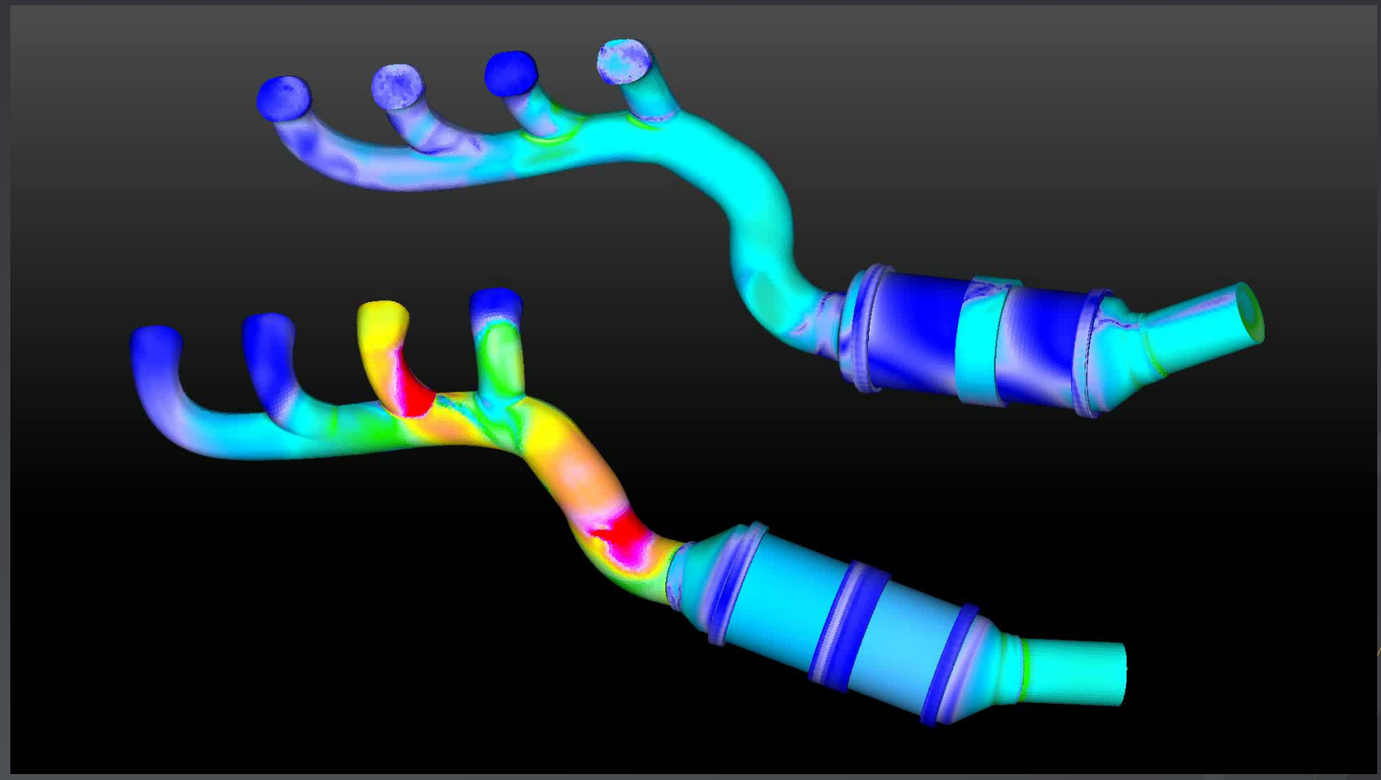



CHEVROLET
ENGINE EVENTS
1
3
5
7
2
4
6
8
TORQUE DEMAND
LOW
MEDIUM
HIGH
GM's Dynamic Fuel Management operates in 17 different cylinder patterns optimizing fuel economy and performance.

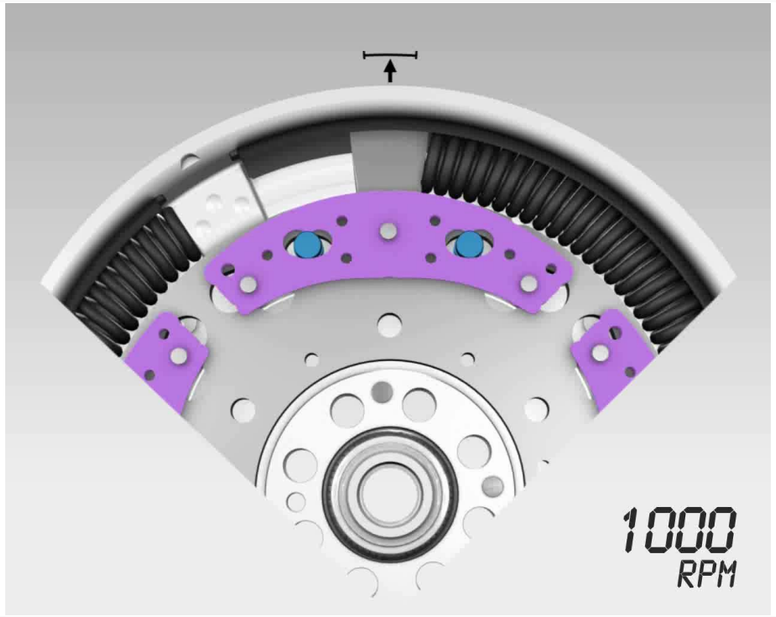
SYSTEM INTEGRATION

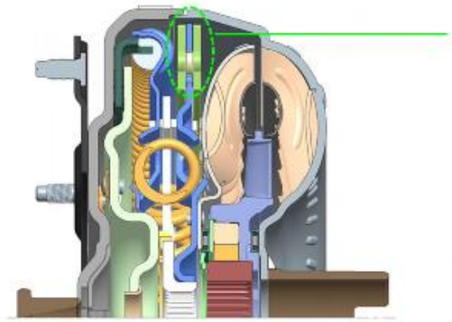
KEY TO DFM SUCCESS

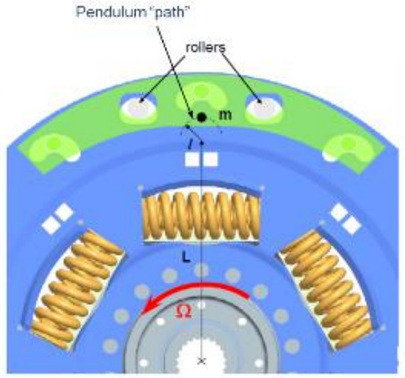
- SEAMLESS OPERATION IN 17 CYLINDER PATTERNS
- DESIGNED AND INTEGRATED AS ONE VEHICLE SYSTEM



