Air Resources Board

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July 7, 2009 Mail-Out #MSC 09-22

TO: All Heavy-Duty Engine/Vehicle Manufacturers
All Other Interested Parties

SUBJECT: GUIDELINES FOR HEAVY-DUTY ON-BOARD DIAGNOSTIC (HD OBD) CERTIFICATION DATA

In order to expedite the HD OBD certification review process, staff has developed guidelines and templates for reporting various elements of the certification documentation. Where applicable, all HD OBD certification information shall be submitted in accordance with these templates. The formats and reporting requirements defined herein shall apply to all 2010 and newer model year HD OBD certification documentation.

Misfire Disablement and Detection Chart

Section (j)(2.5) of title 13, California Code of Regulations, section 1971.1 (i.e., the HD OBD regulation) requires the certification application for heavy-duty gasoline engines and vehicles to include documentation of misfire monitor disablement during the Federal Test Procedure (FTP). For this documentation, a template is provided as Attachment A, "Misfire Disablement and Detection Chart." Data for these charts shall be collected from a vehicle on a chassis dynamometer with random misfire present at the FTP emission threshold level over the light-duty FTP chassis dynamometer drive cycle. For engine certified applications, the engine manufacturer must conduct the required chassis dynamometer testing on a representative vehicle as approved by the Executive Officer. These charts shall be printed as full pages in landscape format with time in seconds plotted on the x-axis and no more than 200 seconds of data on each page. The y-axis scaling shall be unique to each parameter to allow clear identification and observation of each trace. The parameters plotted on the chart shall include vehicle speed, a misfire counter (indicating the number of actual detected misfires for the current 1000-revolution evaluation interval), and a 1000-revolution counter (indicating the number of crankshaft revolutions accumulated while the misfire monitor is enabled for the current 1000-revolution evaluation interval). The FTP misfire threshold (i.e., number of detected misfires per 1000-revolution increment needed to detect a fault as defined in section (f)(2.2.2)(A)) shall be plotted as a horizontal line on the same y-axis scale as that used for the misfire counter.

A status bit indication shall be located immediately below the x-axis of the chart and shall indicate the individual status of all applicable disablements during the test cycle. The status bits shall be aligned with the x-axis of the chart to facilitate correlation of a status bit indicating disablement and the corresponding point on the chart where the disablement is active. One status bit shall indicate the overall status of the misfire monitor (enabled/disabled), a separate status bit shall indicate the point at which a fault is detected by the misfire monitor, and additional status bits shall be provided for each individual disablement that occurs during the test cycle such as fuel cut, negative torque, manual transmission gear shifts, and any other criterion that disables the misfire monitor.

Misfire Probability of Detection Chart

Section (j)(2.5.2) of the HD OBD regulation requires the certification application for heavy-duty gasoline engines to include documentation of misfire monitor probability of detection (Pd) in various engine speeds and loads. For this documentation, a template is provided as Attachment B, "Probability of Detection Chart." Manufacturers are required to submit data for the following misfire patterns: any one cylinder out, random misfire at the FTP threshold, and paired cylinders. Additionally, manufacturers are required to submit Pd data for misfire patterns causing misfire rates equal to or greater than two cylinders out that could be caused by the malfunction of a single component (e.g., shared coils).

The chart shall include engine speed in revolutions per minute (rpm) on the x-axis and calculated load in percent on the y-axis. Engine speed shall start at idle and continue up to redline in increments of 500 rpm. The calculated load axis shall include the following: zero torque, 15%, 30%, 50%, 65%, 80%, and wide-open-throttle (WOT). Calculated load is defined as PID $04 Calculated Load Value in Society of Automobile Engineers (SAE) J1979 (ISO 15031-5), May 2007, "E/E Diagnostic Test Modes." For reference, the calculation is:

$$\frac{(current\_airflow)}{\left[(peak\_airflow\_at\_WOT@STP\_as\_a\_function\_of\_RPM)\times\frac{BARO}{29.92}\times\sqrt{\frac{298}{(AAT+278)}}\right]}$$

For a given misfire pattern, Pd is calculated by dividing the total number of detected misfires by the total number of induced misfires. Pd shall be reported in decimal form with two significant digits. Manufacturers may not average different cylinder Pd values together and then report this average on a single chart. For example, on a four-cylinder engine, manufacturers may not report the single cylinder out misfire pattern by measuring the Pd for each of the four cylinders and then averaging these Pd values into

one chart; instead, the Pd values shall be reported separately on four different charts. In lieu of separately reporting the Pd values for each cylinder, a manufacturer may submit a chart with the worst case (lowest from all cylinders) Pd value for each speed and load point. However, a demonstration must be made by the manufacturer to show that the data submitted are representative of the worst case.

Manufacturers shall fill in all cells with data or notation as follows: manufacturers shall use the abbreviation NA for engine speed/load cells that are not achievable and shall provide reasons for not reporting data in those cells; manufacturers shall use the abbreviation NR for engine speed/load cells that do not require misfire monitoring as defined in section (f)(2.3.1)(C) of the HD OBD regulation.

OBD Summary Tables

Section (j)(2.2) of the HD OBD regulation requires manufacturers to submit OBD calibration data in a standardized format. This format is included in this Mail-Out as Attachment C, "Summary Table." Manufacturers are reminded to use the engineering units specified in section (j)(2.2.2) of the regulation and to ensure that monitors are separated clearly in the summary tables by a horizontal line above and below each different monitor and to provide all text in size 12 pt font. Additionally, manufacturers shall use SAE J1930, "Electrical/Electronic Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms—Equivalent to ISO/TR 15031-2," and SAE J2403, "Medium/Heavy-Duty E/E Systems Diagnosis Nomenclature," terms in the summary table where applicable.

Moreover, many delays in OBD certification are due to manufacturers using vague definitions and values in the summary tables. For example, manufacturers should avoid including a general secondary parameter such as "no fault present", "not defective", or "no fault codes present." Instead, manufacturers should indicate precisely which fault code(s) is required to disable the monitor and whether this fault code disablement is applicable to pending fault codes, confirmed fault codes commanding the malfunction indicator light (MIL) on, confirmed fault codes not commanding the MIL on, or other fault status. In lieu of listing every applicable disablement fault code in the summary table with each monitor, manufacturers may use notation to reference a separate table listing the applicable disablement fault code(s) for the given monitor.

