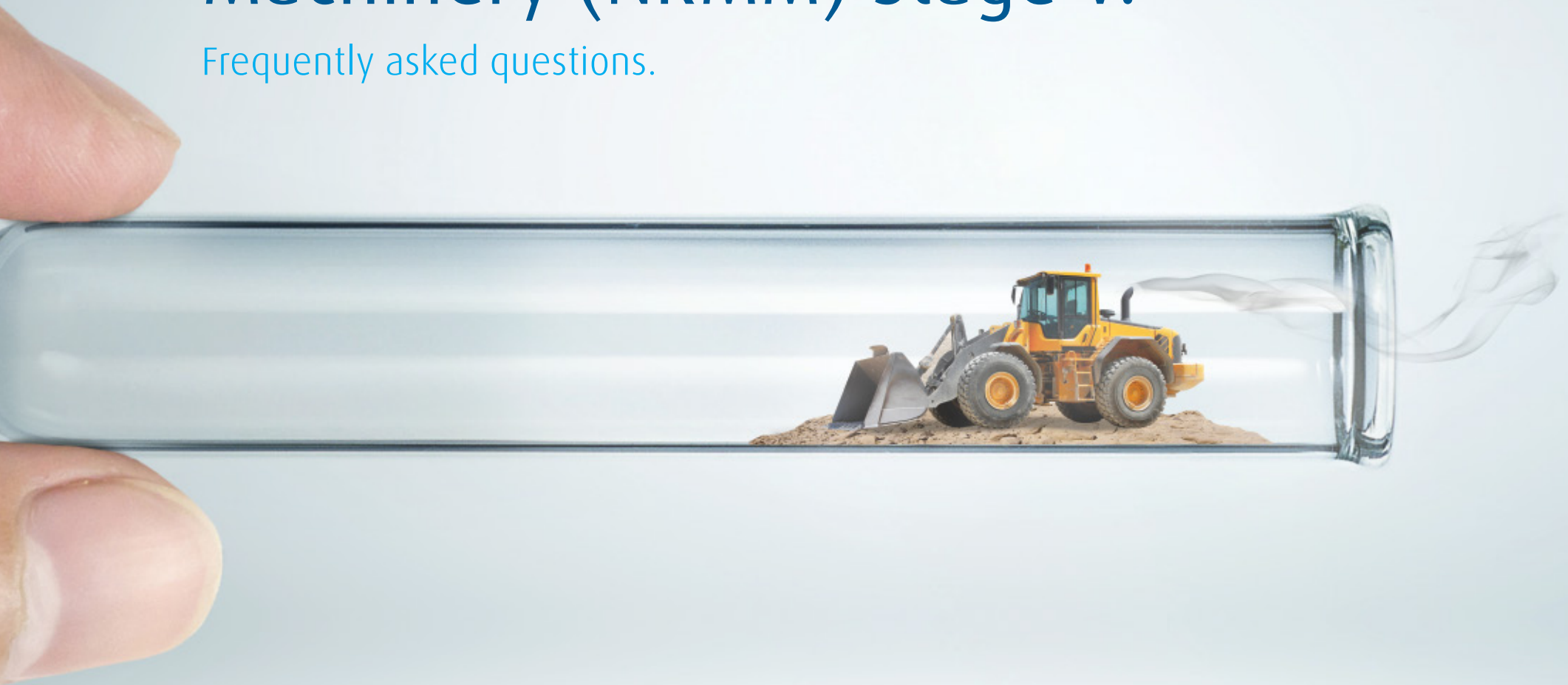


Non Road Mobile Machinery (NRMM) Stage V.

Frequently asked questions.





Quick reference guide.

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General information.



1. What is Stage V?

Stage V is a recent piece of European legislation designed to reduce emissions from Non-Road Mobile Machinery (NRMM). The Stage V scope refers to any tool, machine or item of equipment that is powered by a combustion petrol or diesel engine but is not driven on the road. So it ranges from small, handheld power tools such as chainsaws, hedge trimmers, grass trimmers, brush cutters and blowers through heavy-duty construction machinery and generators to trains and inland waterway vessels. It even includes recreational vehicles such as snow mobiles and jet skis. The pollutants regulated under Stage V are carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx) and particulate matters (PM and PN).

For more information, take a look here: hiq.linde-gas.com/stagev

2. Why is a new regulation on NRMM emissions necessary?

The NRMM sector has become an increasingly important source of air pollution, responsible for around 15% of total NOx emissions and 5% of total PM emissions in the EU. So to achieve long-term air pollution reduction targets and avoid harm to human health and the environment, attention must extend beyond on-road, static and marine emissions to focus also on the off-road sector. Another aim of the new legislation is to harmonise the legislative landscape across the EU, reduce market distortion and cut complexity. This new regulation is set to replace the legal framework currently in place that includes five directives with 15 annexes.

3. What's the impact of Stage V on off-road engine testing?

First of all, Stage V extends the scope of existing regulations to include more engine types. It also changes some of the emission limit values (ELVs) in line with recent changes under the Euro 6 regime that applies to the on-road heavy-duty vehicle sector.

These new ELVs mean that many engine manufacturers may need to change the calibration/instrumentation gases they use to test engine emissions. Finally, the new regulation introduces in-service monitoring. New to the off-road sector, this means that manufacturers will need to use Portable Emission Measurement Systems (PEMS) to test emissions while a vehicle is in service.

Scope & implementation.



