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DRIVING STANDARDS
IN LUBRICANT TECHNOLOGY

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The technical association of
the European lubricants industry

The ATIEL Code of Practice

For Developers, Marketers and Manufacturers
of Engine Lubricants Meeting the Requirements
of the ACEA Oil Sequences

Issue Number 22

25 October 2021

All new engine lubricant developments initiated
after the date of this issue must use this issue.

Foreword

Red **text is used to highlight changes made to the previous version.**

This Code of Practice has been devised by ATIEL on behalf of the European engine lubricants industry, including developers, marketers or manufacturers of lubricants and forms an integral part of the European Engine Lubricants Quality Management System, EELQMS. It is intended to aid continuous improvement in the development of engine lubricants and the consistency and validity of performance claims made for them.

This Issue of the ATIEL Code of Practice (issues 22) is published by ATIEL and comes into effect on 25 October 2021. It supersedes Issue 21. Issue 21 of the Code of Practice remain available on the ATIEL website, for valid claims against ACEA 2016 light duty sequences, until 30 April 2022.

This issue remains valid for ACEA Sequences 2016 for HD engine oil.

This issue considers the ACEA sequence 2021 for LD engine oil.
The main changes are:

- the introduction of a new VGRA Guideline for the Toyota TCD test and worked examples.
- clarification of some definitions.
- The rebranding of VGRA and BOI guidelines (with added examples) for enhanced clarity

This Issue is published simultaneously with a new edition of the ATC Code of Practice. Changes have been made to the two documents to ensure they are now fully harmonised.

To ensure that users of the Code of Practice interpret the document correctly, attention is drawn to the following Table that shows the meaning to be associated with the auxiliary verbs 'must', 'should', 'can' and 'may':

Verb	Meaning	Example
must	mandatory requirement, command	Guidelines included in API 1509 must be applied.
should	recommendation	Lubricant Marketers should be able to demonstrate…
can	capability, ability	PAOs with the same specification can be interchanged without additional testing
may	permission, sanction	A data package may be used to support performance.

The latest version of this document is available on the ATIEL website (www.atiel.eu). New versions of the ATIEL Code of Practice are uploaded to the ATIEL website as they are issued and replace the precedent one. An email notification is sent to the nominated contacts of each signatory to the ATIEL Letters of Conformance (see Section 9.1.1).

Reproduction of this document within recipient organisations is permissible for their internal use, but users of such reproductions have responsibility to ensure that they are using the latest version.

Questions arising from the Code of Practice should be communicated to the ATIEL Secretary General at:

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1 Introduction

1.1. General

ATIEL is committed to supporting the development, marketing and manufacturing of automotive engine lubricants that fully satisfy the European performance and quality requirements deemed necessary by the European Automobile Manufacturers' Association (ACEA) for satisfactory engine life and operation.

The ATIEL Code of Practice, hereafter referred to as the Code, forms an integral part of the European Engine Lubricant Quality Management System (EELQMS- http://www.eelqms.eu/) that has been developed jointly by the European Automobile Manufacturers' Association (ACEA), the Technical Committee of the Petroleum Additives Manufacturers in Europe (ATC) and ATIEL.

The EELQMS is an overarching quality management system (QMS) that embraces various standards, test methods and procedures, Codes of Practice and the ACEA Oil Sequences requirements.

The purpose of this Code is to provide a mechanism and a basis for commitment to standardise practices when developing, marketing, or manufacturing engine lubricants for which compliance with the ACEA Oil Sequences is claimed. The Code has been in operation since 1996 and has made a significant contribution to testing and product quality levels for engine lubricants. The Code is available to all companies on a voluntary basis and nothing in the Code forms part of a contract.

1.2. Overview of the Code

The Code applies to development, marketing and manufacturing of lubricants meeting the ACEA Oil Sequences and stresses the importance of testing requirements as a pre-requisite to the generation of consistent and precise test data.

The Code provides a framework, including a series of guidelines, to be observed during the process of lubricant development, starting from defining the requirements to the marketing and manufacturing of lubricants meeting ACEA Oil Sequences:

- Engine lubricant requirements
  - ACEA Engine Oil Sequences
- Testing and reporting requirements
  - Additive formulation development, and Candidate Data Package
- Lubricant formulation development and Programme Extension Data
  - Viscosity Grade Read-Across (VGRA) Guidelines
  - Base Oil Interchange (BOI) Guidelines
  - Viscosity Modifier Interchange (VMI) Guidelines
  - Performance Additive Package Modification
- Performance validation
  - Final ACEA Performance Data Set

The Code requires all procedures and documentation to be subject to internal auditing and that an accredited auditable quality management system is used for development and manufacture of the final product.

2 Responsibilities

2.1 Stakeholder definitions

Base Stock Manufacturer: the entity that defines the product identifier, specifications and quality management system of base stock(s) that are produced at one or more manufacturing site and that are used in lubricants for which compliance with ACEA Oil Sequences is claimed.

Lubricant Developer: the entity that defines the candidate, and/or the final formulation that is claimed to meet the ACEA Oil Sequences requirements.

Lubricant Manufacturer: the entity that manufactures (including blending, filling, packaging, and labelling), the lubricant from any components or component parts.

Lubricant Marketer: the marketing organisation responsible for the integrity of the brand name and the representation of the branded product in the marketplace.

2.2 Lubricant marketer responsibilities

2.2.1 General

The lubricant marketer is fully responsible for the quality of the lubricant reaching the consumer, together with the performance claims being made in the marketplace. The lubricant marketer remains responsible for all aspects of product liability, including affirmation of their commitment by signing a Letter of Conformance.

2.2.2 Lubricant marketer overall responsibilities in the supply chain

The lubricant marketer remains accountable for the lubricant supply chain, even when significant aspects are outsourced or contracted to other parties.

When the development of the product is contracted to additive suppliers or another third party, it is the responsibility of the lubricant marketer to ensure that the finished product development meets all specifications and performance levels claimed in the marketplace.

When the manufacture of the product is contracted to a third-party manufacturer, it is the responsibility of the lubricant marketer to ensure that the lubricant is manufactured according to the required formulation, including raw materials specifications and finished product quality control standards and that the manufacturer is following an approved quality management system.

When raw materials are purchased from third party suppliers, including base stocks or additives, it is the responsibility of the lubricant marketer to ensure that the raw materials fully meet the specifications agreed. This may require that the base stocks meet the quality assurance requirements of Appendix B.

When the whole chain of development, manufacture and supply is outsourced, it is the responsibility of the lubricant marketer to ensure that all aspects of the supply chain, including all documentation, are fully encompassed within the EELQMS and ATIEL Code of Practice.

2.2.3 Lubricant Marketer responsibilities for base stock slates application

It is the responsibility of the lubricant marketer to ensure that the base stock slates used to manufacture any engine lubricants for which compliance with ACEA Oil Sequences is claimed are limited to those permitted by the lubricant developer in the Final ACEA Performance Data Set. They can be:

- the base stock slates applied in the initial formulation with the Candidate Data Package;

and/or

- the base stock slates permitted through Base Oil Interchange programme extensions conforming to the requirements in Section 6.

Before using any new base stock slate for manufacturing such a lubricant, the lubricant marketer is responsible for verifying with its lubricant developer the compliance with the claimed ACEA Oil Sequences through a complementary base oil interchange programme.

Following the programme extension guidelines given in Section 6 does not absolve the lubricant marketer from the responsibilities described above.

The lubricant marketer can arrange for base stocks slates to be linked, providing that the appropriate linking demonstration has been carried out in accordance with the requirements in B.6.

2.3 Leadership responsibilities

It is the responsibility of management to demonstrate leadership and commitment with respect to the ATIEL Code of Practice by ensuring:

- that the Code is available as a reference for staff and other interested parties as appropriate, including to auditors, and is communicated within the organisation.
- integration of the Code's requirements into the organisation's business processes.
- that the resources, training and expertise needed for compliance with the Code are available.

2.4 Additional Stakeholder Responsibilities

In addition to the lubricant marketers' responsibilities described in 2.2, additional responsibilities, including for other stakeholders, are given in the following Sections:

- Section 5 Lubricant developers' responsibilities for Candidate Data Package requirements, including Test(s) 'Out of Control' or 'Test Unavailable' provisional data set requirements.
- Section 6 Lubricant developers' responsibilities for programme extensions.
- Section 7 Lubricant marketers' and lubricant developers' responsibilities for Final ACEA Performance Data Set requirements
- Section 8 Lubricant marketers' and lubricant manufacturers' responsibilities for manufacturing and blending plant requirements.
- Section 9 Lubricant marketers' and base stock manufacturers' Letters of Conformance
- Appendix B Guidelines for Base Stock Manufacturers' Quality Assurance

3 Framework

This Code provides a technical framework for the development, marketing, and manufacturing of automotive engine lubricants, either independently by a single company or by a process involving the collaboration of several parties, such as a petroleum additive supplier, marketer and blender. In either case, the responsibilities described in Section 2 apply. The Code provides a set of guidelines and standards considered by ATIEL to be compatible with current industry best practice. The primary aim is to generate an ACEA Performance Data Set to support fully the technical integrity of a candidate lubricant relative to the ACEA performance requirements.

The key steps for engine lubricants meeting ACEA Oil Sequences and the corresponding sections of the Code are shown in Figure 1.