As another example of vague secondary parameters, manufacturers frequently use general language in monitoring descriptions such as "front oxygen sensor status: OK." Such a description does not provide staff with enough detail to review the monitor. From this definition, staff cannot discern the criteria that the manufacturer are relying on to verify whether the sensor is "OK" or not and accordingly, cannot ensure that the OBD system is properly designed. Other commonly used terms that are not sufficient for use

in expeditious review of certification applications include qualitative, non-engineering terms such as “stable,” “noisy,” “ready”, “active”, “valid”, or “steady.” Such terms should be replaced with the actual parameters and quantitative conditions necessary to execute the monitor (e.g., instead of “oxygen sensor ready” use “oxygen sensor voltage > 0.55 volts”). Similarly, terms relating to internal flags such as “engine speed: Idle” or “idle conditions: true” should be replaced with the actual specifications using engineering units.

To avoid listing duplicate information in the summary tables, manufacturers may group fault codes together for monitors that share identical monitoring strategies and calibrations (e.g., monitors for bank 1 and bank 2 sensors). The monitoring strategy, thresholds, and secondary parameter calibrations can then be listed once and all applicable fault codes identified and grouped under the Fault Code column in the summary table.

Rate-Based Data Reporting

Section (l)(3) of the HD OBD regulation requires manufacturers to collect and report in-use rate-based data. Two templates are provided in this Mail-Out as Attachments D and E. Attachment D, “HD OBD Diesel Rate-Based Data,” is to be used for diesel engines and Attachment E, “HD OBD Gasoline Rate-Based Data,” is to be used for gasoline engines. These attachments are provided on the Air Resources Board (ARB) website http://www.arb.ca.gov/msprog/obdprog/obdupdates.htm and are required to be used by manufacturers. These data shall be reported to ARB in both hard copy and electronic format. For the electronic submittal, manufacturers may email the data to ARB staff. Manufacturers are required to fill in all fields in this template; the abbreviation NA shall not be used in this template. Manufacturers may insert additional rows in the template to report rate-based data as needed. For the calculated ratio for each monitor, the ratio shall be reported with a minimum of three decimal places. Below are additional details for each field in the rate-based table:

HD OBD Diesel Rate-Based Data (Attachment D):

No.:	Number data sets starting from the number 1.
MY:	Report the model year for the engine in this field.
Manufacturer:	Report engine manufacturer name in this field. Manufacturer name shall be consistent for all data submitted.
Engine Family:	Report the engine family name for the certified engine.
Engine Serial No.:	Report the engine serial number in this field.
VIN:	Report the vehicle identification number (VIN) of the chassis in this field.
MonPerfGrp:	Report the monitoring performance group of the vehicle (Section 1971.1 (l)(3.2.2)): line-haul, urban delivery, or other in this field.

Date:	Report the date that the data was taken in this field formatted as mm/dd/yyyy.
ODO:	Report the odometer reading on the vehicle in miles.
CAL ID:	Report the Calibration Identification Number (CAL ID) in this field. For engines with more than one CAL ID, the CAL ID field should be filled with the CAL ID that best represents the OBD software in the electronic controller unit (ECU); i.e., the CAL ID with the highest priority as defined in section (h)(4.6.3).
Gen Den:	Report the general denominator in this field as defined in section (d)(5.6).
Ign Cycle:	Report the number of ignition cycles in this field.
NMHCCatNum:	Report the numerator for non-methane hydrocarbon converting (NMHC) catalyst monitor in this field.
NMHCCatDen:	Report the denominator for NMHC catalyst monitor in this field.
NMHCCatRat:	Report the ratio for NMHC catalyst monitor in this field.
NOxCatNum:	Report the numerator for oxides of nitrogen (NOx) catalyst monitor (e.g., selective catalytic reduction) in this field.
NOxCatDen:	Report the denominator for NOx catalyst monitor in this field.
NOxCatRat:	Report the ratio for NOx catalyst monitor in this field.
NOxAdsNum:	Report the numerator for NOx adsorber or NOx trap monitor (NOxAds) in this field.
NOxAdsDen:	Report the denominator for NOxAds monitor in this field.
NOxAdsRat:	Report the ratio for NOxAds monitor in this field.
DPFNum:	Report the numerator for diesel particulate matter filter system (DPF) monitor in this field.
DPFDen:	Report the denominator for DPF monitor in this field.
DPFRat:	Report the ratio for DPF monitor in this field.
ExhGasSenNum:	Report the numerator for oxygen or air/fuel ratio sensor monitor in this field.
ExhGasSenDen:	Report the denominator for oxygen or air/fuel ratio sensor monitor in this field.
ExhGasSenRat:	Report the ratio for oxygen or air/fuel ratio sensor monitor in this field.
EGRNum:	Report the numerator for exhaust gas recirculation (EGR) monitor in this field.
EGRDen:	Report the denominator for EGR monitor in this field.
EGRRat:	Report the ratio for EGR monitor in this field.
VVTNum:	Report the numerator for variable valve timing (VVT) monitor in this field.
VVTDen:	Report the denominator for VVT monitor in this field.
VVTRat:	Report the ratio for VVT monitor in this field.

BoostNum:	Report the numerator for boost pressure control (Boost) monitor in this field.
BoostDen:	Report the denominator for Boost monitor in this field.
BoostRat:	Report the ratio for Boost monitor in this field.
FuelSysNum:	Report the numerator for fuel quantity and timing (FuelSys) monitors in this field.
FuelSysDen:	Report the denominator for FuelSys monitors in this field.
FuelSysRat:	Report the ratio for FuelSys monitors in this field.

HD OBD Gasoline Rate-Based Data (Attachment E):

No.:	Number data sets starting from the number 1.
MY:	Report the model year for the engine in this field.
Manufacturer:	Report engine manufacturer name in this field. Manufacturer name shall be consistent for all data submitted.
Engine Family:	Report the engine family name for the certified engine.
Engine Serial No.:	Report the engine serial number in this field.
VIN:	Report the VIN of the chassis in this field.
MonPerfGrp:	Report the monitoring performance group of the vehicle (Section 1971.1 (l)(3.2.2)): line-haul, urban delivery, or other in this field.
Date:	Report the date that the data was taken in this field formatted as mm/dd/yyyy.
ODO:	Report the odometer reading on the vehicle in miles.
CAL ID:	Report the CAL ID in this field. For engines with more than one CAL ID, the CAL ID field should be filled with the CAL ID that best represents the OBD software in the ECU; i.e., the CAL ID with the highest priority as defined in section (h)(4.6.3).
Gen Den:	Report the general denominator in this field as defined in section (d)(5.6).
Ign Cycle:	Report the number of ignition cycles in this field.
B1CatNum:	Report the numerator for Bank 1 catalyst monitor in this field.
B1CatDen:	Report the denominator for Bank 1 catalyst monitor in this field.
B1CatRat:	Report the ratio for Bank 1 catalyst monitor in this field.
B2CatNum:	Report the numerator for Bank 2 catalyst monitor in this field.
B2CatDen:	Report the denominator for Bank 2 catalyst monitor in this field.
B2CatRat:	Report the ratio for the Bank 2 catalyst monitor in this field.
B1O2Num:	Report the numerator for Bank 1 front oxygen or air/fuel ratio sensor monitor in this field.
B1O2Den:	Report the denominator for Bank 1 front oxygen or air/fuel ratio sensor monitor in this field.
B1O2Rat:	Report the ratio for Bank 1 front oxygen or air/fuel ratio sensor monitor in this field.

