IN-SERVICE MONITORING

FREQUENTLY ASKED QUESTIONS

FAQ

machinery

Delegated Regulation (EU) 2017/655 and Regulation (EU) 2016/1628 on requirements relating to In-Service Monitoring for internal combustion engines for non-road mobile





The European Association of Internal **Combustion Engine Manufacturers**

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1 INTRODUCTION

Commission Delegated Regulation (EU) 2017/655 on monitoring of gaseous pollutant emissions from in-service combustion engines installed in non-road mobile machinery (NRMM), amended by Delegated Regulation (EU) 2018/987 (hereafter "Delegated Regulation (EU) 2017/655"), sets out the methodology to comply with the requirements of Article 19 of Regulation (EU) 2016/1628 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for NRMM.

Regulation (EU) 2016/1628 requires that the gaseous pollutant emissions from engines belonging to engine types or engine families of emission Stage V that have been type-approved in accordance with that Regulation are monitored by testing in-service engines installed in NRMM and operated over their normal operating duty cycles.

Such testing is to be conducted, under the responsibility of the manufacturer and in compliance with the requirements of the approval authority, on engines that have been correctly maintained, in compliance with the provisions on the selection of engines, test procedures and reporting of results for the in-scope engine categories.

Correspondingly, Delegated Regulation (EU) 2017/655 establishes those provisions for monitoring of gaseous pollutant emissions from in-service internal combustion engines installed in NRMM using portable emission measurement systems (PEMS).

Unless and until an amendment to Delegated Regulation (EU) 2017/655 extends the scope, it applies solely to engine (sub-)categories NRE-v-5 and NRE-v-6, i.e. variable speed engines of category NRE with a range of reference power from 56 to 560 kW.

The purpose of this frequently asked questions document (hereinafter 'FAQ') is to contribute to a clear understanding of Delegated Regulation (EU) 2017/655. It is intended to provide answers to key questions that are likely to be asked by manufacturers and other organisations such as testing services involved with conducting in-service monitoring of NRMM engines.

Delegated Regulation (EU) 2017/655 applies to the engine manufacturer and does not apply to the original equipment manufacturer (OEM). Throughout this FAQ, "manufacturer" means engine manufacturer.

- Regulation (EU) 2016/1628, Art. 19 (1) and Art. 3 (49)
- Delegated Regulation (EU) 2017/655

2 PLANNING FOR ISM INCLUDING THE SELECTION OF ENGINES AND NRMM TO TEST

2.1 Do I have to test engines that do not have a Stage V type approval?

No, ISM testing is only required for Stage V type approved in-service engines installed in NRMM. Currently this is limited to engines of category NRE-v-5 or NRE-v-6, though it is anticipated that this will in future be extended to other engine categories.

Reference: Delegated Regulation (EU) 2017/655, Article 2, Point 1.



2.2 Which engine families and types are grouped together for testing?

All engine families and types within categories NRE-v-5 and NRE-v-6 produced by the specified manufacturer are combined into an ISM group for the purpose of selecting engines and NRMM.

Reference:

- Delegated Regulation (EU) 2017/655, Art. 2.1. and Annex, Point 2.2.
- GEME meeting minutes as of 07 March 2018, Point 7.

2.3 Do the requirements of Delegated Regulation (EU) 2017/655 apply to each individual engine family?

No, the testing scheme and particularly the quantity of engines to be tested applies to the ISM group of in-scope engine categories, engine families and engine types, not for individual categories, families or types. For example, if the manufacturer selected the testing scheme based upon emission durability period (EDP), has 2 engine families in category NRE-v-5 and 3 engine families in category NRE-v-6, the 18 engines (9 with low operating hours + 9 with high operating hours) must be selected from the combination of those 5 families. It is not required to select 18 engines from each engine family. See also questions 2.2, 2.4, 2.5, 2.10 and 2.20 of this FAQ.

- Delegated Regulation (EU) 2017/655, Art. 2.1. and Annex, Point 2.2.
- European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, GEME meeting minutes as of 07 March 2018, Point 7.

2.4 Is it possible to include engine families type approved by different approval authorities within one ISM group?

Yes, the Delegated Regulation (EU) 2017/655 applies the testing scheme to each manufacturer irrespective of the number of approval authorities that have granted type approvals within that ISM group to that manufacturer. For example, if the manufacturer selected the testing scheme based upon emission durability period (EDP), has 2 engine families in category NRE-v-5 with type-approvals issued by approval authority A. and 3 engine families in category NRE-v-6 with type-approvals issued by approval authority B., the 18 engines (9 with low operating hours + 9 with high operating hours) must be selected from the combination of those 5 families. It is not required to select 18 engines covered by type-approvals issued by approval authority A., plus 18 engines covered by type-approvals issued by approval authority B. See also question 2.16 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.6.

2.5 What criteria must be used to select engines and NRMM for testing?

Engines subject to in-service monitoring test should be installed in one of the most representative categories of non-road mobile machinery for the selected engine type or, where applicable, engine family. It should also be ensured that the final test plan includes the widest variety of engine types and categories of NRMM whilst not exceeding the number of engines to be tested based upon the sampling scheme selected for the ISM group. It is not required to test every engine type within the ISM group. For example, if the manufacturer selected the testing scheme based upon emission durability period (EDP), has 2 engine families in category NRE-v-5 and 3 engine families in category NRE-v-6, comprising a total of 30 different engine types, only 18 engines (9 with low operating hours + 9 with high operating hours) must be selected from the combination of those 30 engine types. See also questions 2.2, 2.3, 2.4, 2.10 and 2.20 of this FAQ.

Reference:

- Delegated Regulation (EU) 2017/655, Annex, Points 1.3. and 2.4.
- European Commission Directorate-general for Internal Market, Industry, Entrepreneurship and SMEs, GEME meeting minutes as of 07 March 2018, Point 7.
- 2.6 When selecting engines and NRMM for testing, is it necessary to comply with the General Data Protection Regulation (GDPR, Regulation (EU) 2016/679)?

Yes, the manufacturer must always ensure that, when selecting engines and NRMM for testing, the methods use do not conflict with GDPR.

Reference: Regulation (EU) 2016/679

2.7 Is it required that the engine to be tested has been placed on the Union market?

Yes, this is required. Up until 31 January 2020 the Union market included the UK. During the transition period that forms part of the agreement on the withdrawal of the UK from the EU, goods placed on the market in the UK during that transition period are treated as being placed on the Union market; This includes NRMM engines and applies until 31 Dec 2020.

