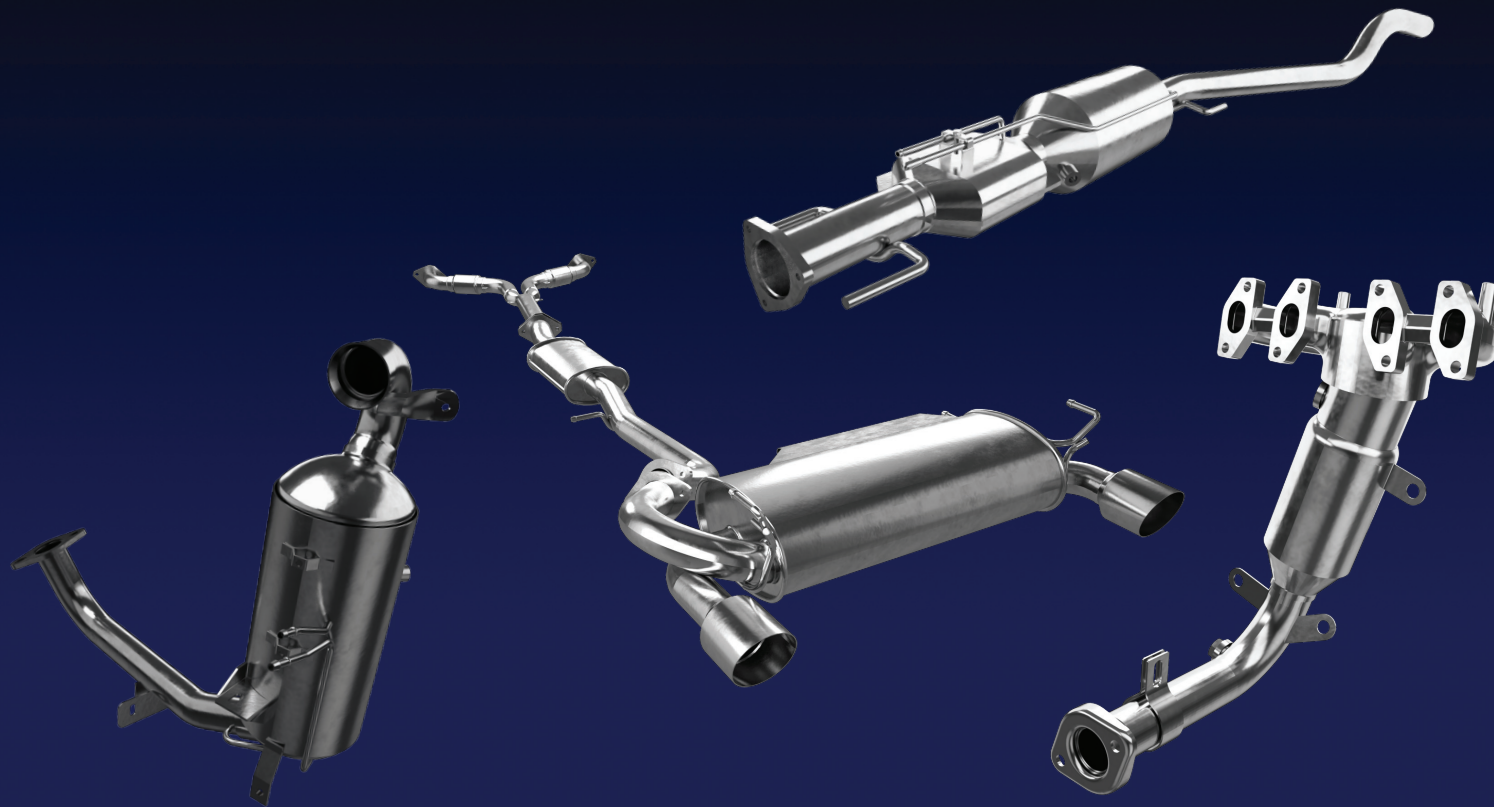


Training Manual



Delivering
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quality...

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- ✓ Public website to drive traffic towards participating garages
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Accredited Garage Pack

This includes everything the garage needs to get involved.

