FAQ

FREQUENTLY ASKED QUESTIONS

IN-SERVICE MONITORING

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 machinery.

May 2023

EUROMOT

DISCLAIMER

This FAQ reflects the view of EUROMOT, as regards the legal provisions of Delegated Regulation (EU) 2017/655 and the Regulation (EU) 2016/1628 that it supplements, and it must not be considered or intended as a legally binding text for any reason whatsoever.

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Accordingly, in case of discrepancies between the content and interpretation of this FAQ and the text of the legislation (Delegated Regulation (EU) 2017/655 and Regulation (EU) 2016/1628), the legislation must be applied.

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TABLE OF CONTENT

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 both Commission Delegated Regulation (EU) 2018/987 and Commission Delegated Regulation (EU) 2022/2387 as corrected by the Corrigendum published in the Official Journal of the European Union L 321 of 15 December 2022 (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.

Whilst this regulation applies to engine manufacturers, it is recommended that other bodies that are conducting in-service testing for their own purposes follow the same procedures.

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).

Initially, Delegated Regulation (EU) 2017/655 applied 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 amending Delegated Regulation (EU) 2022/2387 has extended the scope to all the other stage V engine categories.

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.

It should be noted that whilst Delegated Regulation (EU) 2017/655 mandates that engine manufacturers conduct ISM testing, it does not mandate any pass-fail criteria for the engines that are tested. This is because, as set out by Article 19 of Regulation (EU) 2016/1628, the ISM programme is intended to gather information on the extent to which the emissions measured from the test cycle correspond to the emissions measured in actual operation. It also enables suitable test methodologies to be evaluated on a large scale, and lessons learned accordingly. i.e., the ISM programme is a research project.

Reference:

- *Regulation (EU) 2016/1628, Art. 19 (1) and Art. 3 (49)*
- *Commission Delegated Regulation (EU) 2017/655*
- *Commission Delegated Regulation (EU) 2022/2387*
- *Corrigendum to Commission Delegated Regulation (EU) 2022/2387 published in the Official Journal of the European Union L 321 of 15 December 2022*

2 SCOPE AND ISM GROUPS

2.1 Are all Stage V engine (sub-)categories in scope of Delegated Regulation (EU) 2017/655?

Yes. Although originally limited to (sub-)categories NRE-v-5 and NRE-v-6, following publication of the 2022/2387 amendment all Stage V (sub-) categories are in scope. See also questions 2.2 and 2.4 for engine families and types that are not subject to ISM testing according to the Annex of Regulation (EU) 2017/655

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

2.2 Does the Annex to Delegated Regulation (EU) 2017/655 apply to all engine (sub-) categories that are in scope of that Regulation?

No. For engines of category NRSh, and of sub-categories NRS-vi-1a and NRS-vr-1a the Annex and consequently the requirement to conduct testing does not apply. Engines from these (sub) categories were the subject of a prior pilot project conducted in conjunction with the European Commission Joint Research Centre (JRC). In the case of these engines the manufacturer must ensure that the aging procedure used to establish the deterioration factor used at type-approval is *'…designed to allow the manufacturer to appropriately predict the in-use emission deterioration expected over the emission durability period (EDP) of those engines under typical use.'*

Consequently, the remainder of this FAQ does not apply to engine (sub-)categories NRSh, NRS-vi-1a and NRS-vr-1a.

Reference:

- ***Delegated Regulation (EU) 2017/655, Article 3.***
- ***RC* Science for Policy Report, in-service monitoring for small utility engines, pilot programme for procedure development, Zardini A., Forni F., Montigny F., Carriero M., Perujo A., 2018. (https://publications.jrc.ec.europa.eu/repository/handle/JRC108758)**

2.3 Are Stage V engine types or families that were type-approved prior to the entry into force of amendment 2022/2387 to Regulation (EU) 2017/655 in scope of the amended Regulation?

Yes. It is irrelevant whether the engines were type-approved before or after the entry into force of the amendment. ISM must nevertheless still be conducted as required by Annex I to the amended Regulation.

Reference:

- ***Regulation (EU) 2016/1628, Article 19.***
- ***Delegated Regulation (EU) 2017/655, Article 3a, paragraph 3.***

2.4 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. Engines placed on the EU market in conformity with one of the exemption or transition provisions in Art. 34, or 58 of Regulation (EU) 2016/1628 are not in scope of Regulation (EU) 2017/655.

Engines type approved according to article 35 are subject to ISM.

Reference:

- ***Regulation (EU) 2016/1628 article 19, 34, 35 and 58***
- ***Delegated Regulation (EU) 2017/655, Article 2, Point 1***

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

All engine types and engine families produced by the manufacturer are placed into ISM groups in accordance with their (sub-)category as set out in Table 1 and illustrated in Figure 1 of the Annex to Regulation (EU) 2017/655. One manufacturer may have one ISM Group for each possible type of ISM Group i.e. a manufacturer may have one ISM group A, one ISM group B, etc, but they may not have two group A's, two group B's, etc. The table and figure are included here for convenience. ISM groups O & P covering snowmobile (SMB), All Terrain and Side by Side Vehicles (ATS) are not included in the scope of this FAQ.

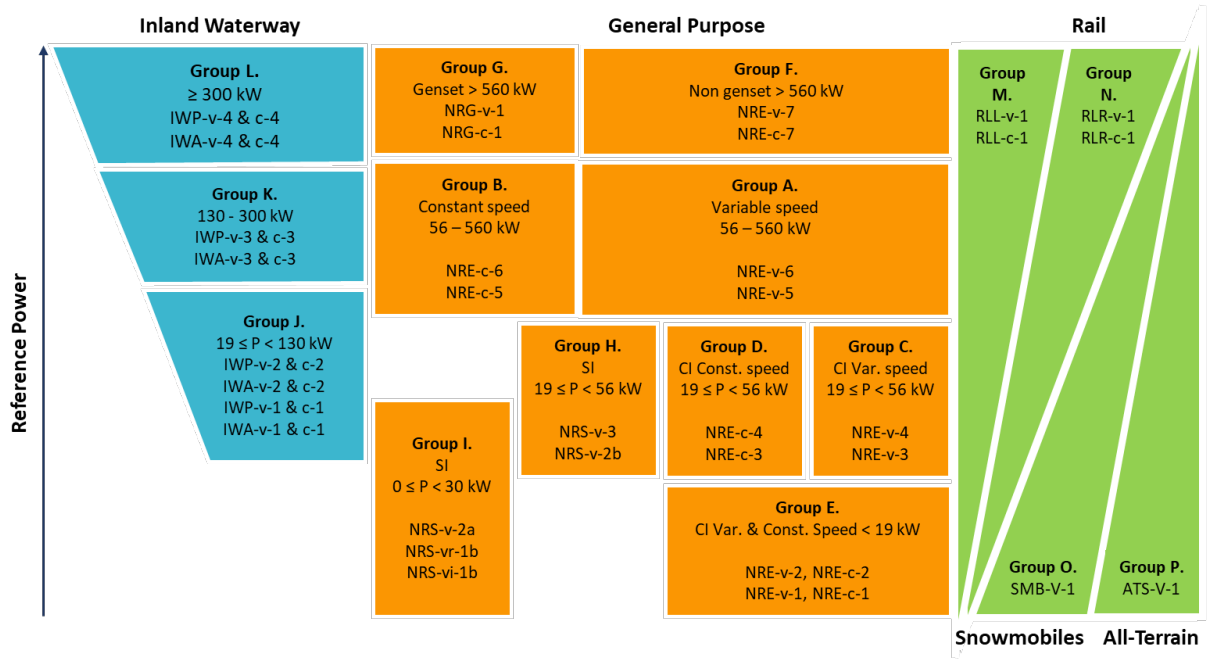
Table 1

ISM Groups

ISM Group	Engine (sub-)categories
A	NRE-v-5, NRE-v-6
B	NRE-c-5, NRE-c-6
C	NRE-v-3, NRE-v-4
D	NRE-c-3, NRE-c-4
E	NRE-v-1, NRE-c-1, NRE-v-2, NRE-c-2
F	NRE-v-7, NRE-c-7
G	NRG-v-1, NRG-c-1
H	NRS-v-2b, NRS-v-3
I	NRS-vr-1b, NRS-vi-1b, NRS-v-2a
J	IWP-v-1, IWP-c-1, IWA-v-1, IWA-c-1, IWP-v-2, IWP-c-2, IWA-v-2, IWA-c-2
K	IWP-v-3, IWP-c-3, IWA-v-3, IWA-c-3
L	IWP-v-4, IWP-c-4, IWA-v-4, IWA-c-4
M	RLL-v-1, RLL-c-1
N	RLR-v-1, RLR-c-1
O	SMB-v-1
P	ATS-v-1

Figure 1

Illustration of ISM Groups



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

2.6 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 has 2 engine families in sub-category NRE-v-5 and 3 engine families in sub-category NRE-v-6, the total number of engines required in the monitoring plan for ISM Group A as set out in section 2.6.1 of the Annex to Regulation (EU) 2017/655 must be selected from the combination of those 5 families. It is not required to select the total number of engines from each engine family. Similarly, If the engine manufacturer has 3 engine families in sub-category RLL-v-1 and 1 engine family in sub-category RLL-c-1, the total number of engines required in the monitoring plan for ISM Group M as set out in section 2.6.2 of the Annex to Regulation (EU) 2017/655 must be selected from the combination of those 4 families. See also question 2.5 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 1.2 and 2.6.

2.7 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 for each ISM Group, irrespective of the number of approval authorities that have granted type approvals within that ISM Group to that manufacturer.

For example, if the manufacturer has 2 engine families in category NRE-v-5 with type-approvals issued by approval authority X. and 3 engine families in category NRE-v-6 with type-approvals issued by approval authority Y., total number of engines required in the monitoring plan for ISM Group A as set out in section 2.6.1 of the Annex to Regulation (EU) 2017/655 must be selected from the combination of those 5 families. It is not required to select the total number of engines covered by type-approvals issued by approval authority X., plus the total number of engines covered by type-approvals issued by approval authority Y. In the case that the ISM Group contains engine types, and/or engine families, approved by different approval authorities, the approval authority designated by all approval authorities involved is responsible for ensuring compliance with the Regulation. See also question 4.6 of this FAQ.

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

3 SELECTION OF ENGINES AND NRMM FOR INCLUSION IN AN ISM PLAN

3.1 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 monitoring 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 testing scheme selected for the ISM group. It is not required to test every engine family or engine type within the ISM group. (See also questions 2.6).

Determination of the most representative categories could be based upon, the most common types of NRMM for which the manufacturer sells engines, the type of engines or NRMM with the highest annual production volume or other suitable operating criteria including the annual operating hours of the NRMM. Approval authorities are required to ensure that it covers the widest variety of engine types and categories of NRMM.

Where a group contains engines of both category IWP and IWA the selection must include, to the extent possible, engines of both categories.

Reference:

- ***Delegated Regulation (EU) 2017/655, Annex, Points 1.2, 1.3., 2.4 and 2.6.***
- ***European Commission – Directorate-general for Internal Market, Industry, Entrepreneurship and SMEs, GEME meeting minutes as of 07 March 2018, Point 7.***

3.2 What qualifies an engine for ISM testing?

Each selected engine 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.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 1.3.

3.3 Must a Test Engine have an ECU that provides the data required in Annex 7?

No, this was the case prior to amendment 2022/2387 but the requirement was removed in that amendment. This is because there are very likely to be engines in the newly-in-scope groups without ECU or with an ECU that does not have the necessary data or transmission capabilities.

Where there is no capability to transmit the data required in Annex 7 the calculations can only be conducted and results reported for the CO_2 mass-based method.

Engines with an Electronic Control Unit (ECU) and a communication interface intended to provide the necessary data as specified in Appendix 7, but with a missing interface or missing data, or where it is not possible to achieve clear identification and validation of the necessary signals, are not eligible for ISM, and an alternative engine must be selected.

The approval authority is not permitted to accept the absence of an ECU or interface, or absent or invalid signals, or lack of conformity of the ECU torque signal, as a reason to reduce the number of engines to be tested under the ISM Regulation.