B2O2Num:	Report the numerator for Bank 2 front oxygen or air/fuel ratio sensor monitor in this field.
B2O2Den:	Report the denominator for Bank 2 front oxygen or air/fuel ratio sensor monitor in this field.
B2O2Rat:	Report the ratio for Bank 2 front oxygen or air/fuel ratio sensor monitor in this field.
EGR/VVTNum:	Report the numerator for exhaust gas recirculation/variable valve timing (EGR/VVT) monitor in this field.
EGR/VVTDen:	Report the denominator for EGR/VVT monitor in this field.
EGR/VVTRat:	Report the ratio for EGR/VVT monitor in this field.
SAIRNum:	Report the numerator for Secondary Air (SAIR) monitor in this field.
SAIRDen:	Report the denominator for SAIR monitor in this field.
SAIRRat:	Report the ratio for SAIR monitor in this field.
EVAPNum:	Report the numerator for 0.150" evaporative system leak (EVAP) monitor in this field.
EVAPDen:	Report the denominator for 0.150" EVAP monitor in this field.
EVAPRat:	Report the ratio for 0.150" EVAP monitor in this field.
B1SO2Num:	Report the numerator for Bank 1 secondary oxygen or air/fuel ratio sensor monitor in this field.
B1SO2Den:	Report the denominator for Bank 1 secondary oxygen or air/fuel ratio sensor monitor in this field.
B1SO2Rat:	Report the ratio for Bank 1 secondary oxygen or air/fuel ratio sensor monitor in this field.
B2SO2Num:	Report the numerator for Bank 2 secondary oxygen or air/fuel ratio sensor monitor in this field.
B2SO2Den:	Report the denominator for Bank 2 secondary oxygen or air/fuel ratio sensor monitor in this field.
B2SO2Rat:	Report the ratio for Bank 2 secondary oxygen or air/fuel ratio sensor monitor in this field.

CAL ID and CVN

Section (h)(4.7.5) of the HD OBD regulation requires manufacturers to submit CAL ID and Calibration Verification Number (CVN) information. A template titled "CAL ID and CVN Data" is provided in this Mail-Out as Attachment F. Manufacturers are required to use the Microsoft Excel electronic template provided on the ARB website http://www.arb.ca.gov/msprog/obdprog/obdupdates.htm for reporting and electronically submitting CAL ID and CVN data to ARB. For the electronic submittal, manufacturers may email the data to ARB staff. CAL ID and CVN data shall be submitted on a quarterly basis for each engine family, including new data associated with running change and field fix calibrations. Successive reports should only include new CAL ID and CVN data not included in previous submitted reports. In cases where more than

one CAL ID and CVN pair are available for a given engine family (e.g., a single set of software in one ECU has multiple CAL IDs and CVNs, a running change software set has been released with a new CAL ID and CVN for an ECU), manufacturers shall use additional rows to report all CAL ID and CVN pairs. No distinction is required in the table between multiple CAL ID and CVN pairs for a single set of software in an ECU versus multiple sets of software available for an ECU that each have a unique CAL ID and CVN. Below are additional details for the CAL ID and CVN table:

Model Year:	Report the model year for the engine in this field.
Manufacturer:	Report engine manufacturer name in this field. Manufacturer name shall be consistent for all data submitted.
Engine Size:	Report the engine size (in liters) in this field.
Engine Family:	Report the engine family for the certified engine in this field
Engine Serial No.:	Report the engine serial number in this field.
Module ID/Address:	Report the module ID/address (e.g., source address in the header bytes as defined in SAE J1979) in hexadecimal (HEX) format in this field.
CAL ID:	Report the CAL ID in ASCII format in this field.
CVN:	Report the CVN in HEX format in this field.

OBD Checklists

To facilitate the OBD review and certification process, ARB staff has provided two checklists: one for diesel engines and one for gasoline engines. These checklists are included in this Mail-Out as Attachment G, "HD OBD Diesel Monitoring Requirements Checklist," and Attachment H, "HD OBD Gasoline Monitoring Requirements Checklist," and are available electronically at: http://www.arb.ca.gov/msprog/obdprog/obdupdates.htm. They are intended to assist engine manufacturers and staff in making sure that pertinent information has been provided in the application. Attachment G lists malfunction criteria that are required to be detected for diesel engines, and requires manufacturers to identify the specific fault code(s) for the diagnostic(s) used to satisfy each criterion. Where components or systems are not supported by the engine, manufacturers shall use the abbreviation NA in the applicable field. Attachment H is similarly structured with the specific requirements for gasoline engines. While intended to be comprehensive, these checklists do not alter or supersede the regulatory requirements of the OBD regulation. These checklists focus on areas where the requirements are complex or where specific malfunction criteria are satisfied with multiple diagnostics, and are helpful to staff to quickly identify the relevant diagnostics when reviewing a system for compliance.

Summary

Staff has provided these templates and guidelines to help expedite the HD OBD certification process. Any variation on these templates by a manufacturer must be approved by ARB before certification material is submitted. Staff may periodically modify these templates to further facilitate certification. Staff will send out an email informing manufacturers of modifications and provide appropriate lead time, where relevant, to incorporate the modifications. Manufacturers interested in receiving future emails should follow the instructions to subscribe to the On-Board Diagnostics Program list at the following website: http://www.arb.ca.gov/msprog/obdprog/obdprog.htm . Go to "Local Links" and "Join Email List." By signing up for this list serve, subscribers will also receive a notice whenever changes are made to the ARB On-Board Diagnostics Program website.

Should you have questions or comments regarding this Mail-Out, please contact Mr. Mike McCarthy, Manager, at (626) 771-3614.

