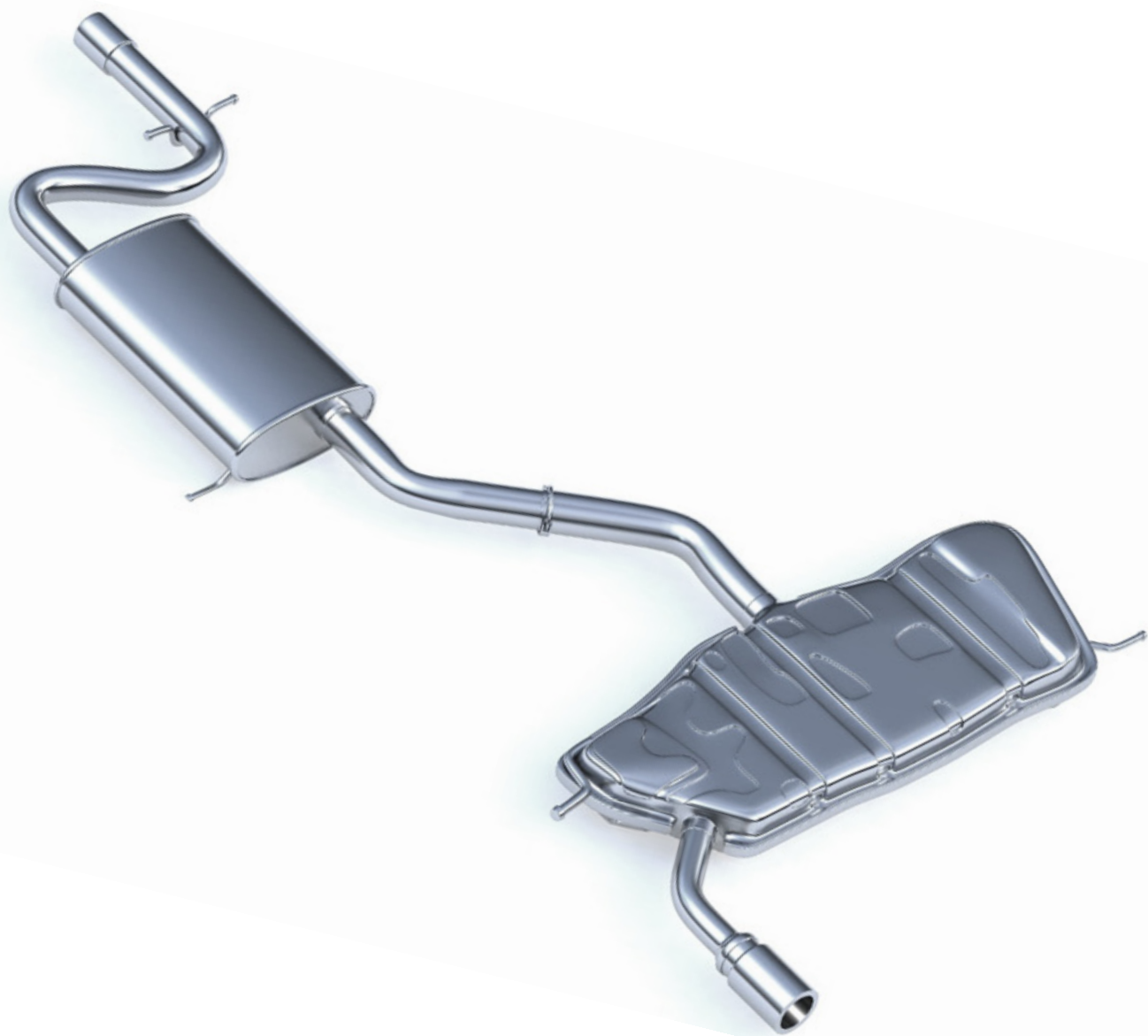




The Exhaust Programme

Student Content - Training Programme Handbook

Module 4 - Exhaust systems

Klarius™ Continuing
Professional Development

Klarius™

Programme Details

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

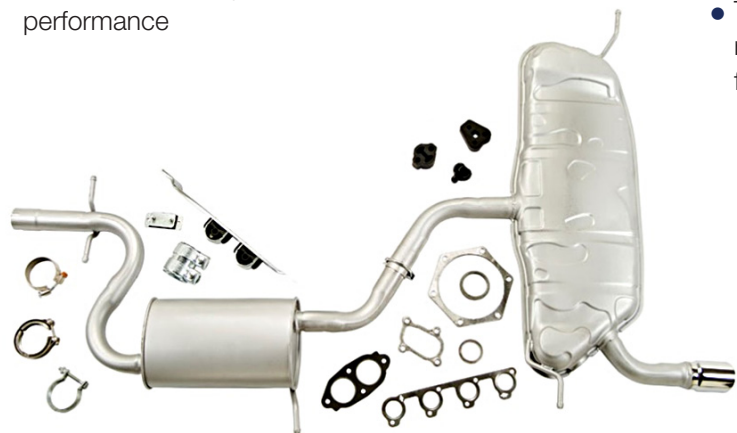
Programme Aims and Objectives

Programme Aims:

- To provide the student with an up to date understanding of the function of an exhaust system
- To provide the student with an understanding of the operational life of an Exhaust System
- To provide the student with the latest information and advice on fitting
- To provide the student with an understanding of how an Exhaust System affects vehicle standards performance

Programme Objectives:

- That the student understands how an Exhaust System works
- That the student can identify the components of an Exhaust System
- That the student understands the likely causes for Exhaust System failure
- That the student can identify when it is appropriate to replace an Exhaust System
- That the student understands the legal responsibilities associated with Exhaust System fitment and correct functioning



Overview of the Programme Content

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development

Klarius™

Programme Aims and Objectives

Programme Learning Outcomes

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

- What an Exhaust System is and its function
- What the difference is between an Exhaust system and other exhaust components, eg CAT, DPF, SCR
- The technical structure of an Exhaust and how it relates to its function
- Reasons for Exhaust failure and how to assess them
- How an exhaust is made and how to identify a Type Approved product
- How to recommend when an Exhaust replacement is appropriate
- The legislative requirements for exhaust emissions 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 its application are assessed via a 20 question multiple choice assessment which will take place at the beginning and at the end of the training session.
- The test is based on the contents of the student manual and tutor presentation given during the 3 hour training session.
- The candidate is required to achieve a minimum of 70% to pass. The final 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 4 - Exhaust Systems

Klarius™ Continuing
Professional Development



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 Exhaust Systems:

Exhausts – Their Function and how they work

- Introduction to Exhausts and their component parts
- Exhaust technical requirements and performance
- Effects on engine efficiency

Exhaust - Failure modes

- Introduction to failure modes
- Causes of failure modes

Exhausts – Understanding and applying diagnostics

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

Exhausts - Fitting advice / Quality / Type Approval

- The differences between good and bad quality replacement exhausts
- Understanding the implications to the garage and customer of poor choice
- Advantages to fitting fully Type Approved Exhausts

