NO_X Control Diagnostic / Particulate Control Diagnostic

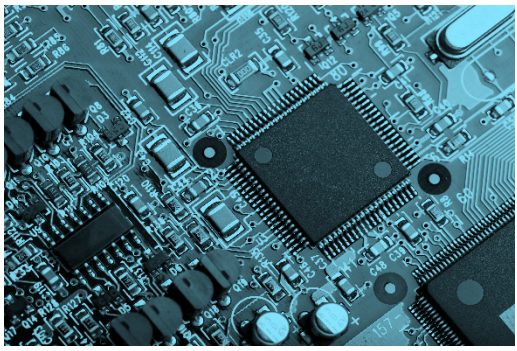
FAQ

Frequently Asked Questions

- Regulation (EU) 2016/1628 of the European Parliament and of the Council
- Commission Delegated Regulation (EU) 2017/654
- Commission Delegated Regulation (EU) 2017/656
- UN Regulation No. 96 - Revision 3 - Amendment 2 - 05 series of amendments

August 2020





EUROMOT
The European Association of Internal Combustion Engine Manufacturers

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INTRODUCTION

Engines in scope of Regulation (EU) 2016/1628 and corresponding UNECE Regulation R96.05 series of amendments are typically subject to diagnostic requirements to ensure proper functioning of NO_X and particulate control measures and shall be designed, constructed and installed so as to be capable of meeting these requirements throughout the normal life of the engine under normal conditions of use. The purpose of this FAQ is to set out the understanding of these requirements.

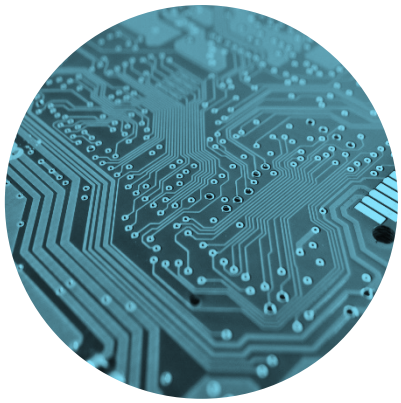
Throughout this text, “manufacturer” means “engine manufacturer” and “OEM” means “machine manufacturer”.

The manufacturer is responsible for complying with the provisions for NCD, and where applicable, for PCD. However, a number of the requirements affect the design of the machine and can only be implemented by the OEM. Where this is the case the manufacturer has met his obligations by providing clear instruction to the OEM, detailing technical requirements to apply to the machine needed for the correct installation of the engine in the non-road mobile machinery.

1 GENERAL REQUIREMENTS

1.1 NO_X Control Diagnostic / Particulate Control Diagnostic families

1.1.1. What parameters define each NCD or PCD engine family?



An NCD or PCD engine family is characterized by basic design parameters for monitoring the NCD or PCD system that shall be common to engines within the family. This applies in particular to the functional principle of the NO_x or particulate control systems, the methods and enabling criteria for NCD or PCD monitoring including the diagnostic frequency.

The similarities have to be demonstrated by the manufacturer and approved by the type-approval authority.

Engines that do not belong to the same engine family may still belong to the same NCD or PCD engine family. An engine family may include engines belonging to more than one NCD or PCD family. It is not required that the NCD family structure is the same as the PCD family structure.

References:

- **Regulation (EU) 2017/654, Annex IV, 1.1 (3), (8) / UNECE R96.05, Annex 9, 1.1 (c), (h)**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.4.6. / UNECE R96.05, Annex 9, A.1.2.4.6.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.2. / UNECE R96.05, Annex 9, A.1.10.2.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.2.3, Fig. 4.3 / UNECE R96.05, Annex 9, A.1.10.2.3., Fig. A.9-3**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 2.3.6. / UNECE R96.05, Annex 9, A.2.2.3.6.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 9.2.1., Fig. 4.8 / UNECE R96.05, Annex 9, A.2.9.2., Fig. A.9-8**

1.1.2. Is the time to activate inducements a family parameter (e.g. engine types with severe inducement activation of 12 and 15 hours after reagent dosing interruption)?

The number of hours before an inducement is imposed must be equal or less than the regulatory specified time period (e.g. 20 hours for severe inducement for dosing activity error). Engine types with similar activation periods may be combined to a NCD family.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.4.6.1., 7.3.1., 7.3.2., 8.4.1., 8.4.2., 9.4.1., 9.4.2., 11.4.2.1.3., Table 4.4 / UNECE R96.05, Annex 9, A.1.2.4.6.1., A.1.7.3.1., A.1.7.3.2, A.1.8.4.1., A.1.8.4.2., A.1.9.4.1., A.1.9.4.2., A.1.11.4.2.1.3., Table A.9-4**

1.1.3. Can an engine used for type approval of a NCD family already be certified with a different Type Approval Authority?

Engines that do not belong to the same engine family may still belong to the same NCD engine family. Retesting of the NO_x Control Diagnostic is not required if the engine belongs to a NCD family that has already been type-approved. Nevertheless, the manufacturer has to demonstrate (with algorithms, functional analysis, etc.) that the engines can be included in the same NCD family.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.4.6., 10.2.1., 10.2.3. / UNECE R96.05, Annex 9, A.1.2.4.6., A.1.10.2.1., A.1.10.2.3.**

1.2 Diagnostic Trouble Codes (DTC)

1.2.1. What definitions apply to this section?

The following definitions apply to this section:

Diagnostic Trouble Code ("DTC"): A numeric or alphanumeric identifier which identifies or labels a NO_x Control Malfunction (NCM) and/or Particulate Control Malfunction (PCM).

Scan or maintenance tool: External test equipment used for off-board communication with the NCD and/or PCD system that can view a message or DTC made available by the system, and which, where permitted, using a pass code provided by the manufacturer, can erase that DTC or reset associated counter.

Pass code: A code provided by the engine manufacturer to enable, where permitted, a DTC to be erased or associated counter to be reset, either directly or via a scan or maintenance tool.

Proprietary scan or maintenance tool: A scan or maintenance tool provided by the manufacturer upon request, that may directly erase a DTC or reset associated counter without need for a pass code.

Erasable: DTC can be cleared; The "erase" command should not reset any parameters therefore if the condition for its existence still exists the DTC should re-appear once the diagnostic monitors complete their next checks. It may not erase any mandated log of the DTC in a computer memory or counter.

Self-healing: A process by which a DTC may be cleared by virtue of the reason(s) for its existence having been remedied. Any computer memory or counter associated with the DTC must, where applicable, remain frozen at the required value for the required time after self-healing. It may not erase any mandated log of the DTC in a computer memory or counter.

Resettable: Counters associated with a DTC may be reset to original state prior to occurrence. It may not erase any mandated log of the DTC in a computer memory or counter.

References:

- **Regulation (EU) 2017/654, Annex IV, 1.1. (1), (9) / UNECE R96.05, Annex 9, 1.1. (a), (i)**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.4., 11.2.2.1. / UNECE R96.05, Annex 9, A.1.2.4., A.1.11.2.2.1.**

1.2.2. What are the requirements for erasing diagnostic trouble codes?

Diagnostic Trouble Codes (DTC) must not be automatically erased by the NCD or PCD system until the failure related to that DTC has been remedied.

If a malfunction of the NO_x Control System has been corrected (e.g. by replenishing adequate reagent), the diagnostic system detects that system integrity has been restored. As a consequence of this self-healing diagnostic, the related DTC are cleared.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.4.3. / UNECE R96.05, Annex 9, A.1.2.4.3.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 2.3.3. / UNECE R96.05, Annex 9, A.2.2.3.3.**

1.2.3. Are there any additional options for erasing diagnostic trouble codes?

Any DTC associated with a NO_x control or particulate control malfunction may optionally be erased upon request of a proprietary scan or maintenance tool or by using a pass code provided by the engine manufacturer.

