

SUPPLY CHAIN SUSTAINABILITY

SCHOL

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Plant Category Group Minimum Standards

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Introduction and reasoning

Plant and Equipment (P&E) is used extensively in the construction sector with a wide variety of machinery for a diverse range of applications: from static generators used to run welfare cabins through to 40 tonne articulated dump trucks. All consume fuel in one form or another to power their operation and provide the service they are there to do. Consequently, they inevitably cause sustainability impacts.

Due to this, there is a desire from within the industry to have a common set of forward-looking and challenging yet achievable sustainability performance standards to be used when purchasing or hiring P&E to reduce impacts from construction sites across the UK.

Taking this approach will not only bring sustainability benefits from reduced impacts, but also greater consistency in the choice, use and performance characteristics of the P&E, something that all actors in the value chain will appreciate for commercial and contractual reasons

Priority Sustainability Issues

The working group discussions have focussed on priority sustainability issues where the industry can have a meaningful effect through setting common and consistent standards to apply and communicate across the value chain.

The consequences of the use of the P&E and the consumption of fuel and other materials, result in local and global environmental impacts, which include the following, amongst others:



Air quality



Climate change



Health and safety



Resource consumption



Biodiversity

- Local **air quality** (AQ) impacts through the emissions of nitrogen oxides (NO_x), hydrocarbons (HC) and particulates (PM_{2.5} & PM₁₀) and the associated health impacts on workers and local communities
- Global **climate change** from the emissions of CO₂ and other greenhouse gases (GHG) due to inefficient engines and/or operatives using the P&E inefficiently or inappropriately
- Local **health and safety** issues from poorly trained operatives using the equipment
- Global impacts of **resource consumption** due to use of oils and lubricants
- Local impacts on **biodiversity** and water quality due to oil and lubricant leaks from poorly maintained equipment

These five impacts are the focus of the P&E category group.

Sector Survey and Baseline

The first part of the research and development for School-wide minimum standards has been to understand the ‘lie of the land’ with respect to what criteria other organisations – clients, regions and projects – use to drive down these sustainability impacts. The following organisations were researched as a representative sample for the UK:



**Highways
England**



London



Crossrail



HS2

Table 1 summarises the current and future air quality (AQ) standards and emissions thresholds for these organisations as well as their approach to driver safety and behaviour. The detail for each organisation is provided in **Appendix 1**.

The common theme is that they all prescribe thresholds for AQ emissions based on existing legislation, namely the Euro Standards for road-going vehicles (i.e. HGVs), and the Non-Road Mobile Machinery (NRMM) Regulations for other P&E. The detail of the Euro and NRMM standards is given in **Appendix 2** and **Appendix 3** respectively.

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Table 1. Comparison of AQ Emissions Standards for Different Organisations

Organisation	Highways England	London		Crossrail	HS2	
Plant/vehicle	2014	2015	2020	2017	2017	2020
<i>HGV (road-going) Euro</i>	IV	VI		-	VI	
<i>NRMM (Greater London and Rest of UK ¹) Stage</i>	III B	III A	III B	III B or IV	III B	IV
<i>NRMM (London Central Activity Zone) Stage</i>		III B	IV		IV	V
<i>FORS</i>	Compliant - Bronze	-	-	Compliant - Bronze	Bronze – Silver	

¹ Rest of UK applicable to HS2

Research and engagement

With support and guidance of plant hire companies in the group, we have engaged with many plant manufacturers. This has been a two-fold approach to discuss the School’s ambitions for addressing the sustainability issues in, and around plant.

Firstly, using existing relationships with plant manufacturers, we sent a questionnaire to canvas opinions on how ‘clean’ their plant engines are now, 2019, and in the future, looking to 2025. A copy of the questionnaire is at [Appendix 4](#). This approach built on discussions from the Plant category group meeting, wherein it was decided to go to a greater level of granularity in describing plant and equipment, and setting standards for them, more than is currently provided by any of the client organisations depicted in [Table 1](#) above.

We received responses from CAT, Komatsu, Kubota, Prolectric, Trime, Wacker Neuson and JCB. This provided us with a set of outputs that were useful, but it was discussed and agreed that more detailed discussions with manufacturers would be beneficial to gauge what the plant market can provide now, what the rate of change in fleet is, and consequently, where it can be in the future.



This led to a series of eight face-to-face meetings with manufacturers to delve deeper into these conversations. The School spoke with the following: JCB, Wacker Neuson, Harrington, Makita, Trime, CAT, Proelectric and Volvo¹.

The outcome of these discussions, and our investigations, has enabled us to propose the following School minimum standards for NRMM plant and equipment for now, 2019, and for the future – 2022 or 2025, depending on the plant and equipment.

Road-going vehicles have been discussed with the likes of Volvo, but not in the same detail as NRMM. The proposed minimum standards for this needs further work with relevant stakeholders.

Proposed Minimum Standards – NRMM

Based on the research undertaken for non-road machinery, it is proposed that we refer to the *NRMM Regulations Emissions Standards* in the main, with variations for specific smaller pieces of kit, and a growing recognition and presence of alternative, non-diesel power sources in the form of batteries, hybrids and solar.

The rationale has been that, whilst a specific client, region or project can set one 'blanket' standard across its entire jurisdiction, the School must be cognisant of being applicable to many different clients, regions and types of project. Likewise, the standards need to be more sophisticated by taking into account:



¹ Also invited: Komatsu, Hitachi, Doosan, Morris Site Machinery, Pramac, SDMO, Cummins, Hilti, Milwaukee and Bosch.

- Different kinds of plant and equipment, from a handheld saw, up to a 70-tonne articulated dumptruck
- Real-world availability of the various kinds of P&E
- The time it takes for fleet to turn over and refresh

The next few paragraphs summarise the discussions by plant type, followed by **Table 2**, which provides the proposed current and future standards for the School. For some plant, the future proposal is 2022 and for others 2025, which depends on how quickly the fleet for these products is in use before it is refreshed.

Small Plant and Tools



It was evident from discussions with Wacker Neuson and Makita that battery-powered machinery is commonplace, but that there are still petrol- and diesel-powered units in the fleet that will be replaced in the coming few years.

