The reasons for the proposed USCAR modifications:
1) NOx sensor/s are not ready (especially, SCR downstream NOx sensor) by the time catalyst light-off temperature is achieved. For this reason, the only way to determine NOx conversion efficiency and therefore 50% catalyst light-off temperature is to use FTIR analyzers, i.e. during FTP;
2) To accommodate potential future AT architecture with engine close coupled SCR AT element in exhaust, USCAR proposes to replace "post-DOC" heat energy with "pre-SCR" heat energy term.
Note: for dual SCR applications, only first SCR catalyst is considered.

USCAR proposed modifications that also specified below are the following:
1) Define SCR light-off temperature using emission analyzers on FTP cycle only.
2) "Catalyst light-off time" is based on FTP cycle per 1) above.
3) "Engine output energy" is based on FTP cycle per 1) above.
4) FUL AT/vehicle is used for the above data collection.
All three tracker stop triggers above are constant values per diesel application and will be used for each of four categories:
- Heat energy release
- Engine output energy
- EGR mass flow
- Timer
5) Specifying "the MIL is commanded on" in subsection (6.14.3) for pause tracking eliminates pausing for a pending malfunction detection, therefore that language is proposed to delete.
6) For 1968.2 use "FTP75" and for 1971.1 "HD FTP" instead of "FTP" cycles.

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(6.14) Cold Start Emission Reduction Strategy Tracking Requirements
(6.14.1) For purposes of section (g)(6.14), the following terms shall be defined as follows:
(A) "Catalyst light-off temperature" is defined as the SCR catalyst inlet temperature at which the substantially warmed SCR catalyst NOx conversion efficiency reaches 50 percent~~;~~ first time measured by FTIR analyzers on an FTP75 cycle;
(B) "FTP catalyst light-off time" is defined as the time from engine start until the SCR catalyst inlet temperature reaches the light-off temperature on an FTP cycle;
(C) "Engine output energy", in units of Joules (J) or Watts (W)*s, is defined by integrating brake engine power output over time, with:
"Brake engine power output" = 2π x (brake engine torque) x (engine RPM)/60 in units of W, and
"Brake engine torque" = (engine reference torque) x [(indicated torque) – (friction torque)].

Commented [IA1]: FTP75 for 1968.2 and HD FTP for 1971.1 are proposed.

(D) "Specified FTP engine output energy" is defined as the accumulated engine output energy measured from engine start until the SCR catalyst inlet temperature reaches the light-off temperature on an FTP cycle.

(E) "~~Post-diesel oxidation catalyst (DOC)~~ Pre-selective catalytic reduction (SCR) catalyst heat energy" is defined as the heat energy flow ~~through the DOC~~ prior to the SCR over time, with:

"Heat energy flow ~~through the DOC~~prior the SCR" = (heat capacity of exhaust gas (C_p)] x (exhaust mass flow ($m_{exhaust}$)) x (temperature difference between ~~DOC outlet~~SCR inlet and ambient) /1000.

(6.14.2) For 20 percent of 2026, 50 percent of 2027, and 100 percent of 2028 and subsequent model year vehicles equipped with diesel engines, manufacturers shall implement software algorithms to individually track and report in a standardized format the following parameters. During driving cycles where the CSERS cold start criteria (as defined in section (c)) are met at engine start, each parameter shall start accumulating/incrementing from engine start until the conditions described below for each parameter are met:

(A) Heat energy release tracker #1 (kiloJoules (kJ)): accumulate ~~post- DOC~~ pre-SCR heat energy (in units of kJ) until the FTP catalyst light-off time, as defined in (g)(6.14.1)(B) above, is achieved.

(B) Heat energy release tracker #2 (kJ): accumulate ~~post-DOC~~ pre-SCR heat energy until the specified FTP engine output energy, as defined in (g)(6.14.1)(D) above, is achieved.

(C) Heat energy release tracker #3 (kJ): accumulate ~~post-DOC~~ pre-SCR heat energy until the ~~on-road~~FTP catalyst light-off temperature, as defined in (g)(6.14.1)(A) above, is achieved.

(D) Engine output energy tracker #1 (kJ): accumulate engine output energy until the FTP catalyst light-off time, as defined in (g)(6.14.1)(B) above, is achieved.

(E) Engine output energy tracker # 2 (kJ): accumulate engine output energy until the ~~on-road~~FTP catalyst light-off temperature, as defined in (g)(6.14.1)(A) above, is achieved.

(F) EGR mass flow tracker # 1 (kilograms (kg)): accumulate EGR mass flow until the FTP catalyst light-off time, as defined in (g)(6.14.1)(B) above, is achieved.

(G) EGR mass flow tracker # 2 (kg): accumulate EGR mass flow until the specified FTP engine output energy, as defined in (g)(6.14.1)(D) above, is achieved.

(H) EGR mass flow tracker # 3 (kg): accumulate EGR mass flow until the ~~on-road~~FTP catalyst light-off temperature, as defined in (g)(6.14.1)(A) above, is achieved.

(I) Engine energy output timer (seconds): increment time until the specified FTP engine output energy, as defined in (g)(6.14.1)(D) above, is achieved.

(J) Catalyst Light-Off Timer (seconds): increment time until the FTP catalyst light-off temperature, as defined in (g)(6.14.1)(A) above, is achieved.

(6.14.3) The OBD II system shall pause tracking of all parameters listed in section (g)(6.14.2) above within 10 seconds if a malfunction of a component used as an input to any of the parameters or a CSERS malfunction described in section (f)(12.2.2) or (f)(12.2.3) has been detected ~~and the MIL is commanded on~~ for that malfunction. When the malfunction is no longer detected and the MIL is no longer commanded on, tracking of all parameters in section (g)(6.14.2) shall resume within 10 seconds.

(6.14.4) The parameters in section (g)(6.14.2) shall be stored in the two data types described below.

(A) Current driving cycle data

(B) Historical data, using an exponentially weighted moving average (EWMA) equation with lambda (λ) = 0.2 for calculation of the historical data, with the EWMA equation as follows:

EWMA(t) = (1-λ)*EWMA(t-1) + λ*Y(t) (for t = 1, 2, ..., n), where

EWMA(t) is the weighted mean of historical data (the current

Commented [JP2]: Each reference is to provide clarity.

Commented [JP3]: Specifying "the MIL is commanded on" eliminates pausing for a pending malfunction detection

weighted moving average),
EWMA(t-1) is the weighted mean of historical data calculated one event prior to time t,
Y(t) is the observation at time t,
n is the number of measurements, and
λ is a constant that determines the degree of weighting/filtering for the EWMA calculation.

(6.14.5) For the phase-in schedule described in section (g)(6.14.2) above, the manufacturer may use an alternate phase-in schedule in lieu of the required phase-in schedule if the alternate phase-in schedule provides for equivalent compliance volume as defined in section (c) with the exception that 100 percent of 2028 and subsequent model year vehicles

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shall comply with the requirements.

(6.14.6) For 2023 through 2025 model year vehicles, the manufacturer may meet the requirements in sections (g)(6.14.1) through (6.14.4).

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