It is explicitly stated that for NCD DTCs, erasure should only be possible under “engine-off” conditions and should not occur due to disconnection of battery. The Regulation does not include a similar limitation on erasing PCD DTCs.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.4.3., 11.2.2.1. / UNECE R96.05, Annex 9, A.1.2.4.3., A.1.11.2.2.1.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 2.3.3. / UNECE R96.05, Annex 9, A.2.2.3.3.**

1.2.4. The EU regulation defines requirements for erasing 'NO_x control information' by a scan-tool. Which are the values specified for the reset and where are those values specified?

On request of the scan tool, the following data may be erased or reset to any value including zero.

Erasing / resetting 'NO_x control information' by a scan-tool

NO_x control information	Erasable	Resetable
All DTCs	X	
The value of the counter with the highest number of engine operating hours		X
The number of engine operating hours from the NCD counter(s)		X

DTC's related to the particulate control diagnostic system (PCD) may be erased accordingly (see question 1.2.3.).

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.4.3., 11.2.2.1.1., Table 4.3, 11.3.2. / UNECE R96.05, Annex 9, A.1.2.4.3., A.1.11.2.2.1.1., Table A.9-3, A.1.11.3.2. and questions 1.2.3. and 2.2.9.**

1.3 Warning System

1.3.1. What are the requirements for the visual alarms indicating a malfunction of the NO_x control or particulate control system?

The non-road mobile machinery must include an operator warning system that can communicate visual NCD and PCD warnings to the end user. This may comprise one or more lamps or displays. Annex IV to Regulation (EU) 2017/654 optionally permits the same warning system to be used for displaying warnings associated with NCD, PCD and other malfunctions or maintenance. Consequently, it is not required, but nor is it prohibited, to have separate lamps or displays for communicating NCD or PCD warnings to the operator.

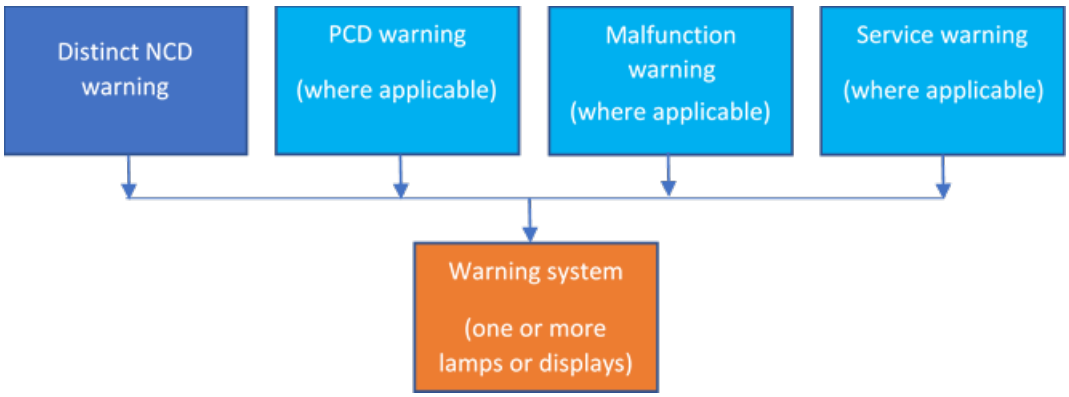
For NCD the Regulation stipulates that whilst the warning system can be the same as that used for other purposes, the warning provided to the operator (i.e. the way in which the lamp(s) are illuminated, or the message displayed) must be distinct from that used for warning of a malfunction, or of the need for engine maintenance. If the NCD warning cannot be distinguished from other warnings, then a separate lamp may be required. An NCD warning

may be temporarily interrupted by other warnings providing important safety related messages.

The Regulation does not contain any corresponding provision that requires the PCD warning provided to the operator to be distinct from other warnings, nor identify the conditions under which the PCD warning may be temporarily interrupted.

Where the warning system is required to communicate an NCD system failure, an EGR valve failure, or PCD failure, the activation of the operator warning system must communicate to the operator that an urgent repair is required.

Where a message display system is used, when reagent level is low a corresponding message must be displayed (e.g. 'fill up reagent'). For other NCD or PCD warnings a specific message may be used (e.g. 'reagent dosing valve disconnected'), or a more general message (e.g. 'critical emission failure') is permitted.



References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 4. / UNECE R96.05, Annex 9, A.1.4.,**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 6.2 7.2., 8.3., 9.3., 11.2. / UNECE R96.05, Annex 9, A.1.6.2., A.1.7.2, A.1.8.3., A.1.9.3., A.1.11.2.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 3, 3.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 4. / UNECE R96.05, Annex 9, A.2.4.**

1.4 Type Approval and Demonstration

1.4.1. Does the NCD or PCD demonstration have to be executed on the parent engine of the family?

The regulation does not require to use the parent engine for NCD or PCD demonstration purposes (since an NCD or PCD engine family may comprise one or more engine families). A suitable and representative engine of the NCD or PCD family shall be used in agreement with the type-approval authority.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.2.2., 10.2.3. (Figure 4.3) / UNECE R96.05, Annex 9, A.1.10.2.2., A.1.10.2.3. (Fig. A.9-3)**

1.4.2. How is the NCD and PCD test cycle defined?

Demonstration test cycles for NCD or PCD are the hot-start NRTC for engines of sub-category NRE-v-3, NRE-v-4, NRE-v-5 NRE-v-6 and the applicable NRSC for all other categories. On request of the manufacturer and with approval of the type-approval authority, an alternative test-cycle (e.g. other than the NRTC or the NRSC) can be used for a specific monitor.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.3.3.7. / UNECE R96.05, Annex 9, A.1.10.3.3.7.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 9.3.3.6. / UNECE R96.05, Annex 9, A.2.9.3.3.6.**

1.4.3. Is it mandatory to include a hot-soak between each hot-start NRTC used for demonstration of alarm or inducement?

No, because it is optional whether the engine is shut down between cycles used for demonstration of alarm or inducement. See also question 1.4.4. and question 2.4.3.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.3.3.5.1., Appendix 4, 9.3.3.5.1. / UNECE R96.05, Annex 9, A.1.10.3.3.5.1., A.2.9.3.3.5.1.**

1.4.4. Is it allowed/required to shut-off the engine between the NCD/PCD test cycles used to demonstrate NCD or PCD malfunctions?

At the choice of the manufacturer, each individual NCD/PCD test cycle in the demonstration test may be separated by an engine shut-off, though this is not required. The time until the next start-up shall consider any monitoring that may occur after engine shut-off and any necessary monitoring condition at the next start up. See also question 1.4.3.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.3.3.5.1. / UNECE R96.05, Annex 9, A.1.10.3.3.5.1.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 9.3.3.5.1. / UNECE R96.05, Annex 9, 1 A.2.9.3.3.5.1.**

1.4.5. Is it necessary to use physical hardware from an NRMM to demonstrate activation of an alarm or an inducement?

No, at the request of the manufacturer, and with the agreement of the approval authority, any components or sub-systems that are typically not physically mounted on the engine including the NRMM sensors, operator warning, and information systems may be simulated.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.4.1.1. / UNECE R96.05, Annex 9, A.1.10.4.1.1.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 9.3.3.7.2. / UNECE R96.05, Annex 9, A.2.9.3.3.7.2.**

1.4.6. How would failures be simulated for demonstration?

At the request of the manufacturer, and with the agreement of the approval authority, the failures subject to testing may be simulated. This includes removal or adjustment of any sensors or actuators either physically or electronically.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.3.3.4., 10.4.1.1. / UNECE R96.05, Annex 9, A.1.10.3.3.4., A.1.10.4.1.1.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 9.3.3.4. / UNECE R96.05, Annex 9, A.2.9.3.3.4.**

1.4.7. What method could be used to accelerate tests?

For the purpose of accelerated testing, the manufacturer is entitled to simulate continuous running by adjusting the relevant diagnostic counters.