Investment in fossil fuel powered machinery is dwindling.

There are several benefits to battery over fossil fuels:

reduced noise, vibration and dust. Despite a (current) greater capex for battery-powered, their ROI is in the region of 3 to 6 months, due to lower running costs. The reduced GHG and AQ emissions are a clear additional benefit. The direction of travel is towards greater use of cordless/battery units.

An important change is in the sale of ‘naked’ products (sold without battery) to replace broken units or to expand available machine numbers, that can then be combined with existing batteries (also sold separately).²

² This raised two issues for future consideration: effective end-of-life processing of equipment under the WEEE Directive, and eco-design of units so they are all compatible with a limited number of battery types and charging units.

Lighting Towers (LT)



There are approximately 20,000 lighting towers (LT) in the UK 'fleet', of which approximately 70% run on 'old style' conventional diesel engines that each consume about 2 litres of diesel per hour. There is a great opportunity to reduce this consumption and the concomitant emissions of AQ and GHG, as well as savings in cost, worker maintenance time and associated safety aspects. According to Trime, eco-diesel engines, when combined with LED lumieres as opposed to conventional metal halide lumieres, can run on 0.55 litres per hour. This is an approximate 75% reduction in use, cost and emissions. Linked to this is the consequential fact that they run for longer before needing refuelling. Furthermore, the possibility of using batteries, hybrids and solar photovoltaic (PV) panels can further reduce emissions, so it is clear what the trend is. PV in particular offers a solution with no noise, vibration or emissions, and batteries used in conjunction with PV panels have been shown to last for 10 days as backup for winter usage by Prolectric. With the fuel saving, the ROI is quick, outweighing any potential increase in capex. This benefit is enhanced with the saving in staff time, due to less frequent refuelling and reduced risk of safety incidents. Whilst the lifetime of a LT is in the region of 5 to 10 years, it is predicted that by 2022 all old style LTs will have been replaced by more efficient, more sustainable variants.



Plant



Small, and some medium plant (excavators and dumpers) are currently *Stage III B* and there are many engines available at *III B* to ‘use up’ before moving to a more stringent stage rating (and allowed for transition by the regulations). Telehandlers and larger plant are currently at *Stage IV*. Having said that, NRMM *Stage V* plant is in production from about March/April 2019, according to CAT, JCB and Volvo, with a steady transition across the range through 2019 and 2020. This takes into account the ‘flex’ agreement with manufacturers to use older engines already ordered and manufactured, before moving to the new stage. In many cases, *Stage V* is achieved by adding diesel oxidation catalysts (DOC) and diesel particulate filters (DPF) to reduce NO_x and PM.

For smaller plant, the feeling was that NRMM *Stage IV* will be skipped and new models will leapfrog from *III B* straight to *Stage V*, or even electric at the smaller end of the scale.

With the time for *Stage V* larger plant to become widely available across the full range (from 2020 onwards), and the lifetime of machines in the fleet (averaging five years), it could be six years before we see a near complete move from *Stage IV* so that *Stage V* enter the plant hire fleet. Newer engines are more fuel efficient thereby saving opex costs. However, this budget usually sits with someone different to the original hire capex cost.



Whilst electric and hybrid powered medium and larger plant are being developed and entering the market, the availability of these at present isn't enough to supply the demand. Moreover, the market is still viewed as being dominated by diesel until battery prices reduce and their working capacity increases.

Generators



Ubiquitous on sites, these are used 24/7 for a variety of purposes. The bulk of the fleet in use is *Stage IIIA*. To get to *Stage V*, which will be available from May 2019, will require the addition of Diesel Oxidation Catalysts (DOC) and Diesel Particulate Filters (DPF) for after treatment for smaller kVA, as well as an electric starter. However, fuel is key: using poor quality fuel that doesn't meet EN590 will invalidate the *Stage V* rating. This is important as *Stage IIIA* generators run well on most kinds of fuel and making sure a new *Stage V* machine is operated properly with the right fuel is more about behaviour change than a purchasing decision. Where *Stage IIIA* generators are relatively basic, *Stage V* are more complex, usually with an in-built computer, and hence there is a significant capex cost increase for relatively little fuel efficiency in return for opex. Overall, manufacturers report a reluctance for buyers to move from a *Stage IIIA* to a *Stage V* model. Hybrid, battery and solar PV generators are available on the market and micro gas turbines are coming through too, so this is long term direction.



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Table 2. Proposed Minimum Standards for School on NRMM Plant and Equipment

PLANT	EXAMPLES	PROPOSED MINIMUM STANDARD FOR 2019	PROPOSED MINIMUM STANDARD FOR 2022 ^a / 2025 ^b
SMALL PLANT AND TOOLS ^a	Saws, whacker plates, etc.	≤50% petrol/diesel motor ≥50% cordless/battery	100% cordless/battery
LIGHTING TOWERS ^a	-	Eco-engine (≤0.55 L / hr) & LED lumieres *	≤67% Eco-engine (≤0.55 L / hr) & LED lumieres ≥33% Eco-engine (≤0.55 L / hr) & LED lumieres plus battery hybrid/PV*
SMALL PLANT <3T ^b	Mini excavators, micro dumpers, mini skip loaders	Stage III B	Stage V or electric
MEDIUM PLANT 3T – 13T ^b	Excavators, dumpers	Stage III B	≤33% Stage III B ≥67% Stage V
	Telehandlers	Stage IV	Stage V
LARGE PLANT >13T ^b	ADTs, Excavators, Wheel Loaders	Stage IV	≤33% Stage IV ≥67% Stage V
GENERATORS ^a	-	Stage III A	Hybrid generator for welfare cabins/ accommodation Stage III A with cleaner fuels elsewhere

* location dependent; ^a proposed minimum standards for 2022., ^b proposed minimum standards for 2025.

These are in line with the expectation of the organisations described in **Table 1**. The group has discussed that these standards should apply to all P&E. However, some P&E categories are used more extensively than others and as such, there should be a prioritisation of efforts to drive the proposed standards through the value chain, in particular with subcontractors, using communications channels we have through the School, as well as independently.