Exhausts - Legislation & MOT requirements

- Understanding UK legal and EU emissions requirements

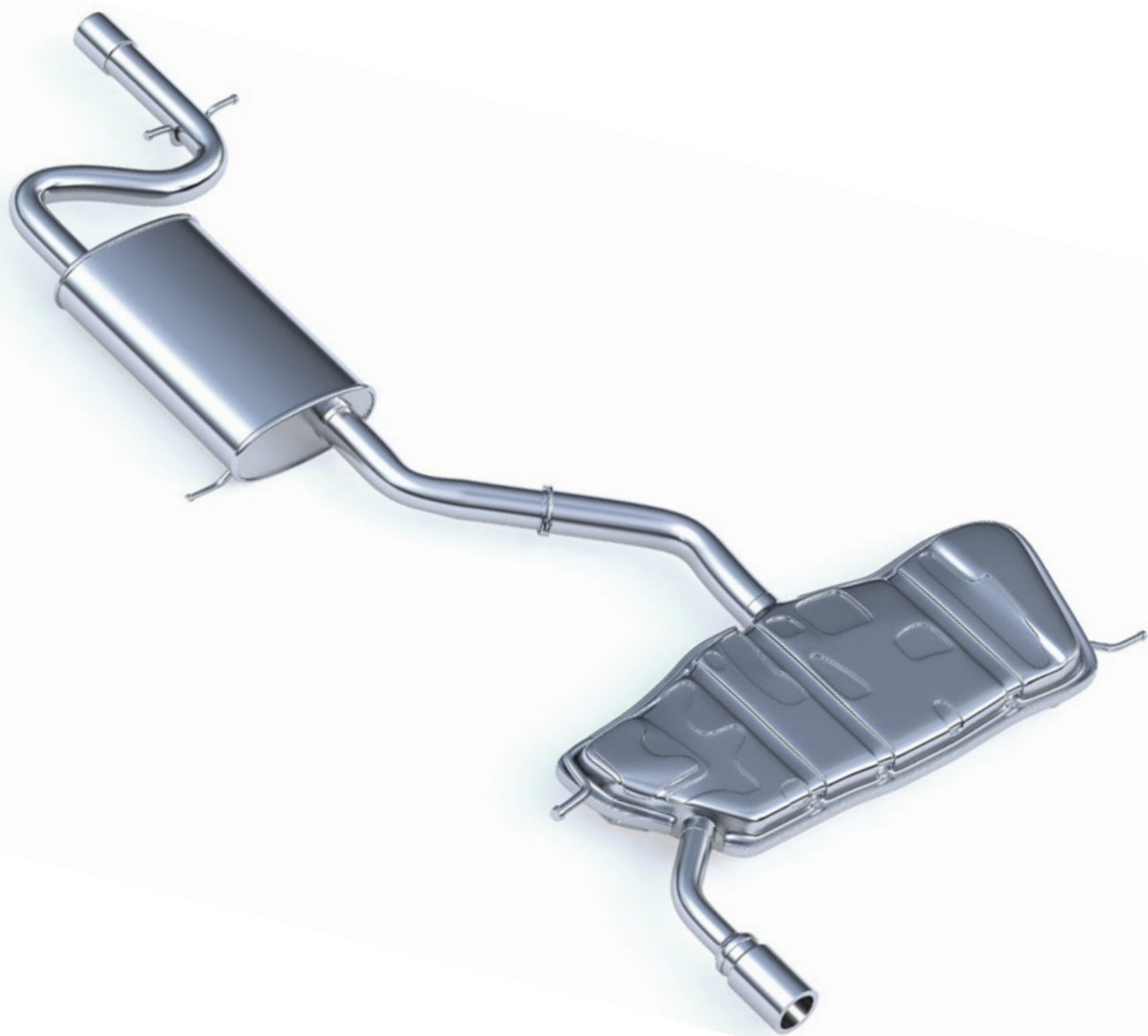


Overview of the Programme Content

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development





The Exhaust Programme

Student Content - Training Programme Handbook

- Introduction to Exhausts and their component parts
- Exhaust technical requirements and performance
- Effects on engine efficiency

Module 4 - Exhaust systems

Klarius™ Continuing
Professional Development

Klarius™

UK Emission Control market - size

UK Market

- There are currently over 35 million vehicles licensed for use in the UK
- Since 1950 the number has increased every year
- Over 30 million of these are passenger cars and light commercials.
- UK Automotive Aftermarket value is estimated at approx. £2.5 billion
- UK Emissions Aftermarket value is estimated at approx. £100m

Replacement

- The average OEM exhaust system lasts 7 years
- Exhausts last longer on diesel engines than on petrol
- Hybrids still have exhausts and true EVs even have condensate pipes
- Stainless systems can still fail due to structural damage and failed mounts

Production

- Klarius Products produced over 1.5 million exhausts and over 50,000 catalytic converters / DPF in 2015 (including exports)
- That is: 6,500 exhausts per working day and 250 cats daily plus, 5,000 mountings daily



The exhaust is a common replacement product, but the component parts and variations are huge... it also looks deceptively simple, but around 10,000 references are needed to cover the most popular models.



The Exhaust Programme

Exhaust systems – Their Function and how they work

- UK Emission Control market - size

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



The Function of the Exhaust System

Technical requirements

- Noise reduction – legal requirements/social/customer requirements
- Emission control - legal EU/UK social/health (CO₂ v NO_x)
- Protect passengers – heat, noxious gases
- Performance – to optimise engine performance, back pressure
- Economy - maintain fuel economy

Customer needs?

- Availability – product must be available on demand
- Quick fitment – convenience / downtime
- Cost effective – aftermarket demands a value+quality+cost competitive solution
- Meets legislation – requirement to be legal in customers' market place
- Looks like OE – visual/quality reassurance/re-sale value; 'If it looks good it must be good'