Sincerely,

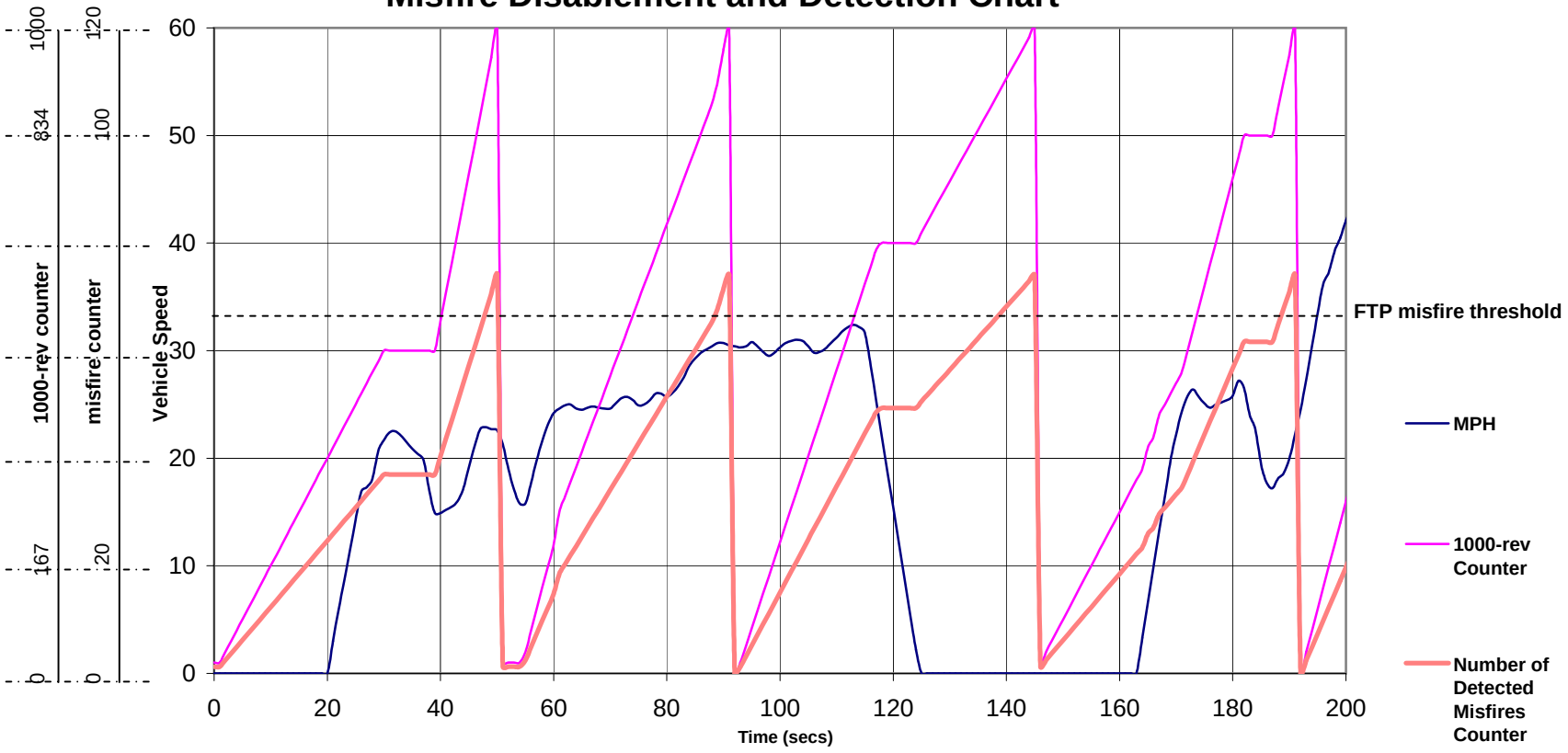
/s/

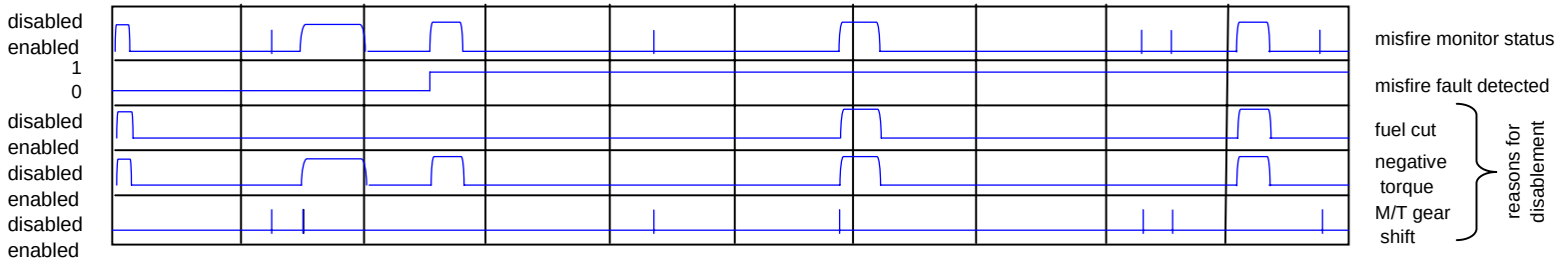
Robert H. Cross, Chief
Mobile Source Control Division

Attachment A: Misfire Disablement and Detection Chart
B: Probability of Detection Chart
C: Summary Table
D: HD OBD Diesel Rate-Based Data
E: HD OBD Gasoline Rate-Based Data
F: CAL ID and CVN Data
G: HD OBD Diesel Monitoring Requirements Checklist
H: HD OBD Gasoline Monitoring Requirements Checklist

cc: Mr. Mike McCarthy, Manager
Advanced Engineering Section

Attachment A:
Misfire Disablement and Detection Chart





Note: Misfire data in this sample chart was collected during light-duty FTP vehicle chassis dynamometer testing.

Attachment B:
Probability of Detection Chart

Misfire Pattern: One Cylinder Out

Engine Speed (rpm)

Calculated Load (%)

	Idle	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	Redline
Zero Torque	1.00	1.00	1.00	1.00	1.00	1.00	NR	NR	NR	NR	NR	NR	NR
15	1.00	1.00	1.00	1.00	1.00	1.00	1.00	NR	NR	NR	NR	NR	NR
30	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	NR
50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
65	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	NA	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
WOT	NA	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

NA Not Achievable
NR Not Required per Section 1971.1 (f)(2.3.1)(C)

Attachment C:
Summary Table

Engine Family	Certification Standard or Family Emission Limit (FEL)
AARBV05.0XYZ	(0.2 g/bhp-hr NOx, 0.01 g/bhp-hr PM, etc...)