In the case of accelerating the consumption of reagent that reagent may also be extracted from the tank.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.4.3., 10.4.5.2.1., 10.4.6.2.1. / UNECE R96.05, Annex 9, A.1.10.4.3., A.1.10.4.5.2.1., A.1.10.4.6.2.1.**

1.4.8. What failures need to be demonstrated?

The compliance to the NCD requirements is demonstrated during EU type-approval by performing:

(a) a demonstration of the warning system activation;

(b) a demonstration of the low level inducement system activation, if applicable;

(c) a demonstration of the severe inducement system activation.

Illustration of the content of the demonstration process in accordance with the provisions in Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.3 and 10.4 / UNECE R96.05, Annex 9, A.1.10.3. and A.1.10.4.

Mechanism	Demonstration elements
Warning system activation specified in Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.3 / UNECE R96.05, Annex 9, A.1.10.3.	– 2 activation tests (incl. lack of reagent) – Supplementary demonstration elements, as appropriate
Low-level inducement activation specified in Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.4. / UNECE R96.05, Annex 9, A.1.10.4.	– 2 activation tests (incl. lack of reagent) – Supplementary demonstration elements, as appropriate – 1 torque reduction test

Mechanism	Demonstration elements
Severe inducement activation specified in Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.4. / UNECE R96.05, Annex 9, A.1.10.4.	– 2 activation tests (incl. lack of reagent) – Supplementary demonstration elements, as appropriate

The compliance to the PCD requirements is demonstrated during EU type-approval by performing a demonstration of the warning system activation.

Illustration of the content of the demonstration process in accordance with the provisions in Regulation (EU) 2017/654, Annex IV, Appendix 4, 9.3. / UNECE R96.05, Annex 9, A.2.9.3.

Mechanism	Demonstration elements
Warning system activation specified in Regulation (EU) 2017/654, Annex IV, Appendix 4, 4.4 / UNECE R96.05, Annex 9, A.2.4.4.	– 2 activation tests (incl. loss of the particulate after- treatment system function) – Supplementary demonstration elements, as appropriate

It should not be required to demonstrate anything further beyond the three points set out at the start of this question for the NCD and, if applicable, the warning demonstration for the PCD. Once a demonstration has been completed, this may be used as evidence of compliance for all engine families that are included in the NCD or PCD family.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.1., 10.2., Table 4.1, 10.3., 10.4. / UNECE R96.05, Annex 9, A.1.10.1., A.1.10.2.3., Table A.9-1., A.1.10.3., A.1.10.4.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 9.1., Table 4.6, 9.3. / UNECE R96.05, Annex 9, A.2.9.1., Table A.9-6., A.2.9.3.**

1.5 Documentation

1.5.1. What NCD and PCD documentation requirements apply for type-approval?

As part of the type-approval process, the engine manufacturer must document the NO_x Control (NCD) and Particulate Control Diagnostic (PCD) systems and include this in the information folder that forms part of that type-approval. This includes:

- A description of the functional operating characteristics of the NO_x control measures
- A report on the demonstration of the NCD and PCD systems, including the examined failures and description of the demonstration procedure. Conclusively, the activation of the applicable warnings and inducements need to be confirmed. The NCD report includes demonstration of CD_{min}.
- Justification for the membership of an engine type or family in a particular NCD or PCD family

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.5., 13.4./ UNECE R96.05, Annex 9, A.1.10.5., A.1.13.4.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 9.3.6. / UNECE R96.05, Annex 9, A.2.9.3.6.**
- **Regulation (EU) 2017/656, Annex I, 1.5, 1.6. / UNECE R96.05, Annex 1, 1.5., 1.6.**

1.5.2. What installation documents need to be provided to the OEM?

The engine manufacturer has to provide information and instructions to the OEM, including where applicable:

- design requirements for the reagent tank, including freeze protection, monitoring of reagent level and means to take samples of reagent;
- information on the possible installation of a non-heated reagent system;
- a statement indicating that the OEM shall provide a warning system as set out in Appendices 1 to 4 of Annex IV;
- information on the interface between the engine and the non-road mobile machinery for the operator warning system;
- information on the interface between the engine and the non-road mobile machinery for the operator inducement system, as set out in section 5 of Appendix 1 of Annex IV;
- information on a means to temporarily disable the operator inducement as defined in point 5.2.1 of Appendix 1 of Annex IV;
- information on the inducement override function as defined in point 5.5 of Appendix 1 of Annex IV.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.1.3. / UNECE R96.05, Annex 9, A.1.2.1.3.**
- **Regulation (EU) 2017/654, Annex XIV, 4. (6), (7), (9), (10), (11), (12), (13) / UNECE R96.05, A.5.4.6., A.5.4.7., A.5.4.9., A.5.4.10., A.5.4.11., A.5.4.12., A.5.4.13.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2, 3, 4**

2 NO_X CONTROL DIAGNOSTIC (NCD)

2.1 General

2.1.1. Which engines are subject to NO_x control measures?

NO_x control measures apply for electronically controlled engines of categories NRE, NRG, IWP, IWA, RLL and RLR, complying with 'Stage V' emission and using electronic control to determine both the quantity and timing of injecting fuel or using electronic control to activate, de-activate or modulate the emission control system used to reduce NO_x. The latter includes electronically controlled EGR systems, even if no SCR system is fitted.

Reference:

- **Regulation (EU) 2017/654, Annex IV, 3.1/ UNECE R96.05, Annex 9, 3.1.**

2.1.2. Is it required to provide a level indicator for NO_x reducing reagent?

Yes. The non-road mobile machinery must include an indicator to inform the operator on the amount of reagent remaining in the tank. The display may be analogue or digital. It can show either the level as a proportion of full tank capacity, the amount of remaining reagent, or the estimated operating hours remaining. It is only necessary for the level to be displayed continuously when an NCD warning is active.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 6.1. / UNECE R96.05, Annex 9, A.1.6.1.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.1.3. / UNECE R96.05, Annex 9, A.1.2.1.3.**
- **Regulation (EU) 2017/654, Annex XIV, 4. (6) / UNECE R96.05, A.5.4.6.**

2.1.3. Is it permitted to integrate the reagent level warning system with the reagent level indicator?

Yes. The Regulation does not prevent the integration of a warning system and reagent level indicator in a single display.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 6.1. / UNECE R96.05, Annex 9, A.1.6.1.**

2.1.4. Is it required to provide a means to take a sample of reagent from the containers installed on the non-road mobile machinery?

Yes. A sampling point must be easily accessible without requiring the use of any specialised tool or device.

References:

- **Regulation (EU) 2017/654, Annex IV, 3.5. / UNECE R96.05, Annex 9, 3.5.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.1.3. / UNECE R96.05, Annex 9, A.1.2.1.3.,**
- **Regulation (EU) 2017/654, Annex XIV, 4. (6) / UNECE R96.05, A.5.4.6.**

2.2 NCD Inducement System and Counters

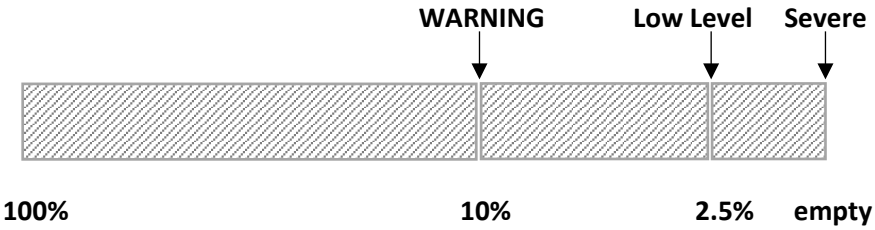
2.2.1. Is an inducement system required for NCD?

Yes, a two-stage (low-level and severe) inducement system, or one-stage (severe) inducement is required. The operations of the NRMM should effectively be disabled under the severe inducement conditions.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5. / UNECE R96.05, Annex 9, A.1.5.**

2.2.2. What is the sequence of events in monitoring a lack of reagent in the tank for a 2-step inducement system?



The threshold values indicated in the figure represent the minimum values at which the warning and inducement systems must be activated. The manufacturer may optionally choose a higher threshold at which these systems are triggered.