The regulation does not require a manufacturer to preferentially choose engines designed with an ECU and interface over those engines that do not have an ECU or interface.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 1.4.

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

No, this was the case until amendment 2022/2387 but the requirement was removed in that amendment. This facilitates testing of engines in NRMM that have left the production line but have not yet been supplied to an importer or end-user. That can be particularly helpful in cases where identifying specific candidate engines held by end-users in the EU market is challenging. It also facilitates testing outside of the EU as was already permitted for the type-approval of engines. (See also question 3.5 & 5.8)

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 1.3 and 3.6.

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

No, this was in most case required until amendment 2022/2387 entered into force (see Question 3.4) but with that amendment it is now more practical to test outside the EU. The manufacturer must provide evidence to the approval authority that the conditions under which the ISM would be conducted are similar to the ones it would have encountered if tested in the Union (operation, ambient conditions, fluids and operating conditions). See also Question 5.8 of this FAQ.

Where a manufacturer has a monitoring plan set up that did not originally include testing outside the European Union, but now wishes to do so, it will be necessary to revise the monitoring plan with the approval authority, demonstrating the above conditions are met.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 3.6.

3.6 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.

For example: in consequence, it may not be possible for the retailer of the NRMM to identify the name of an individual customer to the manufacturer.

Reference: Regulation (EU) 2016/679

3.7 Why are there different ISM testing schemes available to manufacturers?

This is necessary due to the wide variety of different NRMM and different uses for which those NRMM are used, but also recognises that whilst testing engines with both low and high operating hours is preferred due to the additional information this provides, it may not always be possible to identify NRMM with suitably high service accumulation. Finally, it is recognised that the number of tests to be conducted needs to be proportionate, taking into consideration the limited production of engines in certain cases.

Reference: Regulation (EU) 2016/1628, Art. 19. Delegated Regulation (EU) 2017/655, Annex, Point 2.6

3.8 What are the different ISM testing schemes that are available to the manufacturer?

The two main testing schemes are the Emission Durability Period (EDP)-based testing scheme and the alternative based upon a 4-year period.

The objective of the EDP-based scheme is to include engines with both low operating hours and high operating hours, to provide data on whether there is a significant difference in results between the two points. The NRMM age-based scheme is a subset of this approach (solely for ISM groups C, D, E, H and I) recognising that, particularly for smaller NRMM, there may not be a means to determine engine operating hours, but that NRMM age could be used as a surrogate for operating hours. The number of engines to be selected for ISM testing is generally lower for these schemes than for the scheme based upon the 4-year period, to encourage the former to be used.

The testing scheme based upon a 4-year period does not require engines with specific service accumulation to be selected and is likely to be predominantly used for engines of low operating hours where engines with high service-accumulation are unavailable. It also ensures any manufacturers first entering the market after the EDP/NRMM age-based schemes have expired are still subject to ISM. A sub-set of the testing-scheme based upon a 4-year period are the so-called ‘Small-volume manufacturers’ schemes which reduce the testing burden where a manufacturer produces only a small number of engines annually in a specific ISM group.

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

3.9 What are the required operating hour ranges for use of the EDP-based scheme?

The low-hour engines in the power range from ≥ 56 kW to < 130 kW must have accumulated fewer operating hours than 20% of the emission durability period (EDP). For low-hour engines below and above that power range the number of operating hours must be fewer than 10% and 30% respectively.

The high-hour engines in the power range from ≥ 56 kW to < 130 kW must have accumulated more operating hours than 55% of the emission durability period (EDP). For high-hour engines below and above that power range the number of operating hours must be more than 40% and 70% respectively.

Note: When the manufacturer cannot fulfil the above high-hour requirements due to unavailability of engines with the required service accumulation, the approval authority may permit high-hour testing of engines in the power range from ≥ 56 kW to < 130 kW with between 40% and 55% of EDP, subject to the manufacturer providing robust evidence that they have selected engines with the highest available service accumulation. For high-hour engines below and above that power range the number of operating hours in this case must be between 20% and 40% or 60% and 70% respectively.

ISM groups A, B, C, D, E, F, G				
Reference power of selected engine (kW)	**EDP (hours)**	**Low-hour engines (below) (hours)**	**High-hour engines (above) (hours)**	**High-hour engines when limited availability & approval authority agreement (above) (hours)**
P < 19	3000	300	1200	600
19 ≤ P < 37 (constant speed)	3000	300	1200	600
19 ≤ P < 37 (variable speed)	5000	500	2000	1000
37 ≤ P < 56	8000	800	3200	1600
56 ≤ P < 130	8000	1600	4400	3200
130 ≤ P	8000	2400	5600	4800

ISM groups J, K, L, M, N				
Reference power of selected engine (kW)	**EDP (hours)**	**Low-hour engines (below) (hours)**	**High-hour engines (above) (hours)**	**High-hour engines when limited availability & approval authority agreement (above) (hours)**
P < 56	10000	1000	4000	2000
56 ≤ P < 130	10000	2000	5500	4000
P ≥ 130	10000	3000	7000	6000

ISM groups I & H						
Reference power of selected engine (kW)	**Swept volume (cm 3)**	**EDP category**	**EDP (hours)**	**Low-hour engines (below) (hours)**	**High-hour engines (above) (hours)**	**High-hour engines when limited availability & approval authority agreement (above) (hours)**
P < 19	SV ≥ 225	Cat 1 - Consumer	250	25	100	50
		Cat 2 – Semi-professional	500	50	200	100
		Cat 3 - Professional	1000	100	400	200
19 ≤ P < 30	SV ≤ 1000	NA	1000	100	400	200
	SV > 1000	NA	5000	500	2000	1000
30 ≤ P < 56	any	NA	5000	500	2000	1000

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.6.1.1 and table 2, Point 2.6.2.1 and table 3.

3.10 What are the required NRMM age ranges for use of the age-based scheme for ISM groups C, D, E, H and I?

The newer NRMM (effectively low-hour engines) must have a production year not more than 2 years prior to the date of the ISM test. The older NRMM (effectively high-hour engines) must have a production year not less than 4 years prior to the date of the ISM test.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.6.3.1 and figure 2.

3.11 What additional flexibility in the monitoring plan was provided by the amending Regulation (EU) 2022/2387?

In recognition of disruption caused by the COVID-19 pandemic, the risk of further other disruption outside of the control of manufacturers and challenges in identifying suitable high-hour engines for the EDP-based scheme, certain additional flexibility was provided for the existing sub-categories NRE-v-5 & NRE-v-6 (i.e., ISM Group A).

The testing scheme based upon the 4-year period now allows the manufacturer to vary the number of tests each year, so long as the average number of test results delivered meets the criteria and leads to the same total number of tests conducted.

For the EDP-based testing scheme a limited reduction in the high-hours required is permitted where the manufacturer can provide robust evidence that they have selected engines with the highest available service accumulation, as outlined in Question 3.9 of this FAQ. Additionally, the result submission deadlines are postponed from 31 Dec 2022 and 31 Dec 2024 until 24 and 48 months after entry into force of the amending regulation for low and high hour engines respectively, i.e., 28 Dec 2024 and 28 Dec 2026.

Similar allowances are provided for the remaining (newly in scope) engine (sub-)categories. See also FAQ question 4.8.

Reference: Amending Regulation (EU) 2022/2387, Recital 2, Regulation (EU) 2017/655, Annex, Points 2.6.1.1, 2.6.1.2.

3.12 Do ISM tests in (sub-)categories NRE-v-5 and NRE-v-6 that were performed prior to the entry into force of amendment 2022/2387 to Regulation (EU) 2017/655 remain valid?

Yes. These are carried over as part of ISM Group A and count towards the number of tests required for the testing scheme for that group, as set out in section 2.6.1 of the Annex to Regulation (EU) 2017/655.

Reference: Amending Regulation 2020/2387 recital (4) and Delegated Regulation (EU) 2017/655, Article 3a, paragraph 3

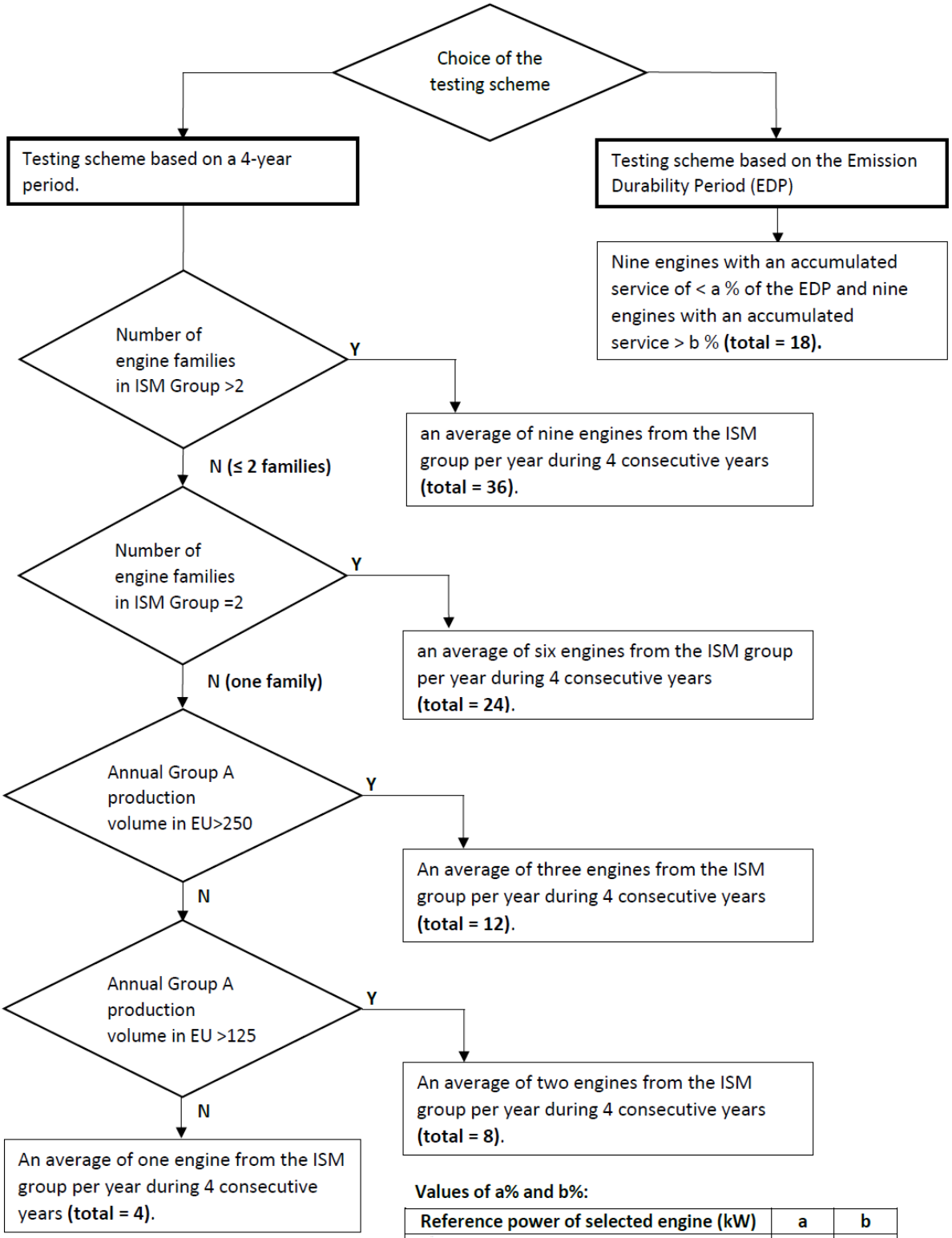
3.13 How many engines from the ISM group must the manufacturer test?

The number of engines to test primarily depends upon the ISM group concerned, whether the testing scheme based on EDP/NRMM age or four-year period has been selected by the manufacturer, and the annual production volume. The latter determines whether the group qualifies under a small volume scheme and for groups other than group A also influences the number of tests when there are more than four engine families. In all cases the number of tests is for the ISM group, not for each engine category, family or type. (See also question 2.6 of this FAQ). The decision trees provided at the end of this question enable identification of the number of tests to be conducted in each case.