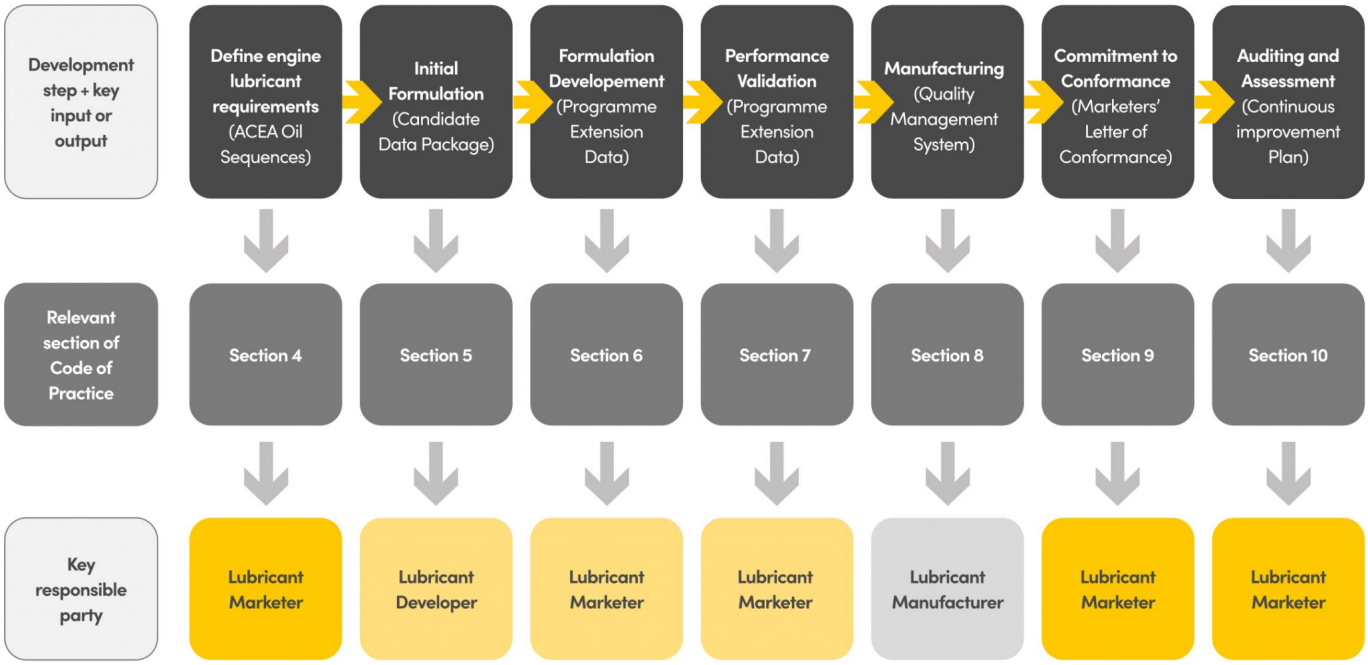

Figure 1 Where to find guidance on the different stages of the engine lubricant development process within the section of the ATIEL Code of Practice

All steps should be auditable by a recognised QMS such as, but not limited to, those described in ISO 9001, IATF 16949 and ISO 17025. The process is one of self-certification and the development process of ACEA quality lubricants using this Code should be referred to in the lubricant marketer's, developer's and/or manufacturer's quality management procedures.

4 Engine Lubricant Requirements

4.1 Introduction

The lubricant developer or lubricant marketer must have available the valid ACEA Sequences document that defines the performance standards and test limits for the quality level required for the lubricant. In addition, there may be other relevant standards that define other performance characteristics, such as the viscosity grade of the product.

As required by ACEA, lubricant marketers making a claim of a lubricant to meet ACEA Sequences oil standards must follow the EELQMS and ATIEL Code of Practice guidelines.

Note 1: ATIEL publishes reference information on its website, www.atiel.eu, for the benefit of developers and marketers, for example advice on ACEA claims representation and incompatible claim combinations.

4.2 ACEA Oil Sequences

ACEA, which represents vehicle manufacturers in Europe, has issued an engine lubricant classification system setting stringent demands on lubricants to satisfy changes in engine hardware technology, largely operating under European conditions, but applicable also in markets worldwide.

The ACEA Oil Sequences for service-fill engine lubricants cover needs for gasoline, light-duty diesel, and heavy-duty diesel engines including those fitted with after-treatment devices; these sequences are further sub-divided into individual performance categories. Each sequence comprises laboratory tests and engine tests, to be run in accordance with test methods developed by ASTM and the Coordinating European Council for the development of performance tests (CEC https://www.cectests.org/), and Japanese Automotive Standards Organization (www.jsae.or.jp/en/standard/index.php).

Subject to local legislation and standards, lubricant marketers have a choice whether to market products meeting the minimum standards of the ACEA Oil Sequences. However, ACEA has specified the following:

*'**Conditions for use of performance claims against the ACEA Oil Sequences***

Compliance with the ATIEL Code of Practice, which forms part of the EELQMS, is mandatory for any claim to meet the requirements of this issue of the ACEA sequences. Therefore, ACEA requires that claims against the ACEA oil sequences can only be made by oil companies or oil distributors who have signed the EELQMS Lubricant Marketers' Letter of Conformance (for details: www.atiel.eu).'

As indicated in this statement, ACEA further reserves the right to define alternative requirements to EELQMS in exceptional circumstances. Where ACEA unilaterally defines such alternatives that do not meet the criteria set out in this Code, ATIEL dissociates itself from any such initiative.

4.3 Validity of the ACEA Oil Sequences

The ACEA Oil Sequences are under constant development. Replacement tests and other changes required by European automobile manufacturers are integrated and new issues are published on a regular basis.

The time permitted between the issuing of new ACEA Oil Sequences and commercial implementation is specified by ACEA. Validities of new and old editions of the ACEA Oil Sequences overlap for limited periods of time and are detailed in the Sequences.

5 Additive Formulation Development/Candidate Data Package

5.1 General background to the data package

A typical development programme may be conducted through testing of a candidate formulation. The performance of this candidate formulation should be demonstrated through a Candidate Data Package, developed in accordance with the ATC Code of Practice.

The lubricant developer or lubricant marketer must validate the Candidate Data Package against the relevant ACEA Sequence requirements.

An essential aim of this Code is to ensure the use of a system of statistically and scientifically valid testing based on current best industry practices. In this regard, ATIEL recognises the importance of existing industry practices as provided under Codes of Practice developed by ATC and the American Chemical Council (ACC), namely:

- the ATC Code of Practice as applied to CEC test methods.
- the ACC Petroleum Additives Product Approval Code of Practice as applied to ASTM test procedures.

ATIEL shares with both the ACC and ATC a mutual interest in the operation of practices by which engine lubricant tests are monitored regularly to encourage more consistent and precise operation and which also act to stimulate the continuous improvement of such test procedures.

5.2 Test methods

The basis of the Code is the availability of quality engine and laboratory test methods, without which lubricants with the required performance cannot be developed. The Code applies, therefore, only to those ACEA Oil Sequences specifying the use of test methods conforming to minimum quality and precision standards. Currently, the minimum quality/precision requirement is either a CEC designated test with a precision statement or an ASTM or JASO test method, also with a precision statement. The Code does not apply to test methods deemed to be of a lower quality than CEC, ASTM or JASO tests.

5.3 Laboratory accreditation

The Code requires laboratories conducting CEC or equivalent tests to:

- cover these tests within the scope of their ISO 17025 accreditation or equivalent.
- submit to the ATC-European Registration Centre (ATC-ERC) a letter of intent to comply with the ATC Code of Practice.

ASTM tests must be conducted in accordance with the requirements specified in the ACC Code of Practice.

JASO tests shall be conducted in accordance with the JSAE requirements.

5.4 Test registration and tracking

The ATC Code of Practice requires all candidate lubricant engine tests, and all reference lubricant tests to be carried out by a registered test laboratory. In addition, CEC and ASTM and other relevant engine tests must be registered with the ATC-ERC and the ACC-MA (Monitoring Agency). The purpose of this registration is to provide unambiguous documentation and a simple tracking system for all registered engine tests, thereby facilitating auditing of the test development process.

5.5 Test(s) 'Out of Control' or 'Unavailable' - provisional data package requirements

If either ASTM or CEC declares any test used in any ACEA Oil Sequences 'out of control' or 'unavailable', ATIEL will notify by e-mail all ATIEL Letter of Conformance signatories and post the information on the ATIEL website (www.atiel.eu). The date of the ASTM or CEC declaration will also be posted on the ATIEL website

Under these circumstances, and on a provisional basis only, a data package that is complete except for the data from this one test may be used in support of performance claims against single or multiple ACEA Oil Sequences.

The use of this temporary waiver must be properly documented in the ACEA Performance Data Set. Form C.1 (Candidate Data Package checklist) and Form C.2 (Programme Extension Data checklist) contain check boxes that may be used as documentation.

In addition, the lubricant developer should include data based on Fundamental Formulation Knowledge, as defined in the ATC Code of Practice, to support the performance of the candidate formulation in the test that was not conducted.

A lubricant marketer using the procedure described in this Section to support temporarily the claims made against ACEA Oil Sequences remains responsible for product quality, as described in Section 2.

After ATIEL has officially notified all ATIEL Letter of Conformance signatories by email that the test in question is 'no longer out of control' or is now 'available', the lubricant marketer using a waived data package must obtain a valid passing result in this test within six months of the notification to maintain the ACEA claim. This expiry date will be posted on the ATIEL website.

If a valid passing result cannot be obtained within six months of the notification, the subject data package can no longer be used to support claims made against the ACEA Oil Sequences.

If more than one test used in any ACEA Oil Sequences is declared 'out of control' or 'unavailable', ATIEL will notify by e-mail all Letter of Conformance signatories and post the information on the ATIEL website. In this case, then, a data package without these engine tests cannot be used to support any ACEA Oil Sequences claim, and will only be valid until after the tests have been brought back in control and passing results have been obtained.

5.6 Use of OEM approvals to evaluate lubricant performance against ACEA Oil Sequence requirements

Some of the engine tests and limits included in ACEA Oil Sequences also form part of individual Original Equipment Manufacturers' (OEMs) in-house specifications and approvals. By granting approval for a specific lubricant formulation against an in-house specification, the OEM endorses that the lubricant formulation has performance capabilities in the specific engine test(s) involved.

The lubricant developer may, therefore, opt to use an OEM approval for a given lubricant formulation in support of an ACEA performance claim for the same formulation instead of carrying out a test solely for the purpose of meeting ACEA requirements. This option may be used even if the OEM approval is given without the test having been carried out on the specific lubricant formulation. The following conditions must be met whenever an OEM approval is used in this way:

a) Only OEMs sponsoring engine test(s) included in the ACEA Oil Sequences and having a lubricant approval system are qualified.

b) OEM approvals used instead of testing are only valid for the test(s) that the OEM sponsors.

c) Test procedure and limits for a test involved with an OEM approval are the same or more severe than those specified in the ACEA Oil Sequences.

d) Additive package modifications involved in obtaining the OEM approval must meet the requirements of the ACC or ATC Codes of Practice, as appropriate.

e) Once the formulation for the engine lubricant to be marketed is defined and identified by a specific formulation code number, the lubricant marketer must obtain specific written confirmation of the approval for the engine lubricant from the OEM, even if there is a generic, package or blanket approval letter.

f) The lubricant marketer must include all relevant test data and the OEM approval letter in the documentation supporting the ACEA Oil Sequence claim (see Section 7).