Reference:

- Delegated Regulation (EU) 2017/655, Annex, Point 1.3. (b)
- Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, part three: Separation Provisions, Title 1: Good placed on Market, Art. 41: Continued circulation of goods placed on the market and Title 2: Ongoing customs procedures Art. 47: Union status of goods.

2.8 Is it necessary for the ISM test to be performed in the territory of the Union?

In most cases it will be necessary to perform the test in the territory of the Union. However, if it can be demonstrated that the individual engine selected for testing has already been placed on the Union market then testing may be performed outside the Union. Placing on the market does not require physical delivery of the engine into the Union but does require that the manufacturing stage has been completed and there is a commercial transaction between two entities for the distribution or use in the Union market. In addition, the engine must have been installed in an NRMM.

Reference: European Commission – Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, questions and answers related to the United Kingdom's withdrawal from the European Union with regard to industrial products as of 01 February 2019, Point A.

2.9 What qualifies an engine for ISM testing?

The engines should:

- have a maintenance record to show that the engine has been properly maintained and serviced in accordance with the manufacturer's recommendations;
- exhibit no indications of misuse (e.g. overloading or misfuelling), or other factors (such as tampering) that could affect the gaseous pollutant emissions performance;
- be in conformity with the EU type-approval documents with regard to the components of the emission control system(s) installed in the engine and in the NRMM;
- have a communication interface and protocol which permits the collection, identification and validation of the necessary electronic control unit (ECU) signals.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 1.3. and 1.4.

2.10 How many engines from the ISM group must the manufacturer test?

The test requirement for the entire ISM group for each manufacturer is either 18 engines (9 with low operating hours + 9 with high operating hours) under the scheme based upon emission durability period (EDP) or 36 engines (9 engines/year for four consecutive years) under the scheme based upon a four-year period. A smaller quantity may be required in the case of a small volume manufacturer. These quantities do not apply to each engine category or engine family. Within these testing schemes it is recommended but not mandatory to select each engine of a given serial number for testing at more than one point in its operating life (see also question 2.20 of this FAQ).

Reference:

- Delegated Regulation (EU) 2017/655, Annex, Point 2.6.
- European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, GEME meeting minutes as of 07 March 2018, Point 7.

2.11 When should the initial sampling plan be submitted?

The initial sampling plan should be submitted within one month of the start of production of an approved engine type or engine family that has been marked with the corresponding Union type approval number. Production and placing on the market of an engine using the field test exemption is not production of an approved engine type.

Reference:

- Delegated Regulation (EU) 2017/655, Annex, Point 2.
- Delegated Regulation (EU) 2017/654, Annex XI.

2.12 What is required in the initial sampling plan?

The following must be included:

- The list of engine families or engine types and category(ies) of NRMM included in the ISM group;
- The list of particular engine(s) and NRMM selected for in-service monitoring test, if already identified;
- The chosen testing scheme, i.e. if the testing will be performed according to Delegated Regulation (EU) 2017/655, Annex, Points 2.6.1, 2.6.2. or 2.6.3.

The manufacturer must provide the criteria used and the justification for the selection of these items. See also Question 2.5. of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.

2.13 When should the plan be updated?

Whenever the list of engine families in the group changes or the list of particular engine(s) and NRMM selected is completed or revised. The updated plan shall include a justification of the criteria used for the selection and the reasons for revising the previous list, if applicable. It should also be updated if the manufacturer changes the chosen testing scheme.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.3.

2.14 Does the sampling plan have to be approved by the approval authority?

Yes, the approval authority must approve the initial and subsequently updated plan(s) or request the appropriate amendments within two months of their submission. Each initial or subsequently updated monitoring plan must be approved by the approval authority before the testing of engines and NRMM identified therein is started:

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 2.4. and 2.5.

2.15 Is it necessary to obtain approval from the approval authority for the particular engine and NRMM selected for testing before commencing the ISM test?

Yes, the particular engine and NRMM selected must be included in the sampling plan and approved by the approval authority before testing commences. In order to comply with this requirement but to avoid delays due to the unavailability of a specific NRMM the manufacturer could submit a short list of particular engines and NRMM from which the final selection will be made.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.5. and Questions 2.9. and 2.10 of this FAQ

2.16 In the case that the ISM group includes engine type approvals issued by different type approval authorities is it required to seek approval of each approval authority?

The manufacturer shall submit to the approval authority that has granted approval of an engine type or, where applicable, engine family, the plan for monitoring in-service engines. In the case that more than one approval authority has granted approval of engines within the ISM group it is advisable for the manufacturer to consult with the authorities concerned regarding the process for approving the ISM plan.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.1.

2.17 How soon must the test programme commence?

There is no deadline to commence the testing programme as long as the deadlines for submitting the initial sampling plan and reporting the results are met.

Reference: See Questions 2.9. - 2.12. and 2.16. of this FAQ

2.18 Can a manufacturer switch from the sampling scheme based upon EDP to the sampling scheme based upon a four-year period?

Yes, when informed that the manufacturer cannot fulfil the requirement under Point 2.6.1., the approval authority must not reject a change from testing scheme according to Annex, Point 2.6.1. to Point 2.6.2.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.6.1.3.

2.19 In case a manufacturer does change from the sampling scheme based upon EDP to the sampling scheme based upon a four-year period, how are the engines tested under the EDP scheme counted?

Tests performed according to Point 2.6.1. of Annex to Delegated Regulation (EU) 2017/655 remain valid and can be used under the testing scheme according to Point 2.6.2. of that Annex. In this case, the total number of engines to be tested under Point 2.6.2. should be reduced by the number of engines already tested and reported in accordance with Point 2.6.1.

For example, in the case that the manufacturer has tested 9 engines under the EDP-based testing scheme of Point 2.6.1., then this reduces the number of tests to be performed under the four-year scheme of Point 2.6.2. to 36 - 9 = 27, i.e. three further years of testing 9 engines per year to be performed.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.6.1.3.

2.20 When selecting engines and NRMM to test according to either Annex, Point 2.6.1. or Point 2.6.2., should the nine engines to be tested be the same each time or be different?