The Exhaust Programme

Exhaust systems – Their Function and how they work

- The Function of the Exhaust System

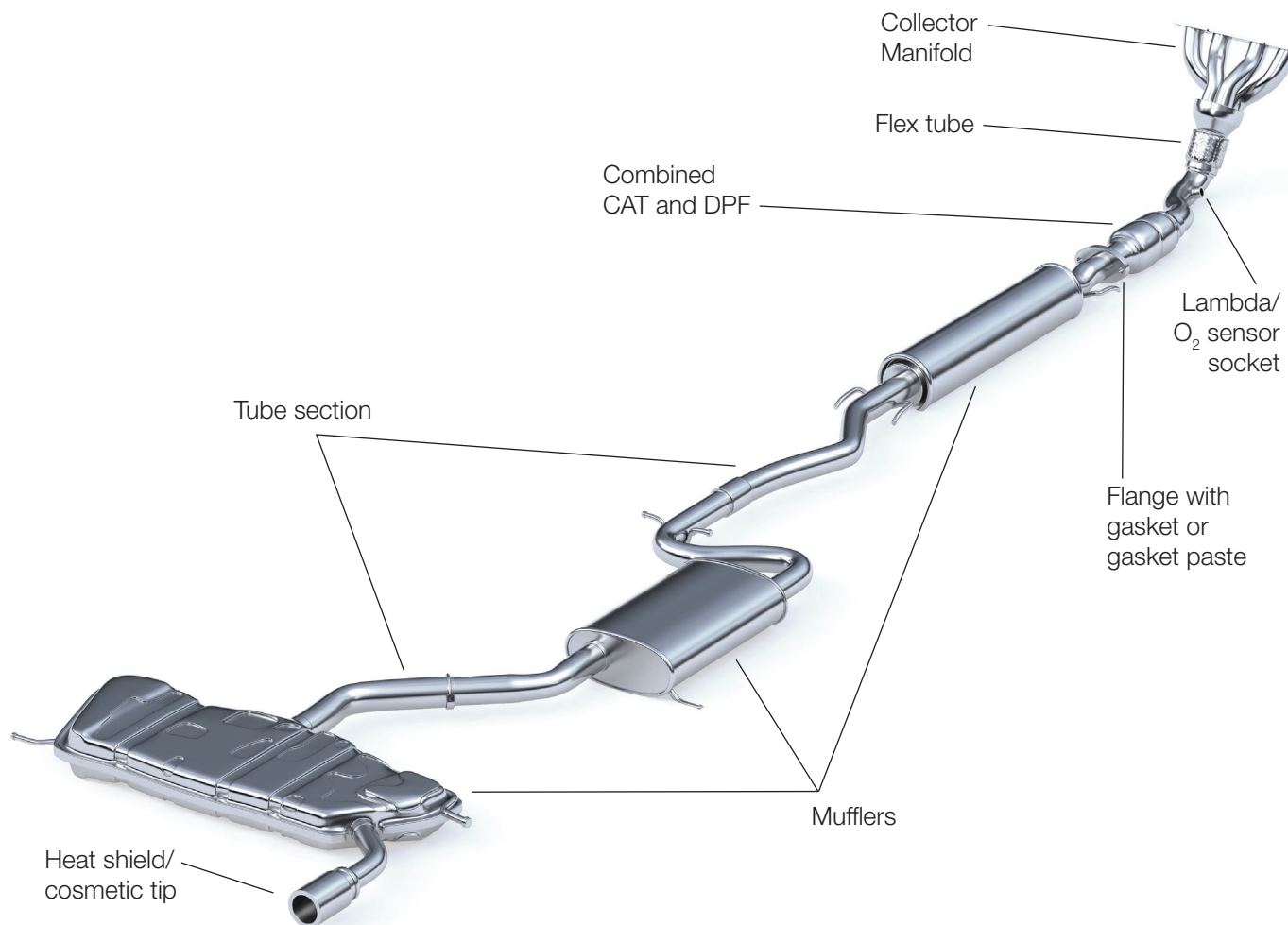
Module 4 - Exhaust Systems

Klarius™ Continuing
Professional Development



Components of an Exhaust System - External

An exhaust system is a collection of components, often tubular in shape, that help to **safely remove from the vehicle, the hot exhaust gases that are produced in the engine during the internal combustion process.** Exhaust systems are used for both petrol and diesel engines, however the **different fuels and combustion processes produce different types of exhaust gases and therefore have different components to deal with these.**



The Exhaust Programme

Exhaust systems – Their Function and how they work

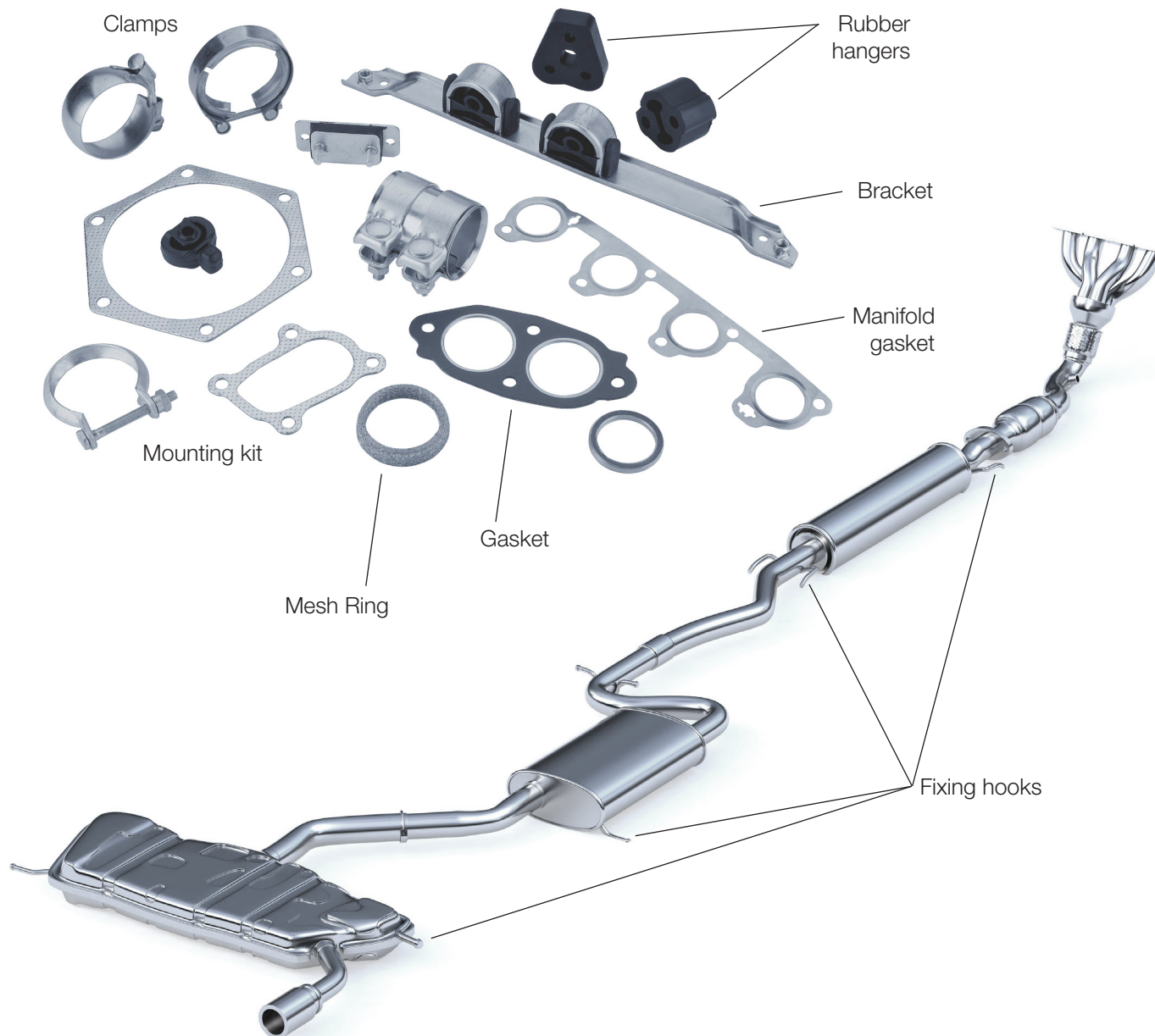
- Components of an Exhaust System - External