Example Group A: The manufacturer selected the testing scheme based on emission durability period (EDP), has 2 engine families in sub-category NRE-v-5 and 3 engine families in sub-category NRE-v-6, comprising a total of 30 different engine types. In this case, 18 engines (9 with low operating hours + 9 with high operating hours) must be selected for testing from the combination of those 30 engine types. See also questions 2.3, 2.5, 2.6, 3.7 and 3.8 of this FAQ.

Example Group J: The manufacturer selected the testing scheme based on a 4-year period, has two engine families in sub-category IWP-v-2 with four engine types, two engine families in sub-category IWA-c-2 with five engine types and one engine family in sub-category IWA-c-1 with one engine type, comprising a total of 10 different engine types. The combined annual production for the EU market after discarding the four families with the highest annual production for that market is 30 engines per year. In this case, an average of 2 engines per year must be selected for testing from the combination of those 10 engine types. i.e., a total of 8 tests over the four-year period. Because this group contains engines of both category IWP and WA the selection must include, to the extent possible, engines of both categories.

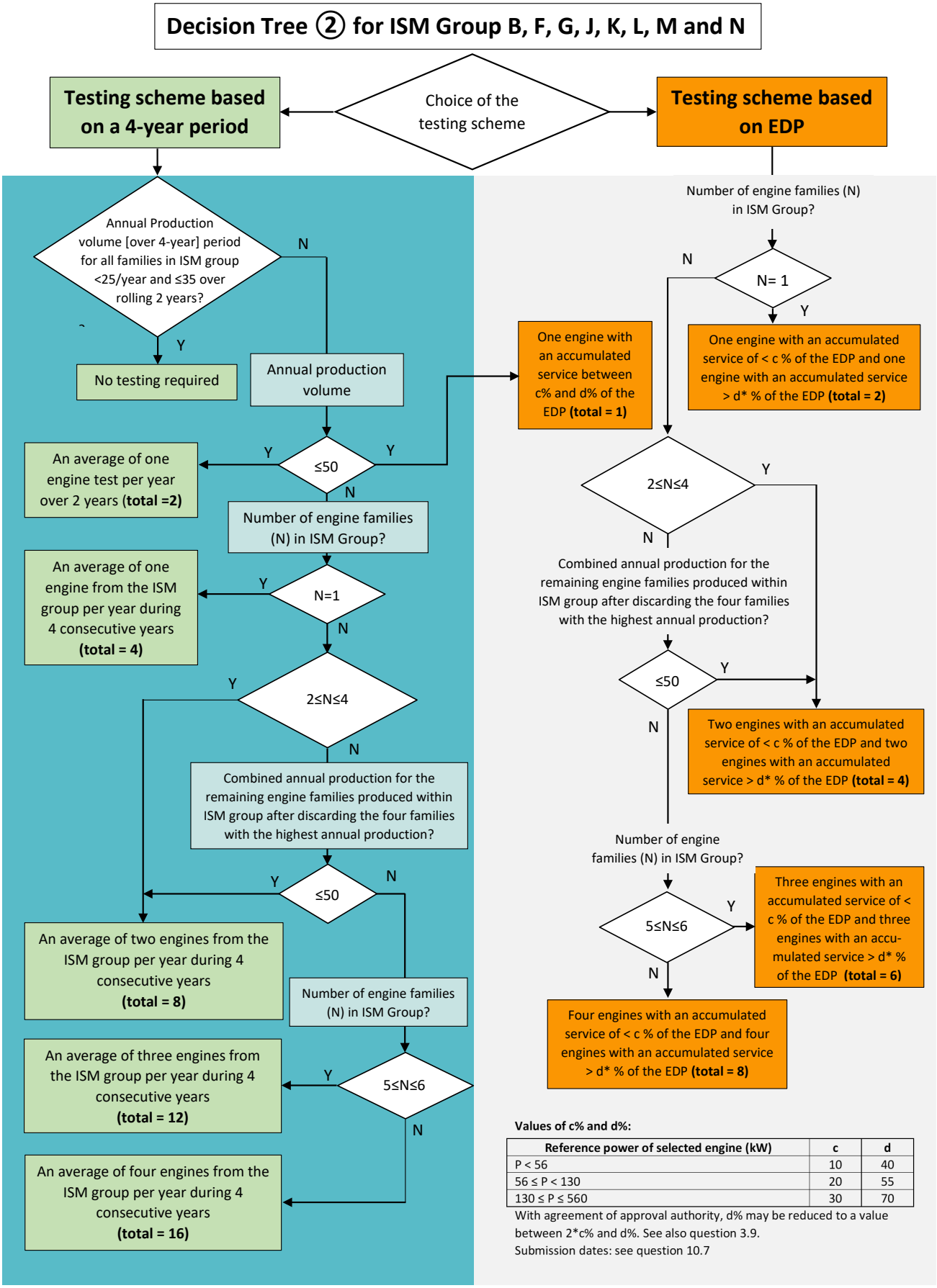
Decision ①Tree for ISM Group A



Values of a% and b%:

Reference power of selected engine (kW)	a	b
56 ≤ P < 130	20	55
130 ≤ P ≤ 560	30	70

With agreement of approval authority, b% may be reduced to a value between 2*a% and b%. See also question 3.9.
Submission dates: see question 10.7



Values of c% and d%:

Reference power of selected engine (kW)	c	d
P < 56	10	40
56 ≤ P < 130	20	55
130 ≤ P ≤ 560	30	70

With agreement of approval authority, d% may be reduced to a value between 2*c% and d%. See also question 3.9.
Submission dates: see question 10.7

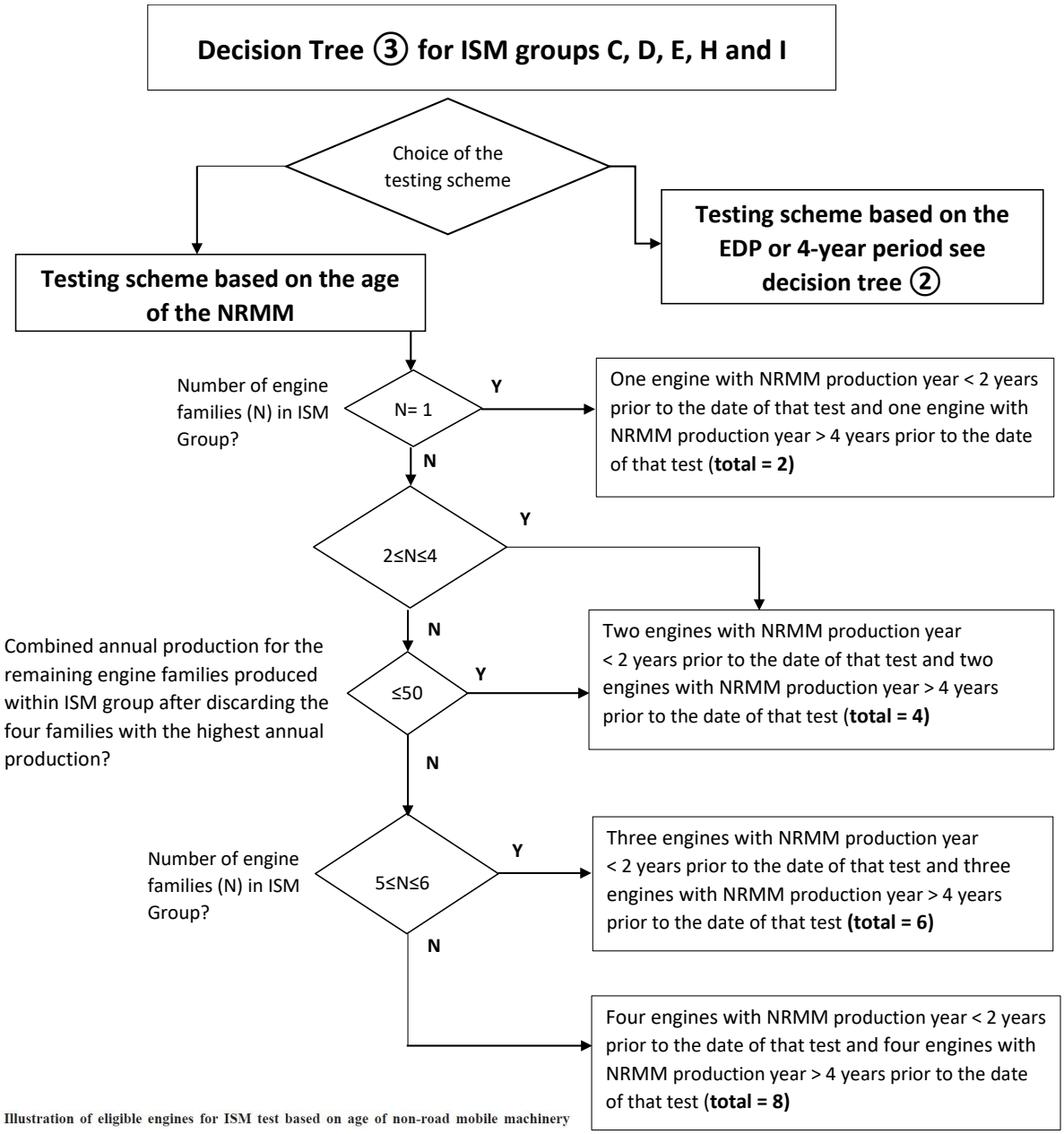
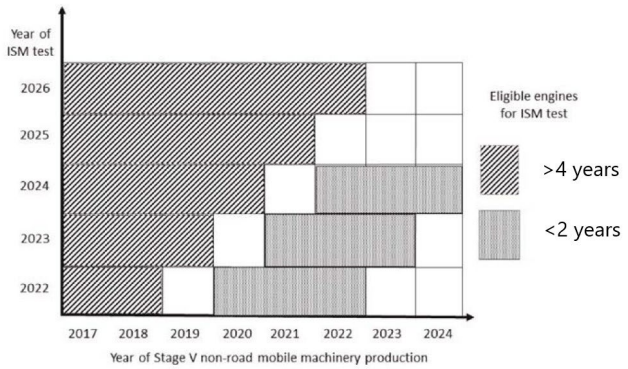


Illustration of eligible engines for ISM test based on age of non-road mobile machinery



Submission dates: see question 10.7

Reference:

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

3.14 What are 'small volume manufacturers' in the context of Delegated Regulation (EU) 2017/655?

'Small-volume manufacturers' refers to any manufacturer that has a very limited production of NRMM engines for the EU market within a specified ISM group, as set out in either points 2.6.1.2.3 or 2.6.2.2.3 of that Regulation. It is the responsibility of the approval authority to check that the production volumes are not exceeded (see also question 3.16 of this FAQ).

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 2.6.1.2.3 and 2.6.2.2.3.

3.15 When does a small volume manufacturers ISM testing scheme apply?

For ISM Group A, in the case of manufacturers that hold EU Stage V type-approvals for no more than two engine families in total in the group the number of tests to be performed under the 4-year testing scheme is reduced.

In the case of all other ISM groups, a reduced testing scheme applies if the combined annual production across all engine families in a particular ISM group does not exceed 50 engines. It is the responsibility of the approval authority to check that the production volumes are not exceeded (see also question 3.16 of this FAQ).

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 2.6.1.2.3 and 2.6.2.2.3.

3.16 Where can details of the annual production volume for the EU market be found?

The manufacturer is required to submit annually, to the approval authority that granted type-approval, a report listing the engines that were produced.

Reference: Regulation (EU) 2016/1628, Art. 37 and Delegated Regulation (EU) 2017/656, Annexes III and VII

3.17 When selecting engines and NRMM to test according to either the EDP-based testing scheme, based upon the 4-year period or based on the age of NRMM (ISM groups C, D, E, H and I only) could the engines to be tested be the same each time or be different?

The engines to be tested with high operating hours under the EDP-based or NRMM age-based scheme can be those with the same serial numbers as those already tested with low operating hours, or they can be different ones at the choice of the manufacturer. Similarly, the regulation does not prohibit engines with the same serial number being chosen more than once for the testing scheme based upon a 4-year period, though it would presumably be necessary to justify to the approval authority that sufficient additional operating hours had accrued between tests to warrant a further test. In any case, the engines to be tested must be identified in the monitoring plan which must be approved by the Approval Authority, taking into account the need to ensure that the engines tested represent the widest variety of engine types and categories of NRMM. See also FAQ question 3.1.