In order to identify which categories of P&E consume most fuel and therefore emit the



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largest amounts of GHG and AQ gases, we undertook a calculation of fuel consumption. This used a combination of:

- Estimated numbers of plant in the UK market gathered from plant hire Partners
- An exemplar piece of equipment to represent the subcategory and its associated engine kilowatt rating, along with a usage pattern model

Together, this was processed with data on fuel consumption by engine size from the RSSB Rail Carbon Tool to provide CO₂e (equivalent) figures, as shown in descending order of emissions in **Table 3** below.

Table 3. Estimation of relative contributions of NRMM Plant to GHG emissions

Plant/vehicle/equipment	Total Market, number	Exemplar Plant	Tonnes CO ₂ e emitted / year
Generators	77,200	30kVA genset	3,835,000
Large Plant (>13T)	26,000	30t excavator	2,357,000
Medium Plant (3T to 13T)	31,600	9 t dumper	1,558,000
Small Tools	590,000	400mm compaction plate	906,000
Small Plant (<3T)	39,200	1.5 t excavator	401,000
Diesel Powered Access	12,100	28m telescopic	298,000
Tower Lights	20,000	Standard diesel and eco-lighting towers	230,000
Totals			9,586,000

It can be seen that the annual total emissions across all plant and equipment is in the order of 10 million tonnes CO₂e. To put this in perspective, 10 MtCO₂e is equivalent to the emissions from energy (gas and

electricity) used in 3,000,000 homes in the UK each year³. More widely, this is equivalent to approximately 2% of the UK's overall emissions⁴.

We now have a net zero carbon reduction target for 2050, which includes these 10 MtCO₂e, in line with all other sectors. This will require a significant and systemic change in powering vehicles and a move to more alternative fuel technologies. This paper makes the case for the start of that process by moving to more fuel efficient options with reduced air quality emissions, with a longer-term view to encourage uptake of other power sources such as hybrid engines, batteries and solar powered plant. Indeed, these three latter options are already commercially available, and more are coming on stream every month.

Furthermore, it is clear from **Table 3** that the biggest emitters overall are generators and large and medium plant; accounting for 81% of all emissions between them. This is due to the number of pieces of plant, the amounts of fuel they each consume during use, as well as their usage patterns. Whilst this has been calculated for GHG emissions, it can be directly correlated to air quality emissions of NO_x and PM₁₀. **Figure 1** below depicts the split in GHG emissions by plant and equipment type.

It is apparent that, whilst this work is applicable and relevant across all plant and equipment, if there is to be any focus of action on specific plant types, it should be on generators and large and medium plant.



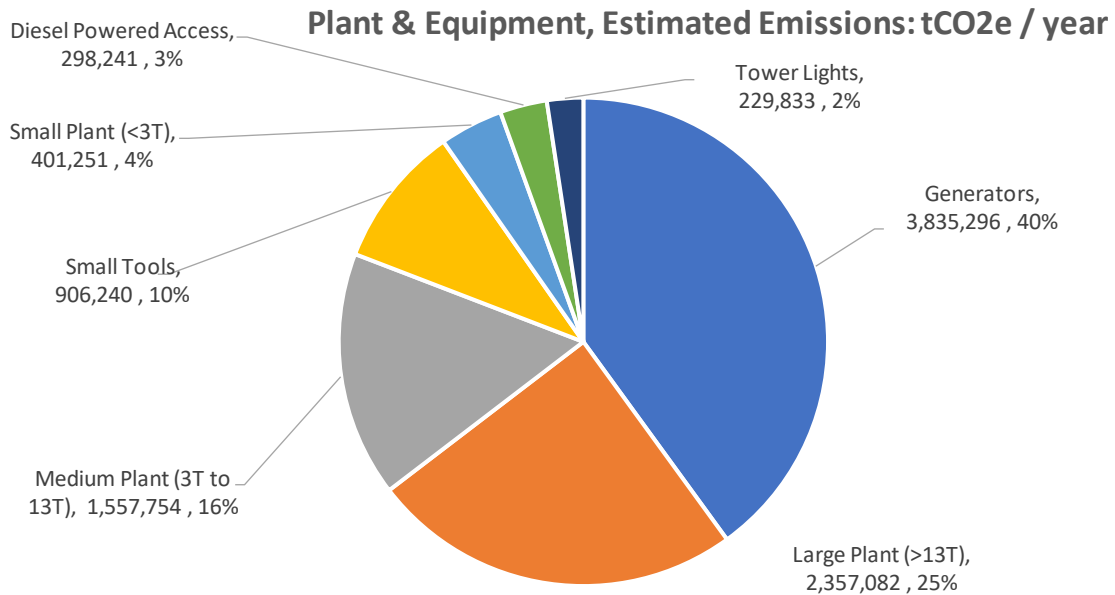
³ Average UK household electricity and gas use is 16,400 kWh per year (<https://www.thegreenage.co.uk/how-much-energy-does-my-home-use/>) equating to 3.3 tCO₂e per year (Defra GHG Conversion Factors for Company Reporting, 2019)

⁴ Committee on Climate Change – Fifth Carbon Budget 2015.

<https://www.theccc.org.uk/wp-content/uploads/2015/11/Committee-on-Climate-Change-Fifth-Carbon-Budget-Report.pdf>

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Figure 1 – Plant and Equipment estimated emissions



Proposed Minimum Standards – Road-going vehicles

For road going machinery it is proposed that we refer to the **Euro Standards**, with the following breakdown in thresholds in **Table 4**. Again, these are in line with the expectations of the organisations in **Table 1**.

All new vehicles have been *Euro VI* since 2013, but with the average lifetime of LGV and HGV vehicles in the fleet, there will still be *Euro V* engines in existence in 2019 (*Euro V* was from 2008). However, it is expected that the *Euro V* vehicles will move out of the fleet in the coming three to four years such that all are *Euro VI* by 2022. There are developments in electric at the LGV end of the scale and diesel hybrid at the HGV end, but it is early days in terms of realistic supply and demand from a minimum standards point of view.

For vans, all new vehicles will be *Euro VI*, but there is growing production and availability of electrically powered vans, alongside the growth of electric cars.

The area of road-going vehicles needs more engagement with the manufacturing community before we set minimum standards.

