

## Annex 1a

# FAD quality seal for exhaust after-treatment systems of diesel engines



**„Regulations for testing components and systems for exhaust after-treatment (EGN) of diesel engine exhaust gases for obtaining the FAD quality seal (FAD-QS)“**

### Part I: General provision

## **Contents**

<b><i>Introduction</i></b> .....	<b>4</b>
<b><i>Preamble</i></b> .....	<b>4</b>
<b>1. <i>Scope</i></b> .....	<b>5</b>
1.1 Exhaust after-treatment systems .....	5
1.2 System components .....	5
<b>2. <i>Terms, definitions and abbreviations</i></b> .....	<b>6</b>
<b>3. <i>Application for obtaining the FAD-QS</i></b> .....	<b>7</b>
<b>4. <i>Testing of EGA components</i></b> .....	<b>9</b>
4.1 Primary components.....	10
4.1.1 <i>Filter medium</i> .....	10
4.1.2 <i>DOC components</i> .....	11
4.1.3 <i>Filter coatings</i> .....	12
4.1.4 <i>SCR catalyst</i> .....	12
4.1.5 <i>NSC12</i>	
4.2 Secondary components.....	12
<b>5. <i>Testing of EGA systems</i></b> .....	<b>13</b>
5.1 System characterization .....	14
5.2 Test cycles .....	15
<b>6. <i>Test benches, test equipment and test labs</i></b> .....	<b>16</b>
<b>7. <i>Measurement, analysis and measuring method</i></b> .....	<b>17</b>
<b>8. <i>Evaluation process</i></b> .....	<b>17</b>
<b>9. <i>Procedure of awarding the FAD quality seal</i></b> .....	<b>18</b>
9.1 General.....	18
9.2 Awarding authority.....	19
9.3 Technical Commission (AK III – FAD e.V.) .....	19
9.4 Test centres .....	20
9.5 Evaluation report.....	20
9.6 Conformity declaration .....	20

<b>9.7 Identification .....</b>	<b>20</b>
<b>9.8 Validity period of FAD-QS.....</b>	<b>20</b>
<b>9.9 Non-transferability of FAD-QS certificate.....</b>	<b>21</b>
<b>9.10 Requirements for applicant .....</b>	<b>21</b>
<b>9.11 List of EGA systems with quality seal .....</b>	<b>21</b>
<b>9.12 Costs .....</b>	<b>21</b>
<b>9.13 Provisions regarding misuse and supervision .....</b>	<b>22</b>
<b>9.13.1 Supervisory authority .....</b>	<b>22</b>
<b>9.13.2 Tasks of supervisory authority .....</b>	<b>22</b>
<b>9.13.3 Checks .....</b>	<b>22</b>
<b>9.13.4 Penalties .....</b>	<b>22</b>
<b>9.13.5 Check funds for prevention of misuse.....</b>	<b>22</b>
<b>9.14 Enactment .....</b>	<b>23</b>
<b>10. References .....</b>	<b>23</b>
<b>11. Annexes.....</b>	<b>23</b>
<b>Annex 1: Categories for FAD quality seal .....</b>	<b>23</b>

## Introduction

With the updating of the exhaust gas legislation it is generally recognized that the further development of in-cylinder measures for emission reduction and exhaust after-treatment depend on each other. That implies for future engine generations to consider basic marginal conditions of exhaust after-treatment already in the development of engine concepts. It may be assumed that due to a number of influencing factors there will be no universal solution for the exhaust after-treatment problem and the system description in future.

Resulting from most different characteristics of diesel engine applications - from road vehicles through to applications in vessels, locomotives and miniature motors - differentiated bills for emission control do exist as well. Increasingly more attention is focused on the effort to harmonize legal requirements. Therefore, there is a broad range of driving forces to integrate emission-reducing measures on the part of diesel engine operators.

The growing product variety in the field of exhaust after-treatment systems connected with different requirements concerning the behaviour in individual cases makes it more and more difficult for the user to assess the quality and applicability of the solution offered and to differentiate in terms of a specific requirement. The „Förderkreis Abgasnachbehandlungstechnologien für Dieselmotoren (FAD) e.V.“ addresses this problem.

Exhaust after-treatment systems which were tested for their specific application characteristics and evaluated according to criteria from a broad practical experience in manufacture and application are qualified by the FAD quality seal and the manufacturer as well as the user shall be supported in finding suitable system solutions.

## Preamble

FAD-QS is an instrument to characterize EGA systems for diesel engine applications. The focus is on the evaluation of EGA systems, i.e. pre-finished solutions depending on the exhaust after-treatment problem. Individual components for most different applications are also characterized for the purpose of a FAD recommendation. The differentiation between system and component evaluation is explained in section 3 and 4 of these regulations.

FAD-QS serves the evaluation of EGA systems primarily in the retrofit field of most different application categories for diesel engines. The scope is not limited to systems without legal approval procedures but includes all systems existing on the market.

FAD-QS does not substitute any applicable test specifications / approval procedures but demands additional application-specific standards originating from the experience in terms of design, manufacture and application of such systems.

The qualification of „FAD-QS“ is only awarded to systems having successfully passed the quality test according to the FAD quality criteria. FAD-QS is not generally awarded but after individual cases of applications applied for had been considered. The scope of testing depends on the specific use applied for by the manufacturer. It is determined by a FAD body having professional competence which evaluates the application documents to be submitted for obtaining the FAD-QS. A test for obtaining the FAD-QS is only carried out upon application and it is subject to a charge. The FAD-QSs are published on the FAD-homepage and updated monthly. From the awarding of FAD-QS no titles to the granting of approvals or warranties of any kind required by law may be claimed.

## 1. Scope

The FAD quality seal is awarded for exhaust after-treatment systems in the field of diesel engines. The product groups depend on the purpose of application and applicable engine categories. The scope or range of the FAD quality seal includes all kinds of diesel engine exhaust after-treatment with respect to after-treatment systems, subsystems and sensors. QS is only granted to exhaust after-treatment systems. The components of the exhaust after-treatment systems get only a recommendation after a successful test according to FAD requirements.