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Components of an Exhaust System – Mountings



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Components of an Exhaust System – Mountings

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Components of an Exhaust System – Exhaust Manifold

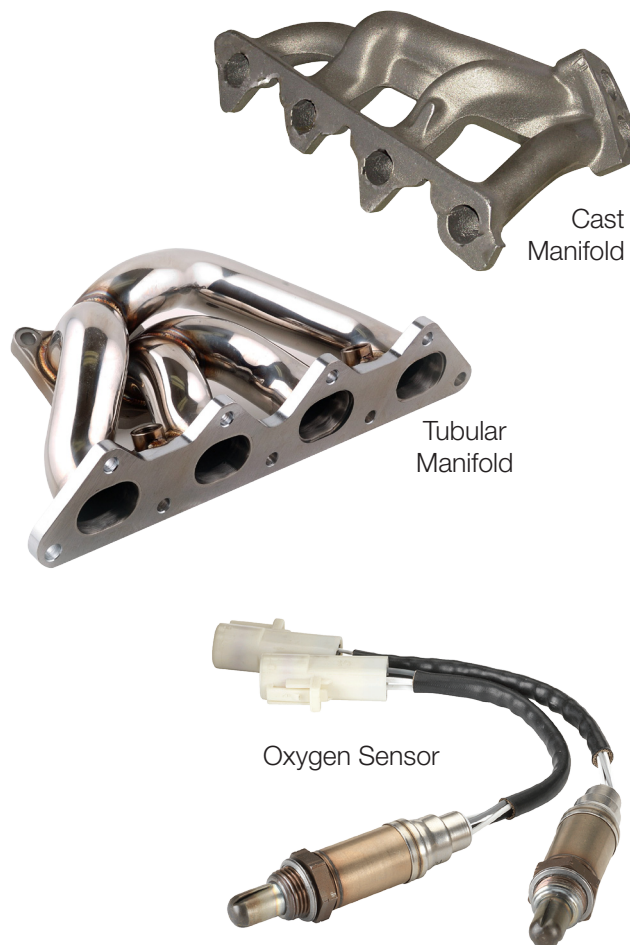
The exhaust manifold is constructed of a number of tubes and attaches to the engine's cylinder head. It takes each cylinder's exhaust gas and guides it away from the engine. The manifold on production cars can be made of steel, stainless steel, or more commonly cast iron.

Collector

The exhaust tubes (or “header” if made of separately welded tubes) move the spent combustion gases from the engine's exhaust ports to a central collection point (“collector”). From there, the gases go through the car's emissions system, mufflers and out of the tail-pipe.

Oxygen sensor

All modern fuel injected cars utilize an oxygen sensor to measure how much oxygen is present in the exhaust. From this the ECU can add or subtract fuel to obtain the correct mixture for maximum fuel economy. The oxygen sensor is typically mounted in the exhaust manifold or close to it in the exhaust pipe.



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Components of an Exhaust System – Exhaust Manifold

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Components of an Exhaust System – Muffler Function

The muffler serves to quieten the exhaust to acceptable levels. Remember that the combustion process is a series of explosions that create a lot of noise, at various complex frequencies.

Most mufflers use baffles to reflect the exhaust sound around, dissipating the energy and quieting the noise. Some mufflers also use fiberglass packing which absorbs the sound and heat energy as the gases flow through.



Absorption muffler



The Exhaust Programme

Exhaust systems – Their Function and how they work

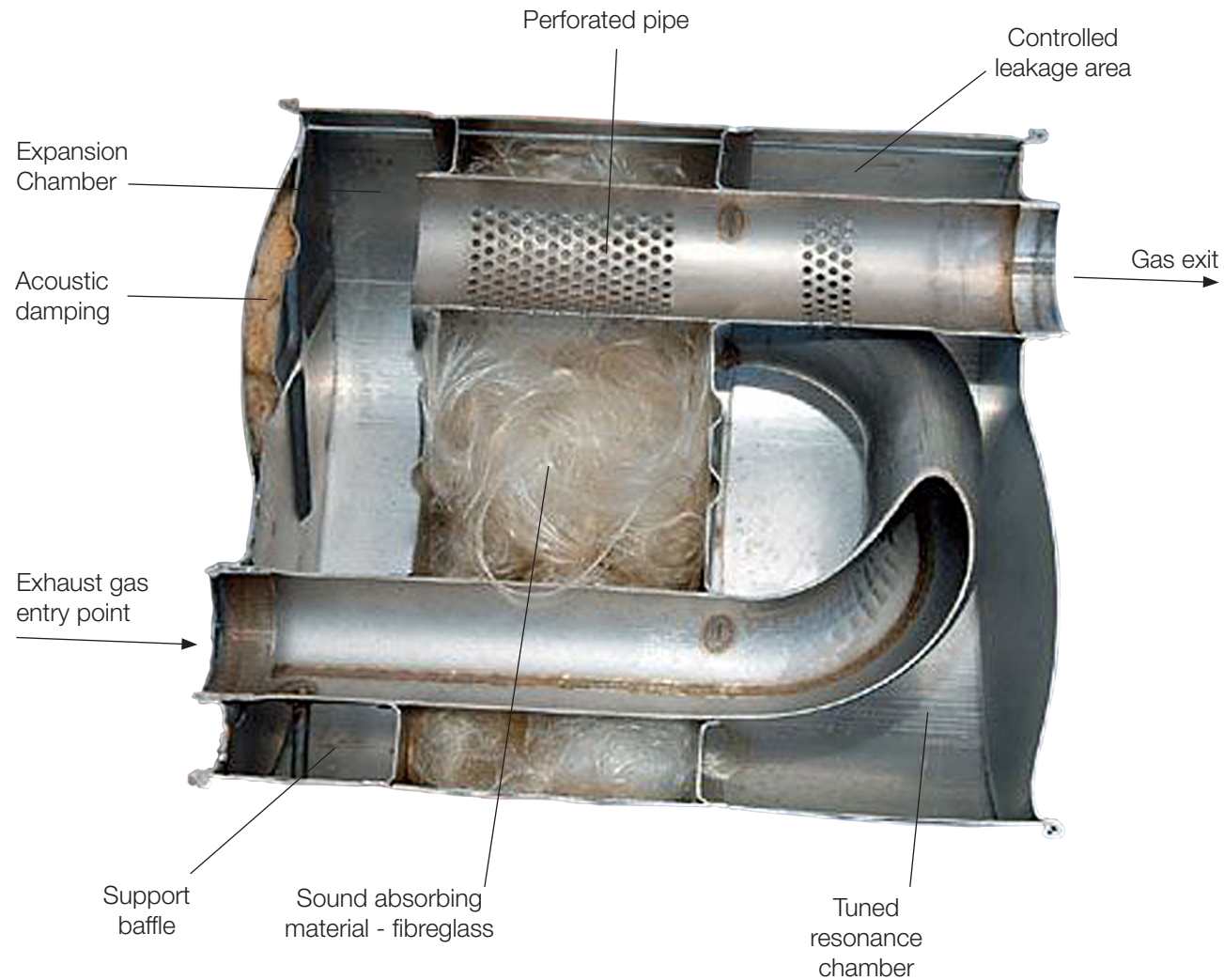
- Components of an Exhaust System – Muffler Function