HYDRA-MATIC
8-SPEED AND 10-SPEED
CENTRIFUGAL PENDULUM ABSORBER

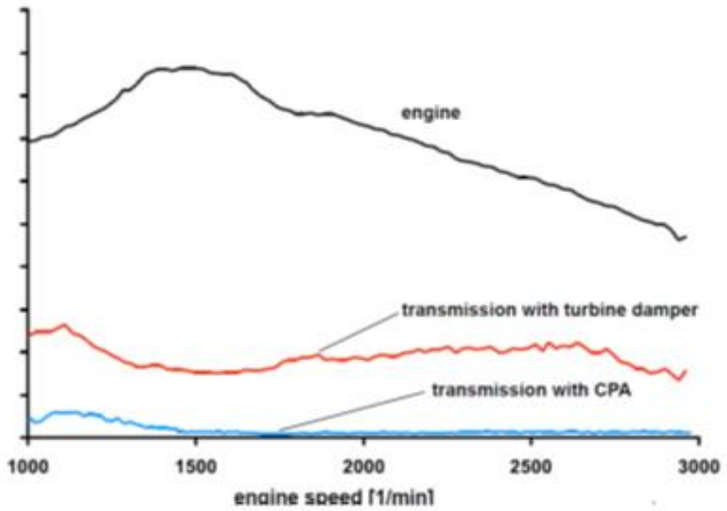






$$f_0 = \frac{\Omega}{2 \cdot \pi} \sqrt{\frac{L}{l}}$$

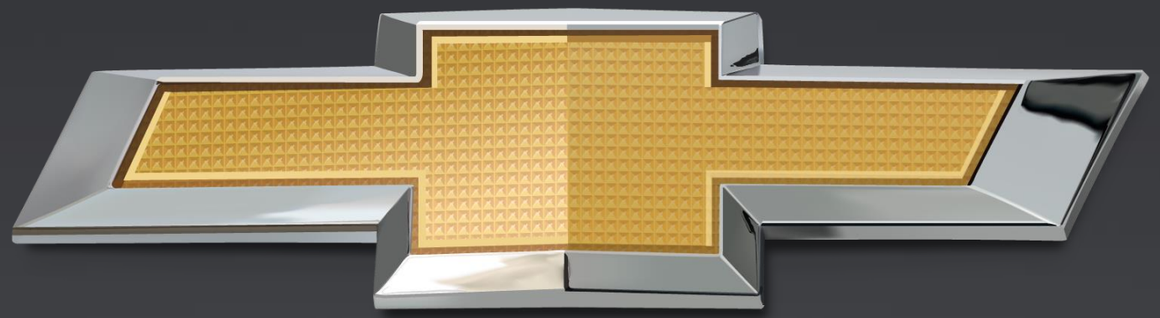
N&V COMPARISON



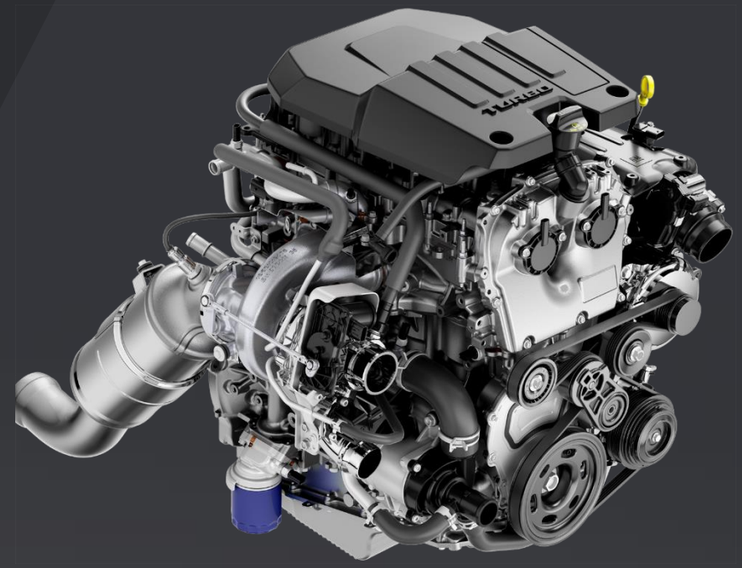
SUMMARY

TAKE A GREAT ENGINE AND MAKE IT BETTER

- GENERAL MOTORS **LEADS** THE INDUSTRY IN CYLINDER DEACTIVATION
- **DYNAMIC FUEL MANAGEMENT** EXPANDS AND IMPROVES UPON AFM
- 17 **DISTINCT** CYLINDER PATTERNS
- **SEAMLESS** VEHICLE INTEGRATION