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

3.18 Does a manufacturer 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 does not have a Stage V type-approval and is consequently excluded from ISM testing. (See also question 2.4)

Engines granted a type-approval under article 35 are not exempted from ISM, as they do have a Stage V type-approval.

Reference: Regulation (EU) 2016/1628, Articles 19, 34, 35 and 58

3.19 Is it permitted to select for category RLL a Stage IIIB engine instead of a Stage V engine?

Yes, in certain circumstances. For engine category RLL the emission limit values for Stage IIIB are the same as those for Stage V, and the engine families and types may be identical. Consequently, when Stage V engines with the required service accumulation are unavailable, the approval authority must accept the selection of a Stage IIIB engine in the case the test report of the Stage IIIB engine family equivalent to category RLL was used to obtain the corresponding Stage V type-approval for that engine family.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.6.2.1.4.

3.20 If there is no NRMM available to test, does a manufacturer need to perform ISM?

The Regulation does not apply in cases where the manufacturer demonstrates that there are no engines in a specified ISM group installed in an NRMM to which it can obtain access for the purpose of in-service monitoring. The manufacturer must ensure due diligence in seeking to find available NRMM to test. In this case, discussions need to take place between the manufacturer and the approval authority that granted the type-approval.

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

3.21 If the NRMM is fitted with two or more engines, which should be selected for testing?

The test quotas contained in the Regulation are based upon the number of engines to be tested, not the number of NRMM to be tested.

The manufacturer is required to select engines for each applicable ISM group that represent the widest variety of engine types and categories of NRMM (See also FAQ question 3.1). In the case the NRMM is fitted with engines from two or more different ISM groups (for example an inland waterway vessel fitted with one engine in each of the ISM groups J, K and L) then there is no barrier in the Regulation to prevent multiple engines being selected for testing, each counted separately towards the quota of the respective ISM group.

In the case of two or more engines in the same ISM group fitted to the same NRMM, either engine could be selected for testing. It would not be required to test both engines and moreover it could be difficult to justify testing both engines, unless each was a different engine type or fulfilled a distinctly different function, given the requirement to ensure the widest variety of engine types and categories of NRMM are selected for testing.

For example, most likely it would not be appropriate to select two identical propulsion engines in the same NRMM. However, where appropriate, testing multiple engines in a single NRMM could be an efficient deployment of test resources, for example, but not limited to, testing two different engines on an inland waterway vessel, where one is for propulsion and the other is used to provide auxiliary power.

Reference: Delegated Regulation (EU) 2017/655, annex points 2.4 and 2.6.

3.22 If the only NRMM available to test has insufficient loaded operation to achieve the criteria for a valid test does the manufacturer need to perform ISM?

It is required to operate the engine installed in the NRMM in a manner that assesses the actual operation of the majority of in-service population of such engines, not include a disproportionate amount of idle activity and include sufficient loaded activity to achieve the minimum test duration. Delegated Regulation (EU) 2017/655 has several provisions to facilitate testing of NRMM that primarily operate at low load, including the use of short idle periods as working events, allowing the average power of a window to be as low as 10% of the reference power of the engine type being tested, and enabling multiple test sequences to be joined in order to achieve the required minimum work. If these measures are insufficient to achieve a valid test and there is no alternative operation possible, or alternative NRMM available, within the specified engine group that would operate at higher power, then the manufacturer should consult the approval authority to which the test plan is submitted. The Regulation does not exempt the manufacturer from the obligation to conducting ISM in this circumstance.

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

4 SUBMISSION, APPROVAL AND AMENDMENT OF THE MANUFACTURER'S PLAN TO MONITOR IN-SERVICE ENGINES

4.1 When should the initial monitoring plan be submitted?

For group A the initial monitoring 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.

For any other ISM group, the initial monitoring plan must be submitted by the later of 26 June 2023 or one month after the start of production of any approved engine type or engine family within that group that has been marked with the corresponding Union type approval number.

Reference:

- ***Delegated Regulation (EU) 2017/655, Annex, Point 2.1 and***
- ***Delegated Regulation (EU) 2017/654, Annex XI***

4.2 What is required in the initial monitoring 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 the EDP, NRMM age, 4-year, or small volume manufacturer testing schemes, according to Delegated Regulation (EU) 2017/655, Annex, Points 2.6.1.1, 2.6.1.2, 2.6.1.2.3, 2.6.2.1, 2.6.2.2, 2.6.2.2.3 or 2.6.3.1

The manufacturer must provide the criteria used and the justification for the selection of these items. See also Question 3.1 of this FAQ.

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

4.3 When should the monitoring 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 monitoring plan must 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 where the number of engine families in the ISM group or, if relevant, annual production volume for the EU changes, or if the manufacturer changes the chosen testing scheme.

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

4.4 Does the monitoring plan have to be approved by the approval authority?

Yes, the approval authority must approve the initial and subsequently updated monitoring 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.

4.5 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 monitoring 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.

See questions 3.1 and 3.2 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 2.5.

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

No. In the case that the ISM group contains engine types and/or engine families approved by different approval authorities, the approval authority designated by all approval authorities involved is responsible for liaising with the manufacturer to ensure compliance with the ISM Regulation. i.e., one approval authority takes overall responsibility.

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

4.7 Can a manufacturer request an adjustment to an agreed monitoring plan?

Yes. This has always been possible by the manufacturer submitting and seeking agreement to an amended monitoring plan. However, a lesson learned from experience during the COVID-19 pandemic was that the regulation should place more emphasis on the mutual dialogue between manufacturer and approval authority to establish a reasonable monitoring plan, rather than imposing rigid requirements. Consequently, along with greater flexibility, amending Regulation (EU) 2022/2387 provided particular guidance to the approval authorities that they should in any case accept a reasonable adjustment of the original ISM monitoring plan when there are unexpected events outside the control of the manufacturer.

Reference: Amending Regulation (EU) 2022/2387, Recital 3.

4.8 How soon must the monitoring programme commence?

There is no specific deadline to commence the testing programme as long as the deadlines for submitting the initial monitoring plan and reporting the results are met. However, the initial monitoring plan and all subsequent updates must be submitted to the approval authority, which must either accept the plan or request changes. Consequently, the approval authority has the power to reject a monitoring plan that it believes is unreasonable, such as conducting all testing for the monitoring plan based on a 4-year period in one year without a valid reason; The schedule needs to be agreed between the two parties.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 2.1-2.3 and 2.6.

4.9 For testing schemes based on a four-year period or for small volume manufacturers is it necessary to test the same number of engines each year?

No. The testing scheme now allows the manufacturer to vary the number of tests each year, so long as the average number of test results delivered meets the criteria and leads to the same total number of tests conducted. See also question 4.8 of this FAQ.

Reference: Regulation (EU) 2017/655, Annex, Points 2.6.1.2 and 2.6.2.2.

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

Yes. When informed that the manufacturer cannot fulfil the requirement due to the unavailability of high-hour engines with sufficient service accumulation the approval authority must not reject such a change. See also FAQ question 3.8 and 3.9.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 2.6.1.1.3, 2.6.2.1.3 and 2.6.3.1.3

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

Tests performed under the EDP-based testing scheme remain valid and can be used under testing scheme based on the 4-year period. In this case, the total number of engines to be tested under the 4-year period. should be reduced by the number of engines already tested and reported in accordance with the EDP-based scheme.

For example, in the case that the manufacturer has tested 9 engines under the group A EDP-based testing scheme of Point 2.6.1.1, then this reduces the number of tests to be performed under the four-year scheme of Point 2.6.1.2. to 36 – 9 = 27, i.e., three further years of testing an average of 9 engines per year to be performed. It is reasonable to assume that the three years would normally be consecutive and commence when the manufacturer decides to change from the EDP-based scheme to the x-per-year based scheme. See also FAQ question 3.8, 3.17 and 4.8.

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

4.12 What changes to the testing scheme are necessary in the case a manufacturer exceeds the annual EU production quantities permitted for the chosen small volume testing scheme before completing submission of results to the approval authority under that testing scheme?

If the permitted production quantities for the selected testing scheme are exceeded during the ISM test period, the manufacturer is required to change testing scheme to one that is appropriate to the increased production quantities. In that case, the total number of engines to be tested under the revised testing scheme must be reduced by the number of engines already tested and reported, in a similar manner to changes from the EDP-based scheme to the testing scheme based on a 4-year period.

For example, a manufacturer expects to produce a total between 25 and 50 engines per year for the EU market across all families in Group B and elects to test an average of one engine per year over 2 years as set out in point 2.6.2.2.3 of the Annex to Regulation (EU) 2017/655. In the second year of ISM testing production reaches 75 engines. In that case, the manufacturer is not eligible to complete the testing scheme as a small volume manufacturer but must instead choose one of the testing schemes under point 2.6.2.1 or 2.6.2.2 of the Annex to that Regulation. The revised quantity remaining to be tested is reduced by one engine in recognition of the testing already conducted.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 2.3, 2.6.1.2.3 and 2.6.2.2.3.

4.13 What changes to the testing scheme are necessary in the case a manufacturer exceeds the number of families or EU production volume permitted for the chosen testing scheme *before* completing submission of results to the approval authority under that testing scheme?

If the permitted number of families or production quantities for the selected testing scheme are exceeded during the ISM test period, the manufacturer is required to change testing scheme to one that is appropriate to the increased production quantities.

For example, a manufacturer with four engine families in ISM group B expected, according to table 4 of the Annex, that the combined annual production for EU market for the remaining engine families produced by manufacturer within group after discarding the four families with the highest annual production for EU market would not exceed 50 engines. In the event that 50 engines were exceeded, or the number of engine families increased, the manufacturer would be required to adapt the monitoring plan accordingly to test the overall quantity of engines appropriate for the higher production volume. The revised quantity remaining to be tested is reduced by the number of engines already tested.

Reference: Delegated Regulation (EU) 2017/655, Annex, table 4, point 2.3.

4.14 What changes to the testing scheme are necessary in the case a manufacturer exceeds the annual EU production quantities permitted for the chosen testing scheme *after* completing submission of all required results to the approval authority under that testing scheme?

Where the monitoring plan was completed as prescribed by the Regulation and to the satisfaction of the approval authority, it is unreasonable to be required to re-open discussion with the approval authority, nor test additional engines, if, some years later, the production quantities of engines increase.

Once the ISM obligation has been completed according to the Regulation there is no obligation to test further engines.

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

5 PREPARING FOR THE OPERATION OF THE NRMM SELECTED FOR AN ISM TEST

5.1 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 in-service 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 3.22 of this FAQ).

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

5.2 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.

5.3 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 must 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 3.22 of this FAQ).

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

5.4 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.

5.5 Is it permitted to remove an engine from the NRMM for testing on the test bed?

In general, it is not permitted, however there is an exception that allows the engine to be removed from the NRMM for engine ISM groups E, I, O and P, subject to additional requirements (see question 5.6 and 6.9 of this FAQ). It is not necessary to demonstrate to the approval authority that the engine cannot be tested in the NRMM.

Reference: Regulation (EU) 2017/655, Annex, Point 4.1.4

5.6 In case an engine of ISM groups E, I, O or P, is removed from the NRMM for testing on the test bed what additional requirements apply?

The engine inclusive of the entire emission control system should be removed from the NRMM and installed on the dynamometer test bench without adjustment to the emission control system. The engine must not be operated using the engine test cycle used for type-approval testing but must instead be operated in a manner similar to the way it would operate in the NRMM from which the engine was removed, and the data must be analysed and reported according to the ISM requirements. The detailed requirements are contained in Point 4.1.4 to the annex of Regulation (EU) 2017/655.

Reference: Regulation (EU) 2017/655, Annex, Point 4.1.4

5.7 Is it permitted to conduct ISM on an engine in a static railway vehicle?

Yes. This is permitted for ISM groups M and N (categories RLL and RLR) whenever it is not possible to install the PEMS systems without exceeding the loading gauge applicable to the rail network. In that case, it is permitted to test the railway vehicle whilst stationary using a representative test duty cycle determined by the manufacturer and agreed with the approval authority.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 4.1.3 and 3.2.2.