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Components of an Exhaust System – Muffler Internals



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Components of an Exhaust System – Muffler Internals

Module 4 - Exhaust Systems

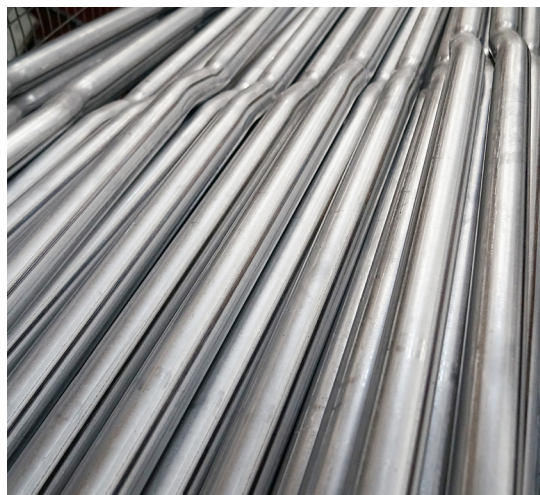
Klarius™ Continuing Professional Development



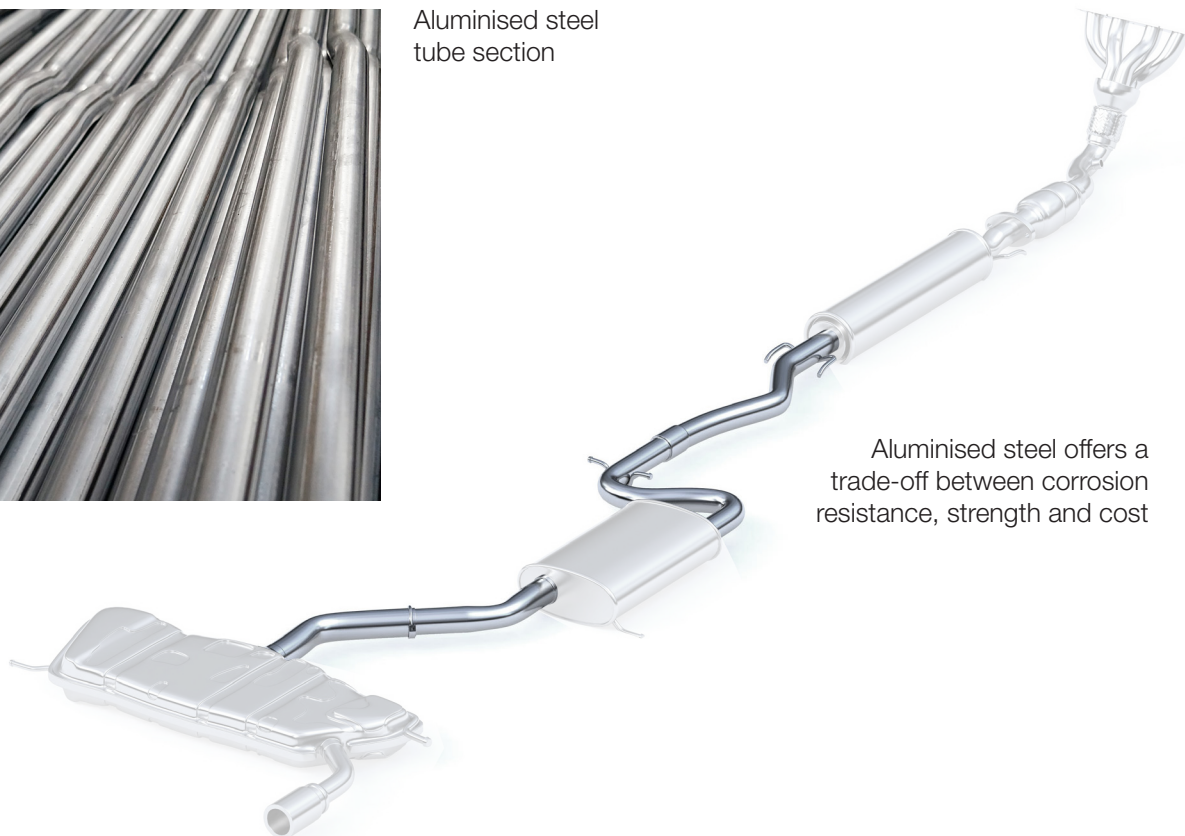
Components of an Exhaust System – Tube section

Between all of the component parts is the exhaust pipe which carries the gas through it's journey out to the tail pipe exit.

Exhaust tubing is usually made of steel, which can be stainless steel, mild steel or **aluminised coated steel tubing**. Aluminised steel has better corrosion resistance than plain steel. It is, however, cheaper than stainless steel and less brittle, so can be less prone to impact damage.



Aluminised steel
tube section



Aluminised steel offers a
trade-off between corrosion
resistance, strength and cost



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Components of an Exhaust System – Tube section

Module 4 - Exhaust Systems

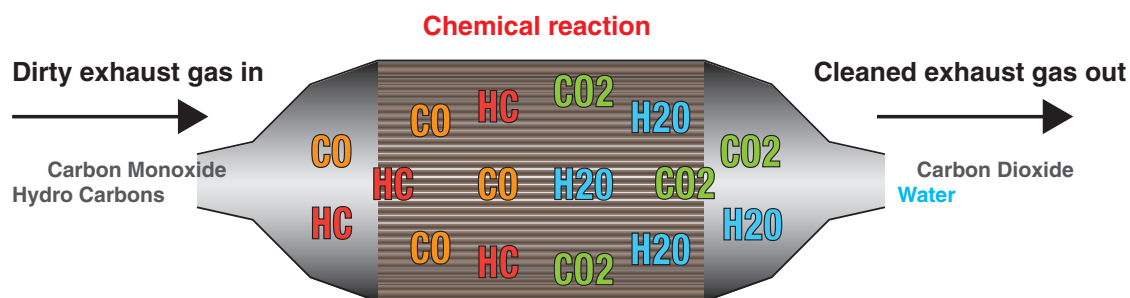
Klarius™ Continuing
Professional Development



Components of an Exhaust System - Catalytic Converters (CATs)

Catalytic Converters are flow-through components that are integrated within the overall exhaust system to help meet European Union exhaust gas emissions standards. They can be both separate from, or integrated within, a Diesel Particulate Filter unit contained in the exhaust system. The Catalytic Converter works by a chemical reaction which helps to convert the toxic exhaust gases into less harmful gases.