CHEVROLET

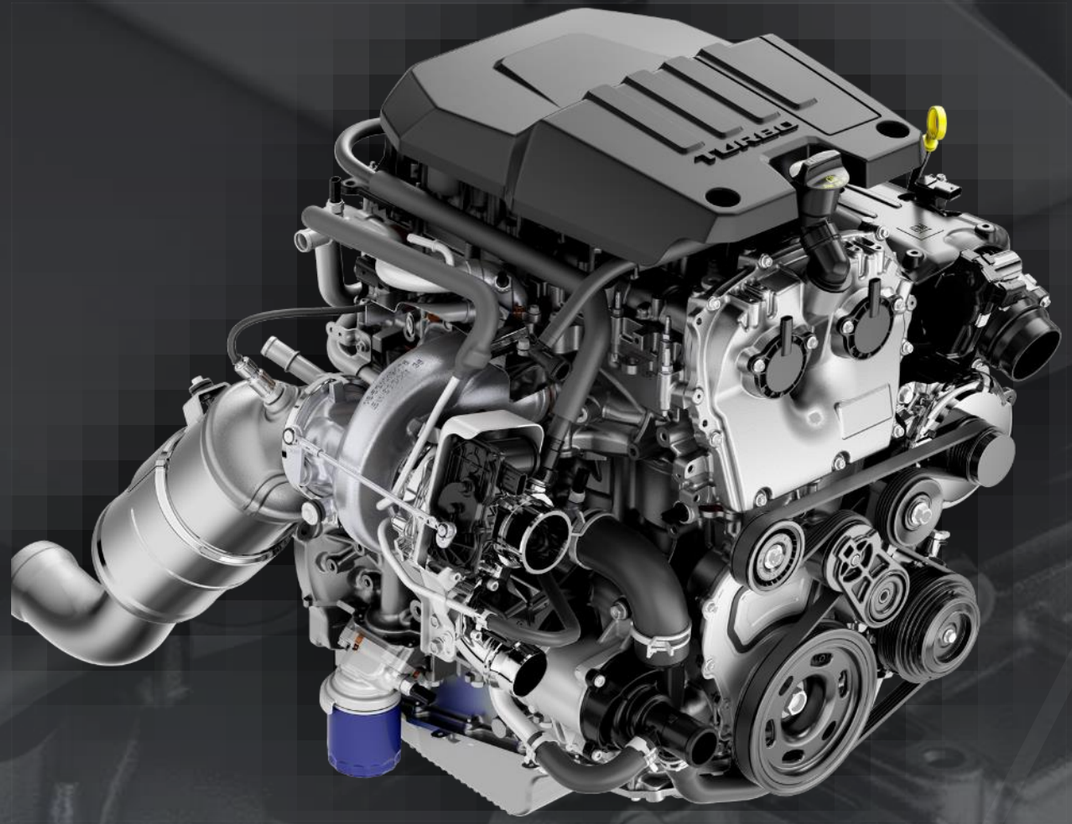


TOM SUTTER

CHIEF ENGINEER
2.7L TURBO

2.7L TURBO OBJECTIVES

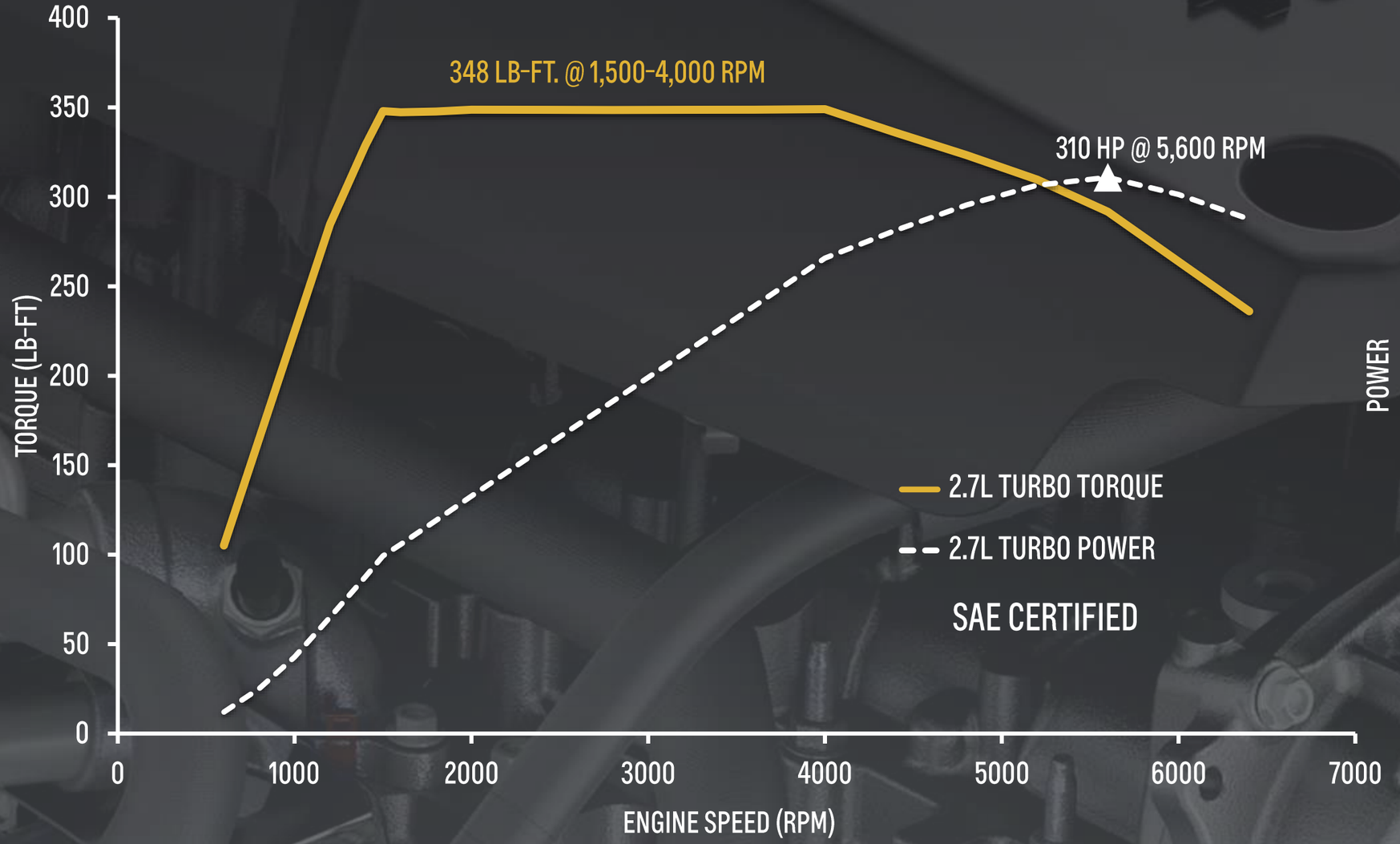
- LEADING EDGE TECHNOLOGY FOR EFFICIENT PERFORMANCE
- LEADING EDGE LOW SPEED TORQUE AND TORQUE RESPONSE WITH TURBOCHARGING
- LEADING EDGE SPECIFIC MASS
- DEMONSTRATE LEGENDARY CHEVROLET TRUCK DURABILITY