- Brochure
- Signage
- Website
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- Access to technical support



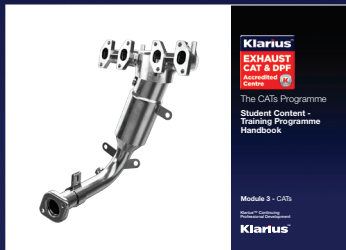


Day 1

Module 1 Exhausts

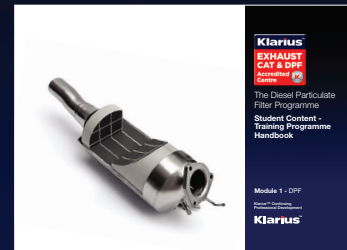


Module 2 CATs

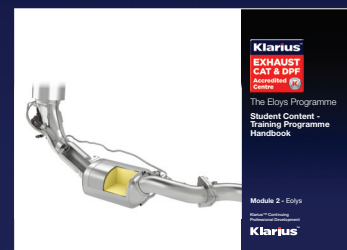


Day 2

Module 3 DPF



Module 4 Additive Systems



Training modules

Validation of the training includes:

- ✓ Check marking structure
- ✓ Ongoing validation / observation
- ✓ IMI Accredited
- ✓ CPD points qualification
- ✓ Part of an apprenticeship program

Klarius manufactures a range of quality replacement emission control products for the Aftermarket. Offering over 10,000 part references from stock, including; exhausts, catalytic converters, diesel particulate filters, product kits and mountings.



Klarius™

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The Diesel Particulate
Filter Programme

Student Content - Training Programme Handbook

Module 3 - DPF

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Programme Details

This training programme provides an introduction to Diesel Particulate Filters, the technology used in them, aspects of component servicing and replacement and their requirement as part of the overall UK legal emissions and MOT vehicle standards.

Programme Aims and Objectives

Programme Aims:

- To provide the student with an up to date understanding of the function of a Diesel Particulate Filter
- To provide the student with an understanding of the operational life of a Diesel Particulate Filter
- To provide the student with an understanding of how a Diesel Particulate Filter affects vehicle performance and therefore impacts on customer satisfaction.
- That the student can identify when it is appropriate to service or replace a Diesel Particulate Filter
- That the student understands the legal responsibilities associated with Diesel Particulate Filter fitment and correct functioning.

Programme Objectives:

- That the student understands how a Diesel Particulate Filter works
- That the student can identify the components of a Diesel Particulate Filter
- That the student understands the likely causes for Diesel Particulate Filter failure



Overview of the Programme Content

Module 3 - DPF

Klarius™ Continuing Professional Development

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Programme Aims and Objectives

Programme Learning Outcomes

On completion of the programme the student will be able to understand and identify the following:

- What a DPF is and it's function
- What the difference between a DPF and a Catalytic Converter is
- The technical structure of a DPF and how it relates to it's function
- Reasons for DPF failure and how to assess them
- DPF diagnostic protocols and how to assess DPF and vehicle performance
- How to recommend when either a DPF service or replacement is appropriate
- The legislative requirements for exhaust emissions in relation to DPFs and how these relate to both garage and customer MOT and service responsibilities.

Programme Assessment

On completion of the programme the student will demonstrate their understanding of the programme content by completing an assessment.

- The course is a 3 hour continuing professional development programme that consists of delivery of both theory and practical knowledge by a programme tutor

- The theory, practical knowledge and it's application are assessed via a 20 question multiple choice assessment based on the contents of the student manual and tutor presentation given during the 3 hour training session – It will take place at the end of the training session and will require the candidate to achieve a minimum of 70% to pass. The student assessments will last 30 minutes.
- Students who have not achieved the minimum pass mark will not receive the programme certificate and will need to retake the test at a later date.