Component/ System	*SAE J2012 Fault Code or J1939 SPN-FMI	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Conditions	Time Required	MIL Illum.
(example) **Three-way Catalyst**	P0420	Oxygen storage	Rear oxygen sensor period versus front oxygen sensor period	> 0.75 switch ratio Disable conditions:	Engine speed Engine load ECT MAP Fuel system status No active DTCs:	1000<rpm<4000rpm >20% >70C > 25 kPa closed loop P0133 P0139 P0105	20 seconds once per trip	two trips
EGR System	P0401/ 2659-18	Low flow by difference in MAP	Delta MAP	< 10 kPa Disable conditions:	Vehicle speed ECT Fuel system status Battery voltage No active DTCs:	> 35 mph > 70C Fuel-cut > 11.0 V P0105	3 seconds	two trips
Manifold Absolute Pressure (MAP) Sensor:								
MAP High	P0108/ 1692-3	Out of Range High	MAP Voltage	> 4.0 V (110 kPa)	Engine Speed	> 300 rpm	Continuous	one trip
MAP Low	P0107/ 1692-4	Out of Range Low	MAP Voltage	< 0.15 V (15 kPa)	Engine Speed	> 300 rpm	Continuous	one trip
MAP Rationality	P0106/ 1692-2	Comparison of modeled MAP to actual MAP signal	High Rationality MAP Voltage:	< 3.1 V (65 kPa)	Engine Speed Vehicle Speed Calculated load	1000 to 5000 rpm > 10 mph > 50%	2 seconds Monitor runs whenever enable conditions are met	two trips
			Low Rationality MAP Voltage:	> 1.0 V (25 kPa)	Engine Speed Vehicle Speed Fuel System Status	> 1500 rpm > 10 mph Fuel Cut		

* Note: List the applicable SAE J2012 Fault Code or equivalent SAE J1939 Suspect Parameter Number (SPN) and Failure Mode Identifier (FMI)

Attachment D:

HD OBD Diesel Rate-Based Data

No.	MY	Manufacturer	Engine Family	Engine Serial No.	VIN	MonPerfGrp	Date	ODO	CAL ID	Gen Den	Ign Cycle	NMHCCatNum	NMHCCatDen	NMHCCatRat
1	2010	ABC Motors	ACARBV06.0XYZ	ABXX748121	XX1XX6356XX748121	Line-Haul	06/12/2010	5000	12345-xyz-678	100	300	10	20	0.500
2	2010	ABC Motors	ACARBV06.0XYZ	ABXX748122	XX1XX6356XX748122	Line-Haul	06/12/2010	5001	12345-xyz-678	101	301	20	40	0.500
3	2010	ABC Motors	ACARBV06.0XYZ	ABXX748123	XX1XX6356XX748123	Line-Haul	06/12/2010	7000	12345-xyz-678	50	400	30	60	0.500
4	2010	ABC Motors	ACARBV06.0XYZ	ABXX748124	XX1XX6356XX748124	Line-Haul	06/12/2010	8000	12345-xyz-678	60	500	40	80	0.500
5	2010	ABC Motors	ACARBV06.0XYZ	ABXX748125	XX1XX6356XX748125	Line-Haul	06/12/2010	9000	12345-xyz-678	70	600	50	100	0.500
6	2010	ABC Motors	ACARBV06.0XYZ	ABXX748126	XX1XX6356XX748126	Line-Haul	06/12/2010	10000	12345-xyz-678	80	700	60	120	0.500
7	2010	ABC Motors	ACARBV06.0XYZ	ABXX748127	XX1XX6356XX748127	Line-Haul	06/12/2010	11000	12345-xyz-678	90	800	70	140	0.500
8	2010	ABC Motors	ACARBV06.0XYZ	ABXX748128	XX1XX6356XX748128	Line-Haul	06/12/2010	12000	12345-xyz-678	100	900	80	160	0.500
9	2010	ABC Motors	ACARBV06.0XYZ	ABXX748129	XX1XX6356XX748129	Line-Haul	06/12/2010	13000	12345-xyz-678	110	1000	90	180	0.500
10	2010	ABC Motors	ACARBV06.0XYZ	ABXX748130	XX1XX6356XX748130	Line-Haul	06/12/2010	14000	12345-xyz-678	120	1100	100	200	0.500
11	2010	ABC Motors	ACARBV06.0XYZ	ABXX748131	XX1XX6356XX748131	Line-Haul	06/12/2010	15000	12345-xyz-678	130	1200	110	220	0.500
12	2010	ABC Motors	ACARBV06.0XYZ	ABXX748132	XX1XX6356XX748132	Line-Haul	06/12/2010	16000	12345-xyz-678	140	1300	120	240	0.500
13	2010	ABC Motors	ACARBV06.0XYZ	ABXX748133	XX1XX6356XX748133	Line-Haul	06/12/2010	17000	12345-xyz-678	150	1400	130	260	0.500
14	2010	ABC Motors	ACARBV06.0XYZ	ABXX748134	XX1XX6356XX748134	Line-Haul	06/12/2010	17000	12345-xyz-678	160	1500	140	280	0.500
15	2010	ABC Motors	ACARBV06.0XYZ	ABXX748135	XX1XX6356XX748135	Line-Haul	06/12/2010	5002	12345-xyz-678	102	302	21	42	0.500

NOxCatNum	NOxCatDen	NOxCatRat	NOxAdsNum	NOxAdsDen	NOxAdsRat	DPFNum	DPFDen	DPFRat	ExhGasSenNum	ExhGasSenDen	ExhGasSenRat
10	20	0.500	10	20	0.500	10	20	0.500	10	20	0.500
20	40	0.500	20	40	0.500	20	40	0.500	20	40	0.500
30	60	0.500	30	60	0.500	30	60	0.500	30	60	0.500
40	80	0.500	40	80	0.500	40	80	0.500	40	80	0.500
50	100	0.500	50	100	0.500	50	100	0.500	50	100	0.500
60	120	0.500	60	120	0.500	60	120	0.500	60	120	0.500
70	140	0.500	70	140	0.500	70	140	0.500	70	140	0.500
80	160	0.500	80	160	0.500	80	160	0.500	80	160	0.500
90	180	0.500	90	180	0.500	90	180	0.500	90	180	0.500
100	200	0.500	100	200	0.500	100	200	0.500	100	200	0.500
110	220	0.500	110	220	0.500	110	220	0.500	110	220	0.500
120	240	0.500	120	240	0.500	120	240	0.500	120	240	0.500
130	260	0.500	130	260	0.500	130	260	0.500	130	260	0.500
140	280	0.500	140	280	0.500	140	280	0.500	140	280	0.500
21	42	0.500	21	42	0.500	41	82	0.500	21	42	0.500