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

Not anymore, so long as the manufacturer can provide evidence that the engine will be tested under conditions that are representative of operating within the EU.

The following examples may be considered suitable evidence, none of which are mandatory or prescribed requirements. Alternative evidence is also acceptable:

- Confirmation that the engine is covered by the EU type-approval and labelled accordingly, and is installed in an NRMM that was produced in conformity with relevant EU machinery legislation and bears the corresponding CE mark (pictures of labels could be provided)
- Documentation that the fluid specifications match those declared by the manufacturer as required for operation in the EU
- An explanation justifying that there are no substantive differences in ambient conditions or the way in which the machine would be operated compared with those typically expected in the EU

See also Questions 3.4. and 3.5 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 1.3 and 3.6.

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

No. In most cases, the testing will be performed in the territory of the Union. However, testing outside the Union is permitted. To do so the manufacturer must provide evidence to the approval authority that the following aspects are representative of the test conditions to which the non-road mobile machinery would be subject if tested in the European Union:

- non-road mobile machinery's operation
- ambient conditions
- lubricating oil, fuel and reagent; and
- operating conditions

For example, the fuel used when conducting ISM outside the EU, would need to be within the range the range of EU market fuel specification for which the manufacturer holds an approval. See also *Questions 3.4. and 3.5 of this* FAQ.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 3.6

5.10 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.

5.11 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.

5.12 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 to operate the NRMM and demonstrate that the alternative operator has adequate capability to operate it at the same level of competence. The level of competence required will depend on the size and complexity of the NRMM involved and the task which it performs.

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

5.13 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.

b) 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.

Engines with an Electronic Control Unit (ECU) and a communication interface intended to provide the necessary data but with a missing interface or missing data, or where it is not possible to achieve clear identification and validation of the necessary signals, are not eligible for in-service monitoring test, and an alternative engine must be selected.

The approval authority is not permitted to accept the absence of an ECU or interface, or absent or invalid signals, or lack of conformity of the ECU torque signal, as a reason to reduce the number of engines to be tested under this Regulation.'

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

5.14 How must NRMM be prepared for testing?

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

a) A check of the engine condition; any identified problems, once solved, must be recorded and presented to the approval authority.

b) The replacement of the oil, fuel and reagent, if any, where no documented evidence is available that the fluid in question complies with the specification listed in the type-approval information package applicable to the engine type, and it is practically and economically feasible to do so. Where it is already possible to confirm that the correct fluids are present it is not necessary to replace these fluids.

c) For engines fitted with an ECU and a communication interface, demonstration of the availability of the ECU data stream information or data logger of the PEMS.

Additionally, it is recommended to check that the NRMM doesn't have any malfunction otherwise the subsequent test may become void.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Points 3 and 8.

5.15 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

5.16 How may the ambient conditions be measured?

Ambient temperature must be measured at least before and after the operating sequence. 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

5.17 Who may perform manufacturer's 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)

5.18 May approval authorities conduct their own confirmatory ISM testing of a manufacturers engines?

Yes. Approval authorities may conduct their own independent confirmatory testing of an engine family/type and NRMM category identified in the manufacturers ISM plan. The approval authority is not required to select the same engine/NRMM tested by the manufacturer but is required to conduct the testing according to the Regulation.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 9.

5.19 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)

6 PREPARATION OF THE PEMS, EFM AND DATASTREAM FOR AN ISM TEST

6.1 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

6.2 Which parts are included in a PEMS?

The PEMS must include the following measurement instruments:

a) Gas analyser

b) Exhaust Flow Meter (EFM)

c) Sensors to measure the ambient temperature and pressure

d) Other measurement instruments required for the in-service monitoring test

PEMS must also include (not subject to calibration)

1) a transfer line to transport the extracted samples from the sampling probe to the gas analysers, including a sampling probe

2) a data logger to store the data collected from the ECU

3) PEMS may include a Global Positioning System (GPS)

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

6.3 When 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. If the Regulation does not specify calibration or verification for a certain portion of the PEMS, it must be calibrated, and its performance verified at a frequency consistent with any recommendations from the measurement system manufacturer and consistent with good engineering judgment.

The calibration of a measurement instrument included in the PEMS should meet the requirements on calibration and performance checks set out in section 8.1 of annex VI to Commission Delegated Regulation (EU) 2017/654, but with a longer period between verifications for gas analyser linearity and NO2-to-NO convertor efficiency.

The following are the maximum period between calibration and commencing the ISM test:

- gas analyser linearity: 3 months.
- NO2-to-NO convertor conversion efficiency: 3 months
- ambient temperature and pressure sensors: 370 days

For the EFM, the minimum frequency for performance and calibration checks, and the details of those checks, must be those specified by the instrument manufacturer.

Continuous gas analyser system-response and updating-recording verification must be performed upon initial installation into the PEMS or after PEMS modification that would affect response. This is achieved by time-shifting all gas analyser signals to achieve alignment relative to each other using measured response times established for each gas analyser.

Any dew point sensor if used, should be calibrated upon initial installation into the PEMS unit and after major maintenance.

Note: Any sensors that are part of the engine or NRMM are not required to be calibrated.

Reference:

- ***Delegated Regulation (EU) 2017/654, Annex VI, Point 8.1.1.***
- ***Delegated Regulation (EU) 2017/654, Annex VI, Point 8.1.4, 8.1.5, 8.1.6, 8.1.7.2, 8.1.8.3, Table 6.5.***

6.4 What are the requirements of gases used for PEMS calibration?

The analytical gases used for calibrating the measurements instruments must meet specific accuracy and purity specifications as described in Delegated Regulation (EU) 2017/654, Annex VI, Point 9.5.1.

Reference: Delegated Regulation (EU) 2017/655, Appendix 1, Point 2.3.

6.5 What additional checks must be performed when the PEMS is installed on a NRMM?

It is necessary to verify that there are no significant vacuum-side leaks by performing a vacuum-side leak verification of the PEMS upon installation, after major maintenance (such as pre-filter changes) and within 8 hours prior to start of the ISM test.

Reference:

- ***Delegated Regulation (EU) 2017/655, Appendix 1, Point 2.1(a).***
- ***Delegated Regulation (EU) 2017/654, Annex VI, Point 8.1.8.7.***

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

The default 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 must 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.

6.7 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.

c) the engine to be tested is of a reference power greater than 560 kW or is installed in an inland waterway vessel or a railway vehicle and the manufacturer demonstrates to the approval authority that installation of an EFM is impractical due to either the size or location of the exhaust on the NRMM.

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 3

6.8 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

6.9 Is it permitted to omit the EFM or PEMS in the case of testing the engine of ISM groups E, I, O or P on the test bed?

No. An EFM and PEMS must be used, however, the manufacturer may in parallel produce a second set of results using the test bed equipment.

Reference: Regulation (EU) 2017/655, Annex, Point 4.1.4

6.10 Is it necessary to install a PEMS and EFM on every exhaust stack of an engine with multiple exhaust stacks?

No, this is not necessary where the manufacturer demonstrates to the approval authority that it is not practical to combine the flow from multiple exhaust stacks, and there is similarity in the technical configuration and operation of the part of the engine exhausting into each stack. In that case it is sufficient to measure the emissions and exhaust mass flow from one exhaust stack and to use that information to calculate the emissions for the entire engine. The demonstration could be by appropriate engineering documentation.

Reference: Delegated Regulation (EU) 2017/655, Annex, Appendix 2, Point 1.2.

6.11 For which engines must engine torque, speed and fuel flow be recorded?

This is required for any engine selected for ISM that is designed to have a communication interface capable to provide these data streams. It is not required for engines not designed to have this capability, though it is permitted for additional sensors to be fitted to provide those signals for ISM purposes.

Reference: Regulation (EU) 2017/655, Annex point 5, Appendix 2, table, footnote 7

6.12 Is it necessary to measure engine torque when testing an engine without an ECU or interface?

No. in this case, the ISM measurements are conducted solely on CO_2 based moving average window.

Reference: Regulation (EU) 2017/655 annex point 8.1.

6.13 How must engine torque be determined?

The recorded value must be either (a) the net torque; or (b) the net torque calculated from the actual engine percent torque, the friction torque and the reference torque, in accordance with standards set out in point 2.1.1 of Appendix 7. The basis for the net torque is uncorrected net torque delivered by the engine inclusive of the equipment and auxiliaries to be included for an emissions test in accordance with Appendix 2 of Annex VI to Delegated Regulation (EU) 2017/654.

Reference: Regulation (EU) 2017/655, Annex, Appendix 2, table, footnote 6 Appendix 7, table 1 footnote 2 and point 2.1.1.

6.14 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 7.18 of this FAQ.

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

6.15 Is it necessary to measure coolant temperature?

Yes. This is required in order to identify the extent of the cold start data to be excluded from the ISM result calculation.

Reference: Delegated Regulation (EU) 2017/655, Annex, table in Appendix 2, Appendix 3 point 2.4

6.16 How can coolant temperature be determined in the case that there is no temperature sensor fitted to the selected ISM candidate production engine?

The Regulation only specifies that the source of the engine coolant temperature should be the ECU or a sensor. It does not describe where or how a sensor should be fitted in the case that the production engine does not have one. It is recommended that in this case the manufacturer uses good engineering judgement to fit a sensor that can be used to determine coolant temperature whilst not interfering with the coolant system fitted to the production engine/machine. It would be unreasonable to expect intrusive modifications to the installed cooling system for the purpose of measuring coolant temperature.

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

6.17 How do you determine the coolant temperature for an air cooled engine?

The air temperature is measured at the reference point identified by the manufacturer in the type approval of the engine.

Reference: Regulation (EU) 2017/655, Annex, footnote 8 in table in Appendix 2.

6.18 Is it necessary to measure exhaust gas temperature?

Yes, but only for engines fitted with an after-treatment device used for NOx reduction. In that case the exhaust gas temperature must be measured during the operating sequence within 30 cm of the outlet of the device used for NOx reduction. Where installation within 30 cm is not possible without damaging the after-treatment it must be installed as close to this location as can be practically achieved. Exhaust gas temperature measurement is not required for engines without a NOx after-treatment device.

Reference: Delegated Regulation (EU) 2017/655, Annex, Appendix 2, table, footnote (4)., Appendix 4 Point 2.2.3.

7 CONDUCTING ISM TESTS

7.1 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 3.1 and 3.2 of this FAQ.

If necessary, the manufacturer will need to rediscuss the monitoring plan with the approval authority. This should not result in a reduction in the number of engines to be tested.

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

7.2 For how long must the ISM test be run?

It is necessary to run the ISM test until enough working events have been captured to accumulate sufficient work or CO_2 mass. The minimum amount of work or CO_2 mass that must be obtained is given by a reference value multiplied with a minimum factor. The aim is to accumulate no more data than a reference value multiplied with a maximum factor. Values and the reference work / mass determination depend on the ISM classes and are given in the table below. In each case the reference value is that for the parent engine of the engine family from which the ISM engine has been selected.

ISM Group	Reference work / CO_2 mass determined by	Minimum factor	Maximum factor
A, C	NRTC (hot start only)	5x	7x
H	LSI-NRTC	5x	7x
E, I, O, P	NRSC (RMC or discrete mode; Appendix 9)	3x	5x
Other	NRSC (RMC or discrete mode; Appendix 9)	5x	7x

All data collected during all operating sequences should be assembled chronologically. If the amount of work or CO_2 reference mass in the working events exceeds that maximum, the ISM calculation should be truncated.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 3.2.3 and 3.5, Appendix 2, Point 2, Appendix 4, Point 3, Appendix 9.

7.3 Is it necessary to accumulate the required minimum amount of work in a single uninterrupted operating sequence or can operating sequences be joined?

