Attachment 3 - BPU Catalyst Aging – Alliance for Automotive Innovation

BPU Correlation Regulation

June 10, 2021

Attachment 3 - BPU Catalyst Aging – Alliance for Automotive Innovation

NMHC Converting Catalyst – Aging and Monitoring

B) For 2025 and subsequent model year vehicles from test groups selected for monitoring system demonstration in section (h):

(i) In addition to the information described above in section (f)(1.2.4)(A), the catalyst system aging and monitoring plan described above in section (f)(1.2.4)(A) shall also include the timeline for submitting the information and data described under section (f)(1.2.4)(B)(ii) below. The timeline may include several dates for data submission for new emission control system designs where the manufacturer has not achieved sufficient in-use aging to demonstrate real world deterioration prior to certification of the OBD II system.

(ii) Information and data to support methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions in sections (f)(1.2.4)(A) must be submitted to the Executive Officer and shall at a minimum include an analysis of the potential failure modes and effects, highlighting the most likely cause of failure, comparison of laboratory aged versus real world aged catalysts, and include the following for a laboratory-aged catalyst and a minimum of three field returned catalysts (data for all field-returned catalysts that are collected for this aging correlation analysis must be submitted to the Executive Officer):

a. Emissions data and all data required by sections (g)(4.1) through (g)(4.9), (g)(5), and (g)(6) from the FTP, HWFET, and US06 cycles,

b. Modal data during the FTP, HWFET, and US06 cycles,

c. Catalyst conversion efficiency as a function of catalyst temperature and exhaust gas flow rate,

d. Catalyst feedgas generation as a function of catalyst temperature, and

e. All data required by sections (g)(4.1) through (g)(4.9), (g)(5), and (g)(6) from all catalysts collected from a wide range of monitoring conditions.

Agree with content

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(iii) The Executive Officer shall approve the catalyst aging method upon finding the data passes each of the following "pass" criteria below. If the manufacturer is not able to locate at least one catalyst to be evaluated under pass criteria 1 through 3 below, the manufacturer may propose to include an additional catalyst described in another pass criterion (e.g., if a catalyst described in pass criterion 2 cannot be located, the manufacturer may use an additional catalyst described in either pass criterion 1 or 3 instead) as representative of the missing catalyst.

a. Pass criterion 1: High mileage or field-returned parts with FTP emission results from section (f)(1.2.4)(B)(ii)a. that are l… by less than 2 sigma below the catalyst monitor malfunction threshold) are passing the NMHC catalyst conversion efficiency mo… ed with an NMHC catalyst monitor deficiency for not detecting a malfunction before emissions exceed the malfunction cri… …ion was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds specified in the regulation.

Criterion #1: High mileage parts pass emissions w/o MIL illumination

b. Pass criterion 2: Field-returned parts that have a conversion efficiency averaged over the FTP test that is representative of the manufacturer's durability demonstration part (i.e., parts degraded within 2 sigma of the catalyst monitor malfunction threshold) meet the following: 1) the NMHC catalyst conver… the MIL during the applicable cycle (i.e., the FTP cycle, Unified cycle, or alternate monitoring conditions approved under section (d… and 2) the data and analysis show robust detection of NMHC catalyst conversion efficiency malfunctions during conditi… le, or alternate monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This t… is certified with an NMHC catalyst monitor deficiency for not detecting a malfunction before emissions exceed th… …nction was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds spec…

Criterion #2: Field returned parts have a conv eff similar to BPU, emissions are below the OBD limit, and MIL is illuminated

c. Pass criterion 3: Field-returned parts that have a conversion efficiency averaged over the FTP test that is worse than the best performing unacceptable conversion efficiency (i.e., degraded by more than 2 sigma from the catalyst monitor malfunction threshold) or have catastrophically failed meet the following: 1) the NMHC catalyst conversion efficiency monitor illuminates the MIL during the applicable cycle (i.e., the FTP cycle, Unified cycle, or alternate monitoring conditions approved under … and 2) the data and analysis show robust detection of NMHC catalyst conversion efficiency malfunctions during conditions meeting the applicable cy… te monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This testing can be done on r… an NMHC catalyst monitor deficiency for not detecting a malfunction before emissions exceed the malfunction criteria, the… deficient durability demonstration part for section (h)(4) testing will be used for this assessment.

Criterion #3: Field returned parts have conv eff worse than BPU, MIL is illuminated, and there is robust detection

Agree with content

NMHC Converting Catalyst – Aging and Monitoring

(C) The Executive Officer may waive the requirements for the submittal of the plan and data under sections (f)(1.2.4)(A) and (B) above for a test group if the plan and data have been submitted for a previous model year and the calibrations and hardware of the NMHC catalyst monitor, the engine, and the emission control system for the current model year have not changed from the previous model year.

- It is unlikely that all calibrations and hardware will remain unchanged from model year to model year.
- Calibration changes are unlikely to affect catalyst aging mechanisms in the field.
- Most hardware changes are unlikely to result in different catalyst aging in the field, unless there is a major technology change.
- This language dis-incentivizes continuous improvement/warranty reduction efforts due to the extensive cost of conducting a correlation effort.
- Counter Proposal: “and the calibrations and hardware of the NMHC catalyst monitor, the engine, and the emission control system for the current model year have not changed substantially in strategy or architecture from the previous model year.”