### 1.1 Exhaust after-treatment systems

Within the meaning of these regulations systems are:

- all kinds of oxidation catalysts being used as independent systems
- all kinds of diesel particulate filter
- all kinds of DeNOx catalysts (SCR, NSC, etc.)
- combined EGA systems

A detailed description is made under section 5 of these regulations.  
Categories 1 to 6 of Annex 1 deal with the field of systems.

### 1.2 System components

In the wording of these regulations components are:

- Catalysts as system components
- Filter media
- Metering device (Additive, AdBlue, etc.)
- Regeneration device
- Exhaust sensors (NOx, NH<sub>3</sub>, etc.)
- etc.

Section 4 of these regulations contains another differentiation. Annex 1 comprises the scope of FAD-QS concerning the characteristics of use. Categories 7 to 9 of Annex 1 deal with the field of system components.

## 2. Terms, definitions and abbreviations

<b>Exhaust opacity</b>	Opacity of exhaust gases by available particles
<b>Filtration efficiency</b>	The filtration efficiency is the difference between 1 and the penetration rate, or resp., the difference from 100 % and the penetration rate in %.
<b>Additives</b>	Fuel additives for an additive-supported regeneration
<b>EGA</b>	Exhaust after-treatment
<b>Annex XXVI StVZO</b> (Regulations Authorizing the Use of Vehicles for Road Traffic)	Regulations for approving particle reduction systems for the use in passenger cars.
<b>Annex XXVII StVZO</b> (Regulations Authorizing the Use of Vehicles for Road Traffic)	Regulations for approving particle reduction systems for the use in commercial vehicles or mobile machinery.
<b>Loading</b>	Soot or particle mass stored in a particle reduction system.
<b>DeNOx</b>	NOx-reduced exhaust after-treatment
<b>DOC</b>	Diesel Oxidation Catalyst
<b>DPF<sup>®</sup></b>	Diesel Particle Filter
<b>Penetration rate</b>	The ratio of a variable measured downstream of the filter to the corresponding value upstream of the filter.
<b>EC</b>	Elementary carbon
<b>ESC-Test</b>	European Stationary Cycle. Test consisting of 13 stationary stages of different speeds and loads pursuant to Appendix III Annex I of Directive 2005/55/EC of the European Parliament.
<b>ELR-Test</b>	European Load Response Test.
<b>ETC-Test</b>	European Transient Cycle
<b>FAD e.V.</b>	Förderkreis Abgasnachbehandlungstechnologien für Dieselmotoren e.V.
<b>FAD-QS</b>	FAD quality seal
<b>FBC</b>	Fuel Borne Catalyst; Additive
<b>FSN</b>	Filter Smoke Number → smoke number
<b>LNT</b>	Lean NOx trap; storage catalyst
<b>Component</b>	Cat filter system incl. necessary noble metal coating

<b>Mobility diameter</b>	Diameter of a sphere having the same mobility like a non-spherical particle.
<b>Partial-flow filter</b>	Work according to the principle of deep-bed filtration in the partial flow. Part of the exhaust gas flow is redirected through a nonwoven or a comparable material to the adjacent channels and the particles are collected in the nonwoven.
<b>NRTC</b>	Non-Road-Transient-Cycle
<b>NSC</b>	Storage catalyst
<b>NTE</b>	Not To Exceed
<b>Particle</b>	Matters in the engine exhaust gas dispersed in suspension at 573 K (300° C).
<b>Particulate catalyst</b>	Partial flow filter
<b>Particulate number concentration</b>	Number of solid particles with a mobility diameter between 20 and 300 nanometres per volume unit in a certain size group.
<b>PM</b>	Particulate matter
<b>PMP</b>	Particle Measurement Program of UN ECE / GRPE: Proposal for the determination of number of particles.
<b>PMS</b>	Particulate reduction system
<b>QS</b>	quality seal
<b>Space velocity (SV)</b>	Ratio of the exhaust gas volume flow in the particle filter or catalyst to the volume of the particle filter or catalyst system. Unit: 1/time.
<b>Regeneration</b>	Burning off the particles (soot) accumulated in the filter. Active regeneration: Particle is heated to the required oxidation temperature by an external energy source. Passive regeneration: No specific initiation of oxidation process in the system envisaged.
<b>SCR</b>	Selective Catalytic Reduction
<b>Secondary emission</b>	Emissions generated by the use of a particle filter or catalyst system.
<b>Wall-flow filter</b>	Filtration according to the wall flow principle.
<b>WHDC</b>	World-wide Heavy-Duty Certification Procedure
<b>WHSC</b>	World-wide steady test cycle
<b>WHTC</b>	World-wide transient test cycle

Will be finally added by terms used, then also a harmonization with the text will follow.

### 3. Application for obtaining the FAD-QS

An application for obtaining a FAD-QS or the application for testing an EGA component may be filed by system and component manufacturers as well as by users. By filing a

formal application with the authority awarding the quality seal an awarding procedure is initiated after open questions had been clarified. Application forms may be downloaded from the homepage of the QS-awarding authority. The relevant form sheet must be selected. The form sheets are classified as follows:

- Diesel particle filter and particle reduction systems
- DeNOx systems
- Combination systems
- Single component test

The documents to be submitted with the application form differ according to the certification desire.

The consideration and approval of an application for obtaining FAD-QS is made according to the following scheme:

- Filing of an application
- Consideration of application, approval of application and commissioning of test body by QS-awarding authority.
- Carrying out and documentation by test body
- Evaluation of test results by QS-awarding authority.
- Preparation of evaluation report by QS-awarding authority.
- Awarding of FAD-QS and entry on the FAD-QS list by QS-awarding authority.

The following scheme illustrates the process of a FAD-QS test.