The subsequent nine engines to be tested can be those with the same serial numbers as the first nine engines tested, or they can be different ones at the choice of the manufacturer. In any case, the engines to be tested must be identified in the test plan which must be approved by the Approval Authority.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.

2.21 What testing must be performed by small volume manufacturers?

In case of manufacturers that hold EU Stage V type-approvals for no more than two engine families in total in the group of engine categories NRE-v-5 and NRE-v-6 ('small volume manufacturers'), if the testing scheme based on a four-years period is chosen by the manufacturer, a smaller number of tests is required annually as set out in Point 2.6.2.3.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.6.2.3.

2.22 Do I have to test engines in scope of Regulation (EU) 2016/1628 but that are subject to an exemption or transition provision?

No, any engine subject to Articles 34 or 58 of Regulation (EU) 2016/1628 do not have a Stage V type approval and are consequently excluded from ISM testing.

Reference: Regulation (EU) 2016/1628, Articles 19, 34 and 58

2.23 If there is no NRMM available to test, do I need to perform ISM?

The Regulation does not apply in cases where the manufacturer demonstrates that it is not able to obtain access to any engine installed in a NRMM for the purpose of in-service monitoring. The manufacturer must ensure due diligence in seeking to find available NRMM to test.

Reference: Delegated Regulation (EU) 2017/655, Article 2, Point 3.

3 PREPRARATIONS FOR PERFORMING AN ISM TEST

3.1 How should the operation of the NRMM to be tested be selected?

The aim should be to perform the work that is normally performed by the NRMM at the location the machine normally works to the extent that is possible. However, it is necessary that the operation:

 a) assesses the actual operation of the majority of inservice population of the selected category(ies) of NRMM;



- b) does not include a disproportionate amount of activity at idle speed; and
- c) comprises sufficient load activity to achieve the required minimum test duration (see question 4.2 of this FAQ).

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 3.2.1 and 3.2.3.

3.2 If the ISM test comprises work that the NRMM normally performs at a location it would normally work is it required to obtain approval of the approval authority for the operation of the NRMM??

No, in this case approval is not required.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 3.2.1. and 3.2.3.

3.3 If it is not possible to perform the work that is normally performed by the NRMM at the location the NRMM normally works is it possible to simulate this activity at a different location?

Yes, in this case a representative test duty cycle shall be determined by the manufacturer that represents as far as possible the NRMM's actual operation. The representative test duty cycle must:

- a) assess the actual operation of the majority of in-service population of the selected category(ies) of NRMM;
- b) not include a disproportionate amount of activity at idle speed; and
- c) comprise sufficient load activity to achieve the required minimum test duration (see question 4.2 of this FAQ).

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 3.2.2 and 3.2.3.

3.4 If the ISM test cannot be performed during the actual operation of the NRMM, is it necessary to obtain pre-approval of the representative test duty cycle?

Yes, if normal work is simulated by a representative test duty cycle this cycle has to be described to and approved by the approval authority.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 3.2.2.1.

3.5 Is it required that the engine to be tested has been placed on the Union market?

Yes. Refer to Question 2.7. of this FAQ.

3.6 Is it necessary for the ISM test to be performed in the territory of the Union?

In most cases it will be necessary to perform the test in the territory of the Union. However, if it can be demonstrated that the individual engine selected for testing has already been placed on the Union market then testing may be performed outside the Union. Refer to Question 2.8. of this FAQ.

3.7 In case an operator that usually operates the NRMM is used during the ISM test, is it necessary to provide evidence of that operator's skills and training?

No, this is not required.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 3.1.1.

3.8 Is it permitted to replace a normal operator during the ISM test?

Yes, as long as evidence is provided to approval authority that the alternative operator possesses enough skills and training to operate the NRMM.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 3.1.1.

3.9 If the normal operator is replaced during the ISM test what evidence of skill and training must be provided?

The manufacturer must provide information on the skills and training that would be required for a normal operator and demonstrate that the alternative operator has adequate capability to operate the NRMM at the same level of competence.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 3.1.2.

3.10 What additional checks must be performed to ensure that the selected engine is eligible for an ISM test?

The intent of ISM is to assess the engine design not to assess the impact of incorrect maintenance, tampering or faults. Consequently, eligible engines must:

- a) have a maintenance record to show that the engine has been properly maintained and serviced in accordance with the manufacturer's recommendations;
- exhibit no indications of misuse (e.g. overloading or misfuelling), or other factors (such as tampering or emission related fault codes) that could affect the gaseous pollutant emissions performance;
- c) be in conformity with the EU type-approval documents with regard to the components of the emission control system(s) installed in the engine and in the NRMM;
- d) have a communication interface that enables collection of the necessary ECU data; and
- e) not influence the gaseous pollutant emissions due to the collection of ECU data.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 1.3. and 1.4.

3.11 How must NRMM be prepared for testing?

The preparation of the NRMM selected for testing must comprise at least the following:

- a) the check of the engine: any identified problems, once solved, must be recorded and presented to the approval authority;
- b) the replacement of the oil, fuel and reagent; and
- c) where applicable, demonstration of the availability of the ECU data stream information.

The requirement of point (b) is intended to ensure that the fluids in question comply with the specifications listed in the type-approval information package applicable to the engine type. Where it is already possible to confirm that the correct fluids are present it should not be necessary to replace these fluids.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Point 3.

3.12 How must ECU data stream information be provided?

Access to data stream information must be provided in accordance with one of the standards listed in Point 2 of Appendix 7 to Delegated Regulation (EU) 2017/655 by means of a wired connection. The manufacturer is required to indicate in the information document the communication standard(s) used.

Reference: Delegated Regulation (EU) 2017/655, Appendix 7, Point 2

3.13 How must ECU data stream information be provided?

Access to data stream information must be provided in accordance with one of the standards listed in Point 2 of Appendix 7 to Delegated Regulation (EU) 2017/655 by means of a wired connection. The manufacturer is required to indicate in the information document the communication standard(s) used.

Reference: Delegated Regulation (EU) 2017/655, Appendix 7, Point 2

3.14 How may the ambient conditions be measured?

Ambient temperature must be measured at least before and after the test. It is intended that the measurement assess the temperature of the air in the vicinity of the NRMM. As an alternative the intake air temperature sensor may be used but in this case an adjustment must be applied to reflect the temperature offset between the air in the vicinity of the NRMM and that in the air intake. Ambient air pressure must be measured with a suitable sensor.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Point 5.1. and Table

3.15 Who may perform ISM tests?

ISM testing must be conducted under the responsibility of the manufacturer and in compliance with the requirements of the approval authority. The engine manufacturer is responsible for the submittal of the official test results and can choose whether to perform the testing itself or to outsource to a third party.