6 Lubricant formulation development/Programme Extension

6.1 Introduction

Once a candidate formulation has been developed meeting all performance targets in the Candidate Data Package, further viscosity grades, use of other base stocks, modifications in additive pack or viscosity modifier may be required. Figure 2 describes the procedures to establish the additional tests or data requirements for such further formulation development. The guidelines in this Section relate specifically to engine lubricants marketed as meeting the requirements of ACEA Oil Sequences.

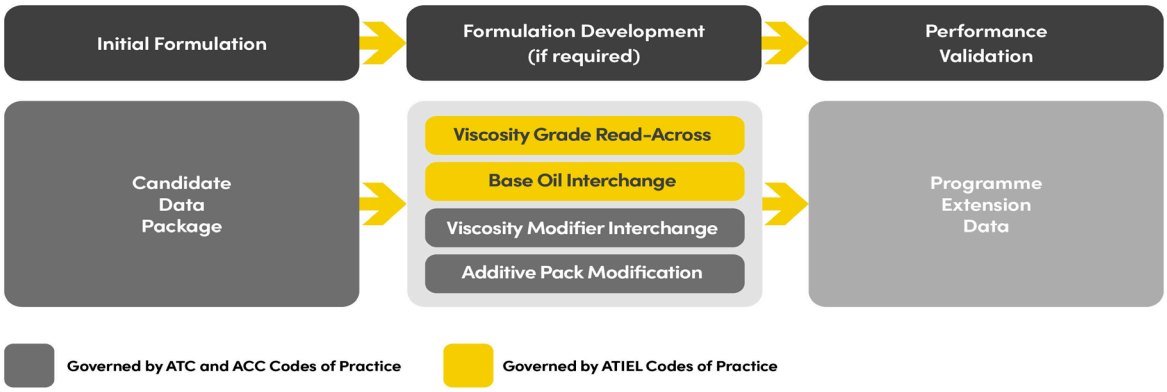

Figure 2 Lubricant formulation development – potential programme extensions and applicable guidelines

The guidelines define the minimum physical and engine testing necessary to ensure the engine lubricant performance remains compliant for the ACEA Sequences claimed:

- viscosity grade read-across (VGRA) – see 6.4
- base oil interchange (BOI) – see 6.5
- viscosity modifier interchange (VMI) – see 6.6
- performance additive package modifications – see 6.7

During the design of a test programme, each individual interchange must be considered step by step. BOI, VMI, VGRA and Performance Additive Package Modifications are four different ‘interchanges. The purpose of the stepwise evaluation is to identify which engine lubricant formulations are to be tested in which engine tests to support the intended ACEA Oil Sequence performance.

All programme extensions must be documented and available for auditing, for example using Forms C.2 and C.3, which are provided as a guide.

6.2 Lubricant developer responsibilities

The lubricant developer is responsible for the content and integrity of development programme run under these guidelines.

When applying the guidelines, the lubricant developer must:

a) ensure that the current guidelines and most up-to-date amendments applicable to the issue date of the ACEA Oil Sequences being claimed are used.

b) ensure that a product meets the specifications claimed against the ACEA Oil Sequences by carrying out the minimum acceptable level of testing defined by the guidelines.

c) run engine tests required to support read-across or interchange in accordance with the ACC or ATC Codes of Practice, as applicable.

d) demonstrate actual performance by testing the original formulation in the specific engine test for which read-across will be applied.

e) use for read-across purposes, only engine test results meeting or exceeding the requirements specified in the relevant ACEA Oil Sequence.

f) observe the requirements and limitations on viscosity grade read-across described in 6.4

g) observe the requirements and limitations on BOI application described in 6.5.2.

h) observe the requirements and limitations on Viscosity Modifier Interchange described in 6.6

i) observe the requirements and limitations on performance additive package modifications described in 6.7

The lubricant developer must ensure that the testing is carried out on typical base stock batches within the corresponding base stock slate. Typical base stocks are defined as not having chemical and physical properties at the extremes of the parameters reported in the sales specifications or technical data sheets.

The lubricant developer should inform the lubricant marketer of the base stock slates used through the whole lubricant development programme and of the base stock concentrations in the final formulation that is qualified for manufacturing the lubricant. This information should form part of the Final ACEA Performance Data Set, including Programme Extension data that is required at the end of any development (see Section 7).

6.3 Engine tests

The engine tests covered in the ACEA Oil Sequences are listed in A.2. Check the guidelines for each engine test to determine the test programme requirements for a specific lubricant formulation to apply viscosity grade read-across or to interchange base oil.

6.4 Guidelines for viscosity grade read across (VGRA)

6.4.1 General

The viscosity grades in VGRA guidelines in Appendix A are defined in the SAE J300 viscosity system, which describes the limits for a classification of engine lubricants in rheological terms only.

This system is used by ACEA to determine the engine lubricant viscosity grades recommended for application in the ACEA Oil Sequences. Lubricant marketers also use this system in formulating, manufacturing, and labelling their products. Lubricant marketers are expected to market only products that are within the relevant viscosity specifications in SAE J300.

VGRA guidelines have been developed to allow extrapolation of engine test data from one viscosity grade to another under certain conditions. It is permitted to apply VGRA guidelines at any time from candidate formulations developed during a programme. The guidelines have been developed by ATIEL API and JASO and are given in Appendix A.

VGRA guidelines may be used to waive testing, provided the requirements described in VGRA guidelines in Appendix A are met for every engine test relevant for the ACEA Oil Sequence claimed.

Note 2: Some VGRA examples are given in Appendix A.

6.4.2 Requirements for applying VGRA guidelines

The following requirements must be met when the VGRA guidelines are applied:

a) Use the same performance additive package at equal concentration for the read-across viscosity grade.

b) Use the same viscosity modifier: adjustments can be made in accordance with the VGRA guidelines.

c) Use base stocks from the same base stock slate. Base stocks can be rebalanced, or replaced within the same base stock slate, or both.

6.5 Guidelines for base oil interchange (BOI)

6.5.1 General

Base stocks can differ in their physical properties and chemical composition, which may result in differences in the performance of formulated engine lubricants in engine tests and in service.

The ATIEL BOI guidelines define the minimum engine testing necessary to ensure that the standard of engine lubricant performance defined by the ACEA Oil Sequences will be maintained when one base stock is substituted by another in validated formulations. These guidelines are given in Appendix A.

Base stocks having the same quality control specifications are assumed to be interchangeable only if they belong to the same slate or to linked slates and so substitution of a base stock by another base stock within the same base stock slate, or within linked slates, is permitted. In all other cases, the guidelines apply.

6.5.2 Requirements for applying BOI guidelines

Application of BOI Guidelines

Engine testing is not required if the concentrations of the base stock to be interchanged are less than or equal to the permitted maximum values shown in BOI guidelines in Appendix A.

Where base stocks from different slates of the same base stock group are interchanged simultaneously, the overall amount interchanged must remain lower or equal to the permitted maximum values shown in BOI Guidelines in Appendix A.

Exception: where a new base stock of a specific Group has been introduced or increased in content to pass an engine test (or because of failing engine test data), the reverse substitution to another Group may not be made subsequently, even if it is permitted under the guidelines, without the relevant engine test having passed in a supporting formulation without the introduced or increased base stock (see Examples BOI 4 & 5 in Appendix A). The lubricant developer must include relevant failing tests in the Candidate Data Package so that the lubricant marketer can avoid any application of reverse substitution that is not permitted because of these failing tests.

Base stocks from more than one group

BOI for formulations containing more than one base stock must be in steps covering each base stock group separately. Each step of the interchange programme must be documented.

Where base stocks from more than one base stock group are interchanged simultaneously:

- cumulative base stock substitutions must not exceed 10% or 30% by mass, as given in the BOI guidelines in Appendix A.
- Every permitted interchange must be done with reference to an effective engine test measurement with the initial base stock slate and not to a previous BOI read-across data (see Example BOI 7 in Appendix A).

In any case, the maximum amount of interchange allowed without further testing shall not exceed 30%

Additive package, viscosity modifier and viscosity grade

When applying the guidelines, the performance additive package and its concentration, the viscosity modifier (VM) (possible concentration adjustment must be less than 15% mass fraction relative) and the viscosity grade of the formulations must remain the same.

BOI test work must be carried out separately from any possible Viscosity Modifier Interchange or other performance additive package modification.

6.5.3 BOI within linked slates

Linked slates are base stock slates that the lubricant marketer or base stock manufacturer or partner group concerned has demonstrated are interchangeable in the required engine tests.

Guidelines on linked slates are given in Appendix B.

6.5.4 Emergency temporary derogation of the ATIEL BOI guidelines

In the event of *force majeure* situation in base stock supply, an emergency temporary derogation of the ATIEL interchange guidelines for unlinked slates may be used. Principles, guidelines, and documentation on utilising this derogation are given in Appendix A.5.

6.6 Viscosity Modifier Interchange (VMI)

6.6.1 VMI programmes in accordance with ATC Code of Practice

Viscosity modifiers (VMs) can differ in their molecular structure and chemical composition, which may result in differences in the performance of formulated engine lubricants in engine tests and in service.

The ATC VMI guidelines given in the ATC Code of Practice define the minimum engine testing required to ensure that the standard of engine lubricant performance defined by the ACEA Oil Sequences is maintained when substituting one VM for another.

6.6.2 VGRA/BOI and VMI in same programme

VGRA or BOI test work must be separate from VMI testing. Apply the procedure described in ATC Code of Practice.

6.7 Performance additive package modifications

6.7.1 Programmes according to ATC/ACC Codes of Practice

If modifications or additions to the performance additive package are required, apply the performance additive package modification guidelines given in the ATC or ACC Codes of Practice, as appropriate.

These Codes also define changes permitted for other additives, such as pour point depressants and foam inhibitors. Document all modifications to the performance additive package. Confirm the availability of the test programme design document in the Forms C.1 and C.2 checklists.

6.7.2 VGRA/BOI and package modification in same programme

Modifications to the performance additive package that are permitted within the ACC or ATC Codes of Practice may be made prior to or after VGRA or BOI testing, provided that:

a) such modifications are supported by the appropriate data as specified in the ACC or ATC Codes of Practice, as applicable.

b) the marketed engine lubricant includes all such modifications.

7 Performance Validation/Final ACEA Performance Data Set

7.1 ACEA Performance Data Set

The ACEA Performance Data Set is a summary of the total documentation required to confirm the performance of an engine lubricant against the relevant ACEA Oil Sequences and is derived from the Candidate Data Package (referred to as ATC-Candidate Data Package in ATC Code of Practice) and, if appropriate, any Programme Extension Data. The derivation of a Final ACEA Performance Data Set is illustrated in Figure 3.