Table 4. Proposed Minimum Standards for School on Road-going Vehicles

Vehicle	Proposed minimum standard for 2019	Proposed minimum standard for 2022
Vans ⁵	Euro VI	≤80% Euro VI ≥20% Electric/ hybrid
7.5t – 32t LGV / HGV	≤50% Euro V ≥50% Euro VI	Euro VI

⁵ In December 2018 there were 10,000 plug-in vans in the UK <https://www.nextgreencar.com/electric-cars/statistics/>. There are approximately 4 million vans (light commercial vehicles) on the UK's roads <https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01>. Therefore plug-in electric vans currently account for 0.25% of the total registered vans in the UK.

Proposed Minimum Standards – Health & Safety & Fuel-Efficient Driving (Climate Change)

It is understood from discussions with plant hire companies that they are currently able to offer silver as a minimum in most cases and gold in many situations.

We therefore propose that for all driven machinery, we refer to the **FORS silver** standard or better, to ensure compliance to reduce the risk of health and safety incidents and to encourage more efficient and smoother driving styles.

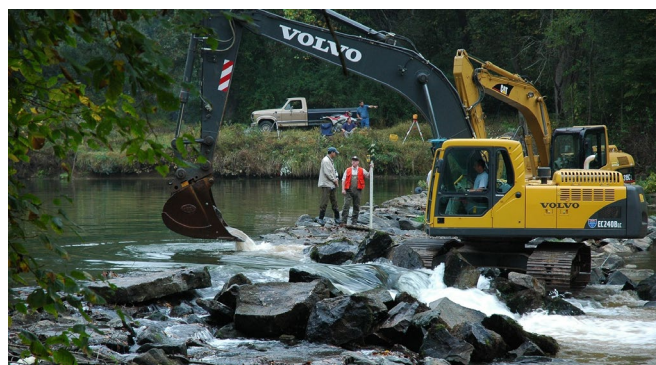


Proposed Minimum Standards – Resource Consumption & Environmental Pollution

One of the key issues flagged was resource consumption: fuels, oils and lubricants, in particular.

Written guidance has been developed with the support of WP Group on maintenance regimes for oils and lubricants to reduce the use of these materials, reduce incidents of leaks and spills into the local environment, and more efficient running of the P&E. This is provided in [Appendix 5](#).

There are other aspects related to the vehicle's capabilities and technical specification, as well as driver/operator capability that are outside the scope of the School's Minimum Standards work. Nonetheless, it is proposed that the Highways England "[Raising the Bar](#)" document is referred to for all other aspects of P&E minimum safety and operator requirements.



Charter

Once the Minimum Standards have been discussed and agreed, it is proposed that Partners in the plant category group sign a **Charter** committing to purchase and hire plant and equipment in accordance with them.

Communications and outreach to supply chain and stakeholders

Agreeing and setting the Minimum Standards is one thing. Ensuring they are communicated, understood and enacted on within the supply chain is another.

Once the Standards are agreed, we propose communicating to the supply chain via the School on:

- What the Standards are and what they mean
- When they come into place
- Who they apply to
- What is required of contractors to show they comply

We will develop a full communications plan as things proceed and the Standards are refined. At this stage, it is envisaged that these communications will consist of:

- A page on the School website from which the standards can be downloaded
- Case Studies provided by Partners on why and how they are reducing their AQ emissions from the P&E they use, and the benefits this brings
- A toolbox talk has been developed on AQ and an e-learning module is in production which will be linked to the Standards
- Presentations to Partners via leadership groups
- Email and social media communications to School members
- Presentations at suitable supplier days
- Measurement on the uptake and use of the standards (at a later date)

*Appendix 1 – Existing Emissions Thresholds,
Criteria and Expectations*

1. A Client: Highways England – Raising the Bar – 2014

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/394701/B1_Plant_and_Equipment_V_September_2014.pdf

Road-going diesel engines

Lorry loader crane, Mixer truck, Telehandler, Road sweeper/collector, Concrete pump, Mobile crane, Volumetric mixer: *Engine emissions compliant to EURO 4 or better and Fleet Operator Recognition Scheme (FORS) compliant – all desirable.*

Non-road mobile machinery (NRMM) diesel engines

180° excavator / backhoe, Forward and side tipping dumper, Mini excavator, Tracked 360° excavator, Compressors / air systems, Concrete extrusion machines, Mobile crushing plant, Tracked dozer, Wheeled loading shovel: *Engine emissions compliant to EU Tier iiiB or better – all desirable*

2. A Region: London

2.1. London Low Emission Zone for NRMM – 2015 ⁶

<https://nrmm.london/content/cleaner-construction-machinery-london>

Air pollution is one of the most significant challenges facing London. We are in breach of European legal limits for Nitrogen Dioxide (NO₂) and many areas exceed safe limits for Particulate Matter (PM) as set by the World Health Organisation. Bold new measures have been proposed by the Mayor to tackle emissions from road transport, particularly diesel vehicles, including an expansion of the Ultra-Low Emission Zone. However, this is only half the problem – **current estimates of emissions from NRMM used on construction sites are shown to be responsible for 7% of NO_x emissions, 14% for PM_{2.5} and 8% of PM₁₀ emissions across the Capital and this is why the Mayor is determined to take action.**

⁶ Read more at <https://www.london.gov.uk/press-releases/mayoral/building-site-air-quality>

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From 1 September 2015 NRMM with a net power between 37kW and 560kW and used in London will be required to meet the standards below. These apply to both variable and constant speed engines for both NO_x and PM emissions. These standards are based on the engine emissions standards in EU Directive 97/68/EC and any subsequent amendments:

- NRMM used on the site of any major development within Greater London will be required to meet Stage IIIA of the Directive as a minimum; and
- NRMM used on any site within the Central Activity Zone or at Canary Wharf will be required to meet Stage IIIB of the Directive as a minimum

From 1 September 2020 the following will apply:

- NRMM used on any site within Greater London will be required to meet Stage IIIB of the Directive as a minimum
- NRMM used on any site within the Central Activity Zone or Canary Wharf will be required to meet Stage IV of the Directive as a minimum

These requirements may be met using the following techniques;

- Reorganisation of NRMM fleet
- Replacing equipment (with new or second-hand equipment which meets the policy)
- Retrofit abatement technologies
- Re-engining

All eligible NRMM should meet the standards above unless it can be demonstrated that the machinery is not available or that a comprehensive retrofit to meet both PM and NO_x emission standards is not feasible. In this situation every effort should be made to use the least polluting equipment available including retrofitting technologies to reduce particulate matter emissions.