Overview of the Programme Content

Module 3 - DPF

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Programme Aims and Objectives

Programme knowledge

The training programme will provide the student with current industry standard and legislative knowledge relating to the following aspects of Diesel Particulate Filters (DPFs):

DPFs – Their Function and how they work

- Introduction to DPFs and their components
- DPF technical requirements and performance

DPFs - Failure modes

- Introduction to failure modes
- Causes of failure

DPFs – Understanding and applying diagnostics

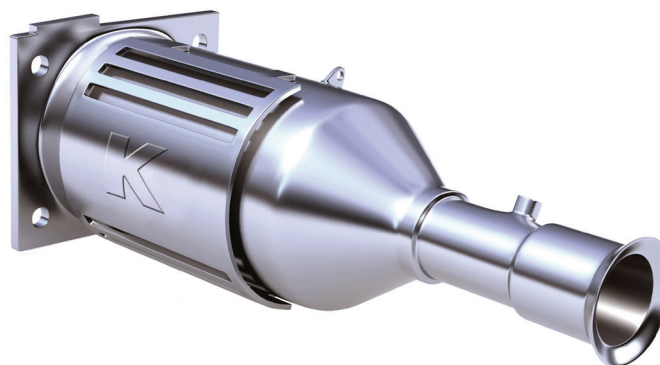
- Assessing and understanding DPF issues
- Diagnosing the correct issues
- Knowing when to service and when to replace

DPFs - Fitting advice / Quality / Type Approval

- The differences between OEM and After Market DPFs
- Understanding the implications to the customer of poor choice
- Advantages to fitting fully Type Approved DPFs

DPFs - Legislation & MOT requirements

- Understanding UK legal and EU emissions requirements
- DPF use in relation to vehicle insurance.



Overview of the Programme Content

Module 3 - DPF

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The Diesel Particulate Filter

DPFs – Their function and how they work

- Introduction to DPFs and their components
- DPF technical requirements and performance

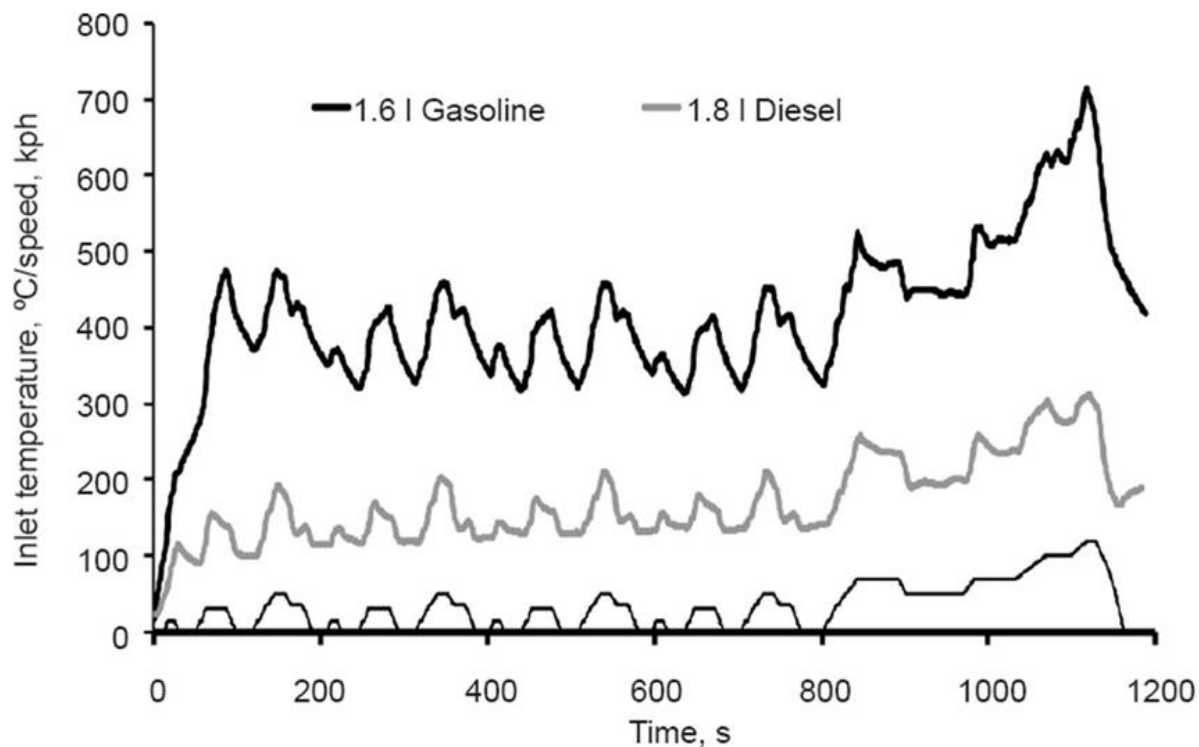
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Background Information