All lubricant developers must maintain a complete record of each development programme conducted under the Code. Conduct all CEC engine tests in accordance with the ATC Code of Practice. For ASTM tests, apply the ACC Code of Practice.

All final formulations should be tested to demonstrate compliance with the laboratory test requirements included in the ACEA Oil Sequences to be claimed.

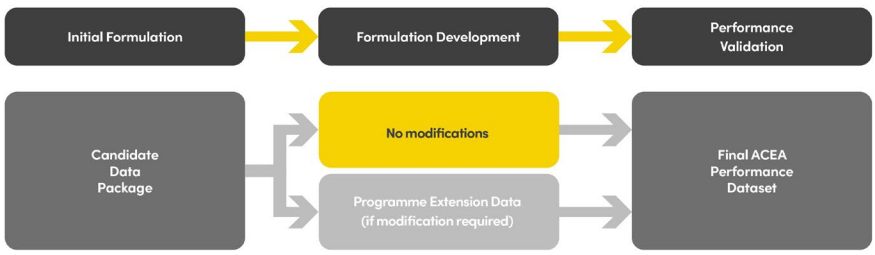

Figure 3 The derivation of a Final ACEA Performance Data Set from the initial Candidate Data Package plus any relevant Programme Extension Data if applicable

7.2 Records

The lubricant marketer must keep on file a copy of the ACEA Performance Data Set for each different engine lubricant (brand and viscosity grade). This Data Set is company confidential but must be made available for Quality Management System audit purposes or, with the lubricant marketer's consent, for review by an external audit organisation.

Form C.1 may be used to compile the information contained in the Candidate Data Package.

Form C.2 may be used to compile the information to be contained within the Programme Extension Data.

Form C.3 may be used by the lubricant developer or lubricant marketer as a standardised format for the ACEA Performance Data Set. It consists of the following parts:

- Part A: Details of the lubricant marketer and engine lubricants
- Part B: Laboratory tests
- Part C: Engine test results
- Part D: Checklist and qualification conformance.

8 Manufacturing

The lubricant manufacturer must ensure that the formulation used for the commercial product accurately reflects the formulation used to establish the ACEA Performance Data Set. This includes the choice of raw materials. Any raw material interchange conducted by the lubricant manufacturer must conform to the requirements given in Section 6.

All lubricants claiming conformance to the ACEA Oil Sequences must be manufactured in plants accredited to auditable quality management systems, such as ISO 9001. Manufacturing records of batches should be traceable and auditable back to the individual components. Records should be available as required.

For new manufacturing plants, a commitment must be made to complete certification against a suitable auditable quality management system within 18 months of the start-up date.

In operations where products are subject to further handling prior to sale (for example re-packaging, re-labelling, or filling remotely from the original manufacturing plant), and where such actions are considered to be capable of affecting product quality, such operations must also be certified against a suitable auditable quality management system.

Quality assurance undertaken by the lubricant manufacturer must be conducted to ensure consistent product quality that meets in full all relevant specifications. This should include regular testing of key physical and chemical properties as specified in the ACEA Oil Sequences.

The manufacturer must define and implement a suitable quality assurance plan for the batches manufactured, if necessary, specifying the frequency of testing for the selected parameters to ensure consistent product quality.

In cases where manufacturing of products is performed on behalf of a third party, the lubricant marketer retains responsibility for the integrity of the brand name and ultimate liability for all aspects of product quality. The lubricant marketer must therefore ensure, through an appropriate auditing or monitoring scheme, that the lubricants are always manufactured in compliance with the ATIEL Code of Practice.

9 Commitment to Conformance

9.1 EELQMS Lubricant Marketers' Letter of Conformance

9.1.1 Introduction

The EELQMS is an overarching quality management system that embraces various standards, test methods and procedures, along with industry Codes of Practice and the requirements of the ACEA Oil Sequences. It is administered on behalf of the stakeholders by ATIEL.

Participation in the EELQMS implies a commitment to develop and manufacture those engine lubricants for which compliance with ACEA Oil Sequences will be claimed, or to have such engine lubricants developed or manufactured by third parties in accordance with the guidelines described in the Code. It also requires incorporation of the EELQMS Guidelines in a quality management system and a commitment to ensure an independent assessment of the marketing, development, and manufacturing processes by internal and/or external auditors who should report their finding to the relevant company management.

As stated in Section 6 of the EELQMS, these commitments are made in a Letter of Conformance issued by the participating entity to ATIEL. Administration of the Letters of Conformance is carried out by SAIL (Services to Associations and Industry in the Lubricants Sector) on behalf of ATIEL.

Lubricant marketers making claims against the ACEA Oil Sequences must submit the EELQMS Letter of Conformance to ATIEL, via SAIL, as required by ACEA.

The EELQMS Lubricant Marketers' Letter of Conformance template is given in Appendix D and in the section on the Code of Practice on ATIEL's website www.atiel.eu.

9.1.2 List of companies who have signed the EELQMS (Lubricant Marketers') Letter of Conformance

The list of signatories of the Letter of Conformance (LoCs) is held on the SAIL website (https://www.sail-europe.eu/registrations) for lubricants marketers. By registering the letter of conformance, entities declare their participation in and commitment to conform to the EELQMS

The appearance of an entity on the list means only that this entity has been entered in its register, as of the date of the list, a Letter of Conformance of the entity concerned that appears to be valid and genuine. ATIEL assumes no responsibility for the implementation by the entities included in the list of their obligations, as defined in such Letter of Conformance, or for any damage that a breach thereof may cause to third parties. ATIEL cannot be held responsible for any claims resulting from inclusion and non-inclusion of entities in this list. ATIEL also declines any responsibility about the audit procedure, which belongs to the domain of the relevant auditor.

9.2 Base Stock Manufacturers' Letter of Conformance

9.2.1 Introduction

Base stock manufacturers may sign a Letter of Conformance declaring that they manufacture base stocks in accordance with the Guidelines for Base Stock Manufacturers' Quality Assurance given in Appendix B. Signing the Base Stock Manufacturers' Letter of Conformance implies a commitment by base stock manufacturers and partner groups to the quality assurance guidelines for the manufacture of base stocks to be used in engine lubricants for which compliance with ACEA Oil Sequences is to be claimed.

Base stock manufacturers signing this letter must ensure that all elements of the Guidelines are fully implemented from the date of signing the letter.

The Base Stock Manufacturers' Letter of Conformance template is reproduced in Appendix D and in the section on the Code of Practice on ATIEL's website –https://atiel.eu/code-of-practice/applying-the-code-of-practice. Administration of the Letters of Conformance is carried out by SAIL (Services to Associations and Industry in the Lubricants Sector) on behalf of ATIEL.

9.2.2 List of Companies who have signed the Base Stock Manufacturers' Letter of Conformance

The list of the Letter of Conformance (LoCs) signatories is on the SAIL website (https://www.sail-europe.eu/registrations) for lubricants marketers and for base stock manufacturers. By registering the letter of conformance, entities declare their participation in the EELQMS

The appearance of an entity on the list means only that this entity has been entered in its register, as of the date of the list, a Letter of Conformance of the entity concerned that appears to be valid and genuine. ATIEL assumes no responsibility for the implementation by the entities included in the list of their obligations, as defined in such Letter of Conformance, or for any damage that a breach thereof may cause to third parties. ATIEL cannot be held responsible for any claims resulting from inclusion and non-inclusion of entities in this list. ATIEL also declines any responsibility about the external audit procedure, which belongs to the domain of the relevant auditor.

10 Auditing and Assessment

10.1 Monitoring, measurement, analysis and evaluation

Lubricant developers, lubricant marketers and lubricant manufacturers must keep records to enable proper monitoring, measurement, analysis and evaluation of their practices and procedures.

These records must be made available upon reasonable request, to satisfy the auditing requirements in section 10.2, subject to relevant safeguards of protecting confidential business information.

Lubricant developers must keep records of all development programmes, including Candidate Data Package, relevant test reports (Section 5), programme extensions and read across (Section 6) and Final ACEA Performance Data Sets (Section 7).

These records should be sufficiently complete to enable independent evaluation that all development work was carried out in compliance with the relevant requirements of the Code.

Lubricant marketers must keep records of Final ACEA Performance Data Sets that demonstrate that the relevant requirements of the claimed ACEA sequences have been met in full.

Lubricant manufacturers must keep records of manufactured batches and their constituent components (as detailed in Section 8) that demonstrate that the manufactured lubricant formulation, including all programme extensions, matches that finalised by the lubricant developer.

10.2 Audit

The records must be made available for periodic internal audit. Internal audits should be independent of the entity being audited.

Internal audits should be thorough, including for example a complete “vertical” audit through a lubricant development project, from design to Final ACEA Performance Data Set, or a complete “horizontal” audit through development, marketing claims and manufacturing procedures.

In addition to internal audit, management may commission an external audit, by a fully independent company or entity with sufficient expertise in either the lubricants industry, or in quality assurance systems.

In case of dispute between marketer and customer, or as a result of periodic quality surveys which may be undertaken, SAIL may request the marketer to provide the records relating to the quality issue of the product in question. Records may include those related to development, manufacturing or marketing, and will be subject to relevant safeguards protecting confidential business information. Failure to provide satisfactory records in a reasonable time period could result in the registration of the marketer’s Letter of Conformance being suspended until the matter is resolved.

10.3 Management review

Management must review the results of all internal and external audits and ensure all appropriate corrective actions are implemented in timely manner.