- The principle of the Catalytic Converter (CAT) is to **convert the toxic leftover Hydrocarbons, Carbon Monoxide and Nitrogen Oxides in the exhaust into water, Nitrogen and Carbon Dioxide**, which are a lot less harmful.
- The **oxidation reduction reaction only happens at higher gas temperatures (350°C+)** so CATs are being placed closer to the manifold, and in some cases as part the manifold in order to increase light off temperature.



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Components of an Exhaust System – Catalytic Converters (CATs)

Module 4 - Exhaust Systems

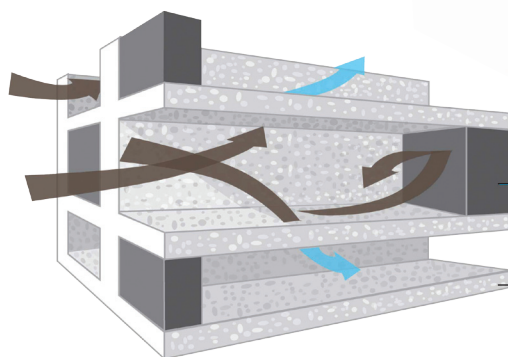
Klarius™ Continuing Professional Development



Components of an Exhaust System - Diesel Particulate Filters (DPF)

Diesel Particulate Filters are components that are integrated within the overall exhaust 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 DPF works by collecting harmful particulates through a fine mesh structure and periodically burning them to remove them from the exhaust. This leaves a small amount of ash each time, which eventually fills the filter, at which point it will have to be replaced.

- The principle of the DPF is to **collect the soot particles** and **periodically burn them off**.
- The natural **combustion** of those **particles** **takes place at around 650°C**
- Whereas the **initial temperature reached by diesel exhaust gases** in the exhaust manifold is **around 300°C**.



Barriers force exhaust gas to pass through filter walls

Fine mesh walls are porous to gas, but capture fine particles



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Components of an Exhaust System – Diesel Particulate Filters (DPF)

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Exhaust System – How it is made

Fitment Testing To ensure that aftermarket exhaust systems match or exceed the standards and fitment requirements developed by the original manufacturers they undergo a number of development processes and are manufactured to recognised quality control standards. **They are also fit tested to the actual model and year of the vehicle they are designed for.**

- Design, Development and Testing
- Sub-assembly, manufacture and Stock/Logistics
- Quality control (ISO9001)



Laser measurement



Welding process



Good quality exhaust designs are fit tested to actual vehicles



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Exhaust System – How it is made

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Manufacturing - Quality Control

Control methods are used to maintain correct tube length, diameter and flange orientation during manufacturing

- Dowel's used to locate bolt holes on a 3 bolt flange



- External mandrel used to control tube length, diameter and flare size



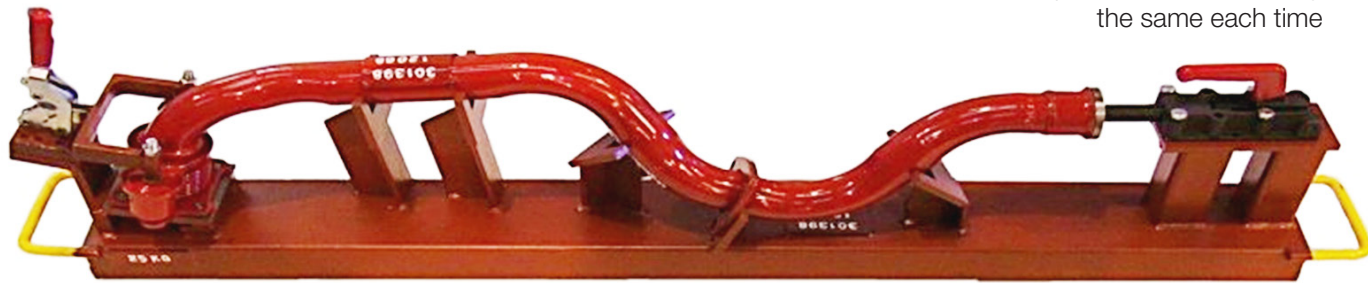
- Internal mandrel used to determine tube length and outside diameter



- Control gate used to determine finished length and exit position



Highly robust metal fixture to ensure parts are made exactly the same each time



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Manufacturing - Quality Control

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Exhaust Quality – Fitment

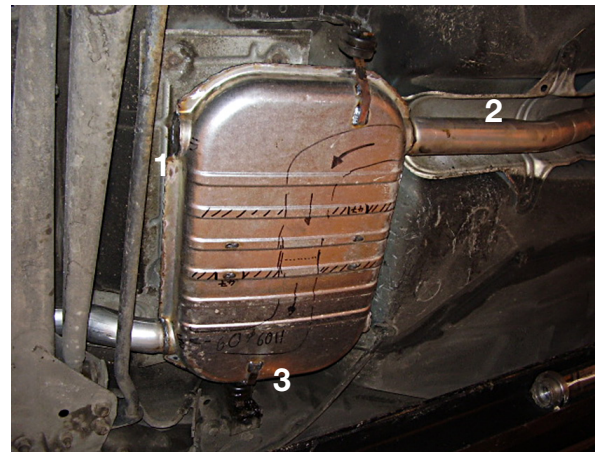
Exhaust development / improvement of fit:

Compare OE design to Klarius – Volvo v70 T5



OE Tested

1. Close to roll bar
2. Poor alignment in tunnel
3. Poor tension on mountings



Klarius solution

1. Clearance improved
2. Alignment corrected
3. Mountings corrected



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Exhaust Quality – Fit

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Exhaust System – Replacement

Fitting exhausts may seem like a simple process, which should be kept simple by using quality parts. There are, however, a few points that are worth underlining.

Fitment tips

- Ensure you have the right product for the exact model and year - making one 'fit' usually means you were supplied the wrong part
- Always order a mounting kit as well as the exhaust
- Check sensors if the CAT or DPF has failed, they are often the cause of issues
- Always specify Type-Approved to be sure of preserving engine performance and fuel economy
- NEVER use gasket paste before the CAT or DPF
- Replace worn mountings
- Always use the bolts and gaskets supplied
- Always use a torque wrench for nuts that go on to head / manifold bolts

Gasket paste should only be used after the CAT and DPF



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Exhaust System – Replacement

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development

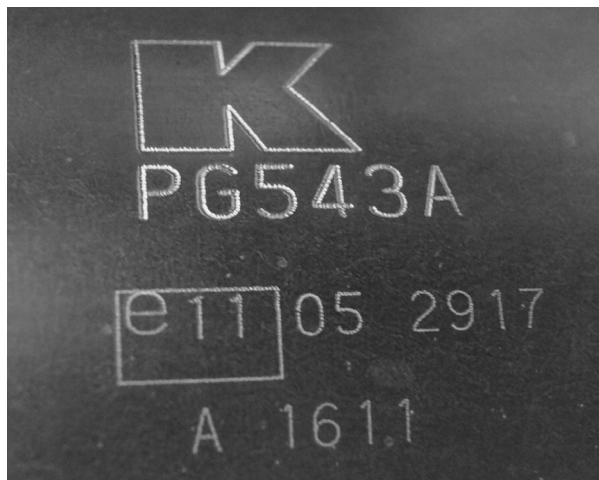


Exhaust Quality – Type Approval

Type Approval – Exhaust Systems (Regulation 59)

For CATs and DPFs it is the law to have a Type Approval certificate, with exhausts (in the UK at least) it is not. It is however a very reliable mark of quality and most major brands will have one.