EGRNum	EGRDen	EGRRat	VVTNum	VVTDen	VVTRat	BoostNum	BoostDen	BoostRat	FuelSysNum	FuelSysDen	FuelSysRat
10	20	0.500	10	20	0.500	10	20	0.500	10	20	0.500
20	40	0.500	20	40	0.500	20	40	0.500	20	40	0.500
30	60	0.500	30	60	0.500	30	60	0.500	30	60	0.500
40	80	0.500	40	80	0.500	40	80	0.500	40	80	0.500
50	100	0.500	50	100	0.500	50	100	0.500	50	100	0.500
60	120	0.500	60	120	0.500	60	120	0.500	60	120	0.500
70	140	0.500	70	140	0.500	70	140	0.500	70	140	0.500
80	160	0.500	80	160	0.500	80	160	0.500	80	160	0.500
90	180	0.500	90	180	0.500	90	180	0.500	90	180	0.500
100	200	0.500	100	200	0.500	100	200	0.500	100	200	0.500
110	220	0.500	110	220	0.500	110	220	0.500	110	220	0.500
120	240	0.500	120	240	0.500	120	240	0.500	120	240	0.500
130	260	0.500	130	260	0.500	130	260	0.500	130	260	0.500
140	280	0.500	140	280	0.500	140	280	0.500	140	280	0.500
21	42	0.500	21	42	0.500	21	42	0.500	21	42	0.500

Attachment E:

HD OBD Gasoline Rate-Based Data

No.	MY	Manufacturer	Engine Family	Engine Serial No.	VIN	MonPerfGrp	Date	ODO	CAL ID	Gen Den	Ign Cycle	B1CatNum	B1CatDen	B1CatRat
1	2010	ABC Motors	ACARBV06.0XYZ	GSXX748121	XX1XX6356XX748121	Urban Delivery	06/12/2010	5000	12345-xyz-678	100	300	10	20	0.500
2	2010	ABC Motors	ACARBV06.0XYZ	GSXX748122	XX1XX6356XX748122	Urban Delivery	06/12/2010	5001	12345-xyz-678	101	301	20	40	0.500
3	2010	ABC Motors	ACARBV06.0XYZ	GSXX748123	XX1XX6356XX748123	Urban Delivery	06/12/2010	7000	12345-xyz-678	50	400	30	60	0.500
4	2010	ABC Motors	ACARBV06.0XYZ	GSXX748124	XX1XX6356XX748124	Urban Delivery	06/12/2010	8000	12345-xyz-678	60	500	40	80	0.500
5	2010	ABC Motors	ACARBV06.0XYZ	GSXX748125	XX1XX6356XX748125	Urban Delivery	06/12/2010	9000	12345-xyz-678	70	600	50	100	0.500
6	2010	ABC Motors	ACARBV06.0XYZ	GSXX748126	XX1XX6356XX748126	Urban Delivery	06/12/2010	10000	12345-xyz-678	80	700	60	120	0.500
7	2010	ABC Motors	ACARBV06.0XYZ	GSXX748127	XX1XX6356XX748127	Urban Delivery	06/12/2010	11000	12345-xyz-678	90	800	70	140	0.500
8	2010	ABC Motors	ACARBV06.0XYZ	GSXX748128	XX1XX6356XX748128	Urban Delivery	06/12/2010	12000	12345-xyz-678	100	900	80	160	0.500
9	2010	ABC Motors	ACARBV06.0XYZ	GSXX748129	XX1XX6356XX748129	Urban Delivery	06/12/2010	13000	12345-xyz-678	110	1000	90	180	0.500
10	2010	ABC Motors	ACARBV06.0XYZ	GSXX748130	XX1XX6356XX748130	Urban Delivery	06/12/2010	14000	12345-xyz-678	120	1100	100	200	0.500
11	2010	ABC Motors	ACARBV06.0XYZ	GSXX748131	XX1XX6356XX748131	Urban Delivery	06/12/2010	15000	12345-xyz-678	130	1200	110	220	0.500
12	2010	ABC Motors	ACARBV06.0XYZ	GSXX748132	XX1XX6356XX748132	Urban Delivery	06/12/2010	16000	12345-xyz-678	140	1300	120	240	0.500
13	2010	ABC Motors	ACARBV06.0XYZ	GSXX748133	XX1XX6356XX748133	Urban Delivery	06/12/2010	17000	12345-xyz-678	150	1400	130	260	0.500
14	2010	ABC Motors	ACARBV06.0XYZ	GSXX748134	XX1XX6356XX748134	Urban Delivery	06/12/2010	17000	12345-xyz-678	160	1500	140	280	0.500
15	2010	ABC Motors	ACARBV06.0XYZ	GSXX748135	XX1XX6356XX748135	Urban Delivery	06/12/2010	5002	12345-xyz-678	102	302	21	42	0.500

B2CatNum	B2CatDen	B2CatRat	B1O2Num	B1O2Den	B1O2Rat	B2O2Num	B2O2Den	B2O2Rat	EGR/VVTNum	EGR/VVTDen	EGR/VVTRat
10	20	0.500	10	20	0.500	10	20	0.500	10	20	0.500
20	40	0.500	20	40	0.500	20	40	0.500	20	40	0.500
30	60	0.500	30	60	0.500	30	60	0.500	30	60	0.500
40	80	0.500	40	80	0.500	40	80	0.500	40	80	0.500
50	100	0.500	50	100	0.500	50	100	0.500	50	100	0.500
60	120	0.500	60	120	0.500	60	120	0.500	60	120	0.500
70	140	0.500	70	140	0.500	70	140	0.500	70	140	0.500
80	160	0.500	80	160	0.500	80	160	0.500	80	160	0.500
90	180	0.500	90	180	0.500	90	180	0.500	90	180	0.500
100	200	0.500	100	200	0.500	100	200	0.500	100	200	0.500
110	220	0.500	110	220	0.500	110	220	0.500	110	220	0.500
120	240	0.500	120	240	0.500	120	240	0.500	120	240	0.500
130	260	0.500	130	260	0.500	130	260	0.500	130	260	0.500
140	280	0.500	140	280	0.500	140	280	0.500	140	280	0.500
21	42	0.500	21	42	0.500	21	42	0.500	21	42	0.500

SAIRNum	SAIRDen	SAIRRat	EVAPNum	EVAPDen	EVAPRat	B1SO2Num	B1SO2Den	B1SO2Rat	B2SO2Num	B2SO2Den	B2SO2Rat
5	5	1.000	5	5	1.000	10	20	0.500	10	20	0.500
7	10	0.700	7	10	0.700	20	40	0.500	20	40	0.500
9	15	0.600	9	15	0.600	30	60	0.500	30	60	0.500
11	20	0.550	11	20	0.550	40	80	0.500	40	80	0.500
13	25	0.520	13	25	0.520	50	100	0.500	50	100	0.500
15	30	0.500	15	30	0.500	60	120	0.500	60	120	0.500
17	35	0.486	17	35	0.486	70	140	0.500	70	140	0.500
19	40	0.475	19	40	0.475	80	160	0.500	80	160	0.500
21	45	0.467	21	45	0.467	90	180	0.500	90	180	0.500
23	50	0.460	23	50	0.460	100	200	0.500	100	200	0.500
25	55	0.455	25	55	0.455	110	220	0.500	110	220	0.500
27	60	0.450	27	60	0.450	120	240	0.500	120	240	0.500
29	65	0.446	29	65	0.446	130	260	0.500	130	260	0.500
31	70	0.443	31	70	0.443	140	280	0.500	140	280	0.500
8	11	0.727	8	11	0.727	21	42	0.500	21	42	0.500