11 Reference publications

11.1 Other Codes of Practice

Parts of this Code require use of other Codes of Practice that are considered to offer best industry practice. These publications are referred to in this document but are not reproduced in detailed form. Users of this Code shall ensure they use the latest editions of the following:

ATC Code of Practice, ATC Office Avenue de Tervueren 188A, box 4, B-1150 Bruxelles, Belgium, available at www.atc-europe.org

ACC Product Approval Code of Practice, American Chemistry Council, 700 Second St., NE, Washington, DC 20002, USA, available at www.americanchemistry.com/paptg

11.2 Other references

ACEA European Oil Sequences: Service Fill Oils for Gasoline Engines, Light-Duty Diesel Engines, Engines with After-Treatment Devices and Heavy-Duty Diesel Engines, ACEA, Avenue des Nerviens 85, B-1040 Bruxelles, Belgium. Available at www.acea.be

SAIL (Services to Associations and Industry in the Lubricants Sector). www.sail-europe.eu

ISO 9001 Quality management systems, International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, available at www.iso.org

IATF 16949:2016 Automotive Quality Management, available at www.iso.org

ISO/IEC 17025: General requirements for the competence of testing and calibration laboratories, available at *www.iso.org*

IP 368: Determination of hydrocarbon types in lubricating oil basestocks - Preparative high performance liquid chromatography method, available at http://publishing.energyinst.org/

ASTM, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959 USA. www.astm.org

CEC, The Co-ordinating European Council for the development of performance tests for fuels, lubricants and other fluid, Kellen Europe, Avenue de Tervueren 188A, 1150 Brussels, Belgium. www.cectests.org

Information about the ATC-ERC system for registration of engine oil tests for CEC tests is available at *ATC European Registration Centre*, 6555 Penn Avenue, Pittsburg, PA 15206, USA, https://atc-erc.org

Information about the ACC-MA system for registration of engine oil tests for ASTM tests is available at *American Chemistry Council Monitoring Agency*, https://acc-ma.org

The *SAE J300 Engine Oil Viscosity Classification Standard* defines the limits for a classification of engine lubricating oils in rheological terms only. It is used by ACEA to define viscosity grades and other rheological properties of engine oils. The latest version is available at SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, USA, www.sae.org.

Information about the *API Base Oil Interchangeability Guidelines for Passenger Car Motor Oils and Diesel Engine Oils* is available in API Publication 1509 Engine Oil Licensing and Certification System at American Petroleum Institute, 1220 L Street, N.W., Washington D.C. 20005, USA, www.api.org/eolcs.

Appendix A

Guidelines for viscosity grade read across and base stock interchange

Issue Number 22, October 2021

This issue supersedes all previous issues.
All new engine lubricant developments initiated after the date of this issue must use this issue.

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"ACEA Oil Sequences" refers to *ACEA European Oil Sequences: Service Fill Oils for Gasoline Engines, Light-Duty Diesel Engines, Engines with After-Treatment Devices and Heavy-Duty Diesel Engines,* ACEA, Avenue des Nerviens 85, B-1040 Bruxelles, Belgium. Available at www.acea.be

For other references, refer to Section 11 of the Code of Practice

A.1 Definitions/Technical terms related to base oils

For the purposes of this Code, the following definitions and terms apply.

Base oil: the base stock or blend of base stocks that, when blended with performance additives, is used in an engine lubricant marketed as conforming to ACEA Oil Sequences.

Base stock: a base oil component that:

a) is produced and used in accordance with the ATIEL base stock quality assurance (Appendix B) and the interchange guidelines given in this Appendix.

b) is produced by a single base stock manufacturer or partner group to the same specification, independently of feed source or manufacturer's location.

c) meets the same base stock manufacturer's or partner group's specification and is identified by a unique formula, product identification number or both.

d) may be manufactured using a variety of different processes including but not limited to distillation, solvent refining, hydrogen processing, oligomerisation, esterification, and re-refining.

e) is substantially free from materials introduced through manufacturing, contamination, or previous use.

Base stock group: a base stock classification system of five base stock groups defined according to physical and chemical characteristics, measured using the test methods specified in Table A.1:

Group I Base stocks containing less than 90 mass % saturates or greater than 0.03 mass % sulphur or both and having a viscosity index greater than or equal to 80 and less than 120.

Group II Base stocks containing greater than or equal to 90 mass % saturates and less than or equal to 0.03 mass % sulphur and having a viscosity index greater than or equal to 80 and less than 120.

Group III Base stocks containing greater than or equal to 90 mass % saturates and less than or equal to 0.03 mass % sulphur and having a viscosity index greater than or equal to 120.

Group IV Base stocks are polyalphaolefins (PAO).

Group V All base stocks not included in Groups I, II, III or IV.
Typically, Group V base oils are added in product developments as performance enhancers. Guidelines covering the addition of Group V base oils are described in the ATC CoP.

Table A.1 The analytical methods to be used in the definition of base stock groups

Property	Test method[1]
Saturate concentration	ASTM D2007
Viscosity index	ASTM D2270
Sulphur concentration (Use one of the listed methods)	ASTM D2622 ASTM D4294 ASTM D4927 ASTM D3120

[1] Alternative test methods may be used providing a satisfactory correlation with the specified ASTM test method has been demonstrated. For example, for saturate concentration, IP 451 aromatic carbon measurement by infra-red (for Groups I or II) or IP 129 bromine number measurement of residual unsaturations (for Groups II, III or IV), or ASTM D 7419 total saturates measurement (for Groups I to III) may also be used

Base stock slate: a product line of base stocks that:

a) is produced by the same base stock manufacturer.
b) meets the ATIEL definition of base stock.
c) is in the same ATIEL base stock group (I to IV).
d) may have different specified viscosities and other properties.
e) has been demonstrated, in lubricants for which compliance with ACEA Oil Sequences is claimed, to be technically substitutable by other appropriate base stocks on the same slate.

Note A.1: Substitution of a base stock by another base stock within the same base stock slate is allowed without the need for further engine tests.

A base stock manufacturer may produce more than one base stock slate.

Base oil interchange (BOI) is the process of substituting base stock(s) from alternative base stock slates in engine lubricants validated as complying with ACEA Oil Sequence(s)

Experts: individuals having expertise in the manufacturing of base stocks or the formulating, developing, manufacturing and/or performance testing of engine lubricants.

Feedstock: the starting material, such as crude oil, refinery intermediate or used lubricating oil, from which base stocks are produced at a manufacturing site. A particular feedstock may originate from a single source or multiple sources.

Linked slates: base stock slates that the lubricant marketer, base stock manufacturer or partner group concerned has demonstrated are interchangeable without the need for further engine testing for the tests for which linking has been demonstrated.

Partner Group: a voluntary grouping of two or more base stock manufacturers who have:

a) base stock slates conforming to the ATIEL definition of base stock slate.
b) linked base stock slates based on a written agreement.

Terms for physical and chemical characteristics related to base oils:

- **Noack:** the measurement test of the "Noack" Volatility Evaporation Loss in accordance with CEC-L-040-93
- **KV:** kinematic viscosity measurement at 100°C (**KV100**), 40°C (**KV40**) or -40°C (**KV-40**) in accordance with ASTM D445
- **Viscosity Index:** calculated in accordance with ASTM D2270
- **Pour Point:** measured in accordance with ASTM D97
- **Unsaturates:** any appropriate measurement of unsaturates content (IP 129 for example)
- **HTHS:** the 'High Temperature/High Shear-rate' dynamic viscosity measurement test at 150°C and 10^6 s^{-1} shear rate in accordance with the standards permitted in the SAE J300 Engine Oil Viscosity Classification Standard.)

A.2 Engine tests *(CoP 6.3)*

Table A.2 Engine tests in ACEA 2021 Oil Sequences: Service-fill oils for light duty gasoline and diesel engines

ACEA requirement [1]	Engine test name [1]	Test method	ACEA 2021 categories [2]	cf VGRA Guidelines	cf BOI guidelines
2.1 Gasoline DI engine cleanliness test	EP6CDT	CEC L-111-16	all A/B & C	VGRA 6 [3]	BOI5
2.2 Low temperature sludge	Sequence VH	ASTM D6593-00	all A/B & C	API 1509 App F [4]	API 1509 App E [4]
2.3 Valve train scuffing wear	Sequence IVB	ASTM D8350	all A/B & C	API 1509 App F [4]	API 1509 App E [4]
2.4 Black sludge	M271EVO	CEC L-107	all A/B & C	VGRA.1 & VGRA.2 [5]	BOI.1
2.5 Fuel economy	M111	CEC L-054-96	all A/B & C except C6	VGRA.3	BOI.3
	Toyota 2ZR-FXE	JASO FE M366	C6	JASO M 364 App 5-4 [6]	JASO M 364 App 5-3 [6]
2.6 Oil dispersion at medium temperature for passenger car direct injection diesel engines	DV6C	CEC L-106-14	all A/B & C	VGRA.1 & VGRA.2 [4]	BOI.2
2.7 DI diesel piston cleanliness & Ring sticking [8]	VW TDI	CEC L-117-20	all A/B & C	VGRA.5 [3]	BOI.5
2.8 Turbocharger Compressor Deposit	Toyota 1KD-FTV	CEC L-114-19	A7/B7 & C6	VGRA.7 [3]	none [7]
2.9 Low Speed Pre Ignition GDI Turbo	Sequence IX	ASTM D8291-19	A7/B7 & C6	API 1509 App F [4]	API 1509 App E [4]
2.10 Chain Wear GDI	Sequence X	ASTM D8279-19	A7/B7 & C6	API 1509 App F [4]	API 1509 App E [4]

(1) As described in the ACEA European Oil Sequences 2021. These engine test names are used throughout this Code

(2) Category A/B comprises engine lubricants intended for gasoline and light-duty diesel engines. Category C comprises catalyst compatible engine lubricants intended for gasoline and light duty diesel engines with aftertreatment devices.

(3) The VGRA guidelines are defined only if the viscosity modifier used in the original engine lubricant formulation is a “non-dispersant” polymer. No VGRA guidelines are available for “dispersant-type” polymer.

(4) This test is under protocol and requirements of API. Refer to the latest version of API Publication 1509 Annex E for BOI and Annex F for VGRA.

(5) The VGRA guidelines are divided in two tables according to whether the viscosity modifier used in the original engine lubricant formulation is a “non-dispersant type” polymer (VGRA.1) or a “dispersant type” polymer (VGRA.2).

(6) This test is under protocol and requirements of JASO. Refer to the latest version of JASO Automotive Gasoline Engine Oil Standard Application Manual (JASO M 364) Appendix 5-3 for BOI and Appendix 5-4 for VGRA.

(7) No provisional BOI Guidelines have been established for the moment for this test. Consequently, there is no BOI allowed except from one 10% interchange from any base stock from group I, II, III or IV to another base stock from group I, II, III or IV.

(8) Alternatively, CEC L-78-99 (TDi2) results can be used. VGRA Guideline 5 and BOI Guideline 5 may be used for both VW TDI test methods.