It is recognised that some NRMM plant is not yet widely available in the numbers required to meet the above standards and that some options for retrofitting or reengining are not currently available or are cost prohibitive. The GLA [retrofit policy](#) includes a list of NRMM that is exempt from this policy and what criteria individual machines will need to meet to obtain an exemption. The GLA have an [exemption policy](#) for when the required

machinery is not available, if retrofitting abatement options are not possible, or the machinery is needed to fit a genuine emergency.

Southwark Council's Technical Guidance on Air Quality – August 2017, is one example of where their approach is aligned to nrmm.london

<https://www.southwark.gov.uk/assets/attach/4406/Technical%20Guidance%20on%20Air%20Quality.pdf>

2.2. London Low Emission Zone for Lorries

<https://tfl.gov.uk/modes/driving/ultra-low-emission-zone/complying-with-ulez>

Road-going diesel engines (HGVs trucks)

TfL stipulates Euro VI for all HGV road-going vehicles.

3. A Client & Project: Crossrail – a wholly owned subsidiary of Transport for London (TfL)

3.1. Best Practice Guide – Air Quality – 2017

https://learninglegacy.crossrail.co.uk/wp-content/uploads/2017/03/HS17_BPG_AirQuality.pdf

Section B5 – Selection of locos

All non-road mobile machinery shall:

- use fuels with a sulphur content equivalent to ultra-low sulphur diesel fuel meeting the specification within EN590:2004
- comply with the current or immediately previous EU Directive Staged Emission Standards; and
- vehicles which are not EU stage III (b) or IV, and the power output is over 37kW, should be fitted with an after-treatment device(s) as stated on the approved list managed by the Energy Saving Trust. Ongoing conformity to a performance standard to be defined and ensured through a programme of on-site checks which should be recorded and reviewed.

The soot/particulate filters are the key to the control of diesel fume in the tunnel. Part of the regular maintenance of tunnel locos should include regular back pressure testing of filters with the criteria being set for the removal, cleaning and regeneration.

Machine Selection

Machines should be selected on the basis that their emissions conform to the latest EU regulations, which in the UK are given in ‘The nonroad mobile machinery (emissions of gaseous and particulate pollutants) Regulations 1999 1053’. The table below is an example of the emissions that must be achieved for vehicles introduced after the end of 2014 [NRMM Stage IV]. Machines should not be oversized as larger machines that run at low power are less efficient than smaller machines running closer to full power as shown below.

3.2. Lorry Driver Induction Training - the road to safer driving

<http://www.crossrail.co.uk/construction/road-safety-information/lorry-driver-training#>

Crossrail has trained over 9,000 lorry drivers on how to share safely London’s roads with cyclists and other vulnerable road users. Every frequent lorry driver working on the construction of Crossrail must complete a custom-made course designed in consultation with cycling and road safety campaign groups and the police.

4. A Client & Project: HS2

4.1. HS2 HIGH SPEED TWO PHASE ONE INFORMATION PAPER E31: AIR QUALITY – 23rd February 2017 ⁷

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/672406/E31_-_Air_Quality_v1.5.pdf

Road-going diesel engines (HGVs trucks)

HS2 is stipulating Euro VI for all HGV road-going vehicles.

Non-road mobile machinery

The Greater London Authority (GLA) Supplementary Planning Guidance (SPG ⁸) on the control of dust and emissions during construction and demolition sets requirements for NRMM emissions based upon the EU

⁷ Also see HS2 High Speed Two – Air Quality Strategy – July 2017

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/632198/s2_air_quality_strategy.pdf section 6.2.4.

⁸ <https://www.nrmm.london>

emission stages. Requirements for the scheme [HS2] are based on those of the SPG, but are more stringent, requiring the earlier up-take of cleaner engines. Table 1 below shows the levels.

Table 1: NRMM Engine Emission Stage Requirements (of engine power between 37kW and 560kW)

Area	London SPG Stage Requirements		HS2 Requirements	
	From 2015	From 2020	From 2017	From 2020
London Central Activity Zone (includes Euston)	III B	IV	IV ^(1,2)	V
Rest of Greater London	III A	III B	III B ⁽²⁾	IV ^(1,2)
Rest of country	Not applicable	Not applicable	III B ⁽²⁾	IV ^(1,2)

Notes:

(1) III B for $37 \leq P < 56\text{kW}$, as there is no corresponding Stage IV at EU level

(2) III A for constant speed engines of any power, as there is no corresponding Stage III B or IV at EU level

The Greater London Authority [exemptions policy](#) [for when the required machinery is not available, if retrofitting abatement options are not possible, or the machinery is needed to fit a genuine emergency] set out in the SPG will apply route wide to HS2.

**4.2. HIGH SPEED TWO PHASE 2a INFORMATION PAPER E8:
VEHICLE FLOW MANAGEMENT AND SAFETY REQUIREMENTS
DURING CONSTRUCTION – 17th July 2017**

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/628454/E8_Vehicle_flow_management_and_safety_requirements_during_construction_v1.0.pdf

Principal Contractors will need to ensure that their heavy goods vehicle fleets operate in accordance with an approved and audited fleet quality plan, such as the Fleet Operator Recognition Scheme (FORS) standard or,

for non-UK Principal Contractors, ISO39001. Other quality management plans may also be considered, as long as they address the themes of the FORS standard and have independent auditing.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/637988/hs2_phase_one_traffic_management_plan.pdf

Principal Contractor joint venture partners who are UK registered shall either:

- achieve and adhere to FORS Bronze level and achieve and adhere to Silver level (where relevant to the vehicle and driver safety requirements in 5.7, 5.8 and 5.9) as soon as practicable and normally, in relation to Silver level within 6 months of commencement of construction works for the HS2 Phase 1 project, unless otherwise agreed by HS2 Ltd. HS2 Ltd may issue guidance on the adoption and progression of FORS through TANs as necessary.