The threshold values are based upon reagent remaining, which may be different to the indicated tank level. i.e. there may still be reagent in system when the gauge reads zero.

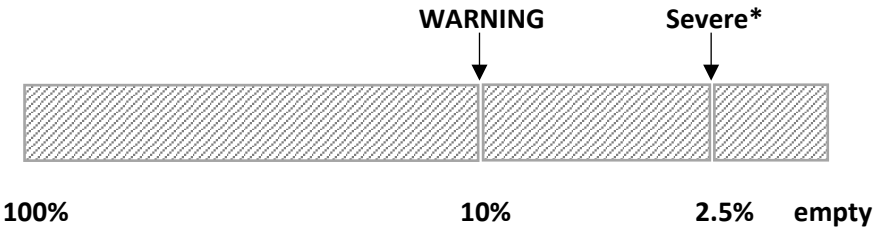
Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 6.2., 6.3. / UNECE R96.05, Annex 9, A.1.6.2., A.1.6.3.**

2.2.3. What is the sequence of events in monitoring a lack of reagent in the tank for a 1-step inducement system?

The threshold values indicated in the figure represent the minimum values at which the warning and inducement systems must be activated. The manufacturer may optionally choose a higher threshold at which these systems are triggered.

The threshold values are based upon reagent remaining, which may be different to the indicated tank level. i.e. there may still be reagent in system when the gauge reads zero.

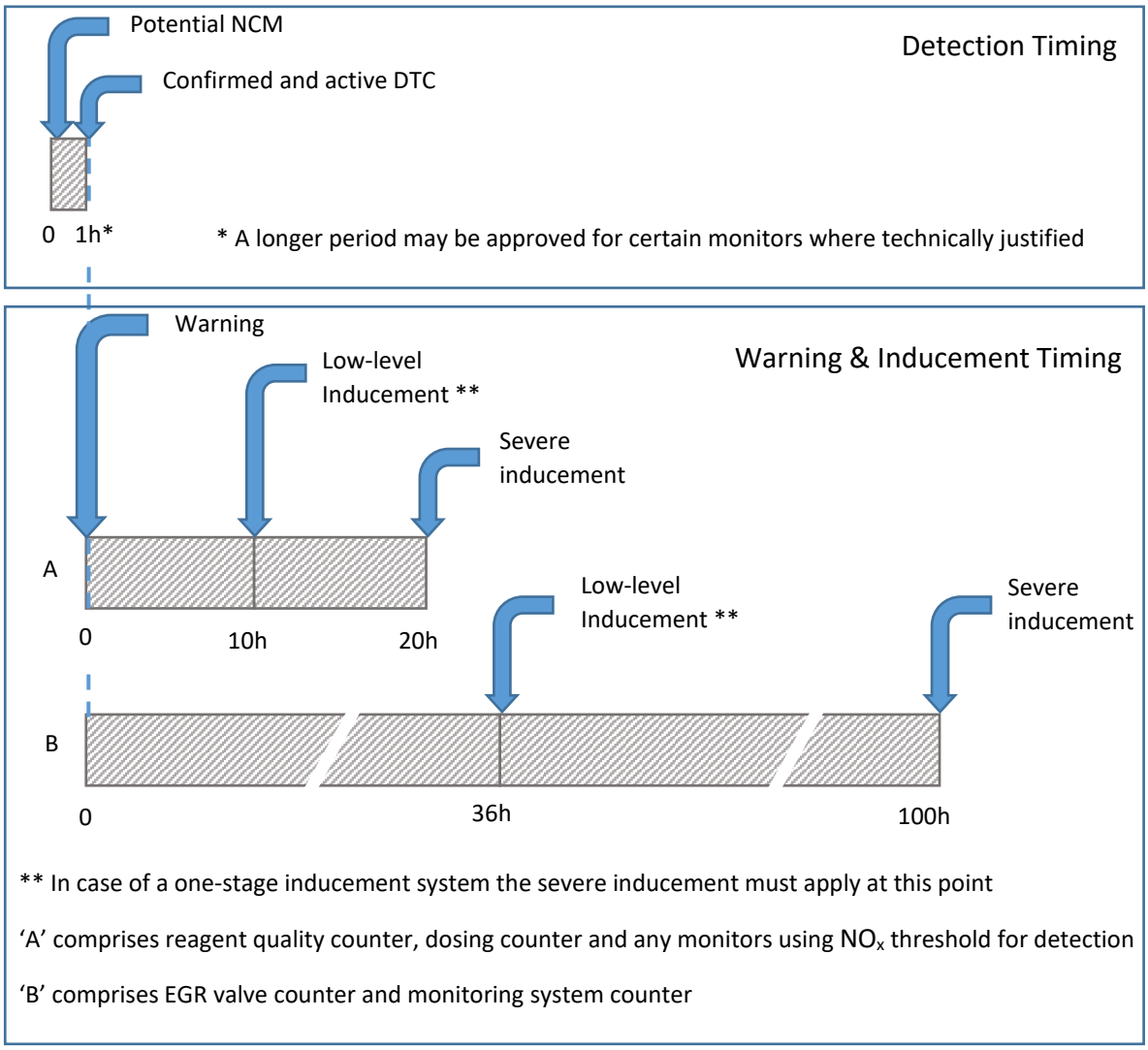


* In case of a one-step inducement the severe inducement applies at 2.5%, except where manufacturer elects to shut down the engine as the one step severe inducement, in which case the manufacturer may decide to delay the application of the inducement until the tank is empty.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5.1.2., 6.2., 6.3. / UNECE R96.05, Annex 9, A.1.5.1.2., A.1.6.2., A.1.6.3.**

2.2.4. What are the escalation steps of the operator warning and inducement system?



The threshold values indicated in the figure represent the maximum elapsed engine run time before the warning or inducement systems must be activated. The manufacturer may optionally choose a shorter run time threshold at which these systems are triggered.

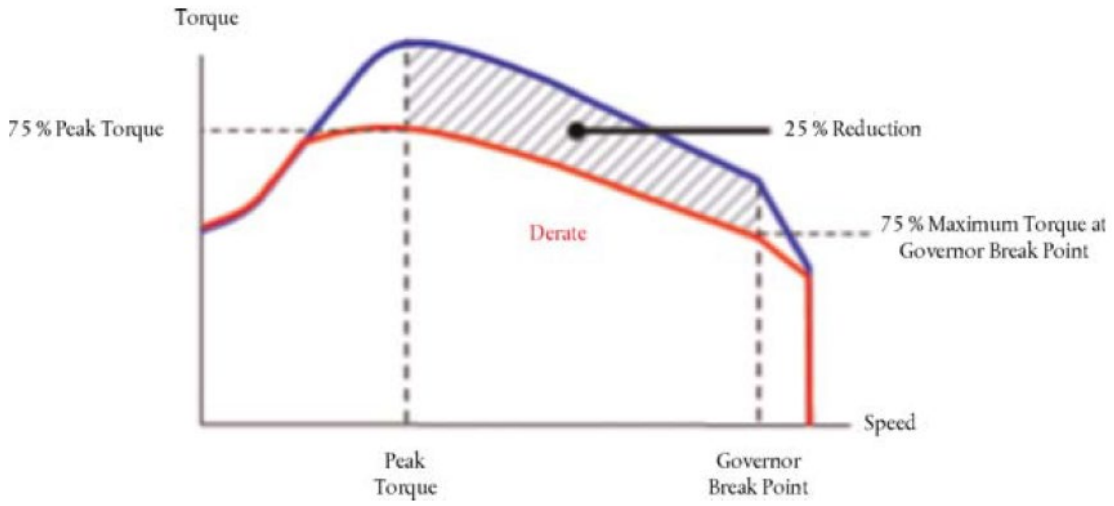
Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 7.3., 8.4., 9.4., 11.4.2.1.3., Table 4.4 / UNECE R96.05, Annex 9, A.1.7.3., A.1.8.4., A.1.9.4., A.1.11.4.2.1.3, Table A.9-4**

2.2.5. The low-level inducement system shall reduce the engine torque between the peak torque speed and the governor breakpoint. How is this breakpoint defined?