Table A.3 Engine tests in ACEA 2016 Oil Sequences: Service-fill oils for heavy duty diesel engines

ACEA requirement (1)	Engine test name (1)	Test method	ACEA 2016 categories (2)	cf VGRA guideline	cf BOI guideline
2.1 Wear	OM646LA	CEC L-099-08	all E	VGRA.4	BOI.4
2.2 Soot in oil	Mack T-8E (5)	ASTM D5697	all E	VGRA.9 (4)	API 1509 App E (3)
2.3 Bore polishing, Piston cleanliness	OM501LA	CEC L-101-08	all E	VGRA.8 (7)	BOI.5
2.6 Biofuel impacted piston cleanliness and engine sludge	OM646LA Bio	CEC L-104-16	E6 E9	VGRA.5 (7)	
2.4 Soot induced wear	Cummins ISM	ASTM D7468	E7 E9	API 1509 App F (3)	API 1509 App E (3)
2.5 Wear (liner-ring-bearings)	Mack T12 (6)	ASTM D7422	E6 E7 E9	API 1509 App F (3)	API 1509 App E (3)

(1) As reported in the ACEA European Oil Sequences 2016. These engine test names are used throughout this Code.

(2) Category E comprises engine lubricants intended for heavy-duty diesel engines.

(3) These tests are under the protocol and requirements for API. Refer to the latest version of API Publication 1509 Annex E for BOI and Annex F for VGRA.

(4) This test is also under the protocol and requirements for API. However specific VGRA guidelines in this table can be applied for engine lubricants claiming an ACEA Oil Sequence.

(5) A Mack T-8E test can be replaced by a Mack T-11 test with a passing result at API CI-4, API CI-4 plus or API CJ-4 approval programme.

(6) For E6 & E7, a Mack T-12 test can be replaced by a Mack T-10 test with a passing result at API CI-4 or API CI-4 plus approval programme.

(7) The VGRA guidelines are defined only if the viscosity modifier used in the original engine lubricant formulation is a “non-dispersant” polymer. No VGRA guidelines are available for “dispersant-type” polymer.

A.3 Guidelines for Viscosity Grade Read Across (VGRA) *(CoP 6.4)*

A.3.1 The SAE J300 viscosity grade classification system

The SAE J300 viscosity system defines the limits for a classification of engine lubricants in rheological terms only. These limits are used by ACEA to determine the engine lubricant viscosity grades recommended for use in the ACEA Oil Sequences.

Two series of viscosity grades are defined; they are written with or without the letter W.

Single-grade lubricants without the letter W are based on a set of minimum and maximum KV100 values and a minimum HTHS viscosity.

Single-viscosity-grade lubricants ('single-grades') with the letter W are defined by maximum low-temperature cranking and pumping viscosities, and a minimum KV100 value.

Multi-viscosity-grade lubricants ('multigrades') are defined by both of the following criteria:

- maximum low temperature cranking and pumping viscosities corresponding to one of the W grades.
- minimum and maximum KV100 values and a minimum HTHS viscosity corresponding to one of the non-W grades.

A.3.2 Tests where VGRA guidelines apply

ATIEL Guidelines

For the CEC engine tests specified in the ACEA Oil Sequences and listed in Tables A.2 (light duty – ACEA 2021) and A.3 (heavy duty – ACEA 2016), apply the guidelines defined in the corresponding VGRA Tables in A.3.3.

These VGRA tables identify which engine tests can be waived ("yes": VGRA is allowed) and which shall be passed ("no": read-across is not allowed) to permit VGRA from an originally tested engine lubricant formulation to a different viscosity grade formulation. "yes if" means that VGRA can be allowed under the specific conditions reported in the footnotes.

Note A.2: Changes beyond the reported limits in viscosity modifier concentration should be considered in accordance with the ATC Code of Practice.

For the ASTM engine test Mack-T-8E, read-across guidelines have been developed by ATIEL only for test data used to support ACEA Oil Sequence claims (Table VGRA.7).

API Guidelines

For ASTM engine tests specified in the ACEA Oil Sequences, except for the Mack-T-8E, use the viscosity grade read-across (VGRA) guidelines described in Appendix F of API 1509.

Laboratory tests

Laboratory tests are those specified in the ACEA Oil Sequences. They include bench tests such as shear stability, Noack evaporative loss, oil-elastomer compatibility, foaming tendencies, corrosion and oil oxidation, physical tests such as kinematic and dynamic viscosities, and chemical analyses such as TBN measurement and sulphated ashes, phosphorus, sulphur, and chlorine concentrations.

VGRA is not allowed for laboratory tests except for the ASTM D6594 High-Temperature Corrosion Bench Test (HTCBT), where the guidelines described in Appendix F of API 1509 can be followed.

A.3.3 VGRA Guidelines by Engine test

VGRA Guideline 1 VGRA guidelines for the DV6C$_1$ or M271Evo engine tests for lubricants formulated with non-dispersant type of viscosity modifier

Test run on	Can be read-across to														
	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20		no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
0W-30	yes if (*)		no	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
0W-40	yes if (*)	yes if (*)		yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)
5W-20	no	no	no		no	no	no	yes if (*)	no	no	no	yes if (*)	no	yes if (*)	yes if (*)
5W-30	yes if (*)	no	no	yes if (*)		no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
5W-40	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)		no	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
5W-50	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)		yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)
10W-30	no	no	no	yes if (*)	no	no	no		no	no	no	yes if (*)	no	yes if (*)	yes if (*)
10W-40	no	no	no	yes if (*)	yes if (*)	no	no	yes if (*)		no	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
10W-50	yes if (*)	no	no	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)		no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
10W-60	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)		yes if (*)	yes if (*)	yes if (*)	yes if (*)
15W-40	no	no	no	yes if (*)	no	no	no	yes if (*)	no	no	no		no	yes if (*)	yes if (*)
15W-50	no	no	no	yes if (*)	no	no	no	yes if (*)	yes if (*)	no	no	yes if (*)		yes if (*)	yes if (*)
20W-40	no	no	no	no	no	no	no	no	no	no	no	no	no		no
20W-50	no	no	no	no	no	no	no	no	no	no	no	yes if (*)	no	yes if (*)	

(*) Yes, VGRA is permitted if the **viscosity modifier concentration increase** in the read-across viscosity grade vs the tested viscosity grade **is less than 15% mass fraction relative**.

If the viscosity modifier concentration increase is larger than 15% mass fraction relative, VGRA can be permitted if **technical support data** as defined in Section h.16 of the ATC Code of Practice is available to justify read across.

VGRA Guideline 2 VGRA guidelines for the DV6C or M271Evo engine tests for lubricants formulated with dispersant type of viscosity modifier

Test run on	Can be read-across to														
	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20		yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	no	no
0W-30	no		yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no	no	no
0W-40	no	no		no	no	no	yes if (*)	no	no	no	yes if (*)	no	no	no	no
5W-20	yes if (*)	no	no		yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	yes if (*)
5W-30	yes if (*)	yes if (*)	no	no		yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	no	no
5W-40	no	yes if (*)	yes if (*)	no	no		yes if (*)	no	no	yes if (*)	yes if (*)	no	no	no	no
5W-50	no	no	yes if (*)	no	no	no		no	no	no	yes if (*)	no	no	no	no
10W-30	yes if (*)	no	no	yes if (*)	yes if (*)	no	no		yes if (*)	no	no	yes if (*)	yes if (*)	no	yes if (*)
10W-40	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no		yes if (*)	yes if (*)	no	yes if (*)	no	no
10W-50	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no		yes if (*)	no	no	no	no
10W-60	no	no	yes if (*)	no	no	no	yes if (*)	no	no	no		no	no	no	no
15W-40	yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no		yes if (*)	no	yes if (*)
15W-50	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no		no	no
20W-40	no	no	no	no	no	no	no	yes if (*)	no	no	no	yes if (*)	no		yes if (*)
20W-50	yes if (*)	no	no	no	yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	

(*) Yes, VGRA is permitted if the **viscosity modifier concentration** variation in the read-across viscosity grade vs the tested viscosity grade **is less than +20% mass fraction relative increase or less than -10% mass fraction relative decrease**.

If the viscosity modifier concentration increase is increased by more than +20% mass fraction relative or decreased by more than -10% mass fraction relative, VGRA can be permitted if a **technical support data** as defined in Section h.16 of the ATC Code of Practice is available to justify read across.

VGRA Guideline 3 VGRA guidelines for the M111 Fuel Economy engine test

Test run on	Can be read-across to														
	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20		no	no	no	no	no	no	no	no	no	no	no	no	no	no
0W-30	yes if (*)		no	no	no	no	no	no	no	no	no	no	no	no	no
0W-40	yes if (*)	yes if (*)		yes if (*)	no	no	no	no	no	no	no	no	no	no	no
5W-20	yes if (*)	no	no		no	no	no	no	no	no	no	no	no	no	no
5W-30	yes if (*)	yes if (*)	no	yes if (*)		no	no	no	no	no	no	no	no	no	no
5W-40	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)		no	no	no	no	no	no	no	no	no
5W-50	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)		yes if (*)	no	no	no	no	no	no	no
10W-30	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	no	no		no	no	no	no	no	no	no
10W-40	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)		no	no	no	no	no	no
10W-50	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)		no	no	no	no	no
10W-60	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)		yes if (*)	no	yes if (*)	no
15W-40	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	no	no		no	no	no
15W-50	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)		no	no
20W-40	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	no	no	yes if (*)	no		no
20W-50	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	

(*) Yes, VGRA is permitted provided the following requirements are met:

- The **KV40** of the finished lubricant of the read-across viscosity grade **is lower than or equal to** that of the tested viscosity grade.
- The **KV100** of the finished lubricant of the read-across viscosity grade **is lower than or equal to** that of the tested viscosity grade.
- The **HTHS@150°C** viscosity of the finished lubricant of the read-across viscosity grade **is lower than or equal to** that of the tested viscosity grade.

VGRA Guideline 4 VGRA guidelines for the OM646LA engine test

Test run on	Can be read-across to																
	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50	30	40
0W-20		yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes	yes
0W-30	no		yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes	yes
0W-40	no	no		no	no	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes	yes
5W-20	no	yes if (*)	yes if (*)		yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes	yes
5W-30	no	no	yes if (*)	no		yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes	yes
5W-40	no	no	no	no	no		yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes	yes
5W-50	no	no	no	no	no	no		no	no	yes if (*)	yes if (*)	no	yes if (*)	no	yes if (*)	no	yes
10W-30	no	no	yes if (*)	no	no	yes if (*)	yes if (*)		yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes	yes
10W-40	no	no	no	no	no	no	yes if (*)	no		yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes	yes
10W-50	no	no	no	no	no	no	no	no	no		yes if (*)	no	yes if (*)	no	yes if (*)	no	yes
10W-60	no	no	no	no	no	no	no	no	no	no		no	no	no	no	no	no
15W-40	no	no	no	no	no	no	yes if (*)	no	no	yes if (*)	yes if (*)		yes if (*)	yes if (*)	yes if (*)	yes	yes
15W-50	no	no	no	no	no	no	no	no	no	no	yes if (*)	no		no	yes if (*)	no	yes
20W-40	no	no	no	no	no	no	yes if (*)	no	no	yes if (*)	yes if (*)	no	yes if (*)		yes if (*)	yes	yes
20W-50	no	no	no	no	no	no	no	no	no	no	yes if (*)	no	no	no		no	yes
30	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no		yes
40	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no	

(*) Yes, VGRA is permitted for multigrade lubricants if the **KV100 in the read-across viscosity grade is greater than or equal to that of the tested viscosity grade**.