Type approval guarantees that the replacement part will perform at least as well as the original. Most vehicle warranties will be invalidated by the use of a non Type Approved system.



Summary

Background

- EU Regulation to control noise
- Legal requirement in most EU member states

What to look for

- Approval number marked on product
- What the numbers mean

Summary of independent tests

- Durability
- Tail-pipe noise
- Drive-by noise
- Back-pressure



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Exhaust Quality – Type Approval

Module 4 - Exhaust Systems

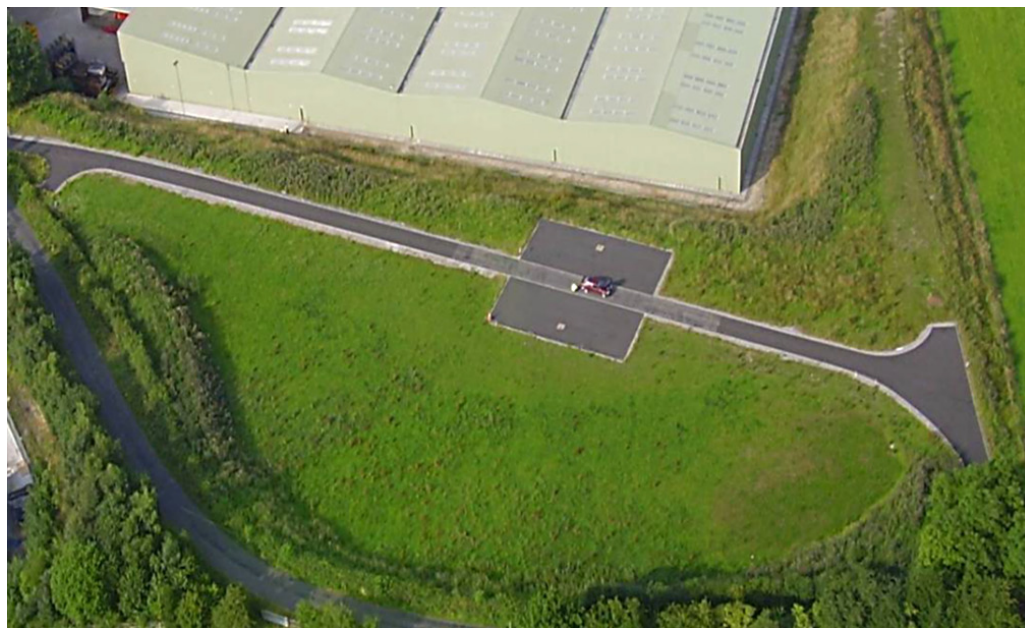
Klarius™ Continuing Professional Development



Type approval - Vehicle Testing

In order to meet many of the **test requirements that are assessed on an exhaust system during type approval, such as noise levels (both static and in motion)** the ability to replicate a number of vehicle driving conditions are required. To achieve this with new components, a private vehicle testing facility is needed.

Klarius has its own VCA approved test track for homologation of new parts. This facility provides the ability to react quickly and efficiently to new market needs and to replicate tests used by OE manufacturers.



ISO10844 -
Homologation
test track



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Type approval - Testing

Module 4 - Exhaust Systems

Klarius™ Continuing
Professional Development



Type Approval – Benefits

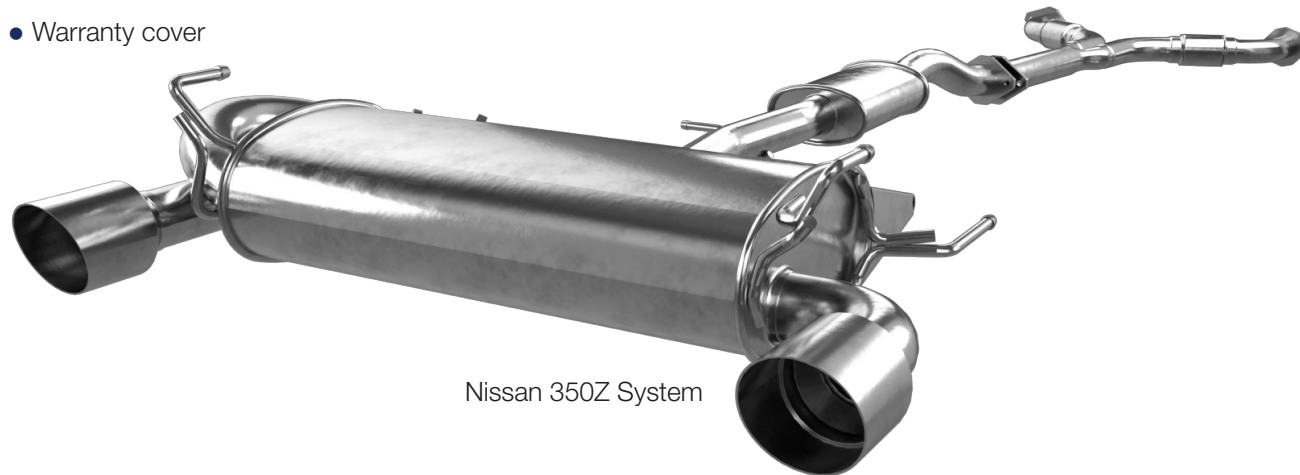
Garages

Business benefits

- Premium material quality
- OEM equivalent function
- Good Fitment
- Low returns & failures
- Faster repair
- More profitable job
- Warranty cover

Consumer Benefits

- No degradation of performance – BHP
- No degradation of fuel economy - ££££
- Fast turnaround
- Warrantied part
- Visually matches original



Nissan 350Z System



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Exhaust Quality – Type Approval

Module 4 - Exhaust Systems

Klarius™ Continuing
Professional Development



Exhaust System - Failures & Replacement

Assessment & diagnostics

When do you replace system or component?

Customer driven

- Blowing noise / noisy
- Internal smells
- Rattles
- Loss of power
- Dash warning light
- Smoke
- Components dropped off / broken

Maintenance/Inspection driven

- Service/MoT - Has it failed? Is it about to?
- Hair line cracks
- Leaking joints
- Perished mounting components
- Dents in pipework/muffler/CAT/DPF
- Early signs of Corrosion
- Loose mounting component



Corroded exhaust system



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Exhaust System - failures & Replacement

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Exhaust System - Failures & Replacement

Questions, causes and advice

- Mileage of car and driving environment – low miles city petrol vs. motorway high miles with diesel systems
- How is it used – vehicle owners driving style/ environment and their impact on exhaust longevity and performance
- Typical vehicle driving conditions: City, Town, Motorway, Country, Winter, Summer, seaside location
- Quality and material of original parts fitted
- CAT security / model, vehicle height vulnerability



Mercedes Sprinter kit



The Exhaust Programme

Exhaust systems – Their Function and how they work

- Exhaust System - failures & Replacement

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



What to do when they go wrong: Repair/Service?