A governor is a device or control strategy that automatically controls engine speed or load. The breakpoint is at the maximum full-load speed permitted by the governor and recorded in the type approval information document.

Low-level inducement torque reduction scheme



References:

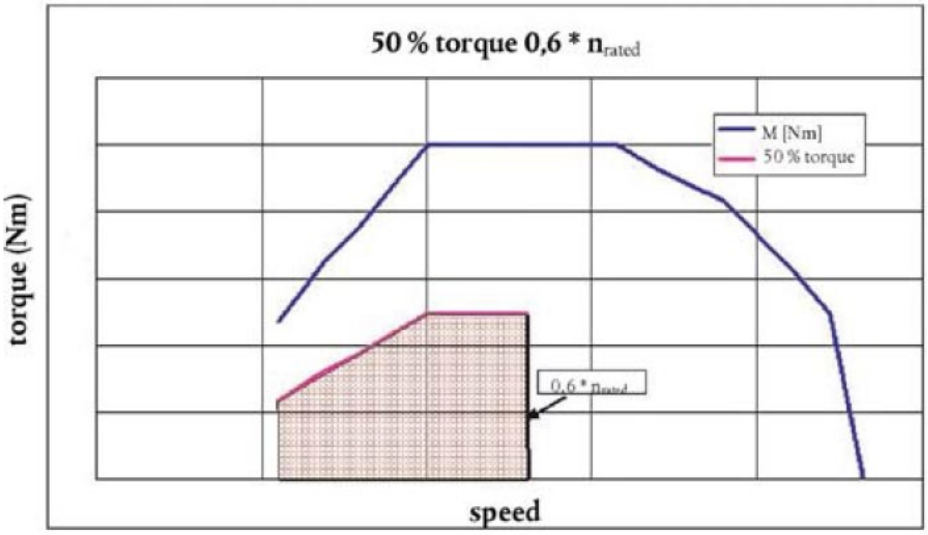
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5.3.2., 5.3.3., Figure 4.1 / UNECE R96.05, Annex 9, A.1.5.3.2., A.1.5.3.3., Fig. A.9-1**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5.4.2.1. / UNECE R96.05, Annex 9, A.1.5.4.2.1.**

2.2.6. How is the torque and speed reduction of the severe inducement system intended to work?

The already reduced torque between the peak torque speed and the governor breakpoint of the low level inducement must be reduced further until it reaches no more than 50% of maximum torque, whilst simultaneously reducing engine speed to no more than 60% of rated speed, so that operation of the engine becomes limited to the shaded area shown in figure 4.2 of Appendix 1 of Annex IV to Regulation (EU) 2017/654. 50% torque refers to the maximum available torque at the respective engine speed.

Where the severe inducement is not preceded by a low-level inducement the reduction must commence from the full-load torque curve.

Severe inducement torque reduction scheme



Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5.4.2.1., Figure 4.2 / UNECE R96.05, Annex 9, A.1.5.4.2.1., Fig. A.9-2.**

2.2.7. Is it permitted to use alternative inducement measures to those set out in question 2.2.5. and question 2.2.6. of this FAQ?

Yes, where that alternative has been demonstrated to the approval authority as having the same or greater level of severity. In the case of the severe inducement the alternative must ensure effective disablement of non-road mobile machinery operation.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5.3.3., 5.4.2., 5.4.2.1., 5.4.2.2. / UNECE R96.05, Annex 9, A.1.5.3.3., A.1.5.4.2., A.1.5.4.2.1., A.1.5.4.2.2.**

2.2.8. How does the severe inducement speed limitation have to be implemented for a constant speed application where the engine speed is fixed?

For constant speed applications, such as, but not limited to, mobile gensets, it is not possible to reduce engine speed. Where the engine speed reduction cannot be implemented, other inducement measures with the same or greater level of severity may be used. Whilst this can include a more severe torque reduction (e.g. reduction to less than 50% of maximum torque), this must ensure the machine cannot continue to be used for its intended function. Where the manufacturer elects to shut down the engine to implement a one-stage inducement then it is permitted to operate without restriction until the supply of reagent is exhausted before implementing an inducement for low reagent level.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5.4.2.1, 5.4.2.2. / UNECE R96.05, Annex 9, A.1.5.4.2.1., A.1.5.4.2.2.**

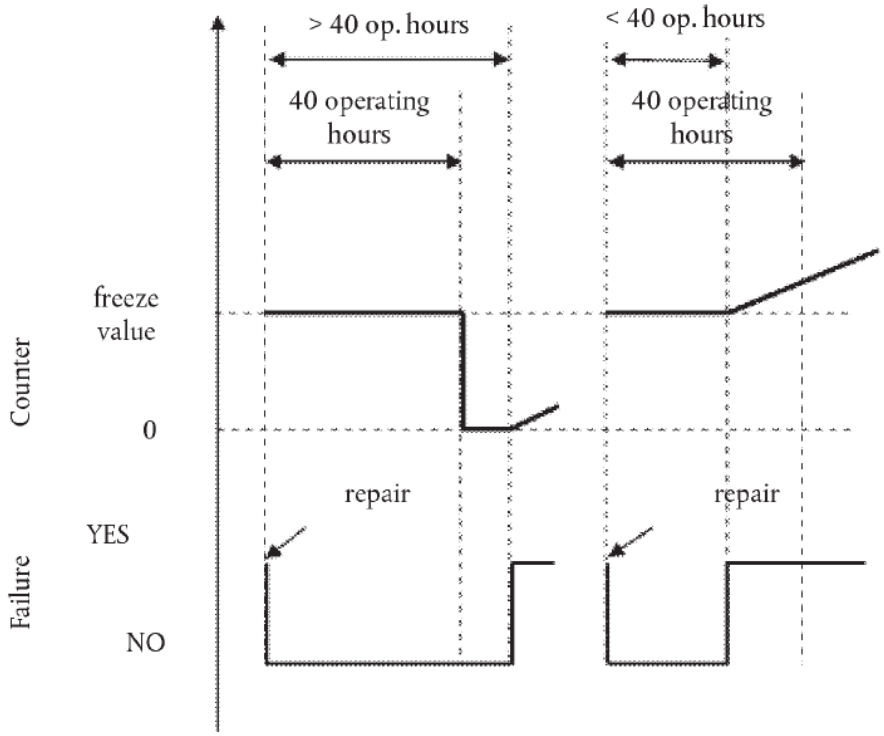
2.2.9. What is the principle of the inducement counters and the meaning of repeated occurrence?

Starting from zero, the counter shall begin counting as soon as a malfunction relevant to that counter is detected and the corresponding diagnostic trouble code (DTC) is set confirmed and active.

The counter continues counting until no relevant NCM is detected, then halts and holds its current value. If the severe inducement is active when relevant NCMs are no longer detected, the counter shall be kept frozen at greater than or equal to 90% or 95% of the counter value for severe inducement or alternatively a value of greater than or equal to the counter value for severe inducement minus 30 minutes, as set out in point 11.4.2.1.2. and table 4.4 of Appendix 1 to Annex IV of Regulation (EU) 2017/654. See also question 2.2.10. of this FAQ.

Once frozen, the counter shall be reset to zero when the monitors relevant to that counter have run at least once to completion of their monitoring cycle without having detected a malfunction and no malfunction relevant to that counter has been detected during 40 engine operating hours since the counter was last held (Repeated Occurrence). The number of engine operating hours for the repeated occurrence may be reduced to a minimum of 36 hours in the future, subject to further amendments in alignment with EU-VI HD on-highway regulation.