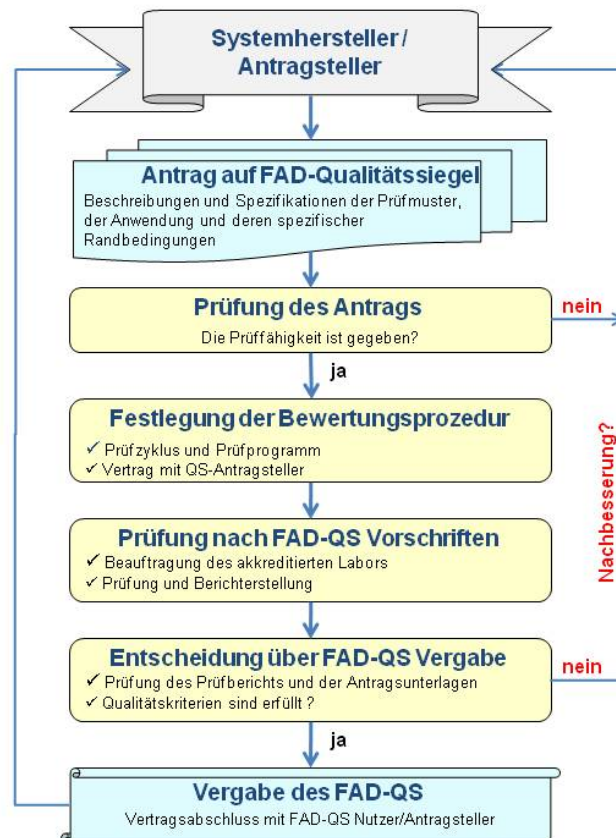


Fig. 3.1: Application, testing and awarding of FAD-QS

#### 4. Testing of EGA components

Within the meaning of these regulations components are parts according to categories 7 to 9 of Annex 1 built in EGA systems and directly or indirectly involved in the function and monitoring of emission reduction measures. Accordingly, in this case it is distinguished between so-called primary components (such as filters, DOC, SCR-cat, etc) and secondary components.

For the testing of individual components FAD specifies test and evaluation criteria according to which the type-specific characterization of properties may be determined which are primarily directly linked to the functional principle (such as filtration, catalytic function) of the component. The focus of the application of the component test shall be on the evaluation of developments of new system components or system components available for a further development (such as new filter media, new coating technologies, new sensors or the like). The testing of component properties is carried out by suitable devices (such as test bench) in order to comparably describe the efficiency. The future application characteristics of the EGA system (categories 1 to 6 of Annex 1 of these regulations) don't play any role in it yet.

The result of the FAD component test is the awarding of a FAD recommendation including all important parameters for a component description and it is based on a well-founded competence of the QS-awarding authority. A recommendation of this kind may also be

granted upon application without going through a FAD test procedure if the QS-awarding authority makes this decision on the basis of references submitted or from its own conviction. This exception may come to bearing particularly for components already tried and tested in use. Usually, a FAD recommendation for components is the prerequisite for the FAD-QS in the approval procedure. It may reduce the test amount in the system test to be carried out there.

## 4.1 Primary components

It is differentiated between components for particle reduction and for the reduction of gaseous exhaust gas emissions (DOC, SCR-Cat, NSC, etc.). For the evaluation of the primary components of filters and catalysts standard variables are defined in the dimensions of diameter x length which are adapted for selected test engines. Definitions for the component dimensions and the test engines to be used are delivered by the QS-awarding authority according to the application specification. The test of primary components is carried out according to specified FAD standard test cycles which may also be extended within the meaning of the application.

### 4.1.1 Filter medium

Filter media are differentiated into filter categories according to the filtration principle. The characterization of filtration properties of the filter medium in the component test is usually carried out on catalytically uncoated parts. If the coating has a determining influence on the filtration result or the retaining efficiency a coating or a second component (DOC) is already approved in the component test upon application of the manufacturer. As a consequence, this constellation is also characterized as a component and the FAD recommendation applies only to the tested combination. The characteristic test variables of the filter component test include:

- Efficiency of particle filtration
- Particle storage capacity
- Pressure loss characteristics  $\Delta p=f(t)$  in case of loading
- Pressure loss  $p_{\max}$  in case of limit loading (as specified by the manufacturer)

The assignment into filter categories of wall-flow and partial-flow filters is essentially based on the differentiation into particle reduction classes for PMS according to [2] and [3].

For the characterization of the filter properties the measurement of stationary load points is made use of in the component test. Based on the 11-stage test (B-cycle) according to ISO 8178 [4] the test is oriented towards two selected test speeds of the corresponding test engine. Representatively for the load, the variable of space velocity is specified which shall lead to a harmonization of the test for different engine categories. Figure 4.1 illustrates a test cycle as an example.

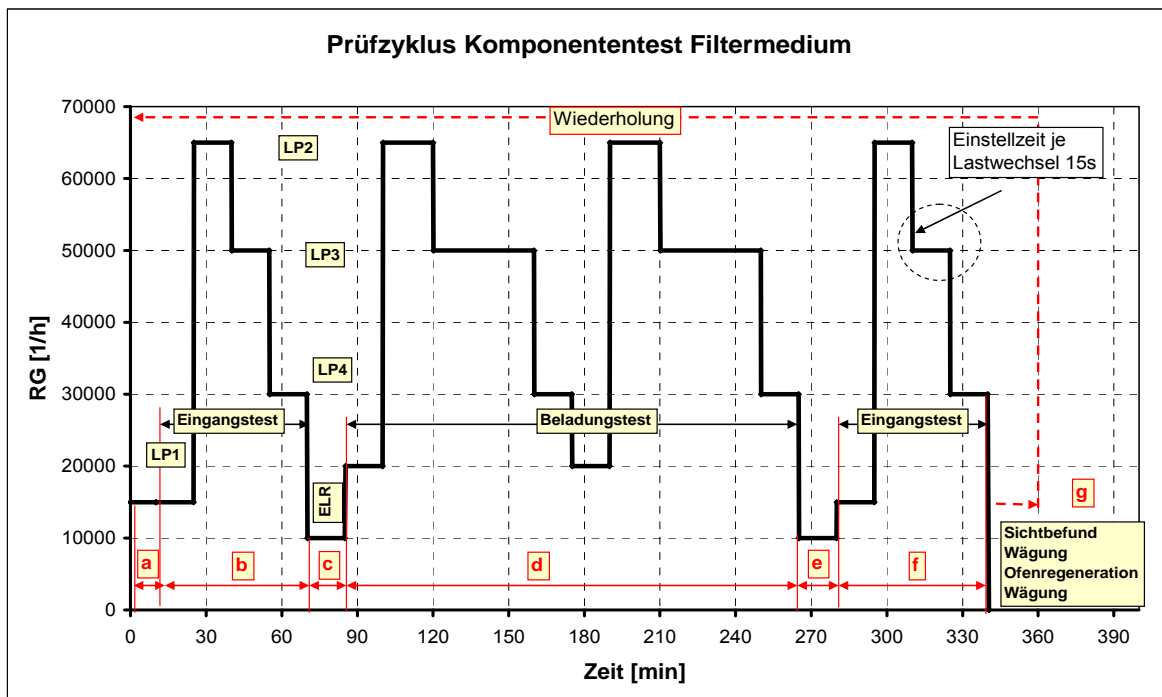


Abb. 4.1 Test curve of component test for filtration

### 4.1.2 DOC components

DOC components are primarily characterized according to the criterion of catalytic oxidation capacity. Basically, it may be differentiated into various application categories and DOC modifications. They include:

- DOC without secondary HC oxidation in different installation positions
- DOC with secondary HC oxidation
- Ammonia traps
- and the like

All DOC cases of application have in common that the conversion activity is determined by the application temperature and the so-called space velocity (SV). According to the application specification there are different requirement profiles and test variables derived from it for:

- Light-off for HC and CO conversion
- Conversion behaviour in the engine map (=f(Temperature, RG))
- NO<sub>2</sub> formation activity for the application in combination with passively regenerating DPF or DeNOx
- Ageing resistance
- CO and HC oxidation to increase exhaust gas temperature
- S-poisoning
- Increased thermal ageing resistance
- Low-temperature conversion of limited and non-limited emissions
- Formation of secondary emissions
- and the like

### **4.1.3 Filter coatings**

Filter coatings are defined as catalytic components within the meaning of the test defined herein. This shall especially offer the possibility of comparably designing modifications in the catalyst definition and in the technological manufacturing process. Test cycles are derived according to the claim of the applicant based on section 4.1.1 and 4.1.2. The amount of the test depends on the application claim and may be variable.

### **4.1.4 SCR catalyst**

SCR catalysts (selective catalytic reduction) are based on the selective catalytic reduction of nitric oxides of the exhaust gas. As reducing agent ammonia (NH<sub>3</sub>) is used which is extracted from reagents to be additionally provided. Usually, a SCR catalyst interacts with an upstream oxidation and hydrolysis catalyst. Therefore, a separate evaluation of the SCR catalyst component is possibly only conditionally meaningful. Hence, the purpose of the component test defined by FAD is an idealized description of the NO<sub>x</sub> conversion capacity under stationary test bench conditions. Metering strategies of the reducing agent supply of the future system solution are left out of consideration here.

In the envisaged test the NO<sub>x</sub> conversion capacity is determined dependent on the NO<sub>x</sub> emission of the test engine and the component design. Usually, NH<sub>3</sub> is used as a reducing agent which is metered through a mass flow controller in a gaseous state and distributed in the exhaust flow via mixer elements. The metering and the setup of the exhaust line up to the test specimen are defined according to FAD quality criteria in order to maintain the comparability of the test results. The test procedures for the selected test engines are fixed by the QS-awarding authority.

### **4.1.5 NSC**

NO<sub>x</sub> storage catalysts (NSC) work discontinuously according to the principle of oxidation/absorption at  $\lambda > 1$  and of desorption/reduction at  $\lambda < 1$ . Therefore, within the meaning of a component test defined herein they can't be usually described separately from the operating regime of a specific engine. For the verification of component modifications, in this case especially of coating variations, an idealized test cycle in a stationary mode of the engine may be agreed upon application similar to section 4.1.4. Upon application the QS-awarding authority suggests test cycles and the test amount and defines them as a component test.

## **4.2 Secondary components**

Within the meaning of these regulations secondary components are all those components built in EGA systems additionally to the primary components. They have a direct and indirect influence on the function of the EGA system or they are involved in the monitoring of it. Excluded are parts (such as temperature and pressure sensors) which are already subject to defined test specifications for the application in categories 1 to 6 of Annex 1.

By means of the secondary component test the functionality of stand-alone system solutions is evaluated which work, to the greatest extent, independently of applications in

the engine control unit and which may also be operated separately on the test bench, in principle. The test is related to the testing of the functionality of the components, not to its effectiveness in an EGA system.

There are the following examples for it:

- Autarkic metering devices
  - Additive metering
  - Reducing agent metering
  - External HC metering
  - and the like
- Stand-alone electrical regeneration systems
- Data logging systems
- Sensors
- and the like

The testing of the components specified in section 4.2 is based on special FAD test routines which are compiled and described in detail depending on the application claim. Upon application the QS-awarding authority suggests test cycles and the test amount and defines them as a component test.

## 5. Testing of EGA systems

Within the meaning of these regulations an EGA system is the coordinated interaction of EGA components for a specific individual case. The constructive integration of the system components in the exhaust train as well as the emission reduction requirement to be met plays a role.

The evaluation of an EGA system within the meaning of FAD-QS is focused on the testing of the functionality of a system solution considering the application conditions and the corresponding system setup as far as it is possible on the test bench true to the original. As regards this, it differs from the existing regulations and test procedures in essential points. The approval for testing starts from essential preconditions and, hence, requires fulfilled conditions. There are the following preconditions for the test:

- The EGA system is based on EGA components each of which has a FAD recommendation
- The EGA system is a system solution and may refer to a field trial attested by logger data or to qualified test results in terms of the application characteristics.
- The typical application conditions may be described and, if necessary, delimited.
- The reproduction of the complete system solution on the test bench is sufficiently possible.

In the case of certifications of systems which have no permission required by law a FAD component test is imperative.