VGRA Guideline 5 VGRA guidelines for the VW TDI or OM646LA Bio engine test

(Applicable only to engine lubricant with non-dispersant type of viscosity modifier)

Test run on	Can be read-across to														
	0W-20	0W-30	0W-40	5W-20	5W-30	5W-40	5W-50	10W-30	10W-40	10W-50	10W-60	15W-40	15W-50	20W-40	20W-50
0W-20		no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
0W-30	yes if (*)		no	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
0W-40	yes if (*)	yes if (*)		yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)
5W-20	no	no	no		no	no	no	yes if (*)	no	no	no	yes if (*)	no	yes if (*)	yes if (*)
5W-30	yes if (*)	no	no	yes if (*)		no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
5W-40	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)		no	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
5W-50	yes if (*)	yes if (*)	yes if (*)	yes if (*	yes if (*)	yes if (*)		yes if (*	yes if (*	yes if (*)	yes if (*)	yes if (*	yes if (*	yes if (*	yes if (*
10W-30	no	no	no	yes if (*)	no	no	no		no	no	no	yes if (*)	no	yes if (*)	yes if (*)
10W-40	yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)		no	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
10W-50	yes if (*)	no	no	yes if (*)	yes if (*)	yes if (*)	no	yes if (*)	yes if (*)		no	yes if (*)	yes if (*)	yes if (*)	yes if (*)
10W-60	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)	yes if (*)		yes if (*)	yes if (*)	yes if (*)	yes if (*)
15W-40	no	no	no	yes if (*)	no	no	no	yes if (*)	no	no	no		no	yes if (*)	yes if (*)
15W-50	no	no	no	yes if (*)	yes if (*)	no	no	yes if (*)	yes if (*)	no	no	yes if (*)		yes if (*)	yes if (*)
20W-40	no	no	no	no	no	no	no	no	no	no	no	no	no		no
20W-50	no	no	no	yes if (*)	no	no	no	yes if (*)	no	no	no	yes if (*)	no	yes if (*)	

(*) Yes, VGRA is permitted if the **viscosity modifier concentration increase** in the read-across viscosity grade vs the tested viscosity grade **is less than 15% mass fraction relative**.

If the viscosity modifier concentration increase is larger than 15% mass fraction relative, VGRA can be permitted if **technical support data** as defined in Section h.16 of the ATC Code of Practice is available to justify read across.

VGRA Guideline 6 VGRA Guideline for the EP6CDT engine test
(Applicable only to engine lubricant with non-dispersant type of viscosity modifier)

VGRA is permitted if the **viscosity modifier treat-rate** is **decreased**, or if the **increase** in viscosity modifier treat-rate in the read-across viscosity grade vs the tested viscosity grade is **less than 15% mass fraction relative**.

This VGRA Guideline is the result of a statistically designed matrix of EP6 test oils run by ATC and ATIEL on a diverse range of technologies.

If the viscosity modifier treat-rate increase is greater than 15% mass fraction relative, VGRA can be permitted if **technical support data** (as defined in Section h.16 of the ATC Code of Practice) is available to justify read across.

VGRA Guideline 7 VGRA Guideline for the Toyota Turbo Charger Deposit test
(Applicable only to engine lubricant with non-dispersant type of viscosity modifier)

VGRA is permitted if the **Base Oil Viscosity (BOV) at 100°C** of the read across viscosity grade is **equal** to **or higher** than that of the tested viscosity grade.
Base oil viscosity at 100°C is the kinematic viscosity of the base oil blend at 100°C of the formulation before additives, viscosity modifier and pour point depressant are added.
This VGRA Guideline is the result of a statistically designed matrix of Toyota Turbo Charger Deposit test oils run by ATC and ATIEL on a diverse range of technologies. The results of the test matrix also showed viscosity modifier treat rates had no effect on the results of the test

VGRA Guideline 8 VGRA guidelines for the OM501LA engine test

(Applicable only to engine lubricant with non-dispersant type of viscosity modifier)

Test run on	Can be read-across to											
	0W-30	5W-30	5W-40	5W-50	10W-30	10W-40	15W-40	15W-50	20W-40	20W-50	30	40
0W-30		no	no	no	no	no	no	no	no	no	no	no
5W-30	no		no	no	yes if (*)	yes if (*)	yes if (*)	yes if (*)	no	no	no	no
5W-40	no	no		no	no	yes if (*)	yes if (*)	yes if (*)	no	no	no	no
5W-50	no	no	no		no	no	no	yes if (*)	no	no	no	no
10W-30	no	no	no	no		no	yes if (*)	no	no	no	no	no
10W-40	no	no	no	no	no		yes if (*)	yes if (*)	no	no	no	no
15W-40	no	no	no	no	no	no		no	no	no	no	no
15W-50	no	no	no	no	no	no	no		no	no	no	no
20W-40	no	no	no	no	no	no	no	no		no	no	no
20W-50	no	no	no	no	no	no	no	no	no		no	no
30	no	no	no	no	no	no	no	no	no	no		no
40	no	no	no	no	no	no	no	no	no	no	no	

(*) Yes, VGRA is permitted if the **viscosity modifier concentration increase** in the read-across viscosity grade vs the tested viscosity grade **is less than 15% mass fraction relative**.

If the viscosity modifier concentration increase is larger than 15% mass fraction relative, VGRA can be permitted if **technical support data** as defined in Section h.16 of the ATC Code of Practice is available to justify read across.

VGRA Guideline 9 VGRA guidelines for the Mack-T-8E engine test

Note A.3 This ATIEL read-across table includes more viscosity grade read-across than API 1509 to reflect the European market. However, these read-across guidelines have been produced only for test data to be used to support ACEA Oil Sequence claims. They cannot be used to support API claims where the relevant read-across guidelines in API 1509 shall be followed.

Test run on	Can be read-across to											
	0W-30	5W-30	5W-40	5W-50	10W-30	10W-40	15W-40	15W-50	20W-40	20W-50	30	40
0W-30		no	no	no	no	no	no	no	no	no	no	no
5W-30	yes		yes	yes	no	no	no	no	no	no	no	no
5W-40	yes	no		yes	no	no	no	no	no	no	no	no
5W-50	yes	no	no		no	no	no	no	no	no	no	no
10W-30	yes	yes	yes	yes		yes	no	no	no	no	no	no
10W-40	yes	yes	yes	yes	no		no	no	no	no	no	no
15W-40	yes	yes	yes	yes	yes	yes		yes	no	no	no	no
15W-50	yes	yes	yes	yes	yes	yes	no		no	no	no	no
20W-40	yes	yes	yes	yes	yes	yes	yes	yes		yes	no	no
20W-50	yes	yes	yes	yes	yes	yes	yes	yes	no		no	no
30	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes		yes
40	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	

A.3.4 VGRA examples

Example VGRA 1: ACEA A3/B4

Question : A 10W-30 ACEA A3/B4 formulation blended with a non-dispersant viscosity modifier (VM) is being developed. As part of the test programme, the plan for the DV6C engine test is to run it as a 15W-40. Viscometric adjustments between both grades are done through the base oil blend with a VM treat rate increase from 8.5% in the 15W-40 formulation to 9.3% in the 10W-30 formulation. Is this allowed?

Answer : **Yes, it is allowed**

In Table A.2, it can be seen that for DV6C engine test, VGRA are considered in tables VGRA.1 and VGRA.2. Table VGRA.1 is selected as the formulation uses a non-dispersant VM.

It can be seen in Table VGRA.1 that a 15W-40 tested formulation can be read-across to a 5W-20, 10W-30, 20W-40 or 20W-50 final formulation if the VM concentration increase in the read-across viscosity grade (here 10W-30) vs the tested viscosity grade (15W-40) is less than 15% mass fraction relative.
The change in VM treat rate is (9,3 – 8,5) / 8,5 = 9,4% increase.

Applying Table VGRA.1 footnote, it appears that the VM concentration increase is less than 15% mass fraction relative and so this VGRA is permitted for the DV6C test.

Example VGRA 2: Heavy Duty formulation

Question : For a heavy duty formulation, a tested OM501LA formulation in 5W-30 viscosity grade has a non-dispersant viscosity modifier (VM) treat rate of 8.5% and the final formulation in 10W-40 viscosity grade has a VM treat rate increased to 10%. Can this OM501LA test result be used to support the final formulation?

Answer : **No, unless there is some technical support data available** as defined in the h.16 section of ATC Code of Practice.

In Table A.3, it can be seen that for OM501LA engine test, VGRA are considered in Table VGRA.6, specifically restricted to formulations with non-dispersant VMs.

It can be seen that a 5W-30 tested formulation can be read-across to a 10W-40 final formulation if the VM concentration increase in the read-across 10W-40 viscosity grade versus the tested 5W-30 viscosity grade is lower than 15% mass fraction relative.

The tested formulation having a VM treat rate of 8.5%, the maximum allowable VM treat rate for this test to support the final formulation is 9.775% (8.5% +15 % increase). At 10% VM treat rate, read-across is not allowed and an OM501LA test is to be run on final formulation.

However, if there are at least two available data points with the same viscosity modifier as in the final formulation at different treat rates (with the same additive pack and base stocks) that show the treat rate does not affect the engine performance, this can be used as suitable **technical support data** to allow VGRA to the final formulation.

Example VGRA 3: EP6CDT

Question: An EP6 test has been run and passed on a **5W-30** engine oil with a non-dispersant viscosity modifier treat-rate of **8%**. As part of the test programme, is it possible to use this test result to support a **0W-20** engine oil, where the only changes are a reduction in viscosity modifier treat-rate to **6%** and a rebalance of the base oil blend?

Answer: **Yes, it is allowed**

In *Guideline 6* for the EP6CDT engine test, VGRA is permitted if the viscosity modifier treat-rate is decreased. No restrictions are placed upon the rebalance of the base oil blend.