Attachment F:
CAL ID and CVN Data

Model Year	Manufacturer	Engine Size (L)	Engine Family	Engine Serial No.	Module ID/ Address	CAL ID	CVN
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748121	$07E8	12345-xyz-670	ABCDEF123456780
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748122	$07E8	12345-xyz-671	ABCDEF123456781
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748123	$07E8	12345-xyz-672	ABCDEF123456782
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748124	$07E8	12345-xyz-673	ABCDEF123456783
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748125	$07E8	12345-xyz-674	ABCDEF123456784
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748126	$07E8	12345-xyz-675	ABCDEF123456785
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748127	$07E8	12345-xyz-676	ABCDEF123456786
2010	ABC Motors	8.0	ACARBV8.00XYZ	ABXX748128	$07E8	12345-xyz-677	ABCDEF123456787
2010	ABC Motors	8.0	ACARBV8.00XYZ	ABXX748129	$07E8	12345-xyz-678	ABCDEF123456788
2010	ABC Motors	8.0	ACARBV8.00XYZ	ABXX748130	$07E8	12345-xyz-870	ABCDEF123456789
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748131	$07E8	12345-xyz-871	ABCDEF123456720
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748132	$07E8	12345-xyz-872	ABCDEF123456721
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748133	$07E8	12345-xyz-873	ABCDEF123456722
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748134	$07E8	12345-xyz-874	ABCDEF123456723
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748135	$07E8	12345-xyz-875	ABCDEF123456724
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748136	$07E8	12345-xyz-876	ABCDEF123456725
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748137	$07E8	12345-xyz-877	ABCDEF123456726
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748138	$07E8	12345-xyz-878	ABCDEF123456727
2010	ABC Motors	9.0	ACARBV9.00XYZ	ABXX748139	$07E8	12345-xyz-879	ABCDEF123456728

Attachment G: HD OBD Diesel Monitoring Requirements Checklist

COMPONENT/SYSTEM	List the DTC or SPN-FMI of monitor that detects the following failure mode: MONITORING REQUIREMENTS:										
Fuel System Monitoring	(e)(1.2.1) Pressure Threshold	(e)(1.2.1) Pressure Functional	(e)(1.2.2) Quantity Threshold	(e)(1.2.2) Quantity Functional	(e)(1.2.3) Timing Threshold	(e)(1.2.3) Timing Functional	(e)(1.2.4)(A) Feedback: Time to CL	(e)(1.2.4)(B) Feedback: Default/OL	(e)(1.2.4)(C) Feedback: CL Limits		
Misfire	(e)(2.2.1) Continuous Misfire	(e)(2.2.2) Threshold Misfire									
EGR	(e)(3.2.1) Low Flow Threshold	(e)(3.2.1) Low Flow Functional	(e)(3.2.2) High Flow Threshold	(e)(3.2.2) High Flow Functional	(e)(3.2.3) Slow Response Threshold	(e)(3.2.3) Slow Response Functional	(e)(3.2.4)(A) Feedback: Time to CL	(e)(3.2.4)(B) Feedback: Default/OL	(e)(3.2.4)(C) Feedback: CL Limits	(e)(3.2.6) EGR Catalyst	
EGR Cooler	(e)(3.2.5) Cooler Threshold	(e)(3.2.5) Cooler Functional									
Boost Pressure	(e)(4.2.1) Underboost Threshold	(e)(4.2.1) Underboost Functional	(e)(4.2.2) Overboost Threshold	(e)(4.2.2) Overboost Functional	(e)(4.2.3) VGT/Boost Slow Response Threshold	(e)(4.2.3) VGT/Boost Slow Response Functional	(e)(4.2.5)(A) Feedback: Time to CL	(e)(4.2.5)(B) Feedback: Default/OL	(e)(4.2.5)(C) Feedback: CL Limits		
Charge Air Cooler	(e)(4.2.4) Charge Air Cooling Threshold	(e)(4.2.4) Charge Air Cooling Functional									
NMHC Catalyst	(e)(5.2.2) Conversion Efficiency Threshold	(e)(5.2.2) Conversion Efficiency Functional	(e)(5.2.2) Missing Substrate	(e)(5.2.3)(A) Aftertreatment Assistance DPF Regen	(e)(5.2.3)(B) Aftertreatment Assistance SCR Feedgas	(e)(5.2.3)(C) Aftertreatment Assistance After PM Filter	(e)(5.2.3)(D) Aftertreatment Assistance After SCR				
NOx Catalyst	(e)(6.2.1) Conversion Efficiency Threshold	(e)(6.2.1) Conversion Efficiency Functional	(e)(6.2.1) Missing Substrate	(e)(6.2.2)(A) Reductant Delivery Threshold	(e)(6.2.2)(A) Reductant Delivery Functional	(e)(6.2.2)(B) Reductant Empty Tank	(e)(6.2.2)(C) Proper Reductant	(e)(6.2.2)(D)(i) Feedback: Time to CL	(e)(6.2.2)(D)(ii) Feedback: Default/OL	(e)(6.2.2)(D)(iii) Feedback: CL Limits	
NOx Adsorber	(e)(7.2.1) NOx Threshold	(e)(7.2.1) NOx Functional	(e)(7.2.1) Missing Substrate	(e)(7.2.2) Failure to Achieve Desorption	(e)(7.2.3)(A) Feedback: Time to CL	(e)(7.2.3)(B) Feedback: Default/OL	(e)(7.2.3)(C) Feedback: CL limits				
PM Filter	(e)(8.2.1) Threshold	(e)(8.2.1) Functional	(e)(8.2.2) Regen Frequency: Threshold	(e)(8.2.2) Regen Frequency: Functional	(e)(8.2.3) Incomplete Regen	(e)(8.2.4) NMHC Conversion	(e)(8.2.5) Missing Substrate	(e)(8.2.6) Active Injection	(e)(8.2.7)(A) Feedback: Time to CL	(e)(8.2.7)(B) Feedback: Default/OL	(e)(8.2.7)(C) Feedback: CL Limits
Upstream Exhaust Gas Sensor Monitoring	(e)(9.2.1)(A)(i) Emission Threshold	(e)(9.2.1)(A)(ii) Circuit Faults	(e)(9.2.1)(A)(iii) Feedback: Default/OL	(e)(9.2.1)(A)(iv) Sufficient for Other Diagnostics	(e)(9.2.4)(A) Heater Performance	(e)(9.2.4)(B) Heater Circuit Continuity					
Downstream Exhaust Gas Sensor Monitoring	(e)(9.2.1)(B)(i) Emission Threshold	(e)(9.2.1)(B)(ii) Circuit Faults	(e)(9.2.1)(B)(iii) Feedback: Default/OL	(e)(9.2.1)(B)(iv) Sufficient for Other Diagnostics	(e)(9.2.4)(A) Heater Performance	(e)(9.2.4)(B) Heater Circuit Continuity					
NOx and/or PM Sensors	(e)(9.2.2)(A) Emissions Threshold	(e)(9.2.2)(B) Circuit Faults	(e)(9.2.2)(C) Feedback: Default/OL	(e)(9.2.2)(D) Sufficient for Other Diagnostics	(e)(9.2.4)(A) Heater Performance	(e)(9.2.4)(B) Heater Circuit Continuity					
Other Exhaust Gas Sensors	(e)(9.2.3) Per Approved Plan	(e)(9.2.4)(A) Heater Performance	(e)(9.2.4)(B) Heater Circuit Continuity								
VVT System	(e)(10.2.1) Target Error Threshold Monitor	(e)(10.2.2) Slow Response Threshold Monitor	(e)(10.2.3) Target Error or Slow Response Functional Monitor								
Cold Start Strategy	(e)(11.2.1) Single Element / Component Functional Check	(e)(11.2.2) System Threshold Monitor	(e)(11.2.3) Single Element / Component Threshold Monitor								
Engine Cooling System	(g)(1.2.1)(A) Time to Reach Threshold Temp	(g)(1.2.1)(B) Maintain Threshold Temp	(g)(1.2.2)(A) Out-of-range High	(g)(1.2.2)(A) Out-of-range Low	(g)(1.2.2)(A) Open Circuit	(g)(1.2.2)(B) Time to Reach Closed Loop	(g)(1.2.2)(C) Stuck Below Highest Minimum Enable Temp	(g)(1.2.2)(D) Stuck Above Lowest Maximum Enable Temp			
Crankcase Ventilation	(g)(2.2.2) Disconnection	(g)(2.2.7) Open CV Functional									