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NOx Converting Catalyst – Aging and Monitoring

(B) For 2025 and subsequent model year vehicles from test groups selected for monitoring system demonstration in section (h):

(i) In addition to the information described above in section (f)(2.2.4)(A), the catalyst system aging and monitoring plan described above in section (f)(2.2.4)(A) shall also include the timeline for submitting the information and data described under section (f)(2.2.4)(B)(ii) below. The timeline may include several dates for data submission for new emission control system designs where the manufacturer has not achieved sufficient in-use aging to demonstrate real world deterioration prior to certification of the OBD II system.

(ii) Information and data to support methods established by the manufacturer to represent real world catalyst deterioration under normal and malfunctioning engine operating conditions in section (f)(2.2.4)(A) must be submitted to the Executive Officer and shall at a minimum include an analysis of the potential failure modes and effects, highlighting the most likely cause of failure, comparison of laboratory aged versus real world aged catalysts, and include the following for a laboratory-aged catalyst and a minimum of three field-returned catalysts (data for all field-returned catalysts that are collected for this aging correlation analysis must be submitted to the Executive Officer):

a. Emissions data and all data required by sections (g)(4.1) through (g)(4.9), (g)(5), and (g)(6) from the FTP, HWFET, and US06 cycles,

b. Modal data during the FTP, HWFET, and US06 cycles,

c. Catalyst NOx conversion efficiency as a function of catalyst temperature and exhaust gas flow rate,

d. Catalyst NOx conversion efficiency as a function of catalyst temperature and NO2 to nitric oxide (NO) ratio,

e. Catalyst NOx conversion efficiency as a function of ammonia storage (relative to the maximum ammonia storage capacity of a new catalyst), and

f. All data required by sections (g)(4.1) through (g)(4.9), (g)(5), and (g)(6) from all catalysts collected from a wide range of monitoring conditions.

Agree with content

Attachment 3 - BPU Catalyst Aging – Alliance for Automotive Innovation

NOx Converting Catalyst – Aging and Monitoring

(iii) The Executive Officer shall approve the catalyst aging method upon finding the data passes each of the following "pass" criteria below. If the manufacturer is not able to locate at least one catalyst to be evaluated under pass criteria 1 through 3 below, the manufacturer may propose to include an additional catalyst described in another pass criterion (e.g., if a catalyst described in pass criterion 2 cannot be located, the manufacturer may use an additional catalyst described in either pass criterion 1 or 3 instead) as representative of the missing catalyst.

a. Pass criterion 1: High mileage or field-returned parts with FTP emission results from section (f)(2.2.4)(B)(ii)b. that are l… …ded by less than 2 sigma below the catalyst monitor malfunction threshold) are passing the NOx catalyst conversion efficienc… certified with a NOx catalyst monitor deficiency for not detecting a malfunction before emissions exceed the malfunct… …unction was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds specified in the regulation.

Criterion #1: High mileage parts pass emissions w/o MIL illumination

b. Pass criterion 2: Field-returned parts that have a conversion efficiency averaged over the FTP test that is representative of the manufacturer's durability demonstration part (i.e., parts degraded within 2 sigma of the catalyst monitor malfunction threshold) meet the following: 1) the NOx catalyst conversi… …the MIL during the applicable cycle (i.e., the FTP cycle, Unified cycle, or alternate monitoring conditions approved under section (d)(3.1.… …d 2) the data and analysis show robust detection of NOx catalyst conversion efficiency malfunctions during conditions m… alternate monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This tes… certified with a NOx catalyst monitor deficiency for not detecting a malfunction before emissions exceed the m… …on was detected when the OBD system was approved by the Executive Officer will be used in place of the OBD thresholds specified…

Criterion #2: Field returned parts have a conv eff similar to BPU, emissions are below the OBD limit, and MIL is illuminated

c. Pass criterion 3: Field-returned parts that have a conversion efficiency averaged over the FTP test that is worse than the best performing unacceptable conversion efficiency (i.e., degraded by more than 2 sigma from the catalyst monitor malfunction threshold) or have catastrophically failed meet the following: 1) the NOx catalyst conversion efficiency monitor illuminates the MIL during the applicable cycle (i.e., the FTP cycle, Unified cycle, or alternate monitoring conditions approved under… …2) the data and analysis show robust detection or NOx catalyst conversion efficiency malfunctions during conditions meeting the applicable cycle… monitoring conditions approved under section (d)(3.1.3)) and all other monitoring conditions. This testing can be done on r… certified with a NOx catalyst monitor deficiency for not detecting a malfunction before emissions exceed the malfunction … manufacturer's deficient durability demonstration part for section (h)(4) testing will be used for this assessment.

Criterion #3: Field returned parts have conv eff worse than BPU, MIL is illuminated, and there is robust detection

Agree with content

NOx Converting Catalyst – Aging and Monitoring

(C) The Executive Officer may waive the requirements for the submittal of the plan and data under sections (f)(2.2.4)(A) and (B) above for a test group if the plan and data have been submitted for a previous model year and the calibrations and hardware of the NOx catalyst monitor, the engine, and the emission control system for the current model year have not changed from the previous model year.

- It is unlikely that all calibrations and hardware will remain unchanged from model year to model year.
- Calibration changes are unlikely to affect catalyst aging mechanisms in the field.
- Most hardware changes are unlikely to result in different catalyst aging in the field, unless there is a major technology change.
- This language dis-incentivizes continuous improvement/warranty reduction efforts due to the extensive cost of conducting a correlation effort.
- Counter Proposal: “calibrations and hardware of the NOx catalyst monitor, the engine, and the emission control system for the current model year have not changed substantially in strategy or architecture from the previous model year.”

Questions?