Exhaust gas temperature's during NEDC (New European Drive Cycle)



- Diesel engines always run lean
- Diesel catalysts can only operate in a two way mode
- Diesel Oxidation Catalysts (DOC) run cooler than a petrol cat
- Diesel typical Exhaust Gas Temperature (EGT) is **100°C - 300°C**
- Diesel Idle EGT is 100°C
- **DPF regeneration EGT is 600°C**



The Diesel
Particulate filter

DPFs – Their function and how they work

- Introduction to DPFs and their components
- DPF technical requirements and performance

Module 3 - DPF

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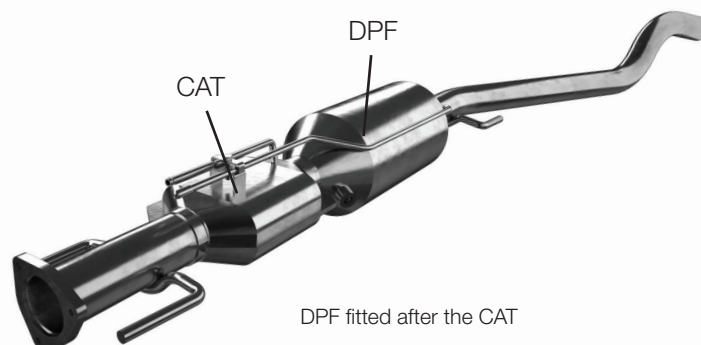


DPF Introduction (Euro V)

European emission standards define the legally acceptable limits for exhaust emissions of new vehicles sold in the EU member states. The emission standards are defined in a series of European Union directives implementing the progressive introduction of increasingly stringent standards.

Before the advent of Diesel Particulate Filters, soot particles were released into the atmosphere at the end of the combustion process causing health and air quality problems.

- From Euro V (2009) - DPFs are being fitted after the catalytic converter to trap these particles. Ever more stringent EU Emissions target (0.005 ppm) are introduced
- 95% of the soot is captured by the DPF.



DPF fitted after the CAT



The Diesel Particulate filter

DPFs – Their function and how they work

- Introduction to DPFs and their components
- DPF technical requirements and performance

Module 3 - DPF

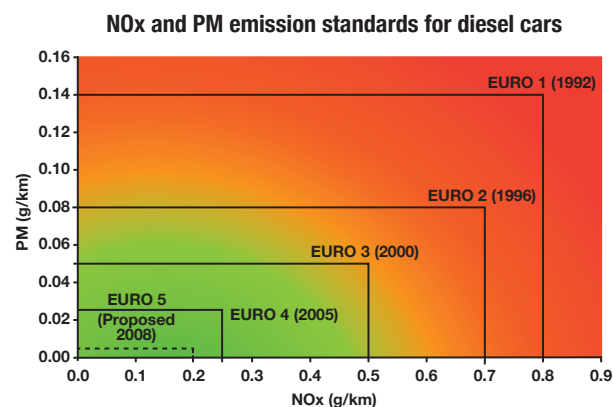
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PETROL	CO	HC	NOx	HC+NOx	Part	NEFZ	Implementation
EURO I	2.72	-	-	0.97	-	40 seg	1992
EURO II	2.2	-	-	0.5	-	40 seg	1996
EURO III	2.3	0.2	0.15	-	-	0 seg	2000
EURO IV	1	0.1	0.08	-	-	0 seg	2005
EURO V	1	0.1	0.06	-	0.01	0 seg	2009
EURO VI	1	0.1	0.06	-	0.01	0 seg	2014

DIESEL	CO	HC	NOx	HC+NOx	Part	NEFZ	Implementation
EURO I	2.72	-	-	0.97	0.14	40 seg	1992
EURO II	1.06	-	-	0.71	0.08	40 seg	1996
EURO III	0.64	-	0.5	0.56	0.05	0 seg	2000
EURO IV	0.5	-	0.25	0.3	0.025	0 seg	2005
EURO V	0.5	-	0.18	0.23	0.005	0 seg	2009
EURO VI	0.5	-	0.08	0.17	0.005	0 seg	2014

All data is in grams per kilometre



Diesel Particulate Filters

Diesel Particulate Filters are components that are integrated within the overall emission control system to help **meet European Union exhaust gas emissions standards**. They can be both separate from, or integrated within, the catalytic converter unit contained in the exhaust system. The Diesel Particulate Filter works by **collecting the particulates in a porous structure** and periodically burning them to remove them from the exhaust.