Reference: Regulation (EU) 2016/1628, Art. 19(1)

3.16 Do ISM tests need to be witnessed?

ISM testing must be conducted under the responsibility of the manufacturer and in compliance with the requirements of the approval authority. This gives the approval authority the right to witness ISM tests should it wish to do so though such attendance is not mandatory. Irrespective of whether the approval authority witnesses the test, the requirements set out in Delegated Regulation (EU) 2017/655 must be followed.

Reference: Regulation (EU) 2016/1628, Art. 19(1)

3.17 Is it necessary to obtain prior agreement of the approval authority for the method to check the conformity of the ECU torque signal?

Agreement of the approval authority is only required in the case that the manufacturer will not use the maximum torque method set out in Appendix 6, points 1.1 and 1.2 of the Delegated Regulation (EU) 2017/655. Refer also to questions 4.20. and 5.8. of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Appendix 6, Points 1.1. and 1.2.

3.18 What is the specification for a PEMS?

A PEMS is any measurement system that can be installed on an NRMM and that complies with the requirements set out in Appendix 1 to the Delegated Regulation (EU) 2017/655.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 6.1.

3.19 How must a PEMS be calibrated?

A PEMS must be calibrated according to the requirements on calibration and performance checks set out in Point 8.1. of Annex VI to Delegated Regulation (EU) 2017/654. See also Figure 1 of this FAQ below.

Reference: Delegated Regulation (EU) 2017/655, Appendix 1, Point 2.1.

Figure 1

Summary of Pre-test system-response, linearity verification and vacuum-side leak verification requirements (Delegated Regulation (EU) 2017/655, Appendix 1, Point 2.1)

Continuous gas analyser system-response and updating-recording verification to be performed upon initial installation in PEMS or after system modification that would affect response ⁽¹⁾

(1) Time-shift all gas analyser signals to achieve alignment relative to each other using measured response times established for each gas analyser Raw exhaust gas flow rate linearity verification to be performed within 185 days before ISM test

Gas analyser linearity verification to be performed within 35 days before ISM test

Vacuum-side leak check upon installation, after major maintenance and within 8 hours prior to start of ISM test

Reference: Regulation (EU) 2017/654 Annex VI table 6.5, point 8.1.5, point 8.1.6 and point 8.1.8.7.

3.20 Is it required to perform a verification of HC contamination ("HC hang-up")?

No, the Regulation does not have any provision to require a verification of HC contamination.

Reference: Delegated Regulation (EU) 2017/655, Appendix 1, Point 2.

3.21 When can an EFM be omitted?

An EFM is required unless one of the following is applicable:

- a) the exhaust system installed in the NRMM results in dilution of the exhaust by air upstream of the location where an EFM could be installed. In this case the exhaust sample must be taken upstream of the point of dilution; or
- b) the exhaust system installed in the NRMM diverts a portion of the exhaust to another part of the NRMM (e.g. for heating) upstream of the location where an EFM could be installed.

In these cases, where the manufacturer is able to provide robust evidence to the approval authority of the correlation between the fuel mass flow estimated by the ECU and the fuel mass flow measured on the engine dynamometer test bench, the EFM may be omitted and indirect exhaust flow measurements (from fuel and intake air flows or fuel flow and carbon balance) may be applied.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Table, Footnote 2

3.22 Is it required to perform a verification of HC contamination ("HC hang-up What is robust evidence of the correlation between the fuel mass flow estimated by the ECU and the fuel mass flow measured on the engine dynamometer test bench?

The regulation does not specify the evidence that must be provided. It is recommended that the manufacturer use good engineering judgement to provide suitable data to the approval authority.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Table, Footnote 2

4 CONDUCTING ISM TESTS

4.1 Is it necessary to conduct an ISM test on a NRMM where it is not possible to ensure safe installation and operation of PEMS?

No, those parties responsible for conducting the ISM test should ensure the installation complies with the locally applicable safety regulations and insurance requirements and should follow the instructions issued by the PEMS, measurement instruments, transfer line and sampling probe manufacturers. Where this is not



possible, the test should not be conducted and a different engine and NRMM should be selected where safe installation and operation can be achieved. See also question 2.23 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Point 4.1.

4.2 For how long must the ISM test be run?

It is necessary to run the ISM test until sufficient work has been accumulated. The minimum amount that must be obtained is five times the work that was recorded during the parent engine hot-start NRTC type-approval test (5x "reference work"). The aim is to accumulate no more than seven times that reference work, however this may be exceeded. Point 2 of Appendix 2 of the Annex to Delegated Regulation (EU) 2017/655 states that this amount of work should comprise only 'valid data'. It is understood that in the context of this point this means 'working events' as determined by the 'Machine work' marking algorithm set out in Point 3 of Appendix 4 of the Annex to Delegated Regulation (EU) 2017/655.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 3.2.3 and 3.5, Appendix 2, Point 2 and Appendix 4, Point 3.

4.3 Is it necessary to accumulate the required minimum amount of work in a single uninterrupted operating sequence?

Yes, unless certain conditions are met, in which case up to three test sequences may be joined together to achieve the required minimum amount of work. Data sampling where more than one operating sequence is combined shall be used only when either:

- the test conditions do not enable the required minimum amount of work to be obtained in a single uninterrupted operating sequence despite attempting to achieve this; or
- when the category(ies) of NRMM selected for testing is employed in multiple working activities with different relevant duty cycle(s).

The detailed conditions set out in Point 4.2.2 of the Annex to Delegated Regulation (EU) 2017/655 must be respected if combining operating sequences. Each operating sequence is required to include a minimum of one Non-Road Transient Cycle (NRTC) work. This is understood to mean one times the work that was recorded during the parent engine hot-start NRTC type-approval test (1x "reference work") after excluding cold start data in accordance with Points 6.4 and 6.4.2 of Appendix 2 of the Annex to Delegated Regulation (EU) 2017/655.