Main phases of replacing the exhaust system: Determine whether to repair or replace the system or its components?

Replacement scenario

- Identify correct components to be replaced – how do you identify the faulty components? Are they rusty, punctured, damaged, hanging loose etc.

Getting the right components

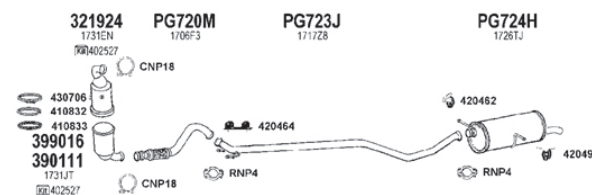
- Checking catalogue data - Check part numbers/ part codes
- Check images match vehicle
- Check OEM numbers
- Test fit / offer up new components vs. removed components

Client Guidance scenario

- Guidance about replacing the system from the same source manufacture
- Typical advisory times to replacement based on damage and typical driving style and environment

Issues for the client/end user

- Quality / longevity reassurance - Warranty
- Fitting time
- Compatibility with remaining system components
- Cost
- Legality



Check catalogue parts drawing for visual match



The Exhaust Programme

Exhaust systems – Their Function and how they work

- What to do when they go wrong: Repair/Service?

Module 4 - Exhaust Systems

Klarius™ Continuing Professional Development



Training Programme Recap

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

- The Product – what is and its components
- The Function – what an exhaust system does and how it achieves this
- The Technology – different types of exhaust systems and their materials
- The Failure modes – why an exhaust system may fail and common causes
- The Diagnostics – how to assess exhaust system condition and diagnose likely issues
- The Product quality - Fitting advice / Quality issues / Type Approval
- The Legal requirements – European Legislation

Now please complete the training assessment multiple choice questionnaire shown overleaf

During this training programme we have covered the following aspects of an exhaust system and how they work and their affect on car performance:



The Exhaust Programme Training Programme Recap

Module 4 - Exhaust Systems

Klarius™ Continuing
Professional Development

Klarius™

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 an exhaust system?

- ☐ components to contain the gas created by the engine
- ☐ a silencer
- ☐ a catalytic converter
- ☐ a fuel filter

2. What is the function of the exhaust system?

- ☐ to contain and re-burn particulate matter
- ☐ to convert exhaust gases to water
- ☐ to safely remove exhaust gases from the vehicle
- ☐ to filter unburned fuel

3. Which of these is NOT an exhaust component?

- ☐ Muffler
- ☐ Fuel injector
- ☐ Manifold
- ☐ Tail pipe

4. Is an exhaust system a service item?

- ☐ Yes
- ☐ No
- ☐ only on German cars
- ☐ only on cars more than 5 years old

5. What exhaust component is fitted against the engine?

- ☐ The exhaust pipe
- ☐ The muffler
- ☐ The fuel injection
- ☐ The manifold

please turn over the page



The Exhaust Programme Student Assessment

Module 4 - Exhaust Systems

Klarius™ Continuing
Professional Development

Klarius™

Student Assessment

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

6. What is the exhaust system DPF?

- ☐ The particulate container
- ☐ an exhaust muffler
- ☐ an unused fuel filter
- ☐ exhaust system mounting bracket

7. What does a DPF do?

- ☐ Collects particulate matter
- ☐ Lowers the exhaust noise
- ☐ Re-tunes the exhaust performance
- ☐ Re-cycles un-used fuel in the exhaust

8. Can DPFs be fitted to petrol engine vehicles?

- ☐ Yes if in a combined catalyst unit
- ☐ Only on fuel injected ones
- ☐ No they are a diesel exhaust only part
- ☐ If the car had one fitted originally

9. What is a typical cause of exhaust system replacement?

- ☐ rust and corrosion
- ☐ the engine management light is on
- ☐ inefficient fuel injection
- ☐ ash build-up

10. What does the catalytic converter do?

- ☐ Makes the exhaust quieter
- ☐ Reduces vehicle emissions
- ☐ Supports the exhaust fitments
- ☐ Reduces service intervals

11. What is a benefit of an aluminised steel exhaust system?

- ☐ They balance out cost with a resistance to corrosion
- ☐ They don't need servicing
- ☐ They act as catalyst as well as an exhaust system
- ☐ They are more expensive than stainless

12. How does a Catalytic converter work?

- ☐ It captures soot in the system
- ☐ It can use cheaper fuel
- ☐ a chemical reaction cleans exhaust gases
- ☐ Modifies the exhaust sound waves

13. Which of these sensors is fitted to modern exhausts?

- ☐ The oxygen sensor
- ☐ The rev counter
- ☐ The service mileage
- ☐ The vehicle ride height

please turn over the page



The Exhaust Programme Student Assessment

Module 4 - Exhaust Systems

Klarius™ Continuing
Professional Development



Student Assessment

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

14. What do mufflers do?

- ☐ They reduce the vehicle cabin temperature
- ☐ They reduce the exhaust gas toxic elements
- ☐ They control exhaust noise
- ☐ They level the rear suspension

15. How do mufflers work?

- ☐ They have asbestos liners
- ☐ They use baffles to dissipate the exhaust energy
- ☐ They are coated with flexible polymers
- ☐ They push the exhaust gas back into the engine

16. Which of these is the exhaust type approval standard?

- ☐ ISO9001
- ☐ There is no type approval standard for exhausts
- ☐ Standard R59
- ☐ It changes every few years

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

- ☐ The capacity of the exhaust system
- ☐ If it matches OE design and performance
- ☐ How quickly it can corrode
- ☐ The exhaust noise levels

18. Which type of exhaust do the EU regulations cover?

- ☐ Just the filter units
- ☐ Both petrol and diesel exhausts
- ☐ Only ceramic ones
- ☐ Just the catalytic converter not the exhaust system

19. When does a customer typically know of exhaust issues?

- ☐ The exhaust is rattling or noisy
- ☐ When their fuel economy increases
- ☐ When the vehicle won't start
- ☐ The clutch is slipping

20. What early exhaust problem signs do garages often notice?

- ☐ Loose or corroding exhaust mounts
- ☐ The air conditioning is slow to start
- ☐ The oil replacement light comes on
- ☐ They can only tell once the exhaust has failed



The Exhaust Programme Student Assessment

Module 4 - Exhaust Systems

Klarius™ Continuing
Professional Development



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

© 2016. All rights reserved. All materials provided are copyright of Klarius Ltd. and may not be reproduced without their express permission.



The Exhaust Programme Training programme close

Module 4 - Exhaust Systems

Klarius™ Continuing
Professional Development

Klarius™