- The principle of the Diesel Particulate Filter (DPF) is to **collect the soot particles** and **periodically burn them off**
- The natural **combustion** of those **particles** takes place at around **600°C**
- Whereas the maximum **temperature reached by exhaust gases** in the exhaust manifold is around **300°C**.



The Diesel Particulate Filter

DPFs – Their function and how they work

- Introduction to DPFs and their components
- DPF technical requirements and performance

Module 3 - DPF

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How Do They Work?

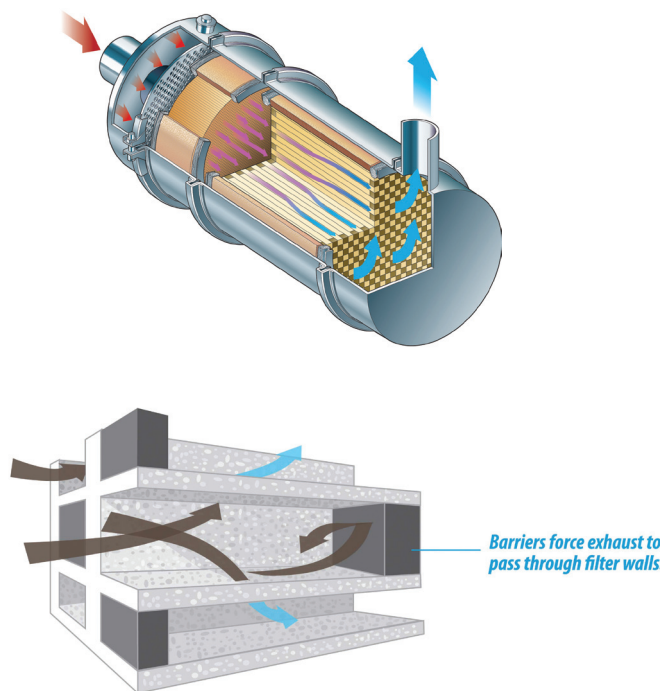
Engine internal combustion processes, in either petrol or diesel engines are an incomplete process. After the fuel air mixture is burned, **a mixture of toxic gases and hydrocarbon molecules are left** over and are contained in the exhaust emissions. These remaining emissions are harmful to people and the environment. **DPFs** have been developed to **reduce the particulate matter emissions**.

Storage

- A Diesel Particulate Filter **collects particulate matter** in the exhaust stream **by means of physical filtration**.
- **Soot particulates** from diesel exhaust are **trapped by a porous ceramic substrate** inside the filter and collected on the walls.

Regeneration

- When the **maximum 'Fill Level'** is reached one of several methods is employed to **clear the filter of the collected particulates**.
- Regeneration occurs periodically to burn stored particulate matter but **ASH residue** remains.
- It is only necessary to **replace the DPF** **when** this process breaks down and the **filter becomes irreversibly clogged with particulate matter**, or it becomes full of **ASH**.



The Diesel Particulate Filter

DPFs – Their function and how they work

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- DPF technical requirements and performance

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Regeneration

Regeneration is a process where the **stored particulate (soot)** collected by the filter core, is **burned to remove the particulates** from the system. In burning the soot, a residual amount of **ash is left over in the DPF unit** - over the lifetime of the DPF unit, the ash builds up inside it. **This build up of ash is a key factor in when the DPF will need to be replaced.**

There are 3 methods by which regeneration takes place:

Passive regeneration

Passive regeneration - a natural regeneration which occurs when there is a prolonged period of high exhaust temperatures.

Active regeneration

An assisted high exhaust gas temperature situation in order to burn contained particulate matter.