Reactivation and resetting to zero of a counter after a period when its value has been frozen



The counter shall continue counting from the point at which it had been held if a malfunction relevant to that counter is detected during a period when the counter is frozen.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 7.3.3., 8.4.3., 9.4.3., 11.4.2.,12. / UNECE R96.05, Annex 9, A.1.7.3.3., A.1.8.4.3., A.1.9.4.3., A.1.11.4.2., A.1.12.**

2.2.10. How should the counters operate in respect to repeated occurrences of a fault?

In case, a NO_x control malfunction (NCM) relevant to a specific counter has been remedied and repeatedly occurs within 40 hours running time, that counter resumes counting from its frozen value. The number of engine operating hours for the repeated occurrence may be reduced to a minimum of 36 hours, in the future subject to further amendments in alignment with EU-VI HD on-highway regulation.

Once the engine is in severe inducement mode, the counters are being reset either to 30 minutes prior to triggering the severe inducement or to the frozen value indicated in the table below:

Counters and inducement

	DTC status for first activation of the counter	Counter value for low-level inducement	Counter value for severe inducement	Frozen value held by the counter
Reagent quality counter	confirmed and active	≤ 10 hours	≤ 20 hours	≥ 90 % of counter value for severe inducement
Dosing counter	confirmed and active	≤ 10 hours	≤ 20 hours	≥ 90 % of counter value for severe inducement
EGR valve counter	confirmed and active	≤ 36 hours	≤ 100 hours	≥ 95 % of counter value for severe inducement
Monitoring system counter	confirmed and active	≤ 36 hours	≤ 100 hours	≥ 95 % of counter value for severe inducement
NO_x threshold, if applicable	confirmed and active	≤ 10 hours	≤ 20 hours	≥ 90 % of counter value for severe inducement

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 11.4.2., Table 4.4, 12. / UNECE R96.05, Annex 9, A.1.11.4.2., Table A.9-4 ; A.1.12. and question 2.2.9.**

2.2.11. How many counters are required to count the number of operating hours for each NCM?

A (specific) counter shall be attributed to each malfunction of the NO_x control system. Optionally, failures may be grouped together with other malfunctions into one or more counters. See also question 2.4.5. on the use of a NO_x sensor to monitor failures.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 7.1.3., 8.2.1., 9.2.1.2.1., 9.2.2.2.1., 11.4.1.3. / UNECE R96.05, Annex 9, A.1.7.1.3., A.1.8.2.1., A.1.9.2.1.2.1., A.1.9.2.2.2.1., A.1.11.4.1.3.**

2.2.12. What is the framework for activating the inducement override function to account for safety concerns or to facilitate self-healing?

An inducement override may be activated to operate the engine freely for no longer than 30 minutes total without restriction in either torque or speed. The override may be activated up to three times (i.e. total 90 minutes) during any combined period when the operator low level or severe inducement is active, as indicated by the warning system.

The time remaining in any 30-minute period may be frozen in event of key-off, unintended engine-stop or battery disconnection. The unused portion may then be used upon engine re-start, but the remaining time may not be extended by that event. The override may self-reset when the reason for the inducement activation has ceased to exist and the corresponding alarm has been de-activated.

The operation of the override function is illustrated in the Annex on page 33 of this FAQ.

Reference:

– **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5.5. / UNECE R96.05, Annex 9, A.1.5.5.**

2.2.13. What are the conditions for disabling the inducement on equipment used in emergency?

The operator inducement system of engines for equipment used in case of an emergency shall not be permanently deactivated.

Temporary disablement during an emergency declared by a national or regional government, their emergency services or their armed services is permitted under certain conditions:

- The operator warning system must remain active;
- Maximum time to disable inducements: 120 engine operating hours, which can be interrupted by periods of engine-off;
- Interface to actively disable inducements marked with ‘EMERGENCY USE ONLY’;
- A double voluntary action is required e.g. a protected switch which requires a cover to be opened before the switch can be activated, or multiple levels of acknowledgement on a touchscreen;
- Disablement system may be re-armed by the input of a manufacturer's temporary security code, or re-configuration of the engine's ECU by a qualified service technician, or an equivalent security feature that is unique to each engine;
- The total number and duration of activations of the disablement must be stored in non-volatile electronic memory;
- Documentation (separate engine variants, installation manual, description of disablement concept, etc.) & Recordkeeping (requests to rearm the system) requirements apply.

Reference:

– **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5.2. / UNECE R96.05, Annex 9, A.1.5.2.**

2.2.14. What constitutes an emergency situation?

An emergency has to be declared by a national or regional government, their emergency services or their armed services.

Any piece of equipment used in an emergency situation, e.g. an excavator used in the aftermath of an earthquake is qualified to apply this feature.

This does not include e.g. completing working process / shifts, meeting deadlines on construction projects or harvesting.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 5.2. / UNECE R96.05, Annex 9, A.1.5.2.**

2.3 Freeze protection

2.3.1. What are the design criteria for heated reagent tank systems?

A heated system must be designed to ensure reagent will be available for use within 70 minutes after engine start at -7 °C ambient temperature. The corresponding design criteria set out by the manufacturer must be communicated to the OEM as required by point 4(6) of Annex XIV to that Regulation. There is no requirement to activate a warning system or inducement during normal de-freezing operation of a system designed to comply with those design criteria.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, point 2.3.2.2. and Annex XIV, 4(6) / UNECE R96.05, A.5.4.6. and Annex 9, A.1.2.3.2.2.**

2.3.2. What are the design criteria for non-heated reagent tank systems?

The warning lamp for a non-heated system shall be activated if, at an ambient temperature of -7 °C or lower at time of engine start, the NCD system concludes there is no dosing of reagent. The severe inducement must consequently be activated within 70 minutes after engine start if no reagent dosing occurs after starting the engine at this temperature. To avoid such activation, it is recommended that non-heated systems are adequately insulated to ensure dosing occurs, or non-heated systems are limited to NRMM that generally operate at temperatures above the freezing point of reagent. Where included in the engine type-approval, the possible installation of a non-heated system should be communicated to the OEM as required by point 4(7) of Annex XIV to Regulation (EU) 2017/654.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, point 2.3.2.3. / UNECE R96.05, Annex 9, A.1.2.3.2.3.**

2.3.3. What are the demonstration requirements for heated reagent tank systems?

The effectiveness of the design criteria set-out by the manufacturer must be evaluated according to the requirements set out in section 2.3.2.2 of Appendix 1 to Annex IV of Regulation (EU) 2017/654. This may be performed using either an entire NRMM or

representative components installed in a cold test chamber, or alternatively using field tests. The evaluation is intended to check the adequacy of the design criteria, not to validate each system designed using those criteria. Consequently, only one evaluation is required to validate one set of design criteria, which may then be used across multiple engine families or NCD families. It is not required that the evaluation be witnessed, nor is any resulting evaluation report part of the required content of the information folder set out in Part A of Annex I to Regulation (EU) 2017/656. However, it is advisable to discuss the proposed evaluation with the approval authority prior to commencing.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, point 2.3, 10 / UNECE R96.05, Annex 9, A.1.2.3., A.1.10.**

2.3.4. What are the demonstration requirements for non-heated reagent tank systems?

There are no demonstration requirements for non-heated reagent tank systems.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, point 2.3., 10 / UNECE R96.05, Annex 9, A.1.2.3., A.1.10.**

2.3.5. Are inducements required for heated reagent systems?

No. The reagent freeze protection provisions are purely a design requirement for heated reagent systems. The inducement scheme applies as normal, e.g. in case of interruption of dosing.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.3.2.2. / UNECE R96.05, Annex 9, A.1.2.3.2.2.**

2.4 Monitoring requirements

2.4.1. What is the timeframe for the NCD System to detect the presence of a malfunction?

The NCD system should be designed so that it can conclude within 60 minutes of engine operation whether a detectable malfunction is present. Upon the request of the manufacturer, and with appropriate justification, the approval authority may permit a longer period. For design purposes it is reasonable to assume that in the context of this requirement 'engine operation' means a balanced mixture of torque and speed settings, consistent with the required method of demonstration. Compliance of the NCD system to this requirement is confirmed by performing a demonstration test according to requirements of Section 10 of Appendix 1 of Annex IV to Regulation (EU) 2017/654. See question 2.4.2. for the explanation of demonstration.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 2.4.2.2., 2.4.2.3., 10 / UNECE R96.05, Annex 9, A.1.2.4.2.2., A.1.2.4.2.3., A.1.10.**

2.4.2. How is the capability of the NCD System to detect the presence of a malfunction within the required timescale demonstrated?