4. What engines/equipment have been added to the scope of NRMM Stage V?

The new entries are:

- Spark-Ignited (SI) non-road engines with $19 \leq P < 56$ kW
- SI non-road engines used in snowmobiles as well as all-terrain and side-by-side vehicles
- SI and Compression-Ignited (CI) engines used in non-road and generator set vehicles with $P > 560$ kW
- Auxiliary engines used in inland waterway vessels with $P \geq 19$ kW
- All rail traction engines

5. What are the Stage V implementation deadlines?

Deadlines depend on the engine category. See the following table for guidelines:

<u>Deadline</u>	<u>Engines scope</u>
<u>January 2018</u>	<u>Type approval of all new engines</u>
<u>January 2019</u>	<u>Engines placed on the market:</u> <ul style="list-style-type: none"> • with $P > 56$ kW and $P > 130$ kW • used in all terrain, side-by-side vehicles and snowmobiles • used in inland waterways vessels with 19 kW $< P < 130$ kW
<u>January 2020</u>	<u>Engines placed on the market:</u> <ul style="list-style-type: none"> • 56 kW $< P < 130$ kW • used in inland waterways vessels with $P > 130$ kW
<u>January 2021</u>	<u>Engines placed on the market used in railcars and locomotives</u>

Calibration & instrumentation gases.



6. Why are calibration and instrumentation gases relevant to the NRMM Stage V regulation?

The instrumentation equipment used to carry out emissions tests needs to be calibrated using extremely pure zero gases and span gases. They also require special instrumentation gases during tests (e.g. 40% hydrogen in helium mixture, purified nitrogen).

Calibration and instrumentation gases thus play a key role in ensuring the accuracy of emissions test results and, by extension, compliance with Stage V requirements. In addition, re-testing may be required if instruments have been calibrated with gases that are not fully compliant with Stage V specifications, thereby compromising the efficiency of the whole process.

7. What calibration and instrumentation gas specifications are required to ensure the results are compliant?

Gas specifications are stated in the Commission Delegated Regulation (EU) 2017/654 and in the UN/ECE Regulation No. 96. Refer to these reference documents or get in touch with your local Linde expert for more details. For example, zero gases (such as purified nitrogen and purified synthetic air) as well as span gases (such as propane, nitric oxide, carbon monoxide in nitrogen/synthetic air) are typically required for engine testing.

Calibration & instrumentation gases.



8. Why do I need to change the calibration/instrumentation gases I currently use?

The new Stage V regulation reduces the emission limit values of some pollutants and includes more engines/equipment in its scope. You need to review the specialty gases range you use in order to ensure your emissions tests deliver reliable and accurate results in full compliance with the new requirements. Moreover, it makes sense to check whether the gases are delivered in the most suitable package for your application (e.g. lab testing or in-service monitoring for instance) and the gas distribution system/equipment you use doesn't compromise your gas quality.

9. What cylinder sizes are available?

Linde packages range from 1-litre to 50-litre cylinders. Smaller cylinders are recommended whenever portability is a key requirement (e.g. for in-service monitoring with Portable Emission Measurement Systems (PEMS)), while higher volume cylinders, also assembled in bundles for instrumentation gases, are more suitable for lab applications.

10. What gases are needed for in-service monitoring?

In-service monitoring involves the use of a Portable Emission Measurement System (PEMS) fitted to the machinery while it is in use. The PEMS needs to be calibrated before and after the test using zero and span gases. The gases used to do this must be delivered in portable cylinders. For example, to monitor hydrocarbon emissions, a portable Flame Ionization Detector (FID) is commonly used. This means that a cylinder with a fuel gas (typically 40% hydrogen in helium) also needs to be fitted to the vehicle. Our ECOCYL® range is perfect for this kind of in-service testing.

Quality and safety.



11. Will Linde HiQ® gases work with my current analytical instruments?

We strongly recommend using compatible equipment with the specialty gases you use. For example, regulators and equipment that are used for welding should not be used for emissions testing as they are likely to affect the purity of the gas and therefore the readings you get. To overcome these issues, we sell a range of equipment that is designed specifically to work with our specialty gases. We recommend our HiQ REDLINE® product range as standard for emissions testing requirements.

12. How does Linde ensure the gas specifications are met?

All of our gases come with Certificates of Analysis and Conformity. This is directly traceable to Linde's industry-leading internal standards. With every certificate, you can rely on our guarantee of quality. What's more, many of our HiQ® specialty gas facilities have received certification as a producer under ISO 9001.

Selected facilities are also independently accredited to international standards such as ISO 17025 and ISO 17034 (previously ISO Guide 34). Such accreditations allow Linde to confidently state that the methods used to certify our accredited calibration gas mixtures are accurate, consistent, documented and validated.

13. How does Linde ensure the safety of its gases in the workplace?

All our gases are delivered with the relevant Safety Data Sheet in compliance with the applicable regulatory requirements. Moreover, we can work with your organisation to ensure you have the right engineering control systems and safety procedures in place to meet the applicable health and safety standards. Our expert advisers can review your testing environment to analyse your gas equipment set-up and any equipment requirements.

Getting ahead through innovation.

With its innovative concepts, Linde is playing a pioneering role in the global market. As a technology leader, it is our task to constantly raise the bar. Traditionally driven by entrepreneurship, we are working steadily on new high-quality products and innovative processes.

Linde offers more. We create added value, clearly discernible competitive advantages, and greater profitability. Each concept is tailored specifically to meet our customers' requirements – offering standardised as well as customised solutions. This applies to all industries and all companies regardless of their size.

If you want to keep pace with tomorrow's competition, you need a partner by your side for whom top quality, process optimisation, and enhanced productivity are part of daily business. However, we define partnership not merely as being there for you but being with you. After all, joint activities form the core of commercial success.

Linde – ideas become solutions.

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