A single operating sequence must be used 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 or CO_2 mass. Up to six sequences may be joined in case of cold conditions (ambient temperature at or below 0°C). Data sampling where more than one operating sequence is combined must be used only when either:

- the test conditions do not enable the required minimum amount of work or CO_2 mass 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 1x the appropriate reference work or reference CO_2 mass in case of testing at ambient temperature at or below 0°C this is reduced to 0.75x for the first operating sequence and 0.5x for subsequent operating sequences. 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. Cold start gaseous pollutant emissions measured data is to be excluded prior to the gaseous pollutant emissions calculations.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 4 and Appendix 2, Points 6.2, Appendix 3 Point 2.4

7.4 What happens if insufficient work and CO_2 mass has been accumulated in a combination of all test sequences?

The test is invalid. The test will need to be repeated. Alternatively, the monitoring plan could be amended to select a different machine or test sequence with the agreement of the approval authority.

Reference: Delegated Regulation (EU) 2017/655 – annex §2.4 and Appendix 2, point 2.

7.5 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. See also Question 6.5 of this FAQ.

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

7.6 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 must 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 as long as the engine is shut down prior to starting the ISM test.

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

7.7 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 as long as the engine is shut down prior to starting the ISM test.

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

7.8 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.

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

No. However, 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 sequence is considered void.

Reference: Point 2.3.2. of Appendix 3 to the Annex of Delegated Regulation (EU) 2017/655

7.10 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.

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

It is required that data completeness of not less than 98% for each operating sequence is achieved i.e., a maximum of 2 % of data may be excluded due to an episode of unintended signal loss. Additionally, no single period of data loss of more than 30 seconds duration may be excluded.

It is not permitted to create signal loss during pre-processing, combination or post-processing of any operating sequence.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 4.3

7.12 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 7.10 or 7.11. 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 7.10.

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

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

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

If the NRMM is not fitted with a malfunction diagnostic or warning system, in the case that the malfunction is clearly detected by aural or visual means, then the test sequence is void.

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

7.14 What checks must be performed during the ISM test?

Where practical and safe to perform, zero verification of the gas analysers may be conducted every 2 hours during an operating sequence. it is permitted 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. Data collected during periodic checks is excluded from the subsequent emissions calculation.

Reference: Delegated Regulation (EU) 2017/655, Appendix 2, Point 7.1. 7.2 and 7.3.

7.15 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

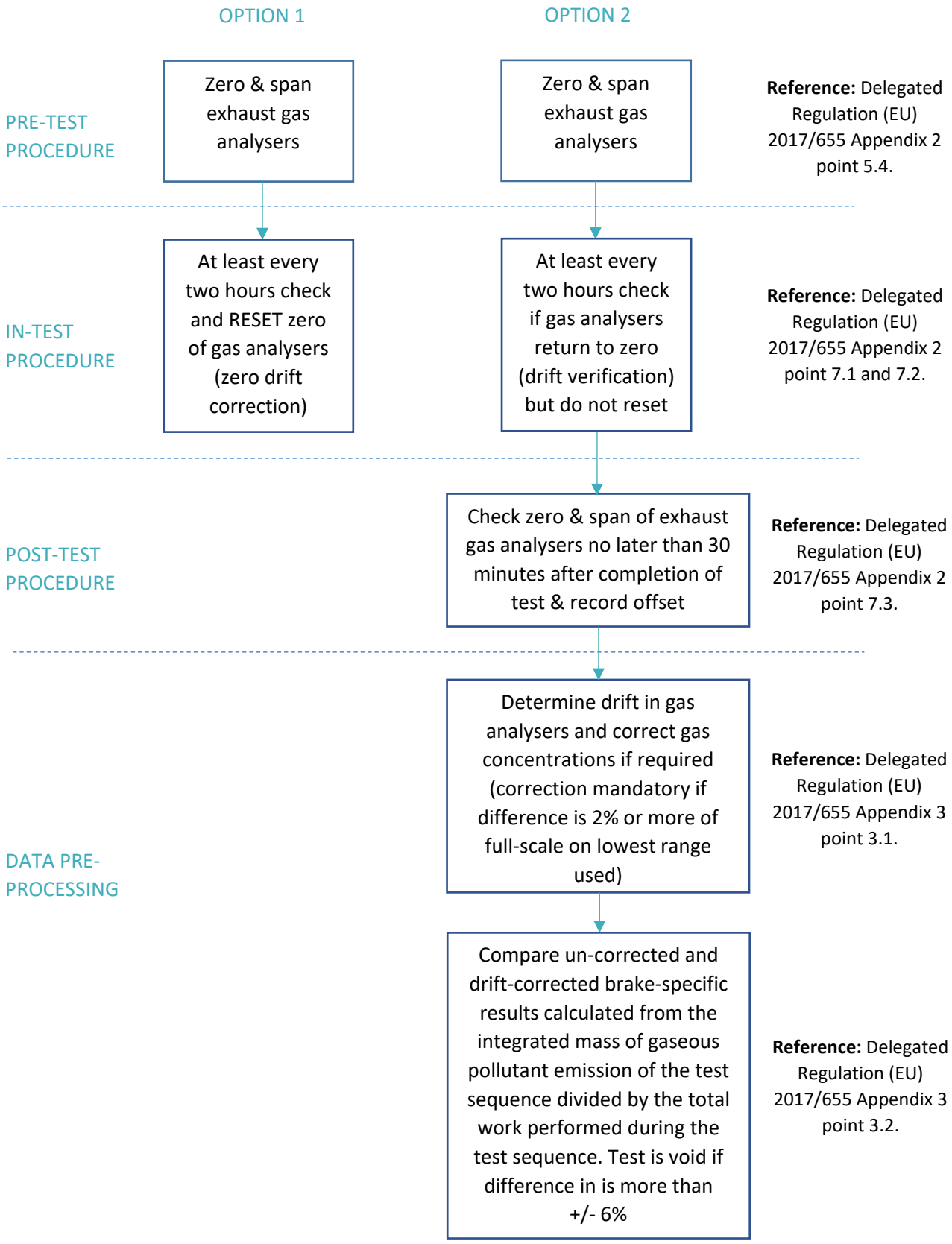
b) A valid post-test zero and span of the gas analysers must be performed within 30 minutes after the measurement is terminated in the case that no correction was made (i.e. the analyser was not reset to zero) during the ISM test. A post-test zero and span of the gas analyser should not be performed in the case that the analyser was reset to zero during the ISM test.

c) 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)



7.16 What are the requirements for the gases to be used for zero and span checks?

The gases used for zero and span checks of continuous gas analysers must be internationally traceable and meet the specifications as described in point 9.5.1 of Delegated Regulation (EU) 2017/654.

Reference: Delegated Regulation (EU) 2017/654, Annex VI, Point 7.3.1.4, 9.5.1

7.17 Is it permitted to perform a post-test verification and 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, Annex, Appendix 3.

7.18 Is it required to check the conformity of the ECU torque signal during each ISM test using the maximum torque method as set in section 1 of Appendix 6?

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 either the verification performed during the tests required for EU type-approval is used, or for engines in ISM groups other than A, C and H, the approval authority may accept a separate demonstration conducted in accordance with the requirements of Appendix 3 of Annex VI to Delegated Regulation (EU) 2017/654 but using the mapping procedures state out in point 2 of Appendix 6 to Delegated Regulation (EU) 2017/655.

If it is possible to reach the torque curve by modifying the load activity and/or the minimum test duration then, it is not required to agree with the Approval Authority the alternative method to reach the maximum torque value.

See questions 3.3 and 5.13 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 5.2. and Appendix 6.

8 DATA PRE-PROCESSING FOR GAESOUS POLLUTANT EMISSIONS CALCULATIONS

8.1 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 7.15) 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 3

8.2 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 3.2.

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

Each brake-specific gaseous pollutant emission value should be calculated from the integrated mass of gaseous pollutant emission of the test sequence divided by the total work performed during the test sequence. That calculation should be performed prior to determination of working events in accordance with Appendix 4 or calculation of gaseous pollutant emissions for each moving average window in accordance with Appendix 5. See also Figure 2 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 3.2.2.1.

8.4 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 6.3, 8.16 and Figure 3 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), for this the exhaust mass flow from the EFM with torque from the ECU during this correlation 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 (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) CO_2 to represent the gas analysers in the second and third correlations.

b) Exhaust mass flow to represent the EFM in the second correlation; and

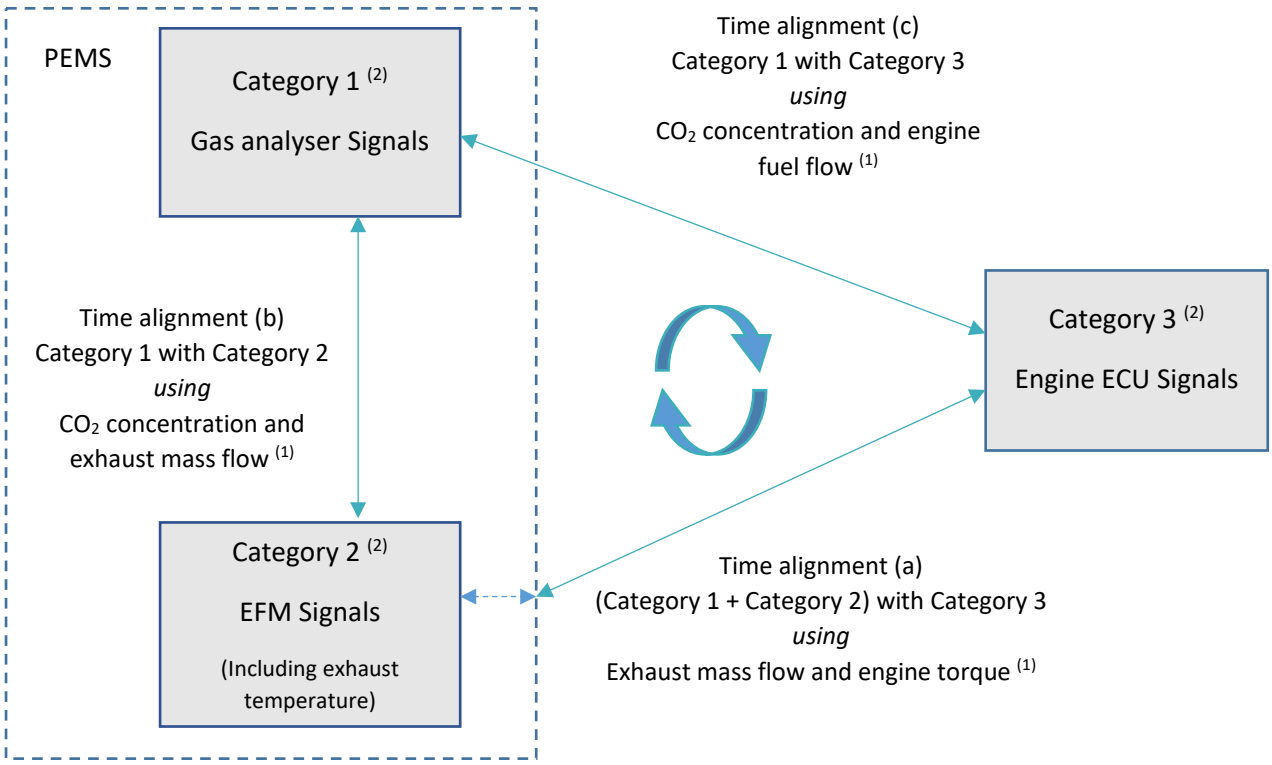
c) Fuel flow to represent the engine ECU in the third correlation.

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

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Points 4.2. to 4.4.

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

8.5 What differences to the time-alignment procedure apply for engines without ECU interface or without the use of an EFM

In the case of engines not designed to have a communication interface to permit the collection of the ECU data the only correlation to be performed is that of Category 1 with Category 2 (the CO_2 concentration and the exhaust mass flow).

In the case of engines for which direct measurement of the exhaust mass flow was omitted in accordance with note 3 of the table Annex 2 the correlations of Category 1 with Category 2 (the CO_2 concentration and the exhaust mass flow) and Category 1 with Category 3 (the CO_2 concentration and the engine fuel flow) must be performed.

Reference: Delegated Regulation (EU) 2017/655, Annex, Appendix 3, Points 4.4.1 and 4.4.2.

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

Point 4.1. 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 prior to and independent of the time alignment requirements in Question 6.3 of this FAQ.