## 5.1 System characterization

The system characterization is the prerequisite for the selection of the test procedures to go through. Depending on the claims of the applicant the amount and expenditure of the test procedure is fixed which is determined by the QS-awarding authority during the approval procedure. Only those systems will be permitted for testing complying most widely with the system state of the practical application taken as a basis. The test is carried out on the engine test bench with a test engine assigned to by the QS-awarding authority. In the system differentiation it is distinguished according to essential claims for emission reduction. It is categorized into the following basic claims:

- Emission reduction
- HC and CO (DOC)
- PM (DPF/partial-flow filter without DOC/coating)
- PM and HC/CO (DPF with DOC/coating, / partial-flow filter)
- NOx (SCR-Cat, NSC)
- Combinations of a) to d) (combined systems)

This differentiation according to the application claim is indicative of the test engine, test amount and measurement to be used. The applicant must fill in a corresponding form. In terms of the content the differentiation in the short characterization means:

- An EGA system according to a), consisting exclusively of a DOC, based on a component pursuant to section 4.1.2.
- An EGA system for particle reduction according to b) or c) is essentially based on a filter component pursuant to section 4.1.1. As a precondition for the approval as an EGA system according to FAD-QS proof for particle retention and particle oxidation (except easy-change filter) must be furnished. In case c) the evidence is extended to the reduction of HC and CO. The focus of the system evaluation is on the characterization of the filter regeneration under operating conditions. For unregulated systems this requires at least a component according to 4.1.3 or the combination with a component according to 4.1.2 (DOC). For regulated systems an integration of an auxiliary component such as the metering system or burner system or a combination out of these components may be imagined. Active systems on the basis of engine after-injection require the approval by the engine manufacturer and they are not evaluated within the framework of these regulations.
- An EGA system for NOx reduction according to d) is usually based on a component according to section 4.1.2 and on components according to 4.1.4 or 4.1.5. As a precondition for the approval as an EGA system according to FAD-QS proof of the continuous and sustainable NOx reduction under operating conditions must be furnished. According to the state of the art it requires the controlled or regulated reducing agent metering according to a metering strategy. The focus of the tests to be carried out is on the testing of the metering strategy under operating conditions.

- If the claim for emission reduction of the particle as well as the NO<sub>x</sub> reduction is mainly determined by the EGA components it is defined as a combined system.

## 5.2 Test cycles

The test cycles for systems are determined by the QS-awarding authority depending on the application specifics. This is done on the basis of logger data to be provided by the applicant. It is differentiated between so-called standard and special tests. Requirements for the test cycles are selected, if necessary, amended according to the application claim and communicated to the applicant. A separate test cycle is not required for every application specifics/individual case, i.e., a new test cycle is not established for every test. The QS-awarding authority decides on a case-by-case basis which test criteria meet the application best. Generally, it is differentiated as follows:

Standard test cycles

- Standard test cycles for filter system with passive regeneration
- Standard test cycles for filter system with partial-flow filtration
- Standard test cycles for filter system with active regeneration

Different combinations are possible.

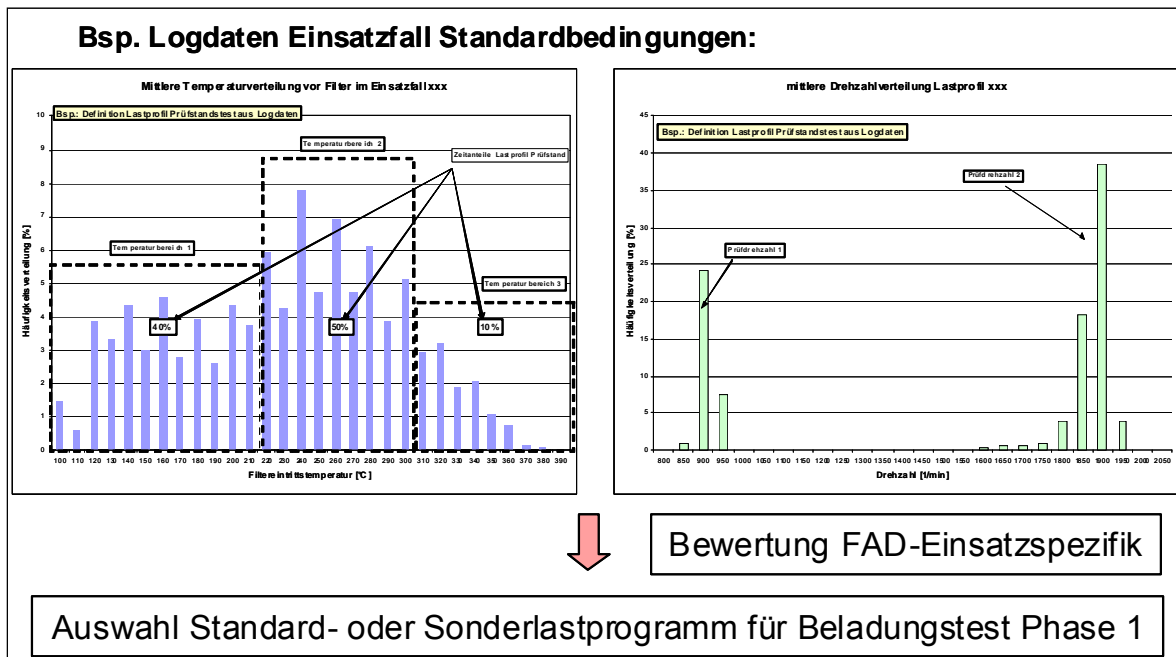
- Standard test cycle SCR-system
- Standard test cycle NSC-system
- Standard test cycle DOC and/or / partial-flow filtration
- Standard test cycle for combined systems

Special tests include additional criteria and are defined if special claims are to be derived from the application conditions. The specifics may be derived from the application conditions themselves or from sophisticated claims regarding the functionality or functional claim. Usually, the special test is based on the standard test or is, if possible, integrated in it.

The following test cycles are typical special test cycles:

- Test cycle for low temperature application
- Test cycle for extreme temperature application
- Test cycle for special fuels with an increased S-content
- Test cycle for applications relating to occupational safety and health
- and the like

The catalogue of defined tests is not rigid but is subject to a permanent up-dating. Fig.5.1 illustrates exemplarily the procedure for the test description and test selection.



**Fig. 5.1 Evaluation of logger data of load profile definition**

Explanation:

- a) Evaluation of logger data in class categories for speed and load according to frequency distribution of the application (usually, only speeds and temperature profiles will only be available before and after the EGA system)
- b) Determination of a limited number of stationary test load points and assignment to the frequency distribution
- c) Selection of a suitable test engine according to the engine category assignment
- d) Adjustment of the available test procedures with the application profile of the application and assignment of a test program (if necessary, modification or new publication of a test routine)

When determining the test cycles the QS-awarding authority is mainly interested in the description of the conditions directly on the EGA system. It is expected that this will be also possible by simplified, quasi-stationary test routines with regard to the test amount to be made and the involved costs of the test.