Note that an operating sequence is considered to be continuous even if the engine is temporarily stopped, so long as the operation of the data logging and PEMS system is not interrupted.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 4 and Appendix 2, Points 6.2, 6.4 and 6.4.2.

4.4 What happens if more data than 7x reference work has been accumulated?

It is generally not practical to stop a test at a specific point in time in order to limit the amount of work that is accumulated. As currently written, the Delegated Regulation (EU) 2017/655 does not prevent the manufacturer from using in the emission calculation the entire set of working events that has been accumulated even if this exceeds 7x reference work. It is anticipated that a future amendment to the Regulation will require the emission calculation to be truncated at the point where 7x reference work has been reached.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Point 2.

4.5 What happens if less data than 5x reference work has been accumulated?

Under certain conditions, it is permitted to join up to three operating sequences to achieve the required minimum amount of data. See question 4.3 of this FAQ.

4.6 How should the power for the PEMS system be provided?

The base procedure is to use an external power supply unit for the PEMS equipment. It is only when it can be demonstrated that it is not possible to use an external power supply unit that power can be drawn from the engine (directly or indirectly) and in such a case the peak power consumption shall not exceed 1 % of the engines maximum power.

The external power supply unit may be a generator, battery pack or other power source. Safety- and emissions requirements at the test site must however always be complied with.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Point 4.2.

4.7 Is it necessary to perform pre-test checks on the PEMS system?

Yes, the requirement set out in Appendix 2, Point 5. must be followed.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Point 5.

4.8 Is it necessary to start the PEMS measurement before starting the engine?

Gaseous pollutant emissions data sampling, measurement of the exhaust parameters and recording of the engine and ambient data shall start prior to starting the engine for the ISM test. The Regulation does not prevent any operation of the NRMM immediately prior to the ISM test.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Points 3 and 6.1.

4.9 Can a regeneration of the aftertreatment system be performed prior to an ISM test?

The Regulation does not prevent any preparation or operation of the NRMM machine immediately prior to the ISM test. Consequently, an aftertreatment regeneration can be performed prior to PEMS testing.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Points 3 and 6.1.

4.10 What happens in the case of regeneration taking place during the ISM test?

Data generated during an emissions aftertreatment system regeneration is not removed during data pre-processing or during determination of working events. It is consequently included during calculation procedures even though there is no process to apply an infrequent regeneration adjustment factor (IRAF) to the data as would be the case at type-approval. Consequently, if such a regeneration takes place during the ISM test it is recommended to make a note of that fact in Point 6.6. of the ISM test report.

Reference: Delegated Regulation (EU) 2017/655, Appendices 3, 4 and 5, Delegated Regulation (EU) 2017/654, Annex VI point 6.6.

4.11 Does operation outside of the specified ambient temperature and pressure invalidate the whole test?

No. Point 2.1.3. of Appendix 4 to the Annex of Delegated Regulation (EU) 2017/655 requires that data points in the extra-extended conditions (i.e. outside the ISM ambient boundary conditions in Point 3.3 of the Annex to Delegated Regulation (EU) 2017/655) are not used in the calculation of the ISM results.

Currently, EMROAD 6.03 Build 1 handles this in a different manner. If the percentage of data points in the extra-extended conditions (i.e. outside the ISM ambient boundary conditions in Point 3.3 of Annex to Delegated Regulation (EU) 2017/655) exceeds 1%, the test calculated using EMROAD is reported as invalid.

Reference:

- JRC Release Notes of EMROAD 6.03 Build 1 software
- Point 2.1.3. of Appendix 4 to the Annex of Delegated Regulation (EU) 2017/655

4.12 In the case that the PEMS system shuts down or fails during the ISM test, can the data collected still be used?

No, because at the end of the ISM test sequence, there would be insufficient time for the measurement instruments and data logger response times to elapse.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Points 6.3. and 7.3.

4.13 In the case of temporary signal loss during the ISM test, can the data collected still be used?

For continuous data sampling, the data can still be used in the case of temporary signal loss of less than 3 minutes.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 4.1.1.

4.14 In the case of a temporary fault with part of the PEMS system, can the data collected still be used?

Where the fault leads to either the shutdown of the PEMS system or a temporary signal loss, see Questions 4.12 or 4.13. In all other cases refer to the instrument manufacturers' instructions to determine whether the collected data has been affected by the temporary fault. If it has been affected the conclusion is the same as for Question 4.12.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Points 6.3. and 7.3. and Annex, Point 4.1.1.

4.15 In the case that an engine malfunction arises during the ISM test is the data collected invalid?

In case a malfunction is clearly notified to the operator via a visual warning, text message or any other indicator, the test is void.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Point 8.

4.16 In the case that a NRMM malfunction arises during the ISM test is the data collected invalid?

In order to comply with Point 1.2 of the Annex to Delegated Regulation (EU) 2017/655, the ISM test must be performed on a NRMM operating its normal duty cycle. In the case that the malfunction prevents the NRMM from performing its normal duty cycle, it implies that the test being performed is not eligible to be used for ISM.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 1.2

4.17 What checks must be performed during the ISM test?

Zero verification of the gas analysers must be performed at least every two hours. That means it is required to check whether the signal of the analyser returns to the zero value. In the case that the signal does not return to the zero value, it is not required to reset the analyser to zero at the time that verification is performed but such correction is permitted. See also Figure 2 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Point 7.1. and 7.2.

4.18 What post-test checks must be performed?

- a) At the end of the ISM test sequence, there must be sufficient time for the measurement instruments and data logger response times to elapse; and
- b) A valid post-test zero and span of the gas analysers must be performed within 30 minutes after the measurement is terminated in the case that no correction was made (i.e. the analyser was not reset to zero) during the ISM test. A post-zero and span of the gas analyser should not be performed in the case that the analyser was reset to zero during the ISM test

See also Figure 2 of this FAQ (following page).

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Points 6.3. and 7.3.

Figure 2

Zero, span and drift checks (Delegated Regulation (EU) 2017/655, Appendix 2, Point 5.4 and Point 7, Appendix 3, point 2)



4.19 Is it permitted to perform a post-test correction for HC contamination?

No, the Regulation does not have any provision to permit a post-test correction for HC contamination.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3 and question 3.20 of this FAQ.

4.20 In the case that the ISM test does not include operation of the engine at least once at a point on the maximum torque curve, is it necessary to perform an alternative check on the conformity of the ECU torque signal?