Reference:

- ***Delegated Regulation (EU) 2017/655, Appendix 3, Point 4.1. and 4.4***
- ***Delegated Regulation (EU) 2017/655, Appendix 7, Point 2***
- ***Delegated Regulation (EU) 2017/654, Annex VI, Points 8.1.5.1. and 8.1.5.3.***

8.7 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 5

8.8 What is the purpose of the data consistency check between the gas analysers and EFM data (fuel flow correlation)?

This is a quality control check between fuel flow determined from ECU and fuel flow determined from exhaust gas measurement. The correlation can be adversely affected by exhaust flow leakage between the engine and the exhaust flow meter (EFM), or by deficiencies in time-alignment between the signals. Consequently, a poor correlation can indicate a concern with the instrumentation installation or data pre-processing. The correlation relies upon a sufficiently precise fuel flow signal from the ECU and a communication interface capable of providing that signal in accordance with Table 2 of Appendix 7.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3, Point 5.1

8.9 How is engine fuel flow calculated for correlation with ECU fuel flow during the data consistency check?

The exhaust flow measured by the EFM together with the measured gas concentrations are used to calculate fuel flow using the carbon balance equation in section 2.1.6.4 of Annex VII of Regulation 2017/654. Typically, a PEMS measures the exhaust gas concentrations on a wet basis, but to use this equation is first necessary to convert the CO_2 and CO to a dry basis using the measured humidity. This conversion may already be performed by the PEMS system, depending upon instrument manufacturer.

Reference: Delegated Regulation (EU) 2017/655, Annex, Appendix 3, Point 5.1, Delegated Regulation (EU) 2017/654 Annex VII, point 2.1.6.4.

8.10 Can the fuel flow correlation be affected by factors unrelated to the instrumentation installation or data pre-processing?

Yes, it can be affected by the precision of the engine fuel flow determined by the ECU. There is also a particular concern that the mandated coefficient of determination (r^2) value of 0.9 may be unachievable if the data is from transient NRMM operation. This is because under these conditions there is a varying non-linear offset in time and magnitude between the input signals provided by the ECU and the output measured at the PEMS and EFM, which cannot be compensated by a linear time alignment. This is caused by the varying gas speed and damping effect of the after-treatment and exhaust system volume as the gas flow through the engine accelerates and decelerates.

Reference: Discussion between European Commission DG JRC and EUROMOT, 2022

8.11 Is it possible to improve the calculated r^2 value in the case of transient NRMM operation?

Yes, Regulation (EU) 2017/655 does not preclude the pre-processing of the fuel flow data prior to performing the correlation. In the case of transient operation with acceleration and deceleration it is possible that averaging the data can improve the result. If the calculated r^2 is less than 0.9, it is recommended to repeat the fuel flow correlation using a rolling average applied to both the measured and calculated fuel flow. It is recommended that this be achieved by increasing the rolling average duration in 1 second increments up to a maximum of 10 seconds until the r^2 value is greater than 0.9 (i.e., the extent of the rolling average should be minimised). If an r^2 value greater than 0.9 is not achieved with a rolling average of 10 seconds, then it is recommended that the test sequence should not be used. It is recommended that the duration of the rolling average (seconds) is recorded.

Reference: Discussion between European Commission DG JRC and EUROMOT, 2022.

8.12 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 5.5.

8.13 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 6.

8.14 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 7.

8.15 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, foot note (1)

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

The following steps must be followed in this order (see also Figure 4 in question 8.21 of this FAQ):

- Exclude temporary signal loss with a maximum of 2% of data with no consecutive period more than 30 seconds duration from each operating sequence due to one or several episodes of unintended temporary signal loss in the original data recording. If signal loss is greater than 2% of data or a period is greater than 30 seconds this then voids the test, and a further test is needed.
- Exclude data from periodic checks of measurement instruments.
- Identify data points that do not comply with the required ambient conditions; If the proportion of data points identified exceed 1% of the entire sequence, then the entire sequence is classed as void and a further test is required.
- Exclude cold start data.
- Perform drift correction (if applicable).
- Perform time alignment.

- Dry-wet correction (in case the measurements are not made wet)
- Identify working and non-working events.
- Ensure that there is sufficient work or CO_2 mass of working events remaining in order to qualify the operating sequence to be used; and
- Calculate result.

Note that the NO_x concentrations measured by the gas analysers must not be corrected for ambient air temperature and humidity.

Reference: Delegated Regulation (EU) 2017/655, Annex Points 4.3, 6.3, 6.4, 6.5, 6.6, figure 3 and 8, Appendix 3, Appendix 4 and Appendix 5.

8.17 When does cold start end and valid gaseous emission data start for water cooled engines?

Cold start data is that which is recorded up to the first point in the test sequence that the earlier of the following occur for the first time:

a) the engine coolant temperature reaches 70°C;

b) at an ambient air temperature above 0°C the engine coolant becomes stabilised within +/-2°C over a period of 5 minutes;

c) at an ambient air temperature at or below 0°C the engine coolant becomes stabilised within +/-5°C over a period of 5 minutes;

d) 20 minutes have elapsed since engine start.

Cold start consequently occurs at a maximum only once in each test sequence, regardless of whether the engine is stopped and re-started within that sequence.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3 Point 2.4.

8.18 When does cold start end and valid gaseous emission data start for air-cooled engines?

Cold start data is that which is recorded up to the first point in the test sequence that the earlier of the following occur for the first time:

a) the temperature measured at the reference point declared by the manufacturer at type-approval becomes stabilised within +/-5°C over a period of 5 minutes;

b) 20 minutes have elapsed since engine start.

Cold start consequently occurs at a maximum only once in each test sequence, regardless of whether the engine is stopped and re-started within that sequence.

Reference: Delegated Regulation (EU) 2017/655, Appendix 3 Point 2.4.

8.19 Does the exclusion for the take-off phase after a long idle apply to an engine without an exhaust after-treatment device to reduce NO_x?

No. The exhaust gas temperature is used to enable the post-processing of the results to exclude (as a non-working event) the emissions from a limited period of engine operation solely during the warm-up of a NO_x reducing after-treatment system after a long idle event.

This only applies in the case the engine has a NO_x reducing after-treatment listed in the type-approval and fitted to the engine. Correspondingly, exhaust gas temperature measurement within 30cm of the outlet of the NO_x after-treatment is not required if there is no such aftertreatment. If for any reason there is measurement of exhaust gas temperature for engines not using NO_x reducing after-treatment, it must not be used in the data post-processing to determine non-working events. See also question 8.16 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Annex, Appendix 2, table, footnote (4)., Appendix 4 Point 2.2.3.

8.20 What is the amount of work or mass of CO_2 required for a vaild test?

See Question 7.2 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 3.2.3 and 3.5, Appendix 2, Point 2, Appendix 4, Point 3, Appendix 9.

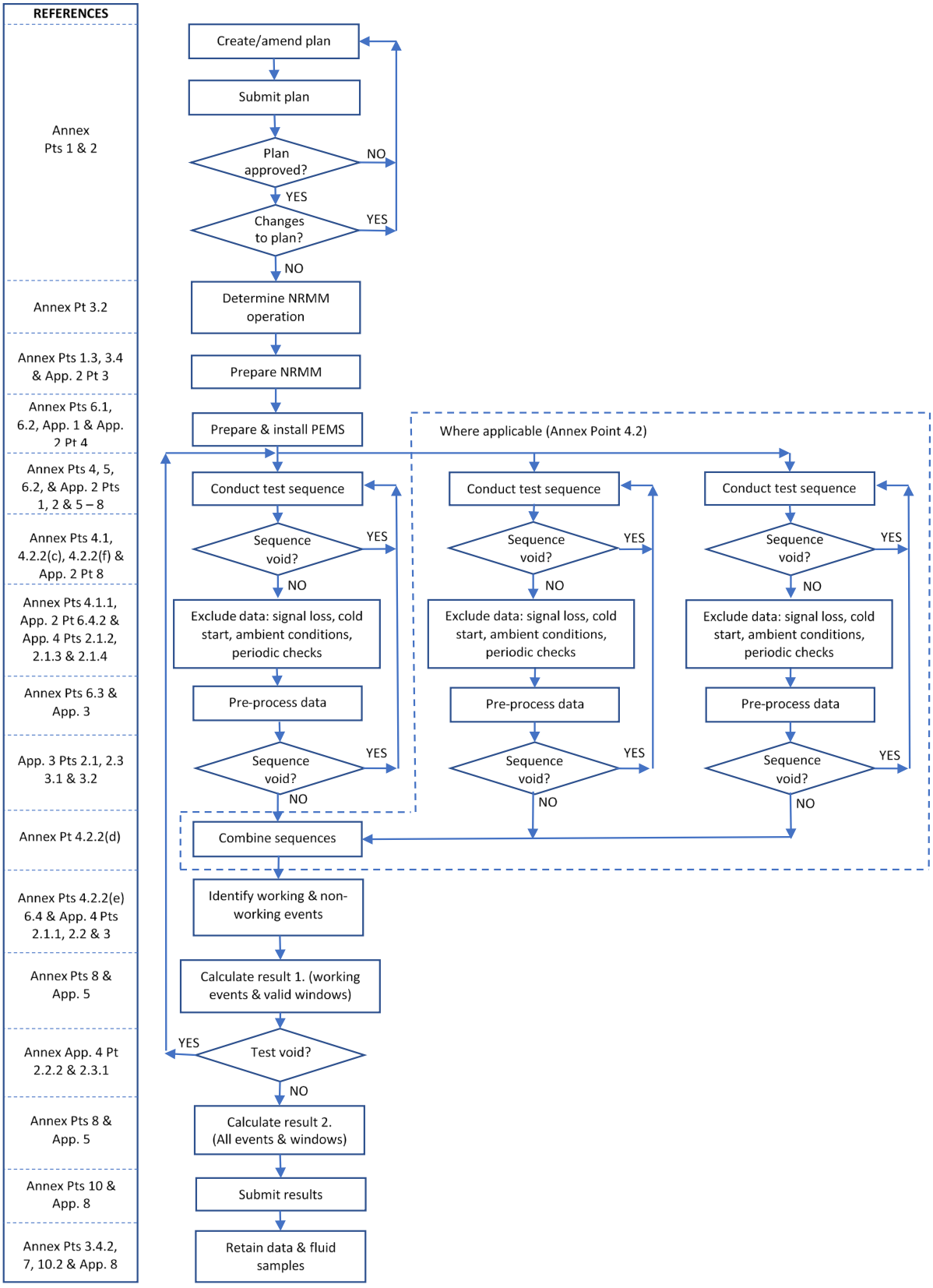
8.21 In the case that multiple operating sequences are joined to create a single ISM test, when should those sequences be joined together?

When combined data sampling is used, the data pre-processing requirements of Appendix 3 to the Annex of Delegated Regulation (EU) 2017/655 must first be applied to each operating sequence prior to combining operator sequences. The determination of working and non-working events set out in point 6.4 of the Annex and the calculation set out in point 8 should be applied to the complete combined data sampling (see also Figure 4 of this FAQ)

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 4.3, 6.3, 6.4, 6.5, 6.6, figure 3 and 8, Appendix 3, Appendix 4 and Appendix 5.

Figure 4: Complete sequence for conducting in-service monitoring



8.22 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. The raw data files should be retained for 10 years by the manufacturer and be made available upon request to the approval authority and the Commission.

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

8.23 What is the consequence in the case that the amount of working events is less than the required reference work or reference CO_2 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.

The test duration for engines in ISM groups E, I, O and P must be between three and five times the applicable reference work in kWh or CO_2 reference mass in g/cycle determined from the type-approval test result.

The test duration for the engines in other ISM groups must be between five and seven times the applicable reference work in kWh or CO_2 reference mass in g/cycle determined from the type-approval test result.

See questions 7.2. and 7.3. of this FAQ

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

8.24 What should the manufacturer do in the case that the only NRMM available to test has insufficient loaded operation to achieve the criteria for a valid test?

The manufacturer should consult the approval authority to which the test plan is submitted. The Regulation does not exempt the manufacturer from the obligation to conducting ISM in this circumstance. See also question 3.22 of this FAQ.