## 6. Test benches, test equipment and test labs

The test bench measurements in the component as well as the system test must be taken in laboratories complying with the standard according to [5]. Exceptions are possible in well-founded cases by the previous decision of the technical commission. Measurements may only be taken by laboratories which were approved as a FAD quality seal laboratory by the QS-awarding authority before. A corresponding list of test labs updated within the framework of the updating service may be retrieved on the homepage of the QS-awarding authority. The definition of the conditions for the integration of the EGA components in the test setup shall guarantee the comparability of the test results obtained at different test centres. Additional important key points such as fuels and lubricants must also be defined.



## 7. Measurement, analysis and measuring method

The measurement, analysis and measuring method must be specified according to the state of the art. Wherever possible, already existing sets of regulations and specifications are referred to. In particular, these are the EC directives, ECE guidelines and ISO standards to be usually used for internal-combustion engines for the drive of or the application in light passenger cars and light commercial vehicles, heavy commercial vehicles and mobile machinery and equipment or agricultural and silvicultural applications (tractors).

The following measured variables are basically used:

- PM – Particulate matter
- PN – Particulate number measurement
- PGV – Particulate size distribution
- EC – Elementary carbon
- Opacity
- Limited gaseous components
- Non-limited gaseous components
- Carbon dioxide - CO<sub>2</sub>
- Nitrogen dioxide - NO<sub>2</sub>
- Ammonia - NH<sub>3</sub>

The technical commission may fix the determination of additional gaseous components for assessment. This is done depending on the exhaust after-treatment to be assessed and the auxiliary materials (reagents, fuel borne catalysts etc.) possibly necessary for it. If additional gaseous components shall be determined the technical commission will inform the applicant and the test lab about it prior to the beginning of the work.

The evaluation of the test cycles specified in 5.2 is made on the basis of the requirements of the corresponding regulations. The adjustment of the requirements specified in them to the requirements of this document (especially as regards the changed test cycles and the like) is made analogously and according to good engineering practice. The evaluation is made by an analysis of the measured values and results before and after the exhaust gas treatment to be evaluated. In cases of doubt an accredited consultant or the technical commission must be consulted.

## 8. Evaluation process

The evaluation of the FAD test of components and systems is stipulated in a nomenclature of FAD in [1]. Due to the use of own test programs evaluation and quality criteria deviating from the legislation also apply which are described in [1]. The component test is carried out within the meaning of a FAD recommendation specifying the essential functional properties of the tested components.

The application-specific system test leads to the awarding of FAD-QS. Starting from the so-called standard test the FAD-QS may be qualified in a differentiated way in case of an extended test amount according to a special test procedure by a corresponding evaluation

amendment depending on the test amount and test requirement.

Test reports drawn up according to specification by the authorized test centres and submitted for assessment to the awarding authority - the institute of Prof. G. Zikoridse as an independent legal entity (Argomotive GmbH) - form the basis for the evaluation of the component as well as system tests. The test reports are drawn up by the awarding authority. In the test report the test results are shown and finally the applicant is informed whether a component recommendation or FAD-QS could be awarded.

Fig. 8.1 illustrates the organizational realization of the awarding modalities of the FAD quality seal.

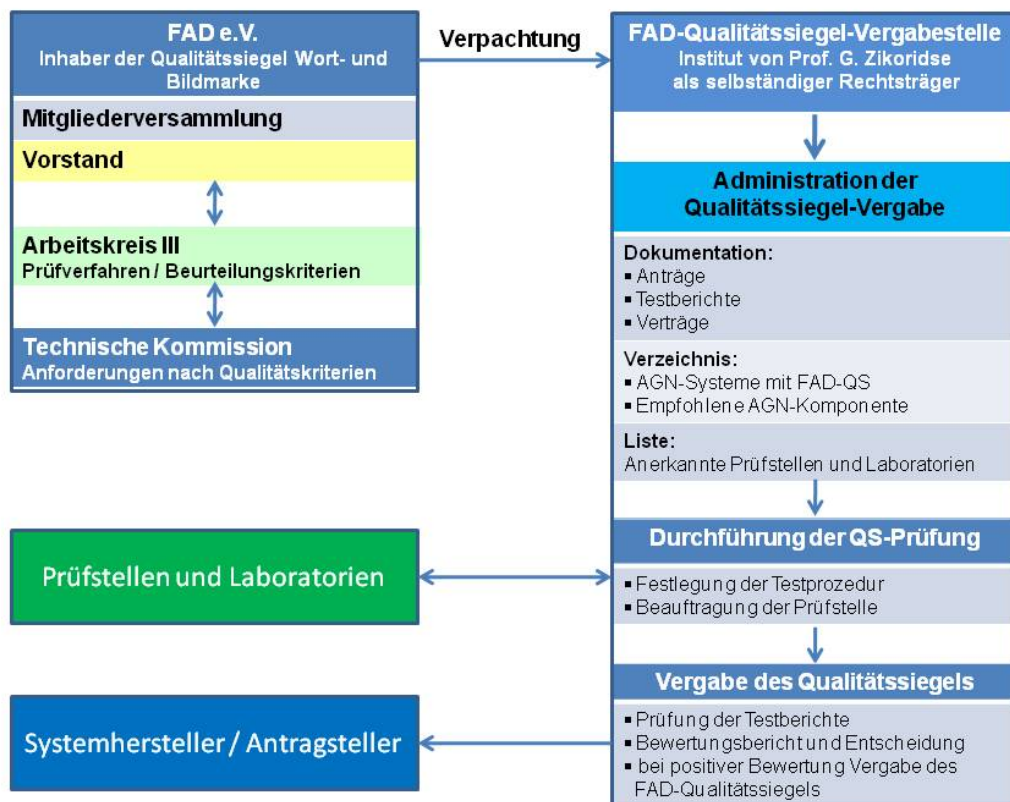


Fig. 8.1: Organizational realization of the awarding modalities of the FAD quality seal.