The capability of the NCD system to conclude within 60 minutes of engine operation (or a longer period if agreed with approval authority) whether a detectable malfunction is present, as set out in question 2.4.1. of this FAQ, is confirmed by performing a demonstration test according to requirements of Section 10 of Appendix 1 of Annex IV to Regulation (EU) 2017/654. This requires the engine to be operated over consecutive NCD test-cycles, and for detection to occur within two NCD test cycles, or, where a longer period has been agreed with the approval authority, within three consecutive NCD test cycles. See question 1.4.2. for the explanation of NCD test cycles.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 10.1, 10.3.3.5., 10.3.3.6. / UNECE R96.05, Annex 9, A.1.10.1., A.1.10.3.3.5., A.1.10.3.3.6.**

2.4.3. Is it required to pre-condition the NCD test cycles by the respective pre-conditioning cycle when demonstrating CD_{min}?

Regulation 2017/654, Annex IV, Appendix 1, point 13.1 requires demonstration of the correct value of CD_{min} by performing an emission test using the hot-start NRTC cycle for engines of sub-category NRE-v-3, NRE-v-4, NRE-v-5, NRE-v-6 and the applicable NRSC for all other engine (sub-) categories. The demonstration is run using a reagent with the concentration CD_{min}.

Point 13.2 of the Appendix provides a choice of pre-conditioning for CD_{min} emission demonstration. The pre-conditioning may either follow the appropriate NCD cycle, or alternatively follow a manufacturer-defined cycle to enable a closed-loop NO_x control system to adapt to the quality of the reagent. Consequently, during pre-conditioning using repeated test cycles it is not necessary to perform a shut-down or hot-soak between cycles.

Nevertheless, when performing a hot-start NRTC emissions measurement run, as specified by point 7.4.2.1. (c) of Annex VI of the Regulation, the hot-start emission measurement run commences with the cranking of the engine immediately after the 20-minute soak period specified in point 7.4.2.1(b). Consequently, at a minimum one 20-minute hot-soak is required immediately prior to starting the engine for the emission test run.

References:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 13.2, / UNECE R96.05, Annex 9, A.1.13.2.**
- **Regulation (EU) 2017/654, Annex VI, 7.3.1.1.2., 7.4.2.1. / UNECE R96.05, Annex 4, 7.3.1.1.2., 7.4.2.1.**

2.4.4. What constitutes an “impeded EGR-valve” and how can it be demonstrated?

The motivation for detecting an impeded EGR valve is to identify cases where the supply of EGR is prevented, which could lead to an increase in NO_x emissions. An impeded EGR valve is one which is prevented from moving and consequently unable to fulfil its function. Systems for detection of impeded EGR valve typically fall into two categories; (a) those that detect a lack of movement of the valve itself and (b) those that detect resulting lack of EGR flow or lack of EGR flow modulation.

The method for demonstrating impeded EGR valve detection must consequently take into consideration the detection method employed. Whilst detection systems falling into both categories (a) and (b) should be capable of detecting the use of an EGR valve that has been deliberately modified (tampered) mechanically or electronically to prevent it opening, those systems in category (b) may also be capable of detecting a blockage in the EGR flow simulated by a blanking plate or similar artificial obstruction. As an alternative to monitoring for an impeded EGR valve it is permitted to monitor for failures using a NO_x sensor located in the exhaust system (see question 2.4.5.).

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 9.1. / UNECE R96.05, Annex 9, A.1.9.1.**

2.4.5. Is it permitted to use a NO_x sensor to monitor for multiple failure modes?

As an alternative to monitoring individual failure modes for an impeded EGR valve or an NCD system malfunction (i.e. electrical failures, removal or de-activation of any sensor), the manufacturer may use a NO_x sensor located in the exhaust system. However, the maximum number of operating hours prior to activation of inducement is reduced. See also opportunity to group counters as set out in question 2.2.11.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 9.5. / UNECE R96.05, Annex 9, A.1.9.5.**

2.4.6. Is an NCD monitor required for engines without SCR system?

Yes, non-SCR engines with an electronically controlled EGR system are also subject to this NCD requirement.

Engines which neither have an SCR-system nor an external EGR do not require a NO_x control diagnostic system.

References:

- **Regulation (EU) 2017/654, Annex IV, 3.1. / UNECE R96.05, Annex 9, 3.1.**
- **Regulation (EU) 2017/654, Annex IV, Appendix 1, 1.1. (1), (9) / UNECE R96.05, Annex 9, 1.1. (a), (i)**

2.5 Rail and marine engines

2.5.1. What are the monitoring requirements for rail and marine engines?

In principle, engines for railcars and inland waterway vessels have to meet the same NCD requirements like construction and agricultural equipment although there are some detailed differences and consequently it is important to refer to the regulation.

For safety reasons, in most cases inducements are not mandated on engines designed for these applications. Alternatively, the total number and duration of all incidents of engine operation with inadequate reagent injection or reagent quality must be stored in non-volatile memory.

In the case of an ECU failure, software corruption, or any other cause requiring an ECU replacement, it is recommended that the manufacturer establish service procedures to save and transfer the non-erasable information in the non-volatile memory or counters to the new ECU wherever possible.

Locomotive engines are subject to monitoring reagent availability and quality, warning the operator in case of insufficiency.

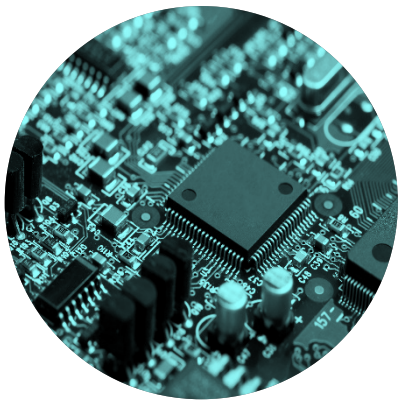
Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 2, 3.**

3 PARTICULATE CONTROL DIAGNOSTIC (PCD)

3.1 General

3.1.1. Which engines are subject to particulate pollutant control measures?



Particulate pollutant control measures apply to engines of sub-categories subject to a PN limit in accordance with the 'Stage V' emission limits, fitted with a particulate after-treatment system.

Reference:

- **Regulation (EU) 2017/654, Annex IV, 4 / UNECE R96.05, Annex 9, 4.**

3.1.2. What is the definition of a particulate after-treatment system?

It means an exhaust after-treatment system designed to reduce emissions of particulate pollutants through a mechanical, aerodynamic, diffusional or inertial separation. This would not include a separate oxidation catalyst.

Reference:

- **Regulation (EU) 2017/654, Art. 1 (5) / UNECE R96.05, 2.1.62.**

3.1.3. Are particulate pollutant control measures required if the malfunction would cause NO_x control malfunction?

No, redundant particulate pollutant control measures do not apply in cases where the NO_x control system and the particulate control system share the same physical components (e.g. same substrate (SCR on filter), same exhaust gas temperature sensor), provided the particulate control malfunction would lead to a corresponding NO_x control malfunction.

Reference:

- **Regulation (EU) 2017/654, Annex IV, 4.1 / UNECE R96.05, Annex 9, 4.1.**

3.2 Monitoring requirements

3.2.1. Is an inducement system required for PCD?

No, an inducement system is not required for PCD.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 5.1. / UNECE R96.05, Annex 9, A.2.5.1.**

3.2.2. Which information need to be stored in non-volatile memory in case of PCD malfunctions?

The particulate pollutant control diagnostic system (PCD) shall store in the non-volatile memory or counters the total number of incidents and the total duration of all incidents of engine operation with a DTC confirmed and active where the operator warning system has been active for 20 hours of engine operation, or a shorter period at the choice of the manufacturer. It must be possible for national authorities to read these records with a scan tool.