Or

- set out how the contractor will achieve and adhere to an alternative quality standard which must address the themes of the FORS standard, such as through new emerging standards

Appendix 2 – Euro Standards for road-going vehicles

Euro Standards for Lorries -

<https://www.dieselnets.com/standards/eu/hd.php>

Table 1
EU Emission Standards for Heavy-Duty Diesel Engines: Steady-State Testing

Stage	Date	Test	CO	HC	NOx	PM	PN	Smoke
			g/kWh				1/kWh	1/m
Euro I	1992, ≤ 85 kW	ECE R-49	4.5	1.1	8.0	0.612		
	1992, > 85 kW		4.5	1.1	8.0	0.36		
Euro II	1996.10		4.0	1.1	7.0	0.25		
	1998.10		4.0	1.1	7.0	0.15		
Euro III	1999.10 EEV only	ESC & ELR	1.5	0.25	2.0	0.02		0.15
	2000.10		2.1	0.66	5.0	0.10 ^a		0.8
Euro IV	2005.10		1.5	0.46	3.5	0.02		0.5
Euro V	2008.10		1.5	0.46	2.0	0.02		0.5
Euro VI	2013.01	WHSC	1.5	0.13	0.40	0.01	8.0×10 ¹¹	

a - PM = 0.13 g/kWh for engines < 0.75 dm³ swept volume per cylinder and a rated power speed > 3000 min⁻¹

Table 2
EU Emission Standards for Heavy-Duty Diesel and Gas Engines: Transient Testing

Stage	Date	Test	CO	NMHC	CH ₄ ^a	NOx	PM ^b	PN ^e
			g/kWh					1/kWh
Euro III	1999.10 EEV only	ETC	3.0	0.40	0.65	2.0	0.02	
	2000.10		5.45	0.78	1.6	5.0	0.16 ^c	
Euro IV	2005.10		4.0	0.55	1.1	3.5	0.03	
Euro V	2008.10		4.0	0.55	1.1	2.0	0.03	
Euro VI	2013.01	WHTC	4.0	0.16 ^d	0.5	0.46	0.01	6.0×10 ¹¹

a - for gas engines only (Euro III-V: NG only; Euro VI: NG + LPG)
b - not applicable for gas fueled engines at the Euro III-IV stages
c - PM = 0.21 g/kWh for engines < 0.75 dm³ swept volume per cylinder and a rated power speed > 3000 min⁻¹
d - THC for diesel engines
e - for diesel engines; PN limit for positive ignition engines TBD

*Appendix 3 – Non-Road Mobile Machinery
(NRMM) Regulations*

NRMM Regulation for Non-road Diesel Engines -

<https://www.dieselnet.com/standards/eu/nonroad.php>

Stage III A/B emission standards for nonroad diesel engines

Cat.	Net Power	Date †	CO	HC	HC+NOx	NOx	PM
	<i>kW</i>						
Stage III A							
H	130 ≤ P ≤ 560	2006.01	3.5	-	4.0	-	0.2
I	75 ≤ P < 130	2007.01	5.0	-	4.0	-	0.3
J	37 ≤ P < 75	2008.01	5.0	-	4.7	-	0.4
K	19 ≤ P < 37	2007.01	5.5	-	7.5	-	0.6
Stage III B							
L	130 ≤ P ≤ 560	2011.01	3.5	0.19	-	2.0	0.025
M	75 ≤ P < 130	2012.01	5.0	0.19	-	3.3	0.025
N	56 ≤ P < 75	2012.01	5.0	0.19	-	3.3	0.025
P	37 ≤ P < 56	2013.01	5.0	-	4.7	-	0.025

† Dates for constant speed engines are: 2011.01 for categories H, I and K; 2012.01 for category J.

Table 3
Stage IV emission standards for nonroad diesel engines

Cat.	Net Power	Date	CO	HC	NOx	PM
	<i>kW</i>					
Q	130 ≤ P ≤ 560	2014.01	3.5	0.19	0.4	0.025
R	56 ≤ P < 130	2014.10	5.0	0.19	0.4	0.025

Stage V emission standards for nonroad engines (NRE)

Category	Ign.	Net Power	Date	CO	HC	NOx	PM	PN
		<i>kW</i>						
NRE-v/c-1	CI	P < 8	2019	8.00	7.50 ^{a,c}		0.40 ^b	-
NRE-v/c-2	CI	8 ≤ P < 19	2019	6.60	7.50 ^{a,c}		0.40	-
NRE-v/c-3	CI	19 ≤ P < 37	2019	5.00	4.70 ^{a,c}		0.015	1×10 ¹²
NRE-v/c-4	CI	37 ≤ P < 56	2019	5.00	4.70 ^{a,c}		0.015	1×10 ¹²
NRE-v/c-5	All	56 ≤ P < 130	2020	5.00	0.19 ^c	0.40	0.015	1×10 ¹²
NRE-v/c-6	All	130 ≤ P ≤ 560	2019	3.50	0.19 ^c	0.40	0.015	1×10 ¹²
NRE-v/c-7	All	P > 560	2019	3.50	0.19 ^d	3.50	0.045	-

^a HC+NOx
^b 0.60 for hand-startable, air-cooled direct injection engines
^c A = 1.10 for gas engines
^d A = 6.00 for gas engines

Table 5
Stage V emission standards for generator set engines above 560 kW (NRG)

Category	Ign.	Net Power	Date	CO	HC	NOx	PM	PN
		<i>kW</i>						
NRG-v/c-1	All	P > 560	2019	3.50	0.19 ^a	0.67	0.035	-

^a A = 6.00 for gas engines

Identifying NRMM Emissions Standard from Engine Type Approval Plates

You can find out what the emissions standard is for an engine by looking at the engine type approval plate, where you will find an EC Type approval number that you can use to work out the emissions standard that the engine meets. A typical type approval plate will take on the following format:

E1*97/68PA*2012/46*0699*04

These numbers are easy to understand once you break them down, which you can do in the following way:

- E1 = member state who tested the engine
- 97/68 = the original EC legislation that the approval is for
- P = the encoding letter of the EU emissions stage (see the table below)
- A = tells you if the engine is variable speed (A) or constant speed (B)
- 2012/46 = the latest level of legislation that the approval relates to
- 0699 = identification number of the manufacturer or importer
- 04 = indicates if the approval has any revisions

Emissions Stage	Power Band of Engine				
	19-37kw	37-56kw	56-75kw	75-130kw	130-560kw
I	*	C	C	B	A
II	D	G	G	F	E
IIIA	K	J	J	I	H
IIIB	*	P	N	M	L
IV	*	*	R	R	Q

Appendix 4 – Plant manufacturer questionnaire

Plant Category Group – Minimum Standards

1. Background

- The Supply Chain Sustainability School – the School - is a large-scale, sector-wide programme, the aim of which is to increase the sustainability skills and competencies of the supply chain in the built environment in order to help everyone meet the challenge of the Construction 2025 Strategy.
- It is free for anyone in the sector to use; it is funded by the CITB and the UK's top construction contractors and clients. For more details go to <https://www.supplychainschool.co.uk/uk/default-home-main.aspx>
- There are now 76 Partners inspiring a more sustainable built environment, from client organisations like Heathrow, Highways England, HS2, National Grid and Anglian Water, through tier contractors such as Skanska, Balfour Beatty, Galliford Try and BAM Nuttall and out to major suppliers such as Flannery, A Plant, Speedy Hire and GAP.
- The School is a collaboration between all parties - clients, contractors and 1st tier suppliers - who have a mutual interest in building the skills of their supply chain. They pay for the School, so it's all FREE for you.

Delivering our vision



“A world class collaboration to enable a sustainable built environment”

Subject Matter	Target Audience	Accreditation	New knowledge
We will provide learning content that builds skills to deliver a sustainable built environment	We will deliver a School free at the point of use for anybody who works in, or may aspire to work in, the built environment sector	We will offer CPD accredited learning where appropriate and learning that contributes to professional qualifications. We will recognise members' effective participation in the School and work with the industry to promote recognition of School members	We will engage with industry, academia and research organisations to instigate and seed fund new research that can be translated into School learning content in the future
Leadership	Geographic reach	Partners	Funding
We will establish the School as the centre of excellence with respect to developing supply chains to deliver a sustainable built environment	We will seek global best practice to reach partners' supply chains across the UK and outside the UK where appropriate. Our delivery partner will respond to opportunities to franchise the School at their own cost and risk	We will seek partners who share the values of the School and who commit to share knowledge, contribute financially and in kind	We will fund the School from partner contributions, franchise fees and appropriate sources of government or industry funding. We will not ask members for money or allow commercial sponsorship of our learning content or activities



2. Plant Group

- Within the School, there are a number of project development groups. One of the largest is called the “Plant Group”
- Plant refers to a wide range of equipment used in the built environment from large and small plant, from lighting towers, generators and small equipment to vehicles.
- The group's aim is to develop and agree on a common set of ‘standards’ that would be adopted and promoted by all those involved with the School. This will

Plant Category Group – Minimum Standards

foster collaboration in a consistent fashion with the aim of lowering emissions, air quality and GHG, and therefore reducing the impact of plant on the environment.

- Currently the project group meet each month and are exploring a number of avenues including setting built environment industry wide standards for plant used on site in the UK.
- At the last meeting the Plant Group discussed the type of equipment that legislation requires to be used in the UK built environment
- We want to influence what equipment is used now and in the future
- We want to understand what engines are being used in plant today and what could be possible in five to ten years' time
- If we have legislation – what is the art of the possible – how green could plant be?
- Should clients and contractors clearly state what type of machine and engine they want on their sites in the future?
- If in the future, clients and contractors insisted on buying or hiring greener engines - what are the risks and challenges of doing this

3. Questionnaire

We value your input, knowledge and insight into this process. We would appreciate it if you could assist us in this by completing the questionnaire below and returning it to the sender by 20 November 2018.

Question 1:

- For the plant categories shown in the table below (those that have the largest impact on both air quality (NO₂, PM₁₀) and greenhouse gas emissions (CO₂) due to the frequency of their use), we would like to obtain information back from you regarding the engine type (or power source – battery/solar/electric etc.) used in your equipment today and what in your opinion will be available in five to ten years' time. Please refer to the existing Euro and NRMM Standards as a framework in your response.
- Companies collecting this information on behalf of the School Plant Group are A-Plant, Flannery, Speedy, GAP
- The Plant equipment categories are Plant, Lighting, Generators and Small Equipment
- Please enter information into the grid below – or if more appropriate please supply information in a format that works for you

Plant category group – Minimum Standards

Date	Today in 2018			In the future 2024			Demand		
Engine Size Definition	What engine type are you using in your manufactured products today?			Ignoring the UK legislation requirements – what could you be manufacturing in five years' time? I.e. what is the art of the possible			Do you feel there will be a greater demand for greener plant equipment in five years' time ?	Supplier List	Who will send the questionnaire to whom
	Small	Medium	Large/ Operated	Small	Medium	Large/ Operated			
Plant	<1.5t	1.5t – 13t	>13t	<1.5t	1.5t – 13t	>13t		JCB, CAT, Komatsu, Volvo, Wacker Neuson, Hitachi	JCB = APH Wacker = GAP CAT, Komatsu, Hitachi = Flannery
Answer									
Lighting Towers								TRIME, Morris Site Machinery, Pramac/generac, Prolectric	TRIME = GAP MSM = Speedy Pramac = Speedy

Plant category group – Minimum Standards

									Proelectric = Speedy
Answer									
Generators	<20KVA	20-250 KVA	>250KVA	<20KVA	20-250 KVA	>250KVA		JCB, Harrington, SDMO, Cummins Pramac	JCB, Harrington = APH SDMO = Speedy Pramac = Speedy
Answer									
Small Equipment	Engine	Battery	Solar	Engine	Batter	Solar		Hilti, Makita, Wacker Milwaukee, Bosch	Hilti = Speedy Wacker = GAP Makita = APH Milwaukee = Speedy Bosch = Speedy
Answer									

Question 2:

In March 2019 the Supply Chain Sustainability School is planning to host a UK event exploring the opportunity to improve air quality and equipment efficiency in the built environment. This event will be open to all partners and members of the School as well as all companies that form part of the overall supply chain.

Would your company be interested in attending and / speaking at such an event? Yes or No....

Anything that you might feel useful to this event would be appreciated. Please let us know.

Ends

[Type here]

Appendix 5 - A Guide to Alternative Diesel Fuels and Efficient Use of Oils

Alternative Diesel Fuels – An Introduction

There is growing awareness of the impacts of using conventional diesel as fuel for vehicles and machinery for two key reasons. Firstly, the combustion process leads to air quality emissions, nitrogen dioxides (NO_x) and particulate matter (PM) in the main, that cause health impacts. Secondly the CO₂ emissions that are a direct consequence of burning fossil fuels and the associated climate change impacts. In response to this many local authorities and construction clients have set requirements on tailpipe emissions to reduce the impact on air quality by demanding cleaner burning engines.

Switching to non-hydrocarbon power sources, such as batteries or solar to power your vehicles and plant is one solution, but this isn't always possible due to cost, availability or applicability. There are however two very good liquid fuels that 'bridge the gap' between conventional diesel and other 'cleaner' forms of power. This Guide provides information and guidance on the alternatives available and their benefits.

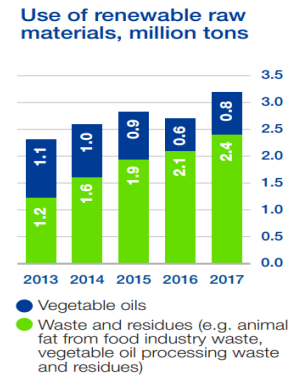
The Alternatives – Two Paraffinic Fuels to Bridge the Gap

- GTL (gas to liquid), a relatively new paraffinic fuel. Like conventional diesel, GTL is a hydrocarbon fuel made from non-renewable sources. However, it is made from waste gases from refinery plants, often methane, that are otherwise flared off. These waste gases are combined into longer chain hydrocarbon molecules that become the liquid diesel fuel;
- HVO (hydro-treated vegetable oil) is a renewable fuel made from waste vegetable oils that are converted into a usable biofuel. The process to make HVO differs from standard biofuel in two ways: the feedstock is waste stream rather than crops grown for biofuel, and the transformation process results in a fuel that burns more cleanly and more efficiently than other biofuels;
- Both fuels have a new euro standard classification as a paraffinic fuel: EN15940; and
- HVO will also be certified as a renewable biofuel in its own category currently being assessed by The Department for Business Energy & Industrial Strategy (BEIS).



The Benefits of Switching Fuels

- GTL and HVO reduce air quality NO_x and PM emissions. Using them in your vehicles and plant means you are more likely to meet your client's emissions limits. Data shows that using GTL in plant reduces NO_x by 6-25% and PM by between 10-90%⁹;
- HVO, being renewable, qualifies for Renewable Obligation Certificates (ROCs)¹⁰ and Renewable Transport Fuel Certificates (RTFC)¹¹ as it contributes significantly to a lower carbon footprint;
- Both are 'drop in' fuels meaning you can mix them in with standard diesel; there is no need to drain or change systems to use the fuel;
- The alternative fuels also confer: better starting performance in cold weather - HVO works down to -40C vs -15C for diesel; safer use and storage as they have a higher flash point; longer shelf-life compared with conventional diesel due to the latter's 7.5% bio content and average life of 6 - 9 months; reduced noise levels in some engines as there is a more even burn; and more readily biodegradable than conventional diesel, meaning any spills are less harmful to biodiversity;
- HVO is good for your organisation's sustainability PR giving you market advantage; and
- As GTL is made from combining smaller gas molecules, the fuel comes without the usual trace additives and contaminants that conventional diesel has, such as sulphur and metals. This means you get a cleaner burn and hence lower emissions.



What next?

- Seek advice from your School Partners, The WP Group, or engage your fuel supplier. They can help you with implementing a switch;

⁹ Shell GTL Fuel Benefits Guide

¹⁰ <https://www.ofgem.gov.uk/environmental-programmes/ro/about-ro>

¹¹ <https://www.gov.uk/guidance/renewable-transport-fuels-obligation>

- For HVO, make sure you get support and expertise from your supplier for the first uses of HVO can clean out any deposits in an engine. However, the results from recent trials involving Scania Euro IV, V and VI have shown significant reductions in emissions and maintenance; and
- Supply is currently growing with demand so there is enough available if you decide to use it.

Efficient Use of Oils – An Introduction

All plant and equipment need oils and lubricants to make them work effectively and efficiently. Without them the machinery quite literally grinds to a halt. But are you using the right one for your plant? Are you maintaining it as often as you should? Indeed, do you swap out the oils too often? Giving proper consideration to the oils you use can lead to a variety of benefits including saved money, reduced maintenance frequency and equipment running more efficiently. This Guide provides information and guidance on what you can do to use your oils more efficiently.

A Different Approach

- You can gain from improving the situation with your use of oils, but to do so you first need to establish a good understanding of what oils you are currently using, for which plant and why and the current frequency of servicing and replacement of oils;
- Once you've done this engage your supplier to get their expertise on whether you can improve the situation by rationalising how many oils you use and to make sure you are using the right product - quite often you can use one oil for several different applications - rather than a multitude of slightly different oils. Moreover, engine design is continually improving and so too should your choice of oil to match the engine's performance; and
- Also speak with your supplier about optimising your maintenance regime – with advances in oil technology there is less need to replace them so often.

The Benefits of Efficient Oil Use

- Better stock control: fewer different kinds of oils means less wastage – money and materials – and less likelihood of inadvertently using the wrong oil;
- Less frequent service intervals: reduced downtime for your plant and the associated cost of not being able to do work, or having to hire in a

replacement; fewer potential health & safety issues from doing more frequent maintenance;

- Plant runs more efficiently and for longer: there are fewer breakdowns; less frequent replacement of components, which means lower costs and less waste; and
- Consider changing from oil drums to tanks and bulk delivery: fewer deliveries, less wasted oil left in the drums, more control over stock levels.

What next?

- Engage your lubricants supplier!