## 9. Procedure of awarding the FAD quality seal

### 9.1 General

a) The application for obtaining the FAD quality seal (FAD-QS) for a system, separately according to type and field of application, must be addressed to the authority awarding the quality seal (Argomotive GmbH Institut für effiziente und umweltverträgliche Antriebstechnologien). Each of the following documents must be attached to the application in four copies:

- Technical description of the system including the field of application (information about the vehicle and/or machine, engine, application specifics)
- Information about the catalyst a DPf, for instance, is combined with

- Information about maintenance and life
  - Drawings including connection parts, parts list
  - Installation position of exhaust train
  - Photos
  - Identification of the system
  - Documents on the legal approval of the system (see component test)
- b) The review of the documents, registration and organisation of the required steps according to the FAD test specifications for obtaining the FAD-QS is made by the authority awarding the quality seal, Argomotive GmbH.
- c) Principally, accredited laboratories are commissioned to carry out the technical test (according to test specification). After the test had been carried out the FAD-QS test report is drawn up there.
- d) The test report serves as a working paper for the QS-awarding authority in evaluating and decision-making.
- e) After the positive assessment of the procedure Argomotive GmbH awards the FAD-QS
- f) FAD-QS is granted for 5 years until revoked
- g) Conformity declaration

The holder of FAD-QS shall undertake to:

1. Manufacture the systems uniformly according to the FAD-QS documentation.
2. Apply for a follow-up test in case of changes.
3. Affix the FAD-QS mark, category and number only on parts fully complying with the QS documentation.
4. Have a retesting, ordered by Argomotive GmbH, carried out at his own expenses.

## 9.2 Awarding authority

The responsibility for carrying out the QS-awarding procedure and the awarding of the quality seal lies with the contractual partner of FAD e.V., Argomotive GmbH. Argomotive GmbH does all the administrative work for the evaluation of the EGN-systems and the awarding of the quality seal. The QS-awarding authority also supervises the application of the quality seal as a supervisory authority and initiates penalties in case of misuse (for instance, withdrawal of FAD-QS).

## 9.3 Technical Commission (AK III – FAD e.V.)

For technical issues of the awarding modalities of the FAD quality seal the management of FAD e.V. elects a Technical Commission the members of which are nominated upon motion of the members of the association. All full members of FAD e.V. are entitled to delegate a proxy. The Technical Commission is a workgroup within the framework of AK III of FAD e.V. The commission consists of at least 5 representatives. Resolutions are adopted by a simple majority of the members present. The Technical Commission has the

following tasks:

- Determination of the requirements in the regulations for obtaining the quality seal
- Determination of permissible test procedures, test standards and measuring techniques/measuring methods for the application-specific test of various EGA systems.
- Elaboration of temporary regulations

In cases of conflicts the management of FAD e.V. may be applied to as a recourse instance.

## **9.4 Test centres**

The test centres appointed by the awarding authority are responsible for the technical test according to the FAD test procedure. The test reports to be drawn up must comply with the FAD quality criteria [1] according to the test report.

## **9.5 Evaluation report**

The evaluation report confirms that the FAD-QS requirements for the EGA system have been met. When drawing up an evaluation report the following points are considered:

- Validity of the test report which shows the test results of the EGA system test,
- Test procedure used.

The evaluation report is drawn up by Argomotive GmbH, as the awarding authority, and may be inspected there upon application.

## **9.6 Conformity declaration**

In addition to the review by the awarding authority the applicant must confirm by means of a conformity declaration that his products as well as the pertinent written documents comply with the requirements of the QS regulations and that he has taken note of all stipulations of the QS regulations and the attachments. The conformity declaration is an integral part of the evaluation report decisive for the QS-awarding. If it is found out during the review that the information given in the conformity declaration is not in accordance with the facts the quality seal may be revoked.

In order to make the re-issued certificate legally valid in case of a renewal the conformity declaration must be re-confirmed, i.e. re-signed and re-dated.

## **9.7 Identification**

Based on the QS-awarding the EGA system may be labelled with the FAD quality seal. The quality seal may be integrated in the type plate.

## **9.8 Validity period of FAD-QS**

The awarding of FAD-QS and the entry of the EGA system or of a series on the FAD-QS list connected therewith as well as the undertaking of the applicant are valid for a period of

5 years. At the end of this term the awarding authority has the right to request the FAD-QS user (applicant) to provide evidence of any new requirements being met. The applicant must request for the renewal of the entry on the list. A retesting may be requested in case of strong suspicion that the product with the quality seal does not conform any more to the originally tested product. A retesting is not required if the applicant signs a declaration that the EGA system or the series is identical with the tested one. Insignificant modifications may be confirmed by a review of drawings by an accredited test institution.

## **9.9 Non-transferability of FAD-QS certificate**

The FAD-QS certificate is only issued for the manufacturer of the exhaust after-treatment system named in the QS-user contract. The EGA system manufacturer shall not transfer the FAD-QS certificate to another manufacturer or his suppliers and sales agents.

## **9.10 Requirements for applicant**

With the certification of his EGA system or a series the applicant accepts the disclosure of test results and the manufacturer-neutral publication of selected results by FAD e.V. or Argomotive GmbH for research purposes. He undertakes to provide no information in his technical documentation and instructions contradicting the results evaluated by the awarding authority. General designations in the documents (technical documentation, sales brochures etc.) are not permitted. Certified systems must be clearly designated. The quality seal layout in the documents must conform to the original.

## **9.11 List of EGA systems with quality seal**

Passing the FAD-QS aptitude test is the precondition for the entry of an EGA system on the FAD-QS list.

The list of the QS-certified EGA-systems is updated in regular intervals, published as comprehensively as possible and provided to interested parties by FAD e.V. or Argomotive GmbH. The list contains the following information on the certified EGA-systems:

- Product name
- Manufacturer/importer
- Field of application
- Power range of internal-combustion engine
- Function description
- Functionality field of EGA systems (FAD-QS-tested)
- Information on emission reduction (FAD-QS-tested)
- Year of certification

## **9.12 Costs**

The applicant is charged for the costs for the FAD-QS by the awarding authority. The fees are specified in the FAD-QS scale of fees.

## **9.13 Provisions regarding misuse and supervision**

### **9.13.1 Supervisory authority**

Any violation of the regulations, attachments and quoted standards is regarded as a misuse. Argomotive GmbH, as the awarding authority, is the supervisory authority with the corresponding supervision powers and competences.