2.7L TURBO

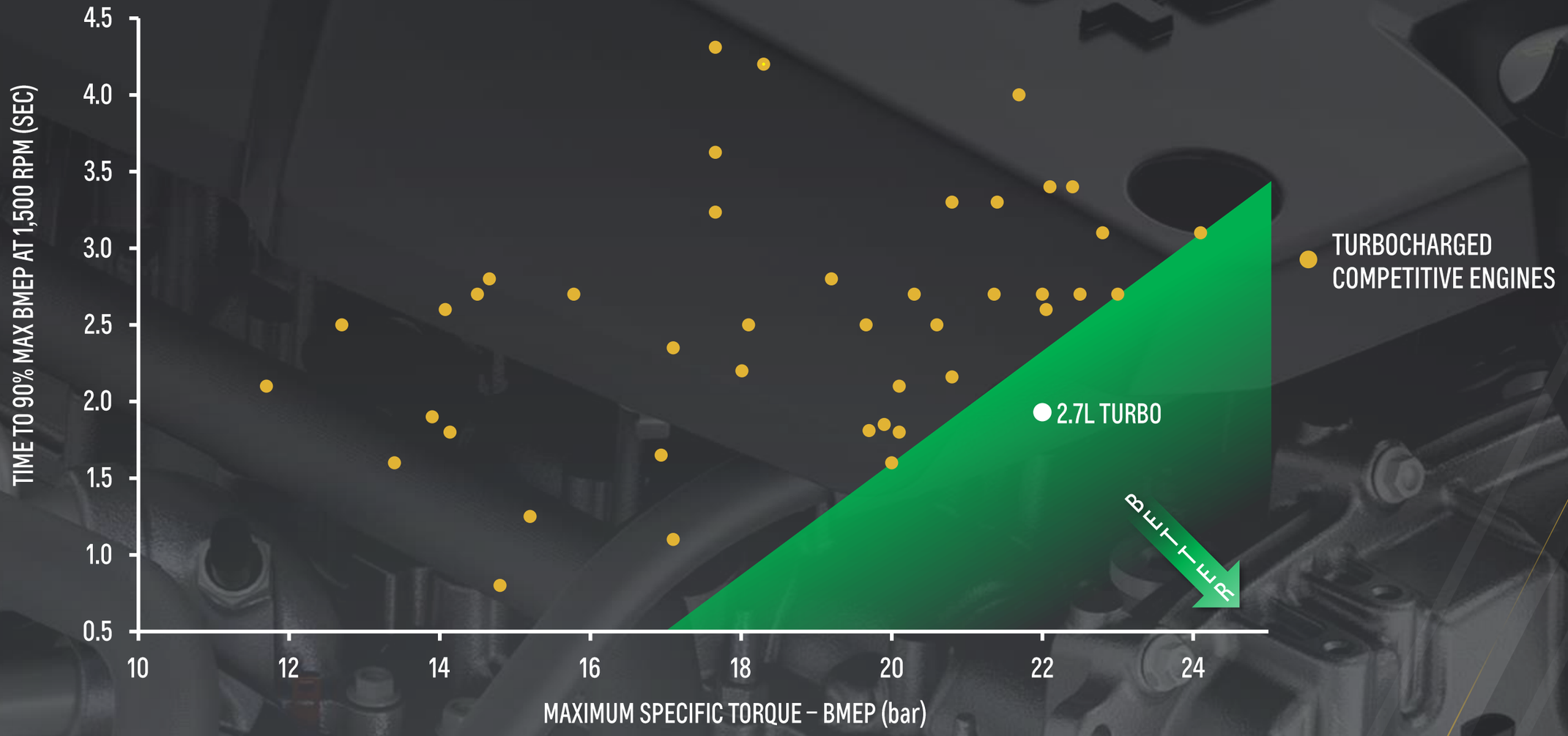
AMONG BEST LOW SPEED TORQUE IN SEGMENT

348 LB-FT PEAK TORQUE AVAILABLE BETWEEN 1,500 - 4,000 RPM



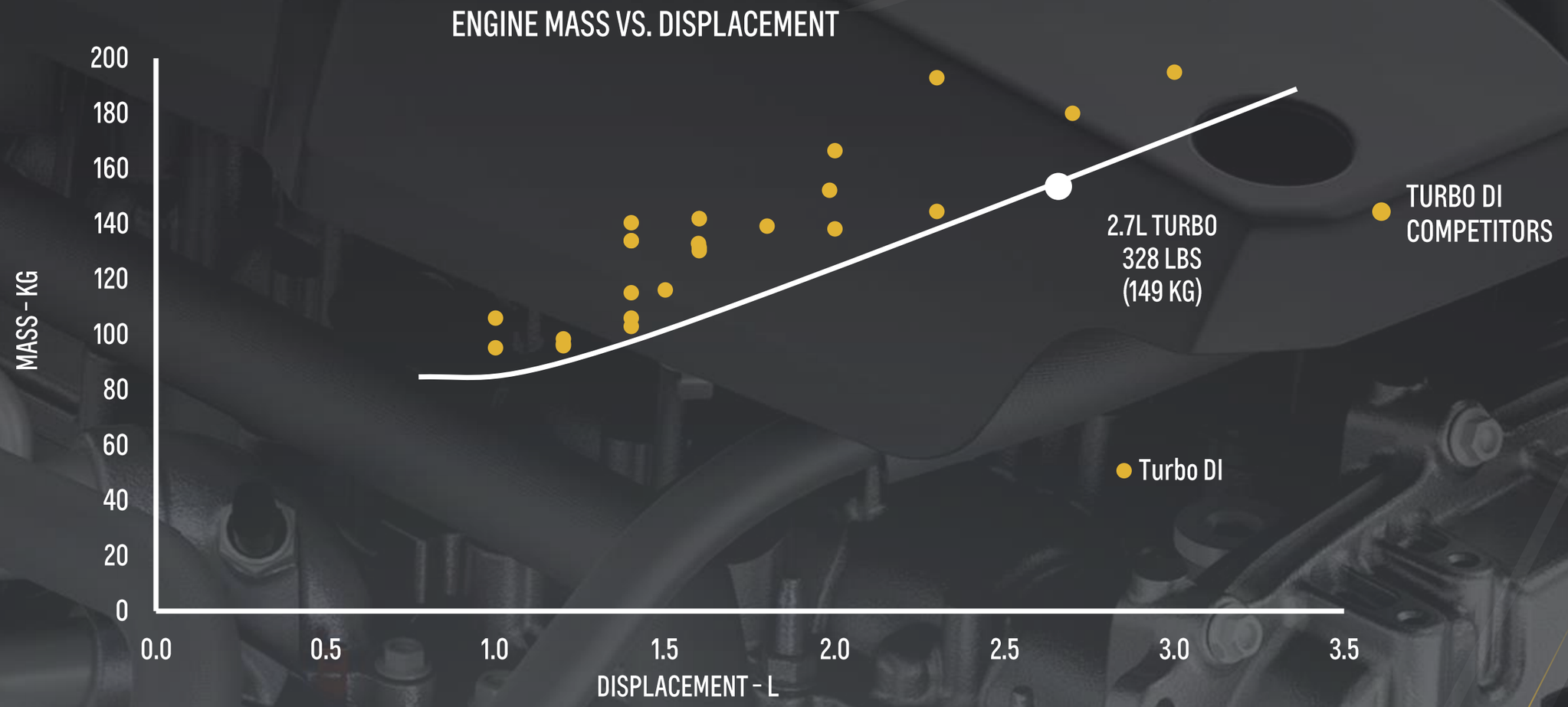
2.7L TURBO

TIME TO 90% TORQUE AT 1,500 RPM IS BEST IN SEGMENT

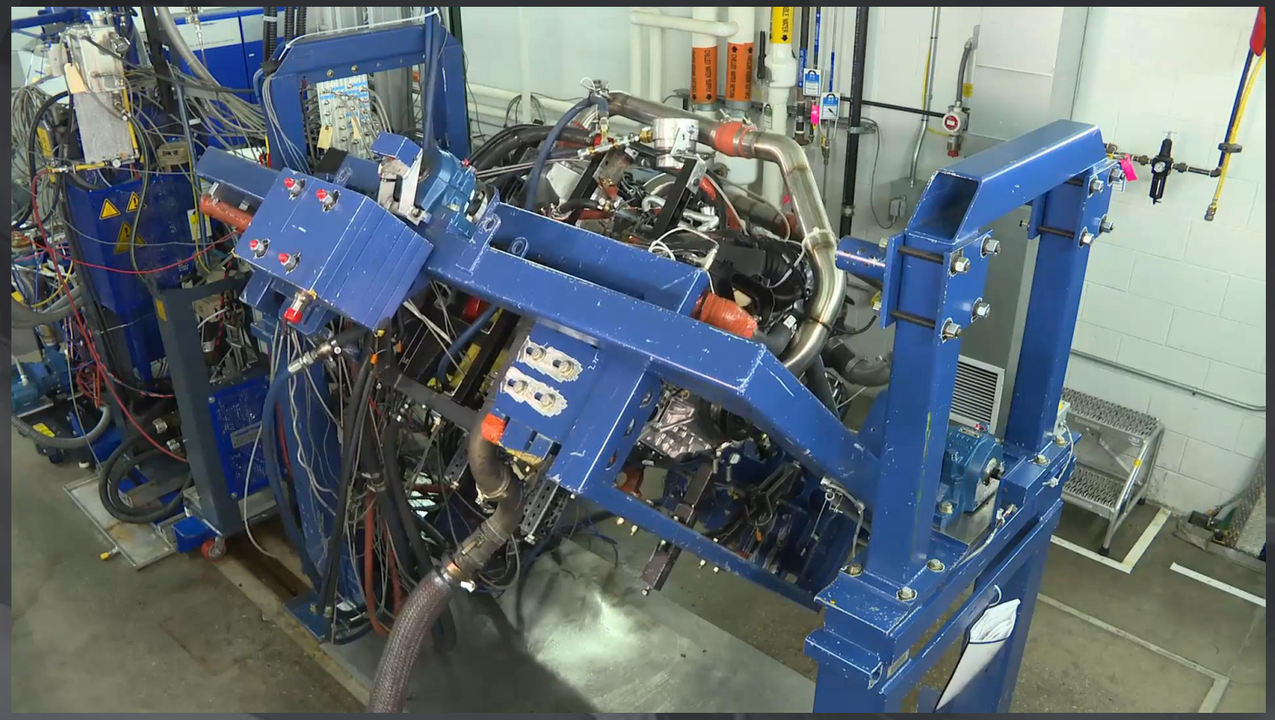


LOW MASS

EQUATES TO BETTER EFFICIENCY, PAYLOAD AND PERFORMANCE



LEGENDARY DURABILITY



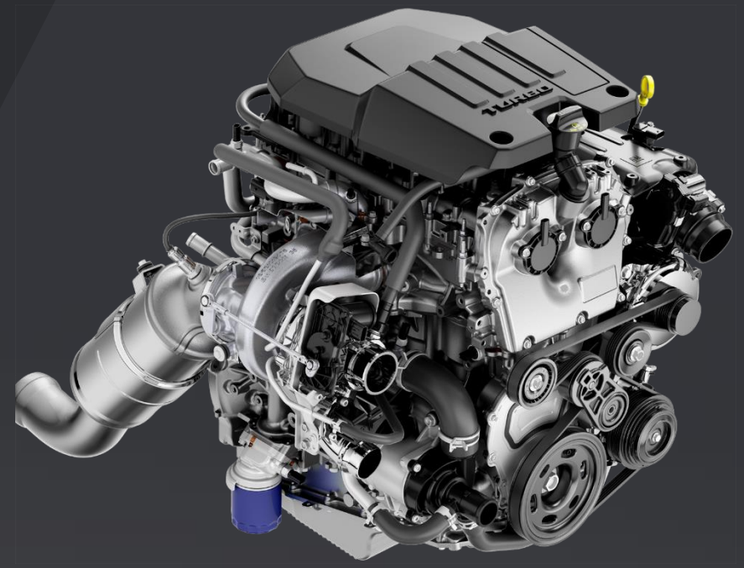
- THE 2019 SILVERADO TRUCK ENGINES WILL HAVE ACCUMULATED AN EQUIVALENT OF OVER 5 MILLION MILES OF VALIDATION TESTING
- REPEATED CYCLING BETWEEN APPROXIMATELY -13°F (-25°C) TO 239°F (115°C) COOLANT TEMPERATURE WHILE RUNNING THE ENGINE UNDER MAX POWER CONDITIONS CONTINUOUSLY FOR MONTHS
- DURABILITY OF GM'S DEACTIVATION SYSTEMS HAVE BEEN TESTED FOR TENS OF MILLIONS OF CYCLES

SUMMARY

TECHNOLOGICALLY ADVANCED TRUCK ENGINE WITH PERFORMANCE AND EFFICIENCY

SUCCESSFULLY ACHIEVED:

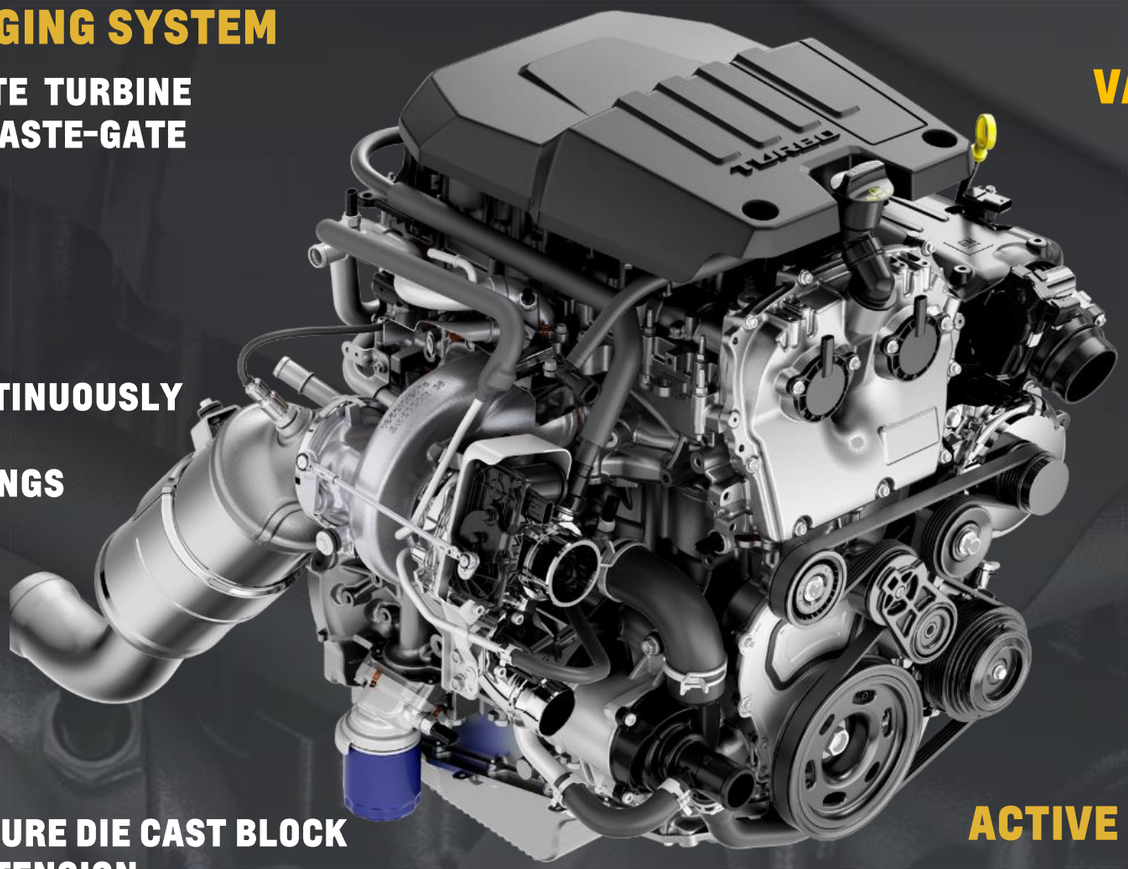
- LEADING EDGE TECHNOLOGY FOR EFFICIENT PERFORMANCE
- LEADING EDGE LOW SPEED TORQUE AND TORQUE RESPONSE WITH TURBOCHARGING
- LEADING EDGE SPECIFIC MASS
- CHEVROLET TRUCK DURABILITY



CRAIG MARRIOTT

ASSISTANT CHIEF ENGINEER 2.7L TURBO

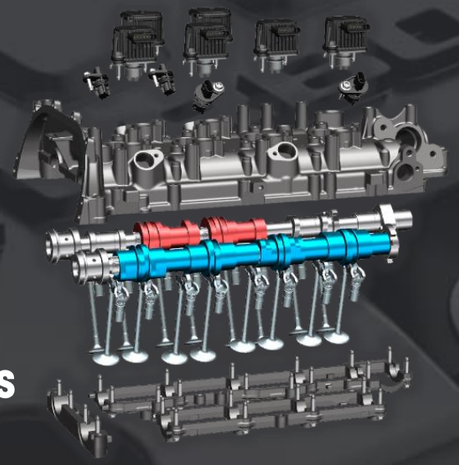
2.7L TURBO
TECHNOLOGY HIGHLIGHTS



TURBOCHARGING SYSTEM
- DUAL-VOLUTE TURBINE
- ELECTRIC WASTE-GATE

FRICTION REDUCTION
- ECM-CONTROLLED CONTINUOUSLY VARIABLE OIL PUMP
- SELECT FIT MAIN BEARINGS
- OFFSET CRANKSHAFT

MASS REDUCTION
- ALUMINUM HIGH PRESSURE DIE CAST BLOCK
- LOWER CRANKCASE EXTENSION
- COMPOSITE INTAKE AIR FUEL MODULE AND OIL PAN



VALVETRAIN
- THREE MODES

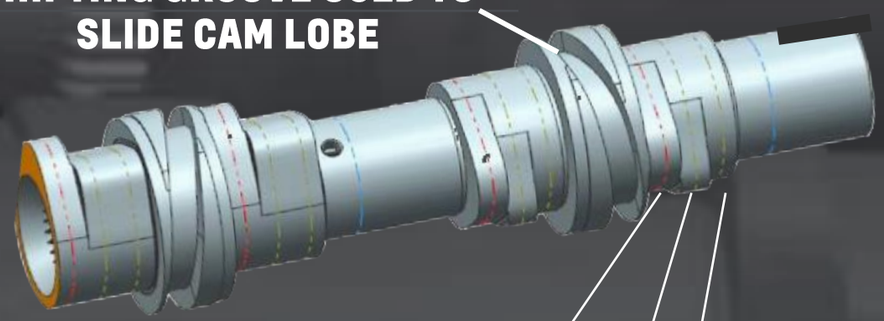
COMBUSTION SYSTEM
- HIGH TUMBLE
- HIGH ENERGY IGNITION
- 3,000 PSI DIRECT INJECTION
- TRIPLE PULSE INJECTION

AUTO STOP/START
- TANDEM SOLENOID STARTER
- SYSTEM WORKS WITH TRANSMISSION

ACTIVE THERMAL MANAGEMENT
- INTEGRAL EXHAUST MANIFOLD
- COOLANT CONTROL VALVE
- ELECTRIC WATER PUMP

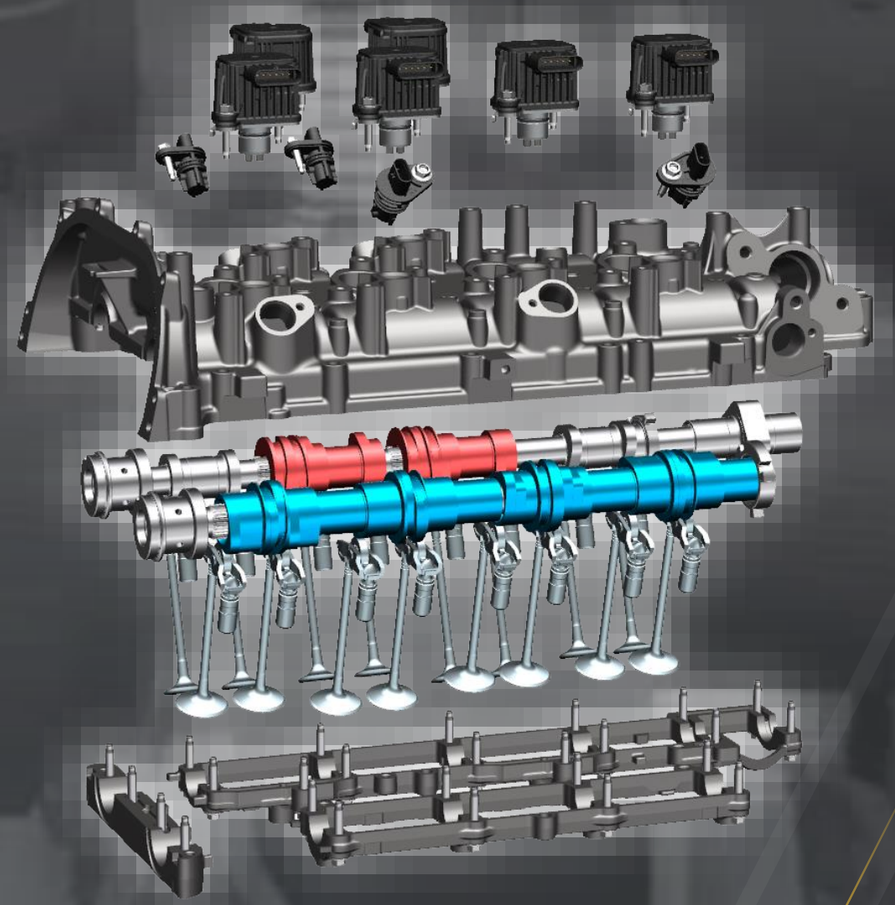
2.7L TURBO VALVETRAIN

INNOVATIVE VALVETRAIN PROVIDES REAL WORLD EFFICIENCY AND POWER AND WHEN YOU NEED IT



TRI-MODES:

1. HIGH VALVE LIFT – FULL POWER
2. LOW VALVE LIFT – CRUISE
3. NO VALVE LIFT – ACTIVE FUEL MANAGEMENT

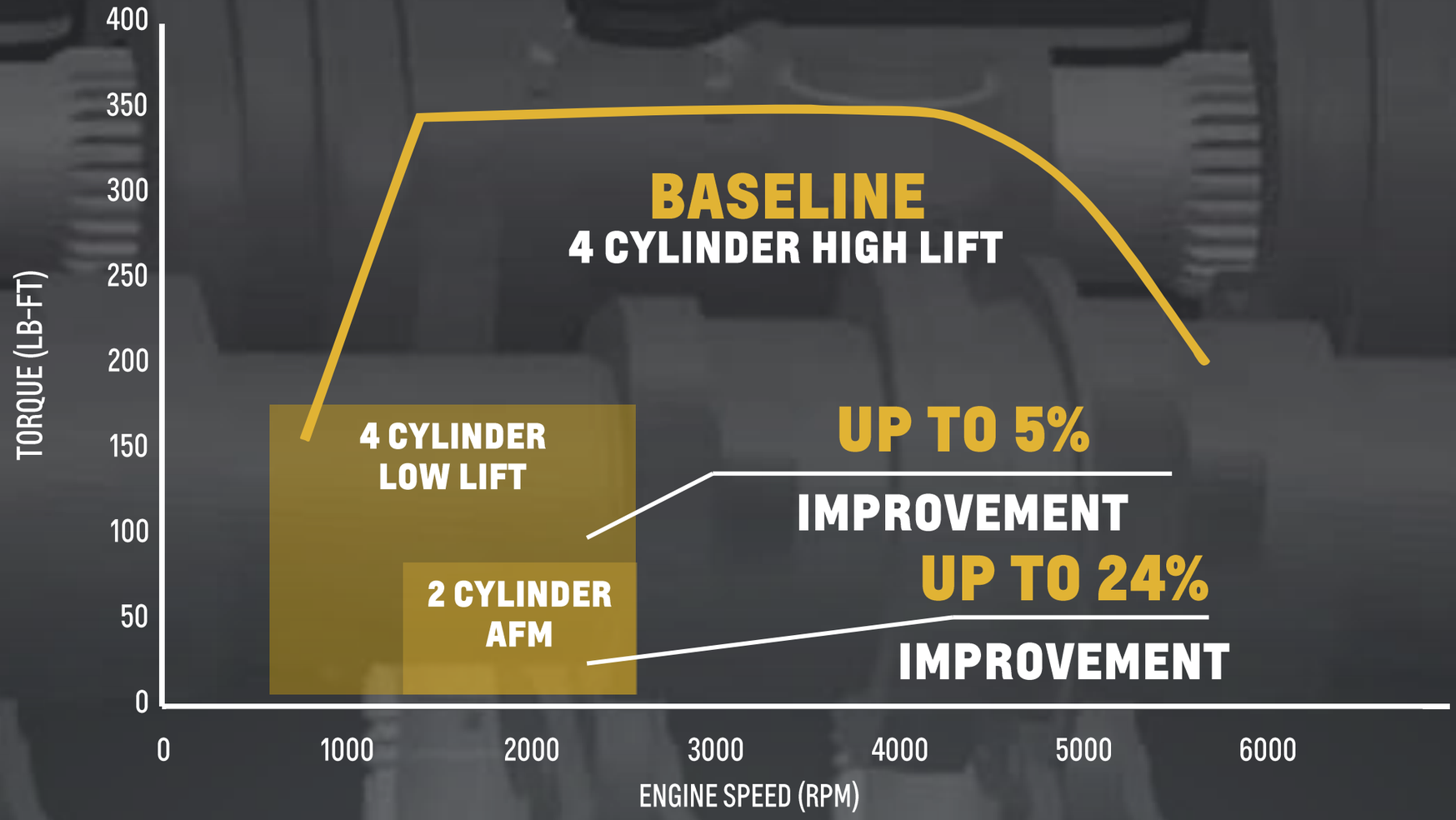


CHEVROLET

MODE 2: LOW VALVE LIFT - CRUISE

2.7L TURBO

EFFICIENCY IMPROVEMENT OF VALVETRAIN MODES



2.7L TURBO
ACTIVE THERMAL MANAGEMENT (ATM)

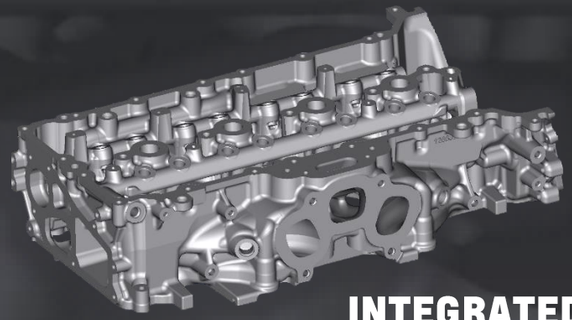
BENEFITS

| COLD START FRICTION REDUCTION:

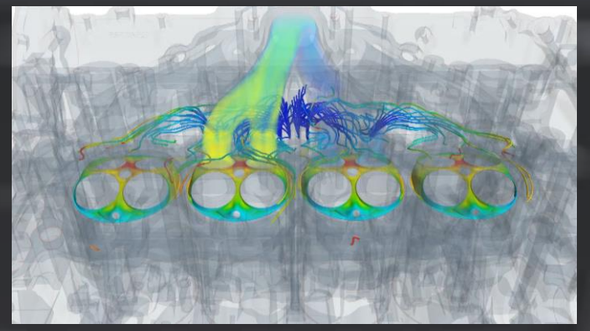
- FASTER WARM-UP
- TRANSMISSION AND ENGINE OIL WARMING

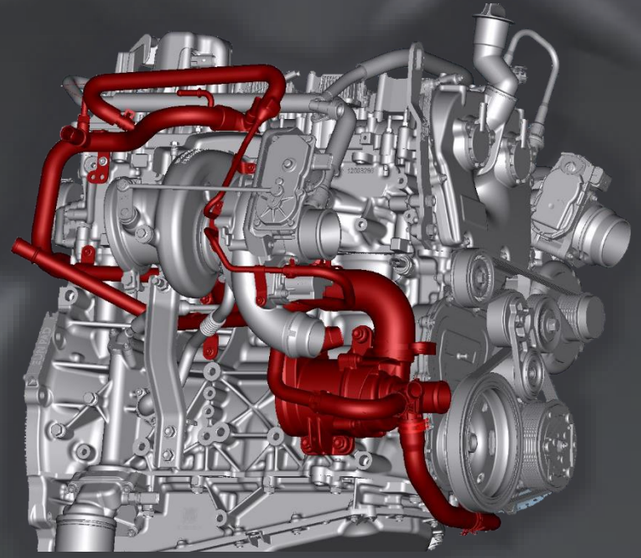
| WARM OPERATION:

- IMPROVES COMBUSTION EFFICIENCY
- EXHAUST COOLING FOR TURBO DURABILITY

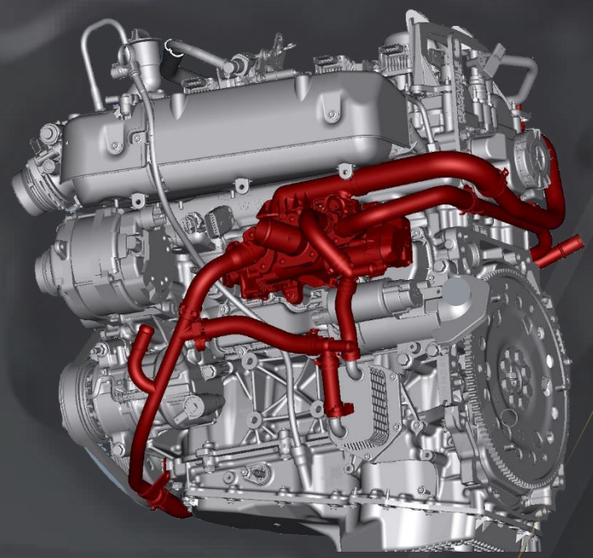


INTEGRATED EXHAUST MANIFOLD



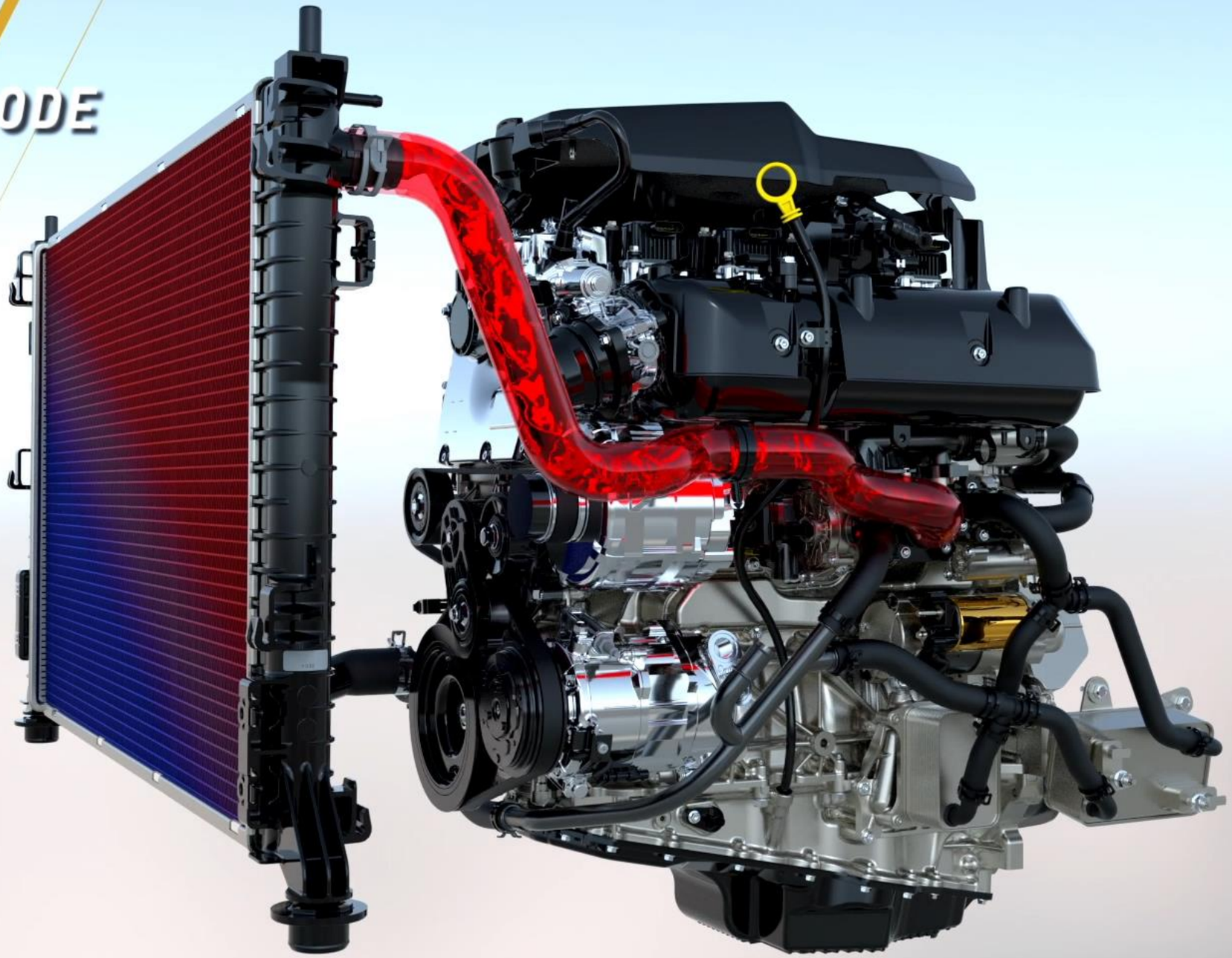


ELECTRIC WATER PUMP



COOLANT CONTROL VALVE

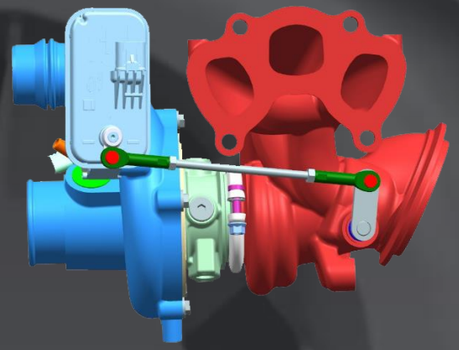
MAXIMUM COOLING MODE



CHEVROLET

DUAL-VOLUTE TURBOCHARGER

WITH ELECTRICAL ACTUATED WASTEGATE

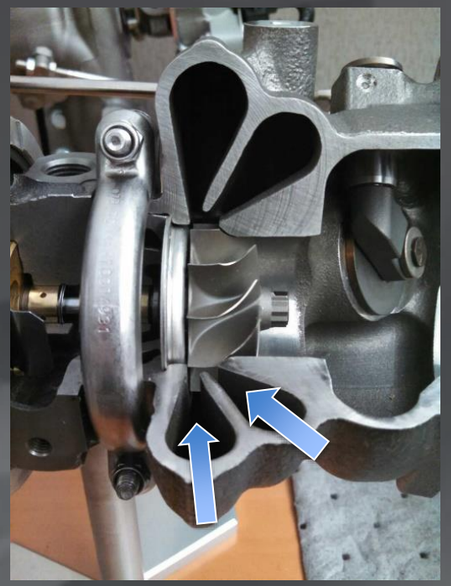


DESCRIPTION:

- ELECTRONIC BOOST CONTROL
- TRI-PORT EXHAUST
- DUAL VOLUTE TURBINE

BENEFITS:

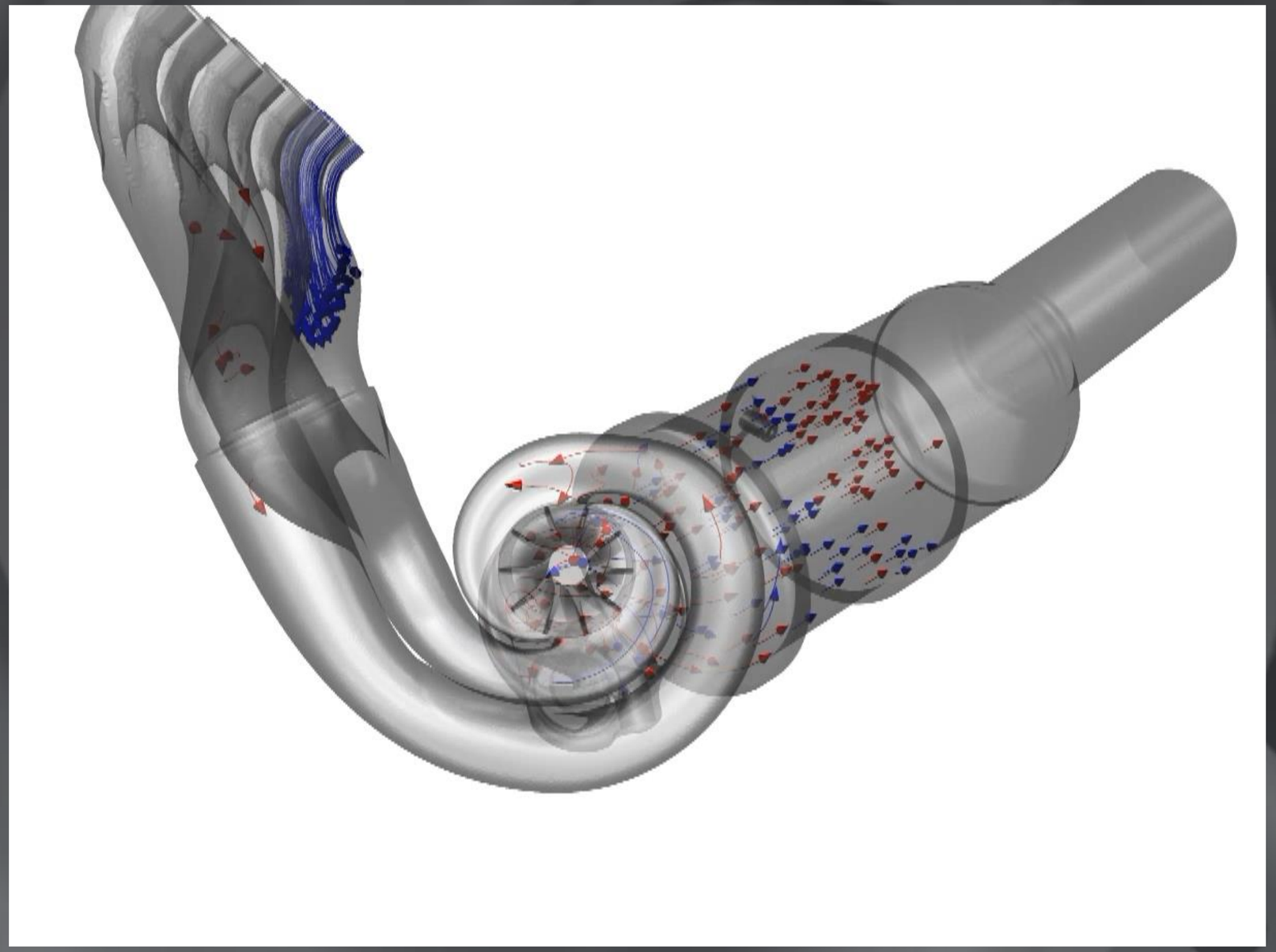
- FAST BOOST RESPONSE
- IMPROVED ENGINE EFFICIENCY



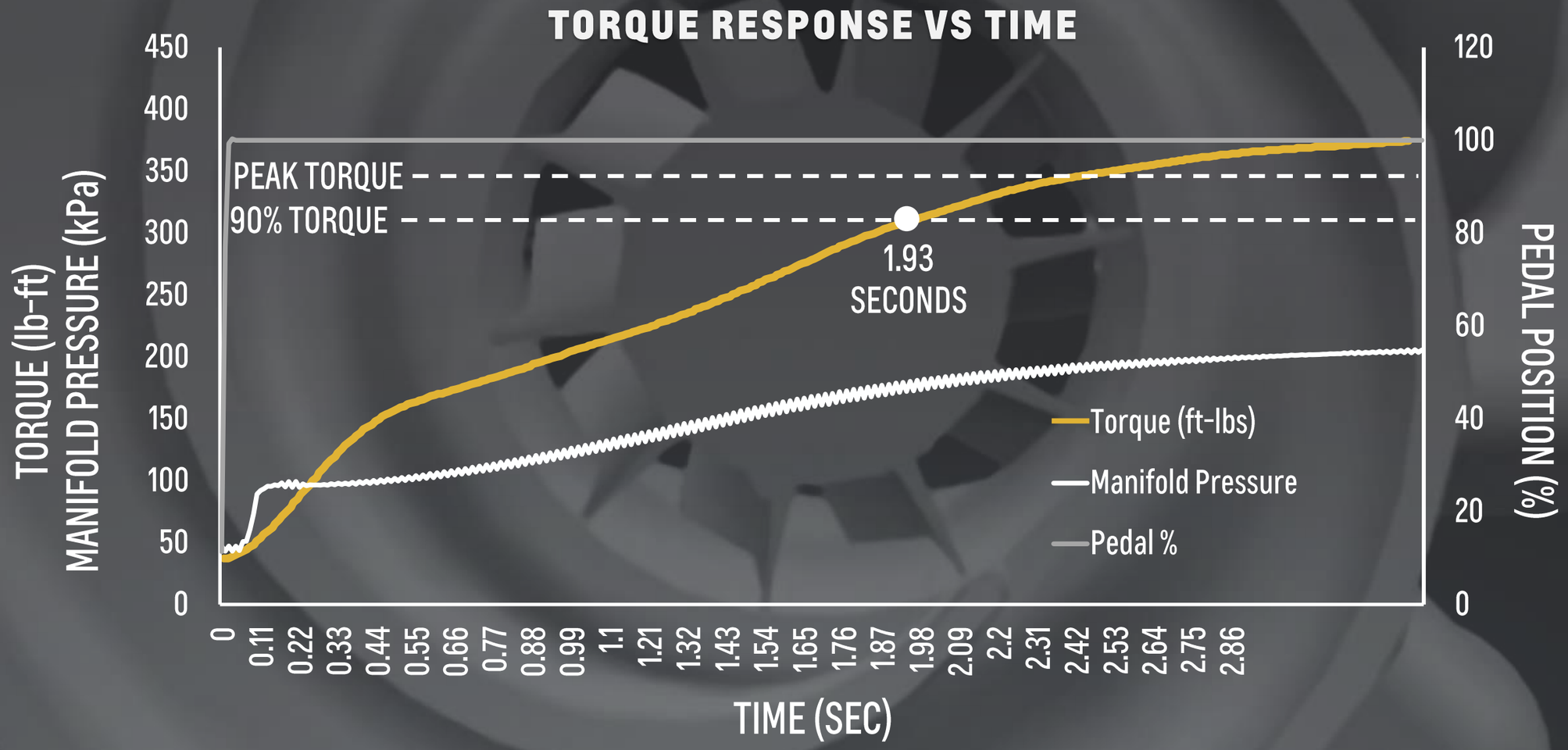
TWIN SCROLL

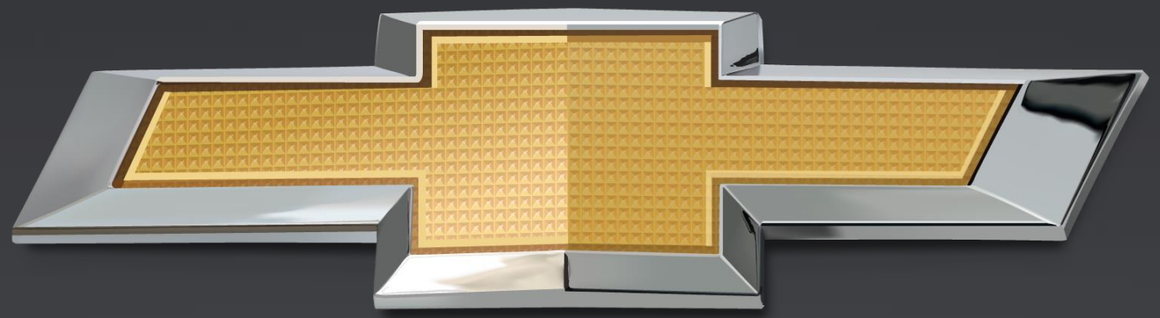
DUAL-VOLUTE

2.7L DUAL VOLUTE TURBINE FLOW



2.7L TURBO
RESPONSIVENESS





CHEVROLET