Non-Road Mobile Machinery (NRMM) Diesel Engine Emissions

Field Guide to Identification of Diesel Engine Emission Compliance

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Contents

1 Purpose

This document is intended to be used as a field guide for the identification of compliant and non-compliant Non-Road Mobile Machinery (NRMM) across Crossrail construction site.

The document is intended as a reference guide for project Environmental Advisors, project Field engineers or others that are tasked with identifying compliance with Crossrail Works Information *'Volume 2B - General Requirements, Part 21 - Environmental Management, Section 21.10.2 Vehicle and Equipment Emissions'*.

This document can also be read in conjunction with Contractor Guidance document CR-XRL-T1-GUI-CR001-50005 and amended versions *"Guidance on Diesel Engine Emissions from Non-Road Mobile Machinery (NRMM) and Retrofitting with Diesel Particulate Filters (DPF)"* which has been issued as a guidance communication document to contractors.

2 NRMM Diesel Engine Emissions

The Crossrail Diesel Engine Emission Requirements for NRMM are:

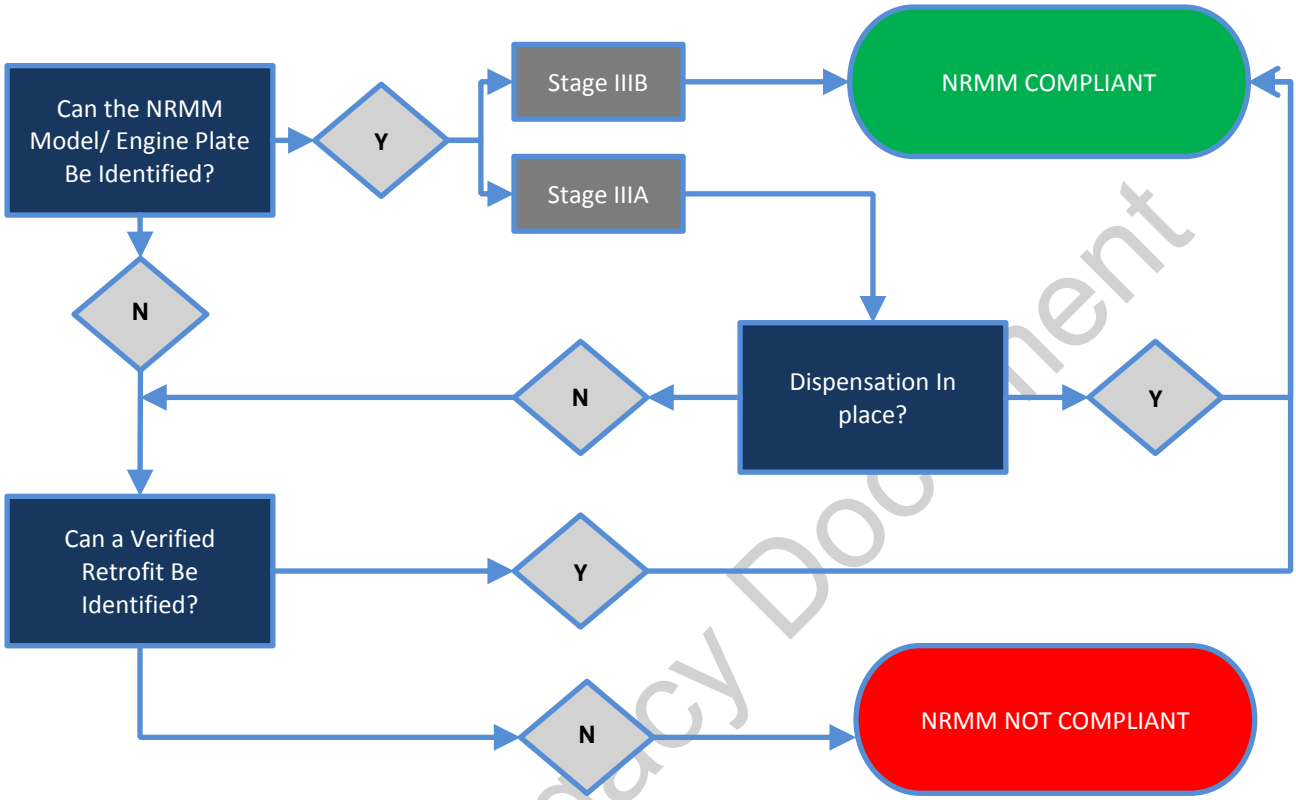
- All Non Road Mobile Machinery (NRMM) with a type approval engine EU Stage IIIA or below, with a power output greater than (or equal to) 37kW, is required to be fitted with a Diesel Particulate Filter.
- All NRMM with a type approval engine EU Stage IIIB or above, with a power output greater than (or equal to) 37kW, will NOT be required to be retrofitted with a Diesel Particulate Filter.
- Any Diesel Particulate Filter retrofitted to NRMM must hold a valid verification scheme certificate from a verification scheme.
- Any requests to supply NRMM which deviate from the Crossrail Diesel Engine Emission Requirements should be explained to the Tier 1 Contractor with an accompanied rationale why NRMM with EU Stage IIIB engine or a suitable retrofit cannot be provided.

NRMM includes any mobile machine, transportable industrial equipment or vehicle with or without body work, brought onto site to carry out operations for the purpose of construction and is not considered a permanent installation.

Examples of NRMM include, but are not limited to: Generators; Bulldozers; Construction machinery; Fork Lift; Mobile cranes.

The focus of Crossrail Diesel Engine Emission Requirements is Particulate Matter (PM). There are no requirements to retrofit Nitrogen Oxides (NOx) abatement technology on any EU Stage IIIA engine. NOx attenuation should comply with the levels as specified in the retrofit verification certification.

3 NRMM Compliant Decision Process



4 Identification of Compliance from Make and Model

Identification of NRMM for the majority of cases can be carried out through an outside visual inspection with reference to a current plant list which should be supplied by the site environment manager or site plant manager.

ENGINE	
Model	Isuzu 4HKIX. European Tier III emissions compliant.
Type	Water cooled, 4-stroke, 4-cylinder in-line, direct injection, turbocharged d
Nett power (ISO 3046-1NF)	128kW (172hp) at 2000rpm.
Piston Displacement	5.193 litres.
Injection	Electronic injection.
Air Filtration	Dry element with secondary safety element and in cab warning indicator.
Cooling	Water cooler via large capacity radiator.
Starter motor	24 volt – 4.5kW.
Batteries	2 x 12 volt Heavy-duty.
Alternator	24 volt 40 amp.
Refuelling pump	Electric type.

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Example A: 4 Identification of Compliance from Make and Model

- NRMM Make is JCB.
- NRMM Model is JS220.
- Search for the model in the Company catalogue.
- JS220 classified as a heavy tracked excavator.
- Engine is an Isuzu 4HKIX, 128kW diesel engine.
- Engine Emissions are European Tier IIIA.
- **This NRMM would therefore not be compliant without a verified retrofit DPF.**

Note: As default assume that a reference in literature to 'Tier III' refers to Stage IIIA and not Stage IIIB.

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Cat® C6.6 ACERT™ Engine

The Cat C6.6 ACERT engine delivers more horsepower using significantly less fuel than the previous series engine.

Emissions Solution

Equipped to meet Stage IIIB emissions standards, the 320E's C6.6 ACERT engine features wall and thru flow filters that perform through the machine work cycle without operator intervention.

All nonroad European Union Stage IIIB diesel engines are required to use only Ultra Low Sulfur Diesel (ULSD) fuels containing 15 mg/kg sulfur or less. Cat® DEO-ULS™ or oils that meet the Cat ECF-3, API CJ-4, and ACEA E9 specification are also required. For further fluid specifications and guidelines, visit: *http://www.cat.com/cda/files/214956/7/SEBU6251-13-secured.pdf*

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Example B: 4 Identification of Compliance from Make and Model

- NRMM Make is CAT.
- NRMM Model is 320E.
- Search for the model in the Company catalogue.
- CAT320E is classified as a hydraulic tracked excavator.
- Engine is a Cat® C6.6 ACERT™, 112kW diesel engine.
- Engine Emissions are Stage IIIB.
- **This NRMM would therefore be compliant.**

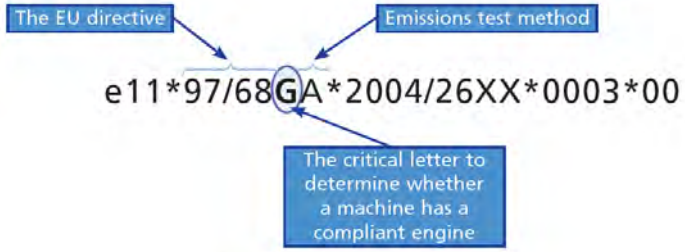
Note: Engine specification often relate to United States standards. EU Stage IIIB is aligned with US Tier 4i or Tier 4interim.

5 Identification of Compliance from Engine EC Type Approval Code

If the process of identification of NRMM cannot be readily achieved (i.e. make and model cannot be readily identified or information from literature cannot be sourced) a more detailed review of the engine itself can help establish compliance.

All diesel engines used in NRMM from 18 to 560 kW must comply with European Directive 97/68/EC (as amended) when the engine is placed on the EU market for the first time.

All engines on NRMM are required to have an EC Type Approval Code permanently fixed to the engine and durable for the lifetime of the engine. The EC Type Approval Code is typically located on the engine plate. The format of the EC Type Approval Code" on the engine data plate is as follows



- In the example above the letter 'G' after the EC Directive number '97/68' is the critical letter.
- The critical letter relates to the emissions level.
- The letters range alphabetically from A through to Q.
    - A to C = Stage I
    - D to G = Stage II
    - H to K = Stage IIIA
    - L to P = Stage IIIB
    - P to Q = Stage IV

The code can be interpreted using the table overleaf.

Interpreting NRMM EC Type Approval Code				
EU Emissions Category Critical Letter	Last allowable date for first placing an engine installed on a machine on the EU market[2]	EU Limit Stage[1]	NRMM Compliant	NRMM Compliant if retrofitted with verified DPF
A	31/12/2003	Stage I	No	No
B	31/12/2004	Stage I	No	No
C	31/03/2005	Stage I	No	No
D	31/12/2008	Stage II	No	Yes
E	31/12/2007	Stage II	No	Yes
F	31/12/2008	Stage II	No	Yes
G	31/12/2009	Stage II	No	Yes
H	31/12/2012	Stage IIIA	No	Yes
I	31/12/2013	Stage IIIA	No	Yes
J	31/12/2014 (for power < 56 kW)	Stage IIIA	No	Yes
K	31/12/2013 (for power ≥ 56 kW)	Stage IIIA	No	Yes
L	No expiry	Stage IIIB	Yes	n/a
M	31/12/2015	Stage IIIB	Yes	n/a
N	30/09/2016	Stage IIIB	Yes	n/a
P	30/09/2016	Stage IIIB	Yes	n/a
R	No expiry	Stage IV	Yes	n/a
Q	No expiry	Stage IV	Yes	n/a

[1]US EPA Interim Tier 4 (4i) is equal to EU Stage III. [2]The dates listed in the following tables are the market placement dates. In most cases, new type approval dates are one year before the respective market placement dates. In some special circumstances an engine can be legally placed on the market after these dates under the "flexibility scheme". If so it will be marked "Engine placed on the market under the flexibility scheme". Machines that have been placed on the market under the 'Flexibility Scheme' shall, for the purposes of the Crossrail Requirements be considered only as meeting the older standard.

Example C: Identification of Compliance from Engine EC Type Approval Code

- Access engine compartment and read engine plate number
- It is a requirement of the directive that the plate is visible in the machine.
- Read EC type approval code
- E.g. E11*97/68 H A *2004/26 *0061 *13
- The letter ‘H’ after the EC Directive number ‘97/68’ is the critical letter.
- The critical letter relates to the emissions level.
- The critical letter ‘H’ in Example C relates to Stage IIIA emission level.
- **This NRMM would therefore not be compliant without a verified retrofit DPF.**

Note: Further information in understanding on all EU Directives compliance available through the Committee for European Construction Equipment (CECE) webpages www.cece.eu under the series of ‘brief guide for identification of non-compliant construction machinery’

6 Identification of Compliance from Diesel Particulate Filter (DPF)

Diesel Particulate Filter (DPF) is a post-exhaust diesel emission control system that is intended to reduce the emissions of particulate matter (PM) from the engine. A NRMM with a retrofitted DPF is able to achieve when used in conjunction with an EU Stage IIIA engine.

The DPF can be mounted internally or externally on the NRMM. Typically the DPF replaces the site of the exhaust silencer or 'muffler'

Any Diesel Particulate Filter retrofitted to NRMM must hold a valid verification scheme certificate from one the follow verification schemes:

- The Energy Savings Trust Energy Savings Trust Non-Road Mobile Machinery Register http://www.energysavingtrust.org.uk/england/Organisations/Certification/Non-Road-Mobile-Machinery-NRMM-certification
- The Swiss Federal Ordinance on Air Pollution Control (OAPC) FOEN Particulate Filter List, (VFT3) http://www.vert-dpf.eu/ http://www.bafu.admin.ch/partikelfilterliste/index.html?lang=en
- Californian ARB Verification Classifications for Diesel Emission Control Strategies, Retrofit Device Verification Database Off-road Level 3 http://www.arb.ca.gov/diesel/verdev/vt/cvt.htm
- Transport for London (TfL) Low Emissions certification (LEC) process, Emission Stage Phase 4 achieving PM emissions limits Standard
- http://www.tfl.gov.uk/assets/downloads/roadusers/lez/lez-approved-filter-device-list.pdf

In most cases when a verification of DPF has been used for compliance more than a simple visual inspection will be required to ensure full compliance. Additional information should also be requested such as;

- Certification of warranty that proves the DPF has a valid verification scheme certificate
- Operator awareness of any DPF and additional requirements for operation.
- The site plant manager or person responsible for safe maintenance of NRMM should be aware of use and maintenance regimes required.
- All DPF should be supplied with a back pressure alarm, this should be operational and the operator should be aware of its purpose and consequences.

Example D: Identification of Compliance from DPF

Compliant DPF Retrofit mounted externally on a stand-by generator. DPF holds a valid verification scheme certificate which can be verified from its warranty. DPF looks in good order and is permanently fixed to the bodywork.

Example E: Identification of Compliance from DPF

Compliant DPF Retrofit mounted externally on a tunnelling machine. DPF holds a valid verification scheme certificate which can be verified from its warranty. DPF looks in good order and is permanently fixed to the bodywork.

Example F: Identification of Compliance from DPF

Compliant DPF Retrofit mounted externally on a forklift. DPF holds a valid verification scheme certificate which can be verified from its warranty. DPF looks in good order and is permanently fixed to the bodywork.

Example G: Identification of Compliance from DPF

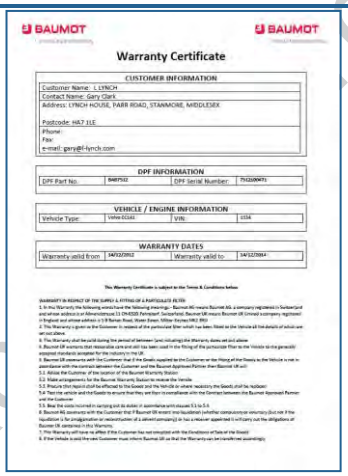
Compliant DPF Retrofit mounted internally on an excavator. DPF holds a valid verification scheme certificate which can be verified from its warranty. DPF looks in good order and is permanently fixed to the bodywork.

Example H: Identification of Compliance from DPF

DPF before mounting displaying identification plate which can be related to a valid verification scheme certificate. Plate number will match the NRMM identification number on the issued warranty once retrofitted.

Example I: Identification of Compliance from DPF

DPF warranty issued to the contractor from supplier and held on file. Warranty relates the DPF identification number to the NRMM identification number.


BAUMOT BAUMOT

Warranty Certificate

CUSTOMER INFORMATION

DPF INFORMATION

VEHICLE / ENGINE INFORMATION

WARRANTY DATES

Example J: Identification of Compliance from DPF

Contractors issued identification of compliance on the external shell of the NRMM using stickers. Although requires checking for compliance they should allow assistance to identification of DPF.

Example K: Identification of Compliance from DPF

Non Compliant DPF Retrofit mounted externally on a Dumper. DPF does not hold a valid verification scheme certificate. DPF is not permanently fixed to the bodywork. Extensive exhaust hose may cause safety concerns.

Example L: Identification of Compliance from DPF

Non Compliant DPF Retrofit mounted externally on a telehandler. DPF does not hold a valid verification scheme certificate. DPF is not permanently fixed to the bodywork. Extensive exhaust hose may cause safety concerns. Exhaust hose has come loose adding to the case for DPF being unsuitable.

Example M: Identification of Compliance from DPF

Non Compliant DPF Retrofit mounted externally on a Dumper. DPF does not hold a valid verification scheme certificate. DPF is not permanently fixed to the bodywork, instead is held on using ratchet straps. Extensive exhaust hose may cause safety concerns.

7 Examples of DPF retrofit on the Crossrail Project

NRMM Type	Plant Make Model	DPF Type / Dispensation Case
Dump Truck	HYDREMA	Baumot BAB - EST Approved
Dump Truck	JCB 722	Baumot BAB - EST Approved
Dump Truck		Puritech - TFL Approved
Dumper 6T-10T	BARFORD SKR9	Baumot BAB - EST Approved
Dumper 6T-10T	DIECI F7000	Johnson-Matthey CRT - EST Approved
Dumper 6T-10T	HITACHI	DCL Mine X Sootfilter - CARB Approved
Dumper 6T-10T	NEUSON	Baumot BAB - EST Approved
Dumper 6T-10T	TEREX	Baumot BAB - EST Approved
Excavator Tracked LARGE >30T	CAT 320E	Baumot BAB - EST Approved
Excavator Tracked MEDIUM 20T- 30T	CASE	Pyroban Acti-Trap - EST Approved
Excavator Tracked MEDIUM 20T- 30T	HITACHI ZX135	Cawdell ART - EST Approved
Excavator Tracked MEDIUM 20T- 30T	HITACHI ZX220	Johnson-Matthey CRT - EST Approved
Excavator Tracked MEDIUM 20T- 30T	HITACHI ZX225	Baumot BAB - EST Approved
Excavator Tracked MEDIUM 20T- 30T	HYUNDAI 145	Baumot BAB - EST Approved
Excavator Tracked MINI/MIDI <10T	HITACHI ZX135	Baumot BAB - EST Approved
Excavator Tracked MINI/MIDI <10T	VOLVO ECR88	Cawdell ART - EST Approved
Excavator Tracked SMALL 10-20T	CASE	Baumot BAB - EST Approved
Excavator Tracked SMALL 10-20T	DOOSAN DX 140	Baumot BAB - EST Approved
Excavator Tracked SMALL 10-20T	HITACHI ZX225	Baumot BAB - EST Approved
Excavator Tracked SMALL 10-20T	HYUNDAI 145	Baumot BAB - EST Approved
Excavator Tracked SMALL 10-20T	HYUNDAI 145	Pyroban Acti-Trap - EST Approved
Excavator Tracked SMALL 10-20T	TAKEUCHI TB175	Baumot BAB - EST Approved
Excavator Wheeled	HITACHI ZX150	Pyroban Acti-Trap - EST Approved
Excavator Wheeled	HITACHI ZX170	Baumot BAB - EST Approved
Excavator Wheeled	JCB JS200W	Baumot BAB - EST Approved
Loading Shovel (Tracked)	CAT 953	Cawdell ART - EST Approved
Loading Shovel (Tracked)	KOMATSU A100M	Cawdell ART - EST Approved
Loading Shovel (Wheeled)	HYUNDAI 770	Baumot BAB - EST Approved
Mobile Elevated Work Platform	GENIE Z45	Puritech - TFL Approved
Telehandler	JCB 535-125	Baumot BAB - EST Approved
Telehandler	JCB 535-95	DCL Mine X Sootfilter - CARB Approved
Telehandler	JCB 540-170	Baumot BAB - EST Approved
Tractor	KALMAR	Cawdell ART - EST Approved
Tunnelling Equipment	LIEBHERR 944	Eminox CRT - EST Approved
Tunnelling Equipment	Robodrill Pantofore	Huss - EST Approved
Tunnelling Equipment	Schoma Locomotive	Engelhard DPX - CARB Approved