Example VGRA 4: EP6CDT

Question: An EP6 test has been run and passed on a **5W-30** engine oil with a non-dispersant viscosity modifier treat-rate of **8%**. As part of the test programme, is it possible to use this test result to support a **5W-40** engine oil, where the only changes are an increase in viscosity modifier treat-rate to **10%** and a rebalance of the base oil blend?

Answer: **No, unless there is some technical support data available** as defined in the ATC Code of Practice, section h.16.

In *Guideline 6* for the EP6CDT engine test, the maximum increase in viscosity modifier treat-rate is 15% relative to the original treat-rate – the maximum treat-rate is **9.2%**.

Example VGRA 5: Toyota Turbo Charger Deposit

Question: A Toyota Turbo Charger Deposit test has been run and passed on a 5W-30 engine oil with a non-dispersant viscosity modifier treat-rate of 7% and a mix of 60% of base oil A (KV100: 4mm²/s) and 20% of base oil B (KV100: 6mm²/s). As part of the test programme, is it possible to use this test result to support a 0W-20 engine oil, where the only changes are a decrease in viscosity modifier treat-rate to 5% and a slight rebalance of the base oil? (From 60/20 to 70/12)?

Answer: **No, it is not allowed**
In *Guideline VGRA 7* for the Toyota Turbo Charger Deposit Test, VGRA is permitted if the Base Oil Viscosity at 100°C is equal or higher than that of the tested oil. Here the BOV is decreased by the base oil rebalance.

Example VGRA 6: Toyota Turbo Charger Deposit

Question: A Toyota Turbo Charger Deposit test has been run and passed on a 0W-20 engine oil with a non-dispersant viscosity modifier treat-rate of 3,5% and only base oil A (KV100: 4mm²/s) As part of the test programme, is it possible to use this test result to support a 0W-30 engine oil, where the only change is an increase in modifier treat-rate up to 7%?

Answer: **Yes, it is allowed**

In *Guideline VGRA 7* for the Toyota Turbo Charger Deposit test, VGRA is permitted if the Base Oil Viscosity at 100°C is equal or higher than that of the tested oil. Here the BOV remains the same.

A.4 Guidelines for Base Oil Interchange (BOI) *(CoP 6.5)*

A.4.1 Tests where BOI guidelines apply

Engine tests guidelines

Practical measurements in engine tests remain the most reliable means of validating the performance of engine lubricants.

For the CEC engine tests specified in the ACEA Oil Sequences and listed in Tables A.2 (light duty – ACEA 2021) and A.3 (heavy duty – ACEA 2016), apply the guidelines defined in the corresponding BOI tables in A.4.2.

Note A.4 Some BOI examples are given in A.4.3.

The BOI tables identify which engine tests can be waived ("not required") and which must be passed ("required") to permit interchange base stocks in an originally tested engine lubricant formulation with those from a different base stock slate.

Some boxes in these tables are highlighted in yellow to draw attention that BOI is permitted under specific conditions.

Note A.5: When applying these conditions, the precision of the measurement method should be taken into account to consider if a certain property is identical or different between original and interchange base stock or between the formulations blended with these base stocks.

Passing results are required only for those engine tests that are a requirement of the ACEA categories for which support is being established. Complete ACEA Performance Data Set documentation is required for the original formulation.

API Guidelines

For ASTM engine tests specified in the ACEA Oil Sequences, use the base oil interchange (BOI) guidelines described in Appendix E of API 1509.

Laboratory tests

Laboratory tests are those specified in the ACEA Oil Sequences. They include bench tests such as shear stability, Noack evaporative loss, oil-elastomer compatibility, foaming tendencies, corrosion and oil oxidation, physical tests such as kinematic and dynamic viscosities, and chemical analyses such as TBN measurement and sulphated ash, phosphorus, sulphur and chlorine concentrations.

BOI is not allowed for laboratory tests except for the ASTM D6594 High-Temperature Corrosion Bench Test (HTCBT), where the guidelines described in Appendix E of API 1509 can be followed.

A.4.2 BOI Tables by engine test

Guideline BOI.1 BOI guidelines for the M271Evo engine test

From Original base stock	*To* Interchange Base Stock (all % in mass of the formulated lubricant)								
	Group I		Group II		Group III		Group IV		Group V
Group I	≤10%	not required	≤10%	not required	≤30%	not required	≤30%	not required	required
	>10%	required	>10%	required	>30%	required	>30%	required	
Group II	≤10%	not required	≤10%	not required	≤30%	not required	≤30%	not required	required
	>10%	required	>10%	required	>30%	required	>30%	required	
Group III	≤10%	not required	≤10%	not required	≤10%	not required	≤10%	not required	required
	>10%	required	>10%	required	>10%	required	>10%	required	
Group IV	≤10%	not required	≤10%	not required	≤10%	not required	≤10%	not required	required
	>10%	required	>10%	required	>10%	required	>10%	conditions on PAO characteristics (1)	
Group V	required		required		required		required		required

(1) Group IV base stocks (PAOs), can be interchanged without additional qualification testing, providing that the interchange PAO meets the original PAO manufacturer's specifications for physical and chemical properties. The following key properties must be met in the substituted stock: KV100, KV40 and KV-40; viscosity index; Noack; pour point; unsaturates.

Guideline BOI.2 BOI guidelines for the DV6C engine test

From Original base stock	*To* Interchange Base Stock (all % in mass of the formulated lubricant)								
	Group I		Group II		Group III		Group IV		Group V
Group I	not required		≤10%	not required	≤30%	not required	≤30%	not required	required
			>10%	required	>30%	required	>30%	required	
Group II	≤10%	not required	≤10%	not required	≤30%	not required	≤30%	not required	required
	>10%	required	>10%	required	>30%	required	>30%	required	
Group III	≤10%	not required	≤10%	not required	≤10%	not required	≤30%	not required	required
	>10%	required	>10%	required	>10%	required	>30%	required	
Group IV	≤10%	not required	≤10%	not required	≤30%	not required	≤10%	not required	required
	>10%	required	>10%	required	>30%	required	>10%	conditions on PAO characteristics (1)	
Group V	required		required		required		required		required

(1) Group IV base stocks (PAOs) can be interchanged without additional qualification testing, providing that the interchange PAO meets the original PAO manufacturer's specifications for physical and chemical properties. The following key properties must be met in the substituted stock: KV100, KV40 and KV-40; viscosity index; Noack; pour point; unsaturates.

Guideline BOI.3 BOI guidelines for the M111 Fuel Economy engine test

From Original base stock	*To* Interchange Base Stock (all % in mass of the formulated lubricant)								
	Group I		Group II		Group III		Group IV		Group V
Group I	≤10%	not required	≤10%	not required	≤30%	not required	≤30%	not required	required
	>10%	HTHS,KV40 conditions (1)	10%–30%	HTHS,KV40 conditions (1)					
			>30%	required	>30%	required	>30%	required	
Group II	≤10%	not required	≤10%	not required	≤30%	not required	≤30%	not required	required
	10%–30%	HTHS,KV40 conditions (1)	>10%	HTHS,KV40 conditions (1)					
	>30%	required			>30%	required	>30%	required	
Group III	≤10%	not required	≤10%	not required	≤10%	not required	≤30%	not required	required
	10%–30%	HTHS,KV40 conditions (1)	10%–30%	HTHS,KV40 conditions (1)	>10%	HTHS, KV40 conditions (1)			
	>30%	required	>30%	required			>30%	required	
Group IV	≤10%	not required	≤10%	not required	≤30%	not required	≤10%	not required	required
	10%–30%	HTHS,KV40 conditions (1)	10%–30%	HTHS,KV40 conditions (1)					
	>30%	required	>30%	required	>30%	required	≥10%	conditions on PAO characteristics (2)	
Group V	required		required		required		required		required

(1) No M111FE testing is required if the **HTHS@150°C and KV40 values of the interchange formulation are lower than or equal to that of the original formulation**.

(2) Group IV base stocks (PAOs) can be interchanged without additional qualification testing, providing that the interchange PAO meets the original PAO manufacturer's specifications for physical and chemical properties. The following key properties must be met in the substituted stock: KV100, KV40 and KV-40; viscosity index; Noack; pour point; unsaturates.

Guideline BOI.4 BOI guidelines for the OM646LA engine test

From Original base stock	*To* Interchange Base Stock (all % in mass of the formulated lubricant)								
	Group I		Group II		Group III		Group IV		Group V
Group I	not required		≤10%	not required	not required		not required		required
			>10%	required					
Group II	≤10%	not required	≤10%	not required	≤30%	not required	≤30%	not required	required
	>10%	required	>10%	required	>30%	required	>30%	required	
Group III	≤10%	not required	≤10%	not required	≤10%	not required	≤30%	not required	required
	>10%	required	>10%	required	>10%	required	>30%	required	
Group IV	≤10%	not required	≤10%	not required	≤30%	not required	≤10%	not required	required
	>10%	required	>10%	required	>30%	required	>10%	conditions on PAO characteristics (1)	
Group V	required		required		required		required		required

(1) Group IV base stocks (PAOs) can be interchanged without additional qualification testing, providing that the interchange PAO meets the original PAO manufacturer's specifications for physical and chemical properties. The following key properties must be met in the substituted stock: KV100, KV40 and KV-40; viscosity index; Noack; pour point; unsaturates.

Guideline BOI.5 BOI guidelines for the TDI, OM646LA Bio, EP6CDT & OM501LA engine tests

From Original base stock	*To* Interchange Base Stock (all % in mass of the formulated lubricant)								
	Group I		Group II		Group III		Group IV		Group V
Group I	≤10%	not required	≤10%	not required	≤30%	not required	≤30%	not required	required
	>10%	required	>10%	required	>30%	required	>30%	required	
Group II	≤10%	not required	≤10%	not required	≤30%	not required	≤30%	not required	required
	>10%	required	>10%	required	>30%	required	>30%	required	
Group III	≤10%	not required	≤10%	not required	≤10%	not required	≤30%	not required	required
	>10%	required	>10%	required	>10%	required	>30%	required	
Group IV	≤10%	not required	≤10%	not required	≤30%	not required	≤10%	not required	required
	>10%	required	>10%	required	>30%	required	>10%	conditions on PAO characteristics (1)	
Group V	required		required		required		required		required

(1) Group IV base stocks (PAOs) can be interchanged without additional qualification testing, providing that the interchange PAO meets the original PAO manufacturer's specifications for physical and chemical properties. The following key properties must be met in the substituted stock: KV100, KV40 and KV-40