Forced regeneration

When passive or active regeneration criteria have not been met. In this instance a technician may need to force the event, using a diagnostic tool.

This should be carefully done in a controlled environment following manufacturers guidelines.



When the DPF reaches 90% full (of ash) it will need replacing



The Diesel Particulate Filter

DPFs – Their function and how they work

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DPF – A Service Item

Whilst all DPFs work in the same way, different car manufacturers use slightly different variations of the technology. These different technologies affect how the DPF works in conjunction with the catalytic converter and also the service and replacement intervals required for the different types of DPF units.

Coated DPFs

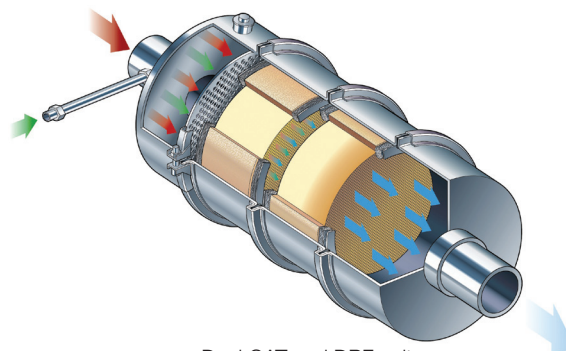
Favoured by German manufacturers. These systems have a DPF coated with precious metals to assist regeneration. It is changed as a service item typically at 150,000 miles.



Coated DPF

Fuel Additive Systems

Favoured by French manufacturers. These systems also use a coated DPF. The fuel additive lowers the temperature at which regeneration can take place but needs to be replaced as a service item typically at 75,000 miles.



Dual CAT and DPF unit



The Diesel Particulate Filter

DPFs – Their function and how they work

- Introduction to DPFs and their components
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DPF Materials

The materials used in the DPF monolith brick have to do two main jobs; they must be able to **provide a fine mesh structure** that can filter and capture tiny particles also be able to **withstand and operate within high temperature environments**, typically up to 600°C.

To achieve this, **specialist materials** are used.

There are primarily two types of DPF monolith on the market:

Silicon Carbide DPFs

- Mostly **OEM** use, considered a premium product
- High melting point (2700°C)

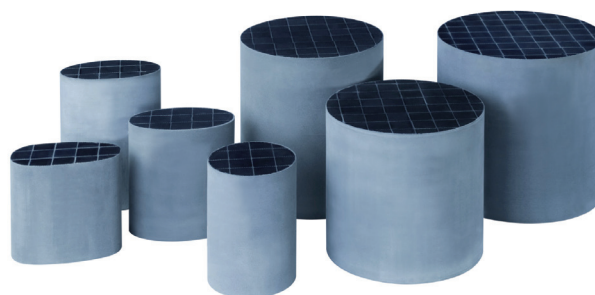
Silicon Carbide DPFs are constructed from small sections cemented together. More commonly used in O.E. DPFs they are classed as a premium product, due to high temperature resistance.

Cordierite DPFs

- Mostly **aftermarket** use, due to ease of manufacture.
- Melting point (1200°C), which is double the normal maximum regeneration event temperature.

Cordierite DPFs look very similar to catalysts. They are mostly used in aftermarket products.

Silicon Carbide DPF



Cordierite DPF



The Diesel Particulate Filter

DPFs – Their function and how they work

- Introduction to DPFs and their components
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Module 3 - DPF

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DPF Quality – Type Approval

Type approval is an independent government test to European Standards, to ensure products meet emissions targets. The specification of the product is recorded and **only that specification is approved**. Automotive EC Directives and UN Regulations **require third party approval** - testing, certification and production conformity assessment **by an independent body**. In the UK, the Vehicle Certification Agency (VCA) is both Approval Authority and Technical Service.

- Most DPFs do require Type Approval
- DPFs are approved using R103
- **Type Approval covers emissions**
- With low cost (& not approved) DPFs – internals are often compromised.



The latest Euro V standard covers all types of DPF units, **both combined and filter only**.