Yes, unless the manufacturer demonstrates to the approval authority that it is not possible to check the ECU torque signal during the ISM test. See also questions 3.17. and 5.8. of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Appendix 6.

5 DATA PRE-PROCESSING FOR GAESOUS POLLUTANT EMISSIONS CALCULATIONS

5.1 How are the resulting values from the pre- and post-test zero and span of the gas analysers used?

When a post-test zero and span has been performed (see Question 4.18) the magnitude of the drift must be checked and, if necessary, a drift correction must be applied. See also Figure 2 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 2.



5.2 How is the drift corrected concentration value calculated?

In accordance with the requirements set out in Point 2.1. or Point 3.5 of Annex VII to Delegated Regulation (EU) 2017/654. See also Figure 2 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 2.2.

5.3 In the case of performing drift correction, how should the comparison between uncorrected and corrected brake specific gaseous pollutant emission values be applied?

Delegated Regulation (EU) 2017/655 does not specify how to perform this comparison. It is understood that EMROAD calculates each brake-specific gaseous pollutant emission value from the integrated mass of gaseous pollutant emission of the test sequence and then divides this by the total work performed during the test sequence and consequently this method of comparison is recommended. This calculation is performed prior to determination of working events according to Appendix 4 or calculation of gaseous pollutant emissions according to Appendix 5. See also Figure 2 of this FAQ.

- Delegated Regulation (EU) 2017/655, Appendix 3, Point 3.2.2.1.
- JRCs EMROAD 6.03 Build 1 software

5.4 How must the time alignment between the engine ECU signals, gas analyser signals and EFM signal be performed?

This alignment is performed after time-shifting all gas analyser signals to achieve alignment relative to each other using measured response times established for each gas analyser (see question 3.19 and Figure 1 of this FAQ). The principle used by the Regulation is to perform three correlations. The first correlation is between the engine ECU signals (category 3) and the combined gas analyser and EFM signals (category 1+2), i.e. an initial alignment between the signals from the engine and the signals from external equipment. The second correlation is between the signals from the EFM (category 2) and those from the gas analysers (category 1). The third correlation is between the engine ECU signals (category 3) and those from the gas analysers (Delegated Regulation (EU) 2017/655, Appendix 3, Point 3.4., subpoint (c) states category 2 but this is understood to be a typographic error and should read category 1).

In each case, to simplify the correlation, one parameter is chosen from each category to represent the entire group of signals. The parameter chosen are as follows:

- a) CO₂ to represent the gas analysers in the second and third correlations;
- b) Exhaust mass flow to represent the EFM in the second correlation; and
- c) Fuel flow to represent the engine ECU in the third correlation.

There is an omission in the text of the Regulation that describes the first correlation. It is recommended that, consistent with EMROAD, for this correlation engine torque is used to represent the engine ECU and exhaust mass flow is used to represent the combined gas analyser and EFM signals (for Heavy-Duty on-highway the vehicle speed signal from the ECU is used to represent the ECU and the vehicle speed signal from the GPS is used to represent the combined gas)

In each case, the entire group of signals within a category is time-shifted together by the same amount.

See also Figure 3 of this FAQ (following page).

- Delegated Regulation (EU) 2017/655, Appendix 3, Points 3.2. to 3.4.
- JRCs EMROAD 6.03 Build 1 software

Figure 3



Summary of Post-test signal time-alignment requirements (Regulation (EU) 2017/655, Appendix 3, Point 3.)

⁽¹⁾ Conduct time-alignment by finding highest correlation coefficient between the two series of test parameters

⁽²⁾ Time-shift all signals within a category by same amount

5.5 How is the time alignment between different exhaust gas analysers taken care of?

Point 3.1. of Appendix 3 to Delegated Regulation (EU) 2017/655 refers to Delegated Regulation (EU) 2017/654, Annex VI, Point 8.1.5.3. which requires the data from the gas analysers to be shifted by their measured response times before performing the emission calculations. Consistent with Delegated Regulation (EU) 2017/654, Annex VI, Point 8.1.5.1., the determination of response times should only be required when the analyser is installed into the PEMS or if the PEMS is reconfigured in a way that would change system response. This is independent of the time alignment requirements in Question 5.4. of this FAQ.

- Delegated Regulation (EU) 2017/655, Appendix 3, Point 3.1.
- Delegated Regulation (EU) 2017/654, Annex VI, Points 8.1.5.1. and 8.1.5.3.

5.6 Must the data consistency check be performed after every ISM test?

Yes, this check must be performed as part of the post-test checks using the data collected during the ISM test. It should be performed after drift correction and time alignment has been performed.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 4.

5.7 What is the purpose of the data consistency check between the gas analysers and EFM data?

This is intended to provide an indication of installation concerns with the EFM (e.g. exhaust flow leaks) or with the time alignment. It relies upon a sufficiently precise fuel flow signal from the ECU.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 4.1.

5.8 Is it required to check the conformity of the ECU torque signal during each ISM test using the maximum torque method?

Yes, unless either:

- in the opinion of the manufacturer and with prior agreement of the approval authority, it is not possible to reach a point on the maximum torque curve under normal operation without overloading the engine installed in the NRMM, or to do so would not be safe, or;
- the manufacturer has proposed to the authority an alternative method which that authority accepts, or;
- the manufacturer has demonstrated to the approval authority that it is not possible to check the ECU torque signal during the ISM test, in which case the verification performed during the tests required for EU type-approval is used.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 4.2. and Appendix 6, and questions 3.17 and 4.20 of this FAQ.

5.9 Who is responsible to decide whether the results of the data consistency check are adequate?

The approval authority has discretion to decide whether to accept or void the test results based on the outcome of the data consistency check. This discretion does not apply to any tolerances that are specified as mandatory.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 4.5.

5.10 Should the emission concentrations be measured on a dry or wet basis?

Measurements should be conducted on a wet basis. If measured on a dry basis they must be converted to a wet basis.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 5.

5.11 Is it permitted to correct NOx concentrations for humidity and temperature?

No, correction is not permitted.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 6.

5.12 What should be done in case the required test parameters are not available in the units required by Delegated Regulation (EU) 2017/655?

The test parameters should be converted to the units required by the table in Appendix 2 of that Regulation.

Reference: Delegated Regulation (EU) 2017/655, table in Appendix 2.