In the case of an ECU failure, software corruption, or any other cause requiring an ECU replacement, it is recommended that the manufacturer establish service procedures to save and transfer the non-erasable information in the non-volatile memory or counters to the new ECU wherever possible.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 5.1., 5.2. / UNECE R96.05, Annex 9, A.2.5.1., A.2.5.2.**

3.2.3. How is the PCD failure mode “Removal of the particulate aftertreatment system" defined?

Complete removal of the particulate after-treatment system inclusive of the removal of any sensors used to monitor, activate, de-activate or modulate its operation.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 6. / UNECE R96.05, Annex 9, A.2.6.**

3.2.4. How is the PCD failure mode “Monitoring of loss of the particulate after-treatment system function” defined?

Complete removal of the particulate after-treatment system substrate (‘empty can’). In this case the particulate after-treatment system housing and sensors used to monitor, activate, de-activate or modulate its operation are still present.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 8.2. / UNECE R96.05, Annex 9, A.2.8.2.**

3.2.5. How is the PCD failure mode “Monitoring of failures of the PCD system” defined?

The PCD system shall be monitored for electrical failures and for removal or deactivation of any sensor or actuator that prevents it from diagnosing any other failures.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 8.3. / UNECE R96.05, Annex 9, A.2.8.3.**

3.2.6. What is the timeframe for the PCD System to detect the presence of a malfunction?

The PCD system should be designed so that it can conclude within the periods of engine operation indicated in the following table whether a detectable malfunction is present.

Monitor types and corresponding period within which a 'confirmed and active' DTC shall be stored

Monitor type	Period of accumulated running time within which a 'confirmed and active' DTC shall be stored
Removal of the particulate after-treatment system	60 minutes of non-idle engine operation
Loss of function of the particulate after-treatment system	240 minutes of non-idle engine operation
Failures of the PCD system	60 minutes of engine operation

Upon the request of the manufacturer, and with appropriate justification, the approval authority may permit a longer period. For design purposes it is reasonable to assume that in the context of this requirement 'engine operation' means a balanced mixture of torque and speed settings, consistent with the required method of demonstration. Compliance of the PCD system to this requirement is confirmed by performing a demonstration test according to requirements of Section 9 of Appendix 4 of Annex IV to Regulation (EU) 2017/654. See question 3.2.7. for the explanation of demonstration.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 2.3.2., 2.3.2.3, Table 4.5, 9.3.3.5.1, Table 4.7 / UNECE R96.05, Annex 9, A.2.2.3.2., A.2.2.3.2.3., Table A.9-5, A.2.9.3.3.5.1., Table A.9-7**

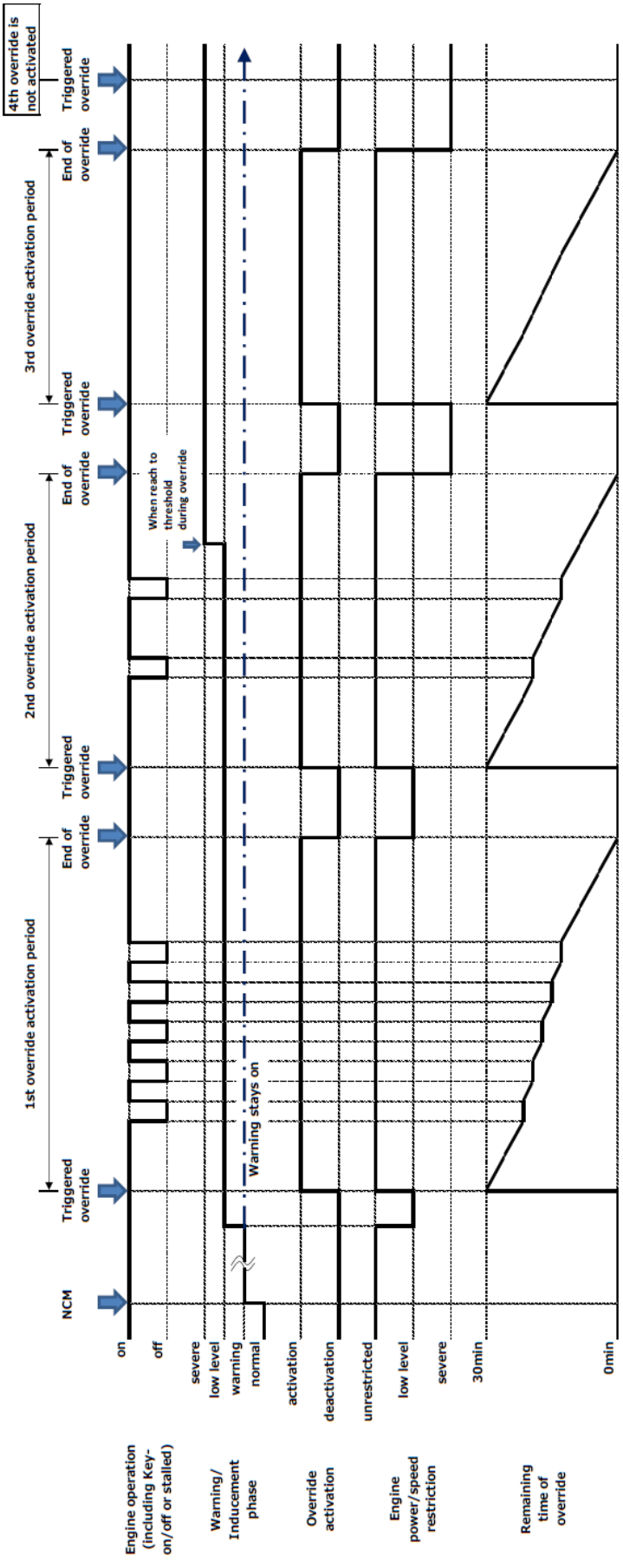
3.2.7. How is the capability of the PCD System to detect the presence of a malfunction within the required timescale demonstrated?

The capability of the PCD system to conclude within the given time periods (see question 3.2.6.) of engine operation (or a longer period if agreed with approval authority) whether a detectable malfunction is present, as set out in question 3.3.6. of this FAQ, is confirmed by performing a demonstration test according to requirements of Section 9 of Appendix 4 of Annex IV to Regulation (EU) 2017/654. This requires the engine to be operated over consecutive PCD test-cycles, and for detection to occur within two or - in case of loss of function - eight PCD test cycles, or, where a longer period has been agreed with the approval authority, within three respectively twelve consecutive PCD test cycles. See question 1.4.2. for the explanation of PCD test cycles.

Reference:

- **Regulation (EU) 2017/654, Annex IV, Appendix 4, 9.1. / UNECE R96.05, Annex 9, A.2.9.1.**

4 ANNEX


NCM
1st override activation period
Triggered override
End of override
2nd override activation period
Triggered override
End of override
3rd override activation period
Triggered override
End of override
4th override is not activated
Triggered override
When reach to threshold during override
Warning stays on
Engine operation (including Key-on/off or stalled)
on
off
Warning/ Inducement phase
severe
low level
warning
normal
Override activation
activation
deactivation
Engine power/speed restriction
unrestricted
low level
severe
Remaining time of override
30min
0min

5 BIBLIOGRAPHY

Regulation (EU) 2016/1628 of the European Parliament and of the Council of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery, amending Regulations (EU) No 1024/2012 and (EU) No 167/2013, and amending and repealing Directive 97/68/EC

Commission Delegated Regulation (EU) 2017/654 with regard to technical and general requirements relating to emission limits and type-approval for internal combustion engines for non-road mobile machinery

Commission Implementing Regulation (EU) 2017/656 on administrative requirements relating to emission limits and type-approval for internal combustion engines for non-road mobile machinery

UN Regulation No. 96 – Revision 3 – Amendment 2 – 05 series of amendments Uniform provisions concerning the approval of engines to be installed in agricultural and forestry tractors and in nonroad mobile machinery with regard to the emissions of pollutants by the engine