	Filter only	Combined
Euro IV		✓
Euro V	✓	✓

UK Type Approved requirements of DPF



The Diesel Particulate Filter

DPFs – Their function and how they work

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Diagnosis/Fault Finding

In normal use, the DPF is a service item, when ASH content reaches full saturation (see p15 for typical service intervals).

DPF systems are prone to failure, often due to the complex electronic system controlling the regeneration events.

It's important to correctly diagnose why regeneration cannot occur which is normally due to vehicle maintenance, or how the vehicle is used.

2 key areas of diagnostic approach:

1 . Vehicle maintenance

Overall vehicle condition

- Damaged exhaust system (low/high back pressure).
- Poor engine maintenance.
- Regeneration will not take place if the Engine Management Light (EML) is on.

Vehicle fluids

- Incorrect oil.
- Engine oil levels too high or too low.
- Incorrect fuel (low sulphur fuel required).
- Insufficient fuel - there needs to be 1/4 + of diesel in the fuel tank - or regeneration will not take place.

Vehicle sensors

- Faulty pressure sensors.
- Faulty temperature sensor.
- Condensation in sensor pipes.
- Faulty Exhaust Gas Recirculation (EGR) valve.

2. Use of vehicle

- DPF work well in high EGT (low EGT is more problematic)
- Avoid short journeys
- Avoid stop / start driving
- Avoid poor quality repair items
- Additive system run out?
- Running vehicle with EML / Faults



The Diesel Particulate Filter

DPFs – Their function and how they work

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MoT / Legality

From February 2014 the inspection of the exhaust system carried out during the MoT test will include a check for the presence of a DPF. **A missing DPF, where one was fitted when the vehicle was produced, will result in an MoT failure¹.**

¹Source: <https://www.gov.uk/government/publications/diesel-particulate-filters-guidance-note>

²Source: <http://www.legislation.gov.uk/uksi/1986/1078/contents/made>

It is an offence under the Road vehicles (Construction and Use) Regulations (Regulation 61a(3))² to use a vehicle which has been modified in such a way that it **no longer complies with the air pollutant emissions standards it was designed to meet**. Removal of a DPF will almost invariably contravene these requirements, making the vehicle illegal for road use.

The potential penalties for failing to comply with Regulation 61a are fines of up to £1,000 for a car or £2,500 for a light goods vehicle.

- Removal of the DPF **will fail an MoT** if a DPF was fitted as standard when the vehicle was produced.
- Removal of the DPF **will invalidate your insurance** if your insurers aren't informed.



The Diesel Particulate Filter

DPFs – Their function and how they work

- Introduction to DPFs and their components
- DPF technical requirements and performance

Module 3 - DPF

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Training Programme Recap

During this training programme we have covered the following aspects of Diesel Particulate Filters and how they work and their affect on car performance:

- The Product – what a DPF is and how it is different from a catalyst
- The Function – what a DPF does and how it achieves this
- The Technology – different types of DPF and their materials
- The Failure modes – why DPFs may fail and common causes
- The Diagnostics – how to assess DPF condition and diagnose likely issues
- The Product quality - Fitting advice / Quality issues / Type Approval
- The Legal requirements – European Legislation & UK MOT criteria

Now please complete the training assessment multiple choice questionnaire shown overleaf



DPFs – Their Function
and how they work

Training Programme Recap

Module 3 - DPF

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Student Assessment

On completion of the programme the student will demonstrate their understanding of the training programme content by completing the following multiple choice assessment.

All answers must be the student's own; any conferring with other students during the assessment will result in disqualification. The assessment will take place within a set time of 30 minutes. All completed assessments will be submitted to the tutor for marking at the end.

Please select (tick) one of the four answer options for each of the 20 questions below.

1. What is a DPF?

- ☐ a particulate filter
- ☐ a silencer
- ☐ a catalytic converter
- ☐ a fuel filter

2. What is the function of the DPF?

- ☐ to contain and re-burn particulate matter
- ☐ to convert exhaust gases to water
- ☐ to reduce exhaust noise
- ☐ to filter unburned fuel

3. What is particulate matter?

- ☐ corroding gasket
- ☐ soot
- ☐ exhaust Gases
- ☐ carbon monoxide

4. Is a DPF a service item?

- ☐ yes
- ☐ no
- ☐ only on German cars
- ☐ only on cars less 5 years old

5. What is the typical service interval of a fuel additive DPF?

- ☐ 20,000 miles
- ☐ 50,000 miles
- ☐ 75,000 miles
- ☐ 120,000 miles

please turn over the page



DPFs – Their Function and how they work Student Assessment

Module 3 - DPF

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Student Assessment

Please select (tick) one of the four answer options for each of the questions below.