5.13 In the case of continuous data sampling, in what order should the processing of data occur?

Delegated Regulation (EU) 2017/655 is not entirely clear on this point. It is recommended that the following steps are followed (see also Figure 4 of this FAQ):

- Exclude data from any episodes of temporary signal loss (up to 3 minutes);
- Exclude data from periodic checks of measurement instruments;
- Exclude data points that do not comply with the required ambient conditions;
- Perform drift correction (if applicable);
- Perform time alignment;
- Exclude cold start data;
- Identify working and non-working events;
- Ensure that there is sufficient work or CO₂ mass of working events remaining in order to qualify the operating sequence to be used; and
- Calculate result.

Reference: Delegated Regulation (EU) 2017/655, Annex Points 4.1, 6.3, 6.4 and 8, Appendix 2 Points 6.4.2 and 8, Appendix 3, Appendix 4 and Appendix 5.

5.14 In the case that multiple operating sequences are joined to create a single ISM test, when should those sequences be joined together?

Delegated Regulation (EU) 2017/655 is not entirely clear on this point. It is recommended that the following steps are followed (see also Figure 4 of this FAQ following page):

- Steps to be performed on individual operating sequences:
 - Exclude data from periodic checks of measurement instruments;
 - Exclude data points that do not comply with the required ambient conditions;
 - Perform drift correction (if applicable);
 - Perform time alignment;
 - Exclude cold start data;
 - Ensure that there is a at least one reference work or reference CO_2 mass of data remaining in order to qualify the operating sequence to be joined to other sequences;
- Join test sequences and perform following additional steps on the entire combined data set:
 - Identify working and non-working events;
 - Ensure that there is sufficient work or CO2 mass of working events remaining in order to qualify the combined operating sequences to be used; and
 - Calculate result.

When sequences are joined together, the requirements set out in Point 4.2.2. of the Annex to Delegated Regulation (EU) 2017/655 must be followed.

Reference: Delegated Regulation (EU) 2017/655, Annex Points 4.1, 4.2, 6.3, 6.4 and 8, Appendix 2 Points 6.4.2 and 8, Appendix 3, Appendix 4 and Appendix 5.

Figure 4

Recommended sequence for conducting in-service monitoring according to current in-force version of Regulation



5.15 Where data is excluded from the calculation is it permitted to delete that data from the file?

Irrespective of how the pre-processing and calculation tool function, it is not permitted to remove any data from the original test data files.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 7.

5.16 What is the consequence in the case that the amount of working events is less than 5x reference work or reference CO₂ mass?

The test is void unless it can be used for combination with further operating sequences according to the requirements of combined data sampling set out in Point 4.2. of the Annex to Delegated Regulation (EU) 2017/655.

- Delegated Regulation (EU) 2017/655, Annex, Point 4.2.
- Questions 4.2. and 4.3. of this FAQ

6 CALCULATION OF RESULTS

6.1 What data must be used when calculating the results of an ISM test?

The first set of calculations must be performed using both workbased and CO_2 -based moving average window (MAW) procedures using only working events. Following completion of the MAW calculations, the conformity factors should be determined using only valid averaging windows (see question 6.2. of this FAQ).



The second set of calculations must be performed by repeating

both work-based and CO₂-based MAW calculations without the determination of the valid data in accordance with Appendix 4. It is understood that in the context of this point 'valid data' means 'working events'. Therefore, the second set of calculations must be performed without applying the 'Machine work' marking algorithm of Point 3. of Appendix 4 to Delegated Regulation (EU) 2017/655. Following completion of the MAW calculations, the conformity factors should be determined using without removing invalid averaging windows.

In both cases, the minimum, maximum and 90th cumulative percentile conformity factors must be reported.

Reference: Delegated Regulation (EU) 2017/655, Appendix 5, Points 2.1 and 4, and Appendix 8, Points 9 and 10.

6.2 What is an (in-)valid averaging window for a work-based MAW calculation?

Valid averaging windows are those whose average power exceeds the threshold of 20% of maximum engine power. Windows that do not reach that threshold are invalid averaging windows.

Reference: Delegated Regulation (EU) 2017/655, Appendix 5, Points 2.2.2.

6.3 What is an (in-)valid averaging window for a CO₂-based MAW calculation?

Valid averaging windows are those whose duration does not exceed the maximum duration calculated according to Point 2.3.1. of Appendix 5 to Delegated Regulation (EU) 2017/655. Windows that exceed that duration are invalid averaging windows.

Reference: Delegated Regulation (EU) 2017/655, Appendix 5, Points 2.3.1.

6.4 What is the maximum engine power used for determination of a valid averaging window?

The maximum engine power is the maximum net power declared at Item 3.2.2.2. of Point 3 of the addendum to the type-approval certificate set out in Annex IV of Regulation (EU) 2017/656 for the engine type that was the subject of the ISM test. The applicable engine torque curve is that which corresponds to the maximum net power for that engine type.

Reference: Item 3.2.2.2. of Point 3 of the addendum to the type-approval certificate set out in Annex IV of Regulation (EU) 2017/656.

6.5 What is the reference work and reference CO₂ mass used for the moving average window calculation and where can these values be found?

The reference work is the work that was recorded during the parent engine hot-start NRTC type-approval test. It can be found at Point 11.3.1 of the addendum to the type-approval certificate set out in Annex IV of Regulation (EU) 2017/656.

The reference CO_2 mass is the CO_2 mass that was recorded during the parent engine hot-start NRTC type-approval test. It can be found at Point 11.3.2 of the addendum to the type-approval certificate set out in Annex IV of Regulation (EU) 2017/656.

Reference: Points 11.3.1. and 11.3.2. of the addendum to the type-approval certificate set out in Annex IV of Regulation (EU) 2017/656.

6.6 When performing the MAW procedure, how should the integration be performed and calculation be incremented?

Following the procedure set out in Points 2.1, 2.2 and 2.3 of Appendix 5 to Delegated Regulation (EU) 2017/655:

- In order to create the first window, the data is integrated in a forward direction until reaching the first data point where the integrated value is greater than or equal to the reference work or reference CO₂ mass; and
- For the subsequent windows, the start of each window is incremented with a time Δt equal to the data sampling period and the integration is repeated. The data sampling period must be equal to 1 second or less.

Reference: Delegated Regulation (EU) 2017/655, Appendix 5, Points 2.1., 2.2. and 2.3.

6.7 When conducting the calculation for the conformity factor using the CO_2 based MAW, how is the mass emission of gaseous pollutant corresponding to the applicable limit (m_L) determined?

 m_L can be determined as follows:

 $m_L = L \cdot W_{ref}$

Where:

L is the applicable limit, g/kWh

 $-W_{ref}$ is the engine reference work, kWh.

Reference: Delegated Regulation (EU) 2017/655, Appendix 5, Points 2.3.2.

6.8 Following the calculation of the result, how can it be determined whether the test is valid or void?

For a valid test, the percentage of valid averaging windows for both work and CO_2 based MAW calculations must be equal to or greater than 50%, (see question 6.2. and 6.3. of this FAQ). In all other cases the test is considered void and a further ISM test must be performed.

Reference: Delegated Regulation (EU) 2017/655, Appendix 5, Points 2.2.2. and 2.3.1.

6.9 In case of a void test is it permitted to conduct a further test using the same NRMM but operate that NRMM with a higher load?

If the minimum percentage of valid averaging windows cannot be met in normal operation of the NRMM, then it should be allowed to operate the NRMM with adjusted load pattern as long as the work produced is still considered normal for the NRMM type.

If the test with adjusted load pattern cannot be performed during the complete (or partial) NRMM's actual operation, then a representative test duty cycle must be determined by the manufacturer in agreement with the approval authority.

If the required load pattern cannot be adjusted enough while considering the normal work done by the NRMM another NRMM has to be chosen for the testing.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 3.2. and Appendix 5, Point 2.2.2.

7 REPORTING OF ISM TEST RESULTS

7.1 To whom must ISM test results be reported?

Results must be reported to the approval authority that granted the type approval for the engines concerned.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.6.

7.2 What information must be reported?

The following must be reported:



- The results of the calculations listed in Question 6.1 of this FAQ in accordance with the reporting procedures set out in Point 10 of the Annex to the Delegated Regulation (EU) 2017/655.;
- Sufficient information for the approval authority to judge whether the test is valid in accordance with Point 4.5. of Appendix 3 to the Annex of Delegated Regulation (EU) 2017/655; and
- the necessary additional evidence in the case that the manufacturer does not use an exhaust flow meter as permitted by note 2 to the table in Point 1. of Appendix 2.

It is not required to submit instantaneous measured data and instantaneous calculated data, however that data must be made available upon request to the European Commission and the approval authority for a period of at least 10 years.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 10.; Appendix 3, Point 4.5.; Appendix 2, Point 1., note 2

7.3 In what format must the information be provided?

The test report shall be structured according to the numbering scheme set out in Appendix 8 to the Annex of Delegated Regulation (EU) 2017/655 and include the fields identified in Point 10. of the Annex to Delegated Regulation (EU) 2017/655. The format for any additional information is not specified by the regulation. The form of the submission (paper, electronic, etc) should be agreed with the approval authority concerned.

It is recommended that the instantaneous measured and instantaneous calculated data, if requested, is provided in a format that can be imported into commonly available software (e.g. MS-Excel).

Reference: Delegated Regulation (EU) 2017/655, Annex, Appendix 8 and Annex, Point 10.

7.4 When must the results of the ISM testing be reported?

For engines tested according to the schedule stipulated in Annex, Point 2.6.1. in Delegated Regulation (EU) 2017/655 the results of the first nine engines must be submitted by 31 December 2022 and the results of the second nine engines by 31 December 2024.

For engines tested according to the schedule stipulated in Annex, Point 2.6.2. in Delegated Regulation (EU) 2017/655 the test results of the first nine engines must be submitted not later than 12 months after the first engine was installed in a NRMM and not later than 18 months after starting the production of the approved engine type or engine family. When the manufacturer demonstrates to the approval authority that no engine has been installed in a NRMM 18 months after starting the production, the test results must be submitted after the installation of the first engine, on a date agreed with the approval authority.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 2.6.1. and 2.6.2.

7.5 What would be the consequences of not submitting to the approval authority the required number of test results according to the deadlines set out in Question 2.17. of this FAQ

In accordance with Art. 8(4) of Regulation (EU) 2016/1628, manufacturers shall ensure that procedures are in place for series production to remain in conformity with the approved type and for monitoring emissions of in-service engines. This implies that failing to fulfil the ISM testing requirements is similar to failing to fulfil conformity of production testing.

If failing to submit the required number of ISM test results according to the deadlines is treated similarly to a failure to fulfil conformity of production testing, the approval authority could withdraw the EU type-approval if sufficient measures to remedy the situation are not taken by the manufacturer. Consequently, if a manufacturer is unable to comply with the deadlines then that manufacturer should discuss this with the approval authority at the earliest opportunity.

Reference: Regulation (EU) 2016/1628, Art. 8(4) and Art. 26(5)

8 POST-TEST RETENTION OF DATA AND MATERIALS

8.1 What data must be retained by manufacturers?

Test data must be retained according to the requirements of Point 7. of the Annex to Regulation (EU) 2016/1628. This requires that no data is modified or removed from a test and that the entire data is retained for a period of at least 10 years. As a matter of good practice, it is also recommended to retain a copy of all material submitted to the approval authority according to Question 7.2. of this FAQ.



In accordance with Point 3.4. of the Annex to Delegated Regulation (EU) 2017/655 the samples of lubricating oil, fuel

and reagent must be retained for a period of 12 months or less if agreed by the approval authority. The manufacturer should take care to retain sufficient quantity of those fluids to enable an analysis to be conducted.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 7. and 3.4.

9 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 typeapproval 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, amended by Delegated Regulation (EU) 2018/989, with regard to technical and general requirements relating to emission limits and type-approval for internal combustion engines for non-road mobile machinery.

Commission Delegated Regulation (EU) 2017/655, amended by Delegated Regulation (EU) 2018/987, on monitoring of gaseous pollutant emissions from in-service combustion engines installed in non-road mobile machinery.

Commission Implementing Regulation (EU) 2017/656, amended by Delegated Regulation (EU) 2018/988, on administrative requirements relating to emission limits and type-approval for internal combustion engines for non-road mobile machinery.

Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016, on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

European Commission – Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, questions and answers related to the United Kingdom's withdrawal from the European Union with regard to industrial products as of 01 February 2019

Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, OJ L 29, 31.1.2020