List the DTC or SPN-FMI of comprehensive component monitor used that detects the following failure mode:

Monitor/System	Out-of-range Low	Circuit-low	Out-of-range High	Circuit-high	Open Circuit	Rationality Low	Rationality High	Other Rationality	Functional		
[Insert name of Comprehensive Component #1] *(e.g., exhaust temp sensor #1, barometric pressure sensor, MAF sensor, etc.)*											
[Insert name of Comprehensive Component #n]											

Attachment H: HD OBD Gasoline Monitoring Requirements Checklist

COMPONENT/SYSTEM	List the DTC or SPN-FMI of monitor that detects the following failure mode: MONITORING REQUIREMENTS:									
Fuel System	(f)(1.2.1) FTP Emission Threshold (e.g., P0xxx)	(f)(1.2.2) Adaptive Limits Reached	(f)(1.2.3) Secondary Fuel Trim FTP Emission Threshold	(f)(1.2.4) Fails to Enter Closed Loop in Approved Time	(f)(1.2.5) Fails to Enter Closed Loop in Approved Time for Engines Shutoff at Idle					
Misfire	(f)(2.2.1) Catalyst Damage	(f)(2.2.2) Emission Threshold								
EGR	(f)(3.2.1) Low Flow Emission Threshold	(f)(3.2.1) No Flow	(f)(3.2.2) High Flow Emission Threshold	(f)(3.2.2) Control Limits Reached						
Cold Start Strategy	(f)(4.2) Threshold	(f)(4.2.) Functional								
Secondary Air	(f)(5.2.1) Insufficient Flow Threshold	(f)(5.2.2) Increased Flow Threshold	(f)(5.2.3) Flow Functional							
Catalyst	(f)(6.2.1) Conversion Efficiency	(f)(6.2.1)(B) NMHC Conversion Efficiency =< 50%								
Evaporative System	(f)(7.2.2)(A) No Purge Flow	(f)(7.2.2) (B) Leak Check								
Upstream Exhaust Gas Sensor Monitoring	(f)(8.2.1)(A) Emission Threshold	(f)(8.2.1)(B) Out-of-range High	(f)(8.2.1)(B) Out-of-range Low	(f)(8.2.1)(B) Open Circuit	(f)(8.2.1)(C) Feedback: Default OL	(f)(8.2.1)(D) Sufficient for Other Diagnostics	(f)(8.2.3)(A) Sensor heater performance	(f)(8.2.3)(B) Sensor heater circuit continuity		
Downstream Exhaust Gas Sensor Monitoring	(f)(8.2.2)(A) Emission Threshold	(f)(8.2.2)(B) Open Circuit	(f)(8.2.2)(C) Sufficient for Other Diagnostics	(f)(8.2.2)(D) Out-of-range High	(f)(8.2.2)(D) Out-of-range Low	(f)(8.2.2)(E) Feedback: Default OL	(f)(8.2.3)(A) Sensor heater performance	(f)(8.2.3)(B) Sensor heater circuit continuity		
VVT system	(f)(9.2.1) Target Error Threshold Monitor	(f)(9.2.2) Slow Response Threshold Monitor	(f)(9.2.3) Functional Response Failure							
Engine Cooling System	(g)(1.2.1)(A) Time to Reach Threshold Temp	(g)(1.2.1)(B) Maintain Threshold Temp	(g)(1.2.2)(A) Out-of-range High	(g)(1.2.2)(A) Out-of-range Low	(g)(1.2.2)(A) Open Circuit	(g)(1.2.2)(B) Time to Reach Closed Loop	(g)(1.2.2)(C) Stuck Below Highest Minimum Enable Temp	(g)(1.2.2)(D) Stuck Above Lowest Maximum Enable Temp		
Crankcase Ventilation	(g)(2.2.2) Disconnection									

List the DTC or the SPN-FMI of comprehensive component monitor used that detects the following failure mode:

Monitor/System	Out-of-range High	Out-of-range Low	Open Circuit	Rationality Low	Rationality High	Other Rationality	Functional			
[Insert name of Comprehensive Component #1] *(e.g., barometric pressure sensor, MAF sensor, etc.)*										
[Insert name of Comprehensive Component #n]										
[Insert name of Comprehensive Component #n]										
[Insert name of Comprehensive Component #n]										
[Insert name of Comprehensive Component #n]										
[Insert name of Comprehensive Component #n]										
[Insert name of Comprehensive Component #n]										