### **9.13.2 Tasks of supervisory authority**

- The awarding authority shall supervise that the quality seal is not misused. For this purpose it carries out checks.
- It renders a report once a year to the general meeting.
- It may impose sanctions in case of misuse pursuant to the QS regulations.

### **9.13.3 Checks**

Type of checks

- Spot checks for quality assurance
- Specific checks in case of strong suspicion on violation of QS regulations

Focus areas of checks (not final)

- Does the sold product conform to the tested system?
- Are the used materials and constructive details in conformity with the test documents?
- Are the fields of application of the system series in conformity with the test documents?
- Is the quality seal also used for untested devices?

### **9.13.4 Penalties**

If a misuse is detected the costs for the checks have to be borne by the FAD-QS user; in addition, a fee is charged depending on the number of sold non-compliant devices. Furthermore, the following measures may be taken depending on the seriousness of the violation:

- Warning
- Instant withdrawal of the usage rights for the wrongly used quality seal
- In case of repeated misuse or violation of the first-time penalty: disallowance of the quality seal; cancellation from the QS list

### **9.13.5 Check funds for prevention of misuse**

The funds are used for the financing of measures for the prevention of any QS misuse.

In case of any misuse of the quality mark the awarding authority makes investigations and carries out hearings of the parties. If required, legal support is requested. For cost coverage annual fees are charged according to the regulations of fees and they are fed in the check fund.

## 9.14 Enactment

The regulations in the present version including all annexes and the regulations of fees become effective as from 1 July 2010.

## 10. References

- [1] „Regulations for testing components and systems for exhaust after-treatment (EGN) of diesel engine exhaust gases for obtaining the FAD quality seal (FAD-QS)“ Part II: quality requirements to exhaust after-treatment systems according to FAD-QS criteria
- [2] Neunundzwanzigste Verordnung zur Änderung der Straßenverkehrs-Zulassungs-Ordnung vom 27.01.06, Anhang zu Artikel 1 Nr. 4, Anlage XXVI
- [3] Dreißigste Verordnung zur Änderung der Straßenverkehrs-Zulassungs-Ordnung vom 24.05.07, Anhang zu Artikel 1 Nr. 5, Anlage XXVII
- [4] DIN / EN ISO 8178 Hubkolben-Verbrennungsmotoren – Abgasmessung  
Teil 1: Messung der gasförmigen Emission und der Partikelemission auf dem Prüfstand.  
Teil 11: Prüfstandsmessung der gasförmigen Emission und der Partikelemission von Motoren für den Einsatz in mobilen Maschinen für den nicht-straßen-gebundenen Bereich unter transienten Bedingungen.
- [5] EN ISO / IEC 17025: 2005 „Allgemeine Anforderungen an die Kompetenz von Prüf- und Kalibrierlaboratorien“

## 11. Annexes

### Annex 1: Categories for FAD quality seal

Category 1: Road vehicles

- Passenger cars
- Light commercial vehicles

Category 2: Road vehicles - commercial vehicles

- Busses
- Trucks

Category 3a: Non-road field - low-duty industrial engines

- Cooling units
- Machinery for fire fighting
- Industrial blowers
- Graders / ground marking machines
- Cable winches and lifts
- Refuse trucks
- Sweeping and cleaning machines

Category 3b: Non-road field - devices for handling of goods

- Lifting devices
- Goods carriers
- Conveyors
- Fork lift truck
- Lifting carriages
- Mobile cranes
- Rotating tower crane

Category 3c: Non-road field - airport accessories

- Lifting vehicles for loading of aircrafts
- De-icers / heating and starting devices
- Airport service vehicles
- Generators, tank trucks
- Apron pushers
- Baggage cars

Category 3d: Non-road field - construction and underground machines

- Asphalt finishers / road finishing machines
- Steam shovels
- Drills
- Crawler tractors
- Concrete mixer
- Scraper
- Machines for the production of concrete surfaces
- Concrete-/ industrial saws / joint cutters
- Cranes
- Bulldozers
- Tip truck
- Excavators
- Caterpillar bulldozers / Grader
- Backhoe loaders
- Loaders
- Tractors
- Wheel loaders
- Road building machines
- Vibrating plate compactors
- Accessories for road repair
- Fork lift trucks for rough terrain
- Road rollers
- Paving machines
- Compactors / beetles / rammers



- Ditch excavators

#### Category 3e: Non-road field - agricultural and silvicultural accessories

- Tractors
- Conveying vehicles
- Combine harvesters
- Cotton pickers
- Harvesters
- Spray machines
- Baling presses
- Ploughs
- Swathers

#### Category 3f: Non-road field - timber harvesting

- Chain saws
- Machines for felling and bundling of logs
- Shredders
- Pushers

#### Category 3g: Non-road field - lawn and garden accessories

- Lawn trimmers / edge cutters / lawn thatchers
- Lawn mowers
- Leaf blowers / leaf vacuum cleaners
- Ride-on mowers
- Chain saws
- Shredders
- Ploughs
- Lawn and garden tractors
- Wood splitters
- Snow blowers
- Chaff cutters / grinders
- Commercial lawn accessories
- Additional mulch mower

#### Category 3h: Non-road field - leisure accessories

- Non-road vehicles
- Non-road motorbikes
- Golf carts
- Snow mobiles
- Special vehicles

#### Category 4: Rail vehicles

- Locomotives

- Railcars
- Rail vehicles
- Push-pull trains
- High-speed trains
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Category 5a: Shipping - commercial ship's propulsion

- Seagoing vessels
- Ocean vessels
- Inland vessels
- Work boats

Category 5a: Shipping - pleasure boats

- Inboard motorboats
- Outboard motorboats
- Boat with rear drive
- Sailing boat with auxiliary power unit (inboard motor)
- Sailing boat with auxiliary power unit (outboard motor)

Category 6a: Stationary machines - generators

- Base load generators
- Combined heat and power plants
- Ship generators
- Peak load generators
- Non-stationary generators
- Emergency generators
- Welders

Category 6b: Stationary machines - pumps

- Non-stationary pumps
- Fire extinguishing pumps
- Industrial pumps
- Concrete pumps

Category 6c: Stationary machines - compressors

- Air compressors
- Gas compressors
- High-pressure cleaners

Category 7: Substrates for Particulate filters

Category 8: Substrates for catalysts

Category 9: Sensors