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

9 CALCULATION OF MOVING AVERAGE WINDOW RESULTS

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

The first set of calculations must be performed using both work-based 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 8.16 and 8.21 of this FAQ).

The second set of calculations must be performed by repeating both work-based and CO_2-based MAW calculations without the determination of the working events in accordance with Appendix 4. 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.

In the case of engines that do not include an ECU and interface to provide engine torque then the two sets of calculations outlined above are only conducted for the CO_2-based MAW technique. See also questions 3.3 and 5.13 of this FAQ.

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

9.2 What is the reference engine power used for determination of a valid averaging window?

The reference engine power is the maximum net power as defined in Article 3, point (26) of Regulation (EU) 2016/1628 and listed in Annex I to that regulation for each engine (sub)-category, for the specific engine type subject to ISM test (i.e. maximum net power for any engine type-approved in a variable speed engine family and rated net power for any engine type-approved in a constant speed engine family).

Reference: Article 3, Point (26) of Regulation (EU) 2016/1628

9.3 What is the reference work and reference CO_2 mass used for the moving average window calculation and where can these values be found?

The reference work and reference CO_2 mass of an engine type, or for all engine types within the same engine family, must be determined as follows:

- For engines in ISM groups A and C the reference work and CO_2 are the work and CO_2 mass that were recorded during the hot-start NRTC type-approval test. It can be found at Point 11.3.1 and Point 11.3.2 of the addendum to the EU type-approval certificate of the engine type or the engine family set out in Annex IV of Regulation (EU) 2017/656.
- For engines in ISM group H the reference work and CO_2 are the work and CO_2 mass that were recorded during the LSI-NRTC type-approval test.
- For engines in ISM groups not listed in above sub-points the reference work and CO_2 are the work and CO_2 mass determined from the type-approval test result of the parent engine using the method set out in Appendix 9 of Delegated Regulation (EU) 2017/655.

Reference:

- ***Regulation (EU) 2017/656, Points 11.3.1. and 11.3.2. of the addendum to the type-approval certificate set out in Annex IV***
- ***Delegated Regulation (EU) 2017/655, Annex, Appendix 9***

9.4 Is it permitted to determine the reference value for work or CO_2 mass for the specific engine type instead of taking the value of the parent engine?

No. it is required to take the reference value from the parent engine.

Reference: Delegated Regulation 2017/655, Annex, Appendix 5, Point 2.1.2

9.5 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 CO_2 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, Annex, Appendix 5, Points 2.1., 2.2. and 2.3.

9.6 What happens if more data than the maximum reference work or CO_2 mass 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 or CO_2 that is accumulated. Delegated Regulation (EU) 2017/655 requires that all data collected will have to be stored but the emission calculation should be truncated at the point where the maximum reference work or CO_2 mass has been reached. See the table in question 7.2 for the appropriate maximum factors.

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

9.7 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 8.16 and 8.21 of this FAQ).

If the percentage of valid windows is less than 50%, the data evaluation must be repeated:

- **Work-based:** the power threshold must be reduced from 20% in steps of 1% until the percentage of valid windows is equal to or greater than 50%. In any case, the lower power threshold must not be lower than 10%
- **CO_2-based:** the value of 0,2 in formula given in point 2.3.1 must be reduced in steps of 0,01 until the percentage of valid windows is equal to or greater than 50%. In any case, the lowest value in the formula must not be lower than 0,10.

In all other cases the test is considered void, and a further ISM test must be performed.

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

9.8 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.

10 SUBMISSION OF ISM TEST REPORTS AND SUPPORTING DOCUMENTATION

10.1 To whom must ISM test reports and supporting documentation be submitted?

Test reports and supporting documentation must be submitted to the approval authority that granted the type-approval for the engines concerned.

In the case that the ISM Groups contains engine types, and/or engine families, approved by different approval authorities, the approval authority designated by all approval authorities involved is the one to be the recipient of the test results. See also question 4.6 of this FAQ.

Reference: Delegated Regulation (EU) 2017/655, Annex, § 2.1, 2.6 and 10.3

10.2 What information must be included in the main test report?

The main test report for in-service monitoring must show the activities and results of the in-service monitoring and include at least the items listed in sections 1 to 8 of Appendix 8 to the Annex of Delegated Regulation (EU) 2017/655. This includes the following sub-sections:

- Engine manufacturer information
- Engine information
- NRMM information
- Engine/NRMM selection
- Portable emissions measurement system (PEMS)
- Test conditions
- Integrated mass of gaseous pollutant emissions
- Averaging window conformity factors (minimum, maximum and 90th cumulative percentile) with non-working events and low power windows excluded
- Averaging window conformity factors (minimum, maximum and 90th cumulative percentile) without excluding non-working events and low power windows

If a regeneration takes place during the ISM test it is recommended to make a note of that fact under 'Test Conditions' in Point 6.6. of the ISM test report (see also Question 7.8 of this FAQ).

The average concentration of each gaseous pollutant emission may be included in the above report, but it is not mandatory. Instantaneous data are not required to be reported but are to be retained by the manufacturer for at least 10 years and made available upon request to the European Commission or the approval authority.

Reference: Delegated Regulation (EU) 2017/655, Annex, points 10.1 and 10.2, Appendix 8, section 1 to 11.

10.3 What values should be inserted in sections 8 and 7 of the main test report for the integrated mass of gaseous emission pollutants and the average concentration of gaseous pollutant emissions?

The integrated mass of gaseous emission pollutants is divided by the total work performed during the test sequence when performing the drift correction. Consequently, it is recommended that the values to be inserted are those prior to the determination of working events in accordance with Appendix 4 of Regulation (EU) 2017/655. See also question 8.21 of this FAQ.

It could be assumed that the average values are based on the same data set as for the integrated values, i.e., prior to determination of working events. However, given that the insertion of the average values is optional ('Not mandatory') these values can be omitted in case of doubt as to what values to insert.

Reference: Delegated Regulation (EU) 2017/655, Annex, Appendix 3, Point 3.3.2.1., Appendix 8 Points 7 and 8.

10.4 What information must be provided in the separate test report containing information to be made publicly available?

The report which is intended to be made public by the approval authority via submission to the IMI database, must contain the following information:

- Make (trade names(s) of manufacturer)
- Category and sub-category of the engine type/engine family
- Commercial name(s) (if applicable)
- Category(ies) of NRMM
- Test location (at regional level providing approximate geographic location only)
- Average ambient conditions (as calculated from the instantaneous measured data)
- Brief description of the work performed
- Averaging window conformity factors (minimum, maximum and 90th cumulative percentile) with non-working events and low power windows excluded
- Averaging window conformity factors (minimum, maximum and 90th cumulative percentile) without excluding non-working events and low power windows

Reference: Delegated Regulation (EU) 2017/655, Annex, section 10.3, Appendix 8 points 1.1, 2.2, 2.4, 3.2, 6.3, 6.4.1, 6.10 Section 9 and Section 10, Article 44(3)(b) of Regulation (EU) 2016/1628.

10.5 What supporting information must be reported?

Sufficient information must be provided to enable the approval authority to conclude whether or not the ISM test fulfilled the requirements set out in Regulation (EU) 2017/655 and can be considered valid. It is recommended to include any specific agreements reached with the approval authority regarding the subject ISM test that are not already documented in the agreed test plan.

That supporting information could include:

1. Engine maintenance record and absence of indications of misuse
2. In case the operator conducting the test is not the usual professional one, information to show the operator has sufficient skills and training to operate the NRMM.
3. In case the ISM test is not performed during the actual operation of the NRMM, information on the agreed representative duty cycle.
4. In case the ISM test is conducted outside the EU, the required evidence that the test conditions are representative of those to which the NRMM would be subjected if tested in the EU.
5. For engines fitted with an interface to provide a torque signal, information demonstrating that the torque signal has been validated.
6. In case an EFM is not used, the necessary justification for its omission and evidence on the correlation between the fuel mass flow estimated by the ECU and fuel mass flow measured on an engine dynamometer test bench.
7. In case only one exhaust stack of a multi-stack engine is tested, the required evidence that combining stacks would be impractical and there is similarity in the exhaust leading to each stack.
8. Information confirming that the ISM test contained sufficient work and/or mass of CO_2 as applicable.
9. Any information on identified problems with the engine, and their solution, during the pre-test engine check.
10. Information confirming the use of oil, fuel and reagent (if applicable) complying with the specification listed in the engine type-approval.
11. In case an engine of ISM groups M or N installed in a railway vehicle is tested with that vehicle stationary, the agreed representative test duty cycle.
12. In case an engine of ISM groups E, I, O or P is removed from the NRMM for testing, the agreed procedure for removing the engine and the agreed representative test cycle.
13. In case electrical power for the PEMS is drawn from the engine, evidence as to why this is necessary, and that the electrical consumption is no more than 1% of maximum engine power.
14. Information on the pre- and post-test zero and span checks and whether any drift correction was applied to an operating sequence.
15. For engines fitted with both an interface to provide a fuel flow signal, and with an EFM, information demonstrating that the correlation between the fuel flow determined from the ECU and that determined from the EFM, and gas concentrations has been measured and the tolerances are within the required range.
16. For engines fitted with an interface to provide engine torque and speed and an EFM, the results of the brake-specific fuel consumption (BSFC) check.
17. Where GPS data is available, information on the ambient pressure check against the altitude.

Reference: Delegated Regulation (EU) 2017/655, Annex, Points 1.3, 3.1, 3.2, 3.6, 5.3, Appendix 1 point 1, Appendix 2 table note 3, points 1.2, 2, 3, 4.1.3, 4.1.4, 4.2, 7.3.2, Appendix 3 points 3, 5.1, 5.2, 5.3, 5.4.

10.6 In what format must the information be provided?

The test report must 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 by European Commission Joint Research Centre (JRC), is provided in a format that can be imported into EMROAD.

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

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

Test reports submission deadlines

Group A	All groups except A
Testing scheme based on a 4-year period	Testing scheme based on a 4-year period
Test result of first 9 engines submission, the sooner date • 24 months after the first engine was installed in a NRMM • 30 months after starting the production of an approved engine type or engine family within the ISM group	Test result of first set of engines submission, the later date of: • 28 December 2024 • 12 months after the first engine was installed in NRMM • 18 months after starting the production of an approved engine type or engine family within the ISM group

Group A, B, F, G, J, K, L, M and N	Group C, D, E, H and I
Testing scheme based on the Emission Durability Period • Low operating hour engines: 28 December 2024 • High operating hour engines: 28 December 2026	Testing scheme based on the age of the NRMM • Low operating hour engines, no more than 2 years old: 28 December 2024 • High operating hour engines, no less than 4 years old: 28 December 2026

Group B, F, G, J, K, L, M and N: Manufacturers producing a total between 25 and 50 engines per year
• 28 December 2025 or • 12 months after the first engine was installed in NRMM

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

10.8 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 10.7 of this FAQ

In accordance with Art. 8(4) of Regulation (EU) 2016/1628, manufacturers must 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)

11 POST-TEST RETENTION OF DATA AND MATERIALS

11.1 What material must be retained by manufacturers?

In accordance with Point 3.4.2 of the Annex to Delegated Regulation (EU) 2017/655 the samples of lubricating oil, fuel and reagent must be retained until at least, whichever is the shortest period of time from the following:

(a) 12 months following the completion of the test, or

(b) 1 month after the manufacturer submits the respective test report to the approval authority.

The manufacturer should take care to retain sufficient quantity of those fluids to enable an analysis to be conducted if necessary.

Reference: Delegated Regulation (EU) 2017/655, Annex, Point 3.4.2

11.2 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) 2017/655. This requires that no data is modified or removed from the raw test data file(s) used. Those raw test data file(s) must be retained at least for 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 10.2, 10.4 and 10.5 of this FAQ.

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

12 BIBLIOGRAPHY

Regulation (EU) 2016/1628 of the European Parliament and of the Council of 14 September 2016, amended by Regulation (EU) 2020/1040 and Regulation (EU) 2021/1068 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, amended by Delegated Regulation (EU) 2018/989 and Commission Delegated Regulation (EU) 2021/1398, with regard to technical and general requirements relating to emission limits and type-approval for internal combustion engines for non-road mobile machinery.

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EUROMOT

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