6. What is the DPF Monolith?

- ☐ the brick inside the housing
- ☐ an exhaust muffler
- ☐ an unused fuel filter
- ☐ DPF mounting bracket

7. What is a DPF brick made from?

- ☐ stainless steel
- ☐ platinum
- ☐ silicon carbide / cordierite
- ☐ flexible polymers

8. What is the process of regeneration?

- ☐ returning unburned fuel to the engine
- ☐ recirculating exhaust gases
- ☐ burning particulate matter from the DPF
- ☐ re-circulating exhaust gases to reduce exhaust noise

9. Under normal use, what is the primary cause of DPF replacement?

- ☐ rust and corrosion
- ☐ leaking exhaust pipes
- ☐ inefficient fuel injection
- ☐ ash build-up

10. What is the DPF regeneration exhaust gas temperature?

- ☐ 100 degrees
- ☐ 600 degrees
- ☐ 750 degrees
- ☐ 1500 degrees

11. What is a benefit of Coated DPFs?

- ☐ they are more resistant to rust
- ☐ they don't need servicing
- ☐ they aid regeneration
- ☐ they are cheaper to replace

12. Which of the following is true for a Fuel Additive System?

- ☐ it is more economical to run
- ☐ it can use cheaper fuel
- ☐ it lowers the regeneration temperature
- ☐ it doesn't need replacing

13. Which of the following regeneration methods needs a technician to help?

- ☐ passive Regeneration
- ☐ active Regeneration
- ☐ forced Regeneration
- ☐ technical regeneration



DPFs – Their Function and how they work Student Assessment

Module 3 - DPF

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Student Assessment

Please select (tick) one of the four answer options for each of the questions below.

14. What is required to force regeneration?

- ☐ a new EGR valve
- ☐ a re-mapped engine ECU
- ☐ a new DPF
- ☐ a diagnostic tool

15. Which of the following conditions will prevent regeneration?

- ☐ the engine management light is off
- ☐ the engine is high mileage
- ☐ the engine management light is on
- ☐ the outside temperature is below 10 degrees

16. How much diesel is needed for regeneration to take place?

- ☐ a full tank
- ☐ at least 1/4 tank
- ☐ above the fuel warning light
- ☐ it will still work on an empty tank

17. What aspect of the DPF does Type Approval cover?

- ☐ the capacity of the DPF
- ☐ DPFs don't require type approval
- ☐ the emissions of the DPF
- ☐ the exhaust noise levels

18. Which types of DPF must be type approved?

- ☐ all combined CAT & DPF units, and Euro V filter only DPF
- ☐ only ceramic ones
- ☐ it just covers the catalytic converter not the DPF
- ☐ Euro IV DPF Filter

19. Will removing the DPF cause an MOT fail?

- ☐ only for vehicles made after 2003
- ☐ not if it is separate from the catalytic converter
- ☐ if the vehicle was fitted with one as standard, yes it will
- ☐ No it is an exempt item from the test

20. Can the DPF affect your insurance?

- ☐ yes, but only for high performance cars
- ☐ yes if it is removed and the insurer isn't informed
- ☐ no, it is not an insurance policy concern
- ☐ no, all DPFs work the same way



DPFs – Their Function and how they work

Student Assessment

Module 3 - DPF

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Training programme close

Thank you for attending, we look forward to seeing you at further training events as you continue to develop your career and professional knowledge.

This training programme has been supported and accredited by The Institute of the Motor Industry www.theimi.org.uk



Additional training and continuing professional development support materials and videos are available at the following website:

www.klarius.eu/onlinetraining

Login details

User name: dpftraining

Password: Student_ID

Additional information about Klarius' complete range of type approved aftermarket vehicle products can be found at: www.klarius.eu

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DPFs – Their Function
and how they work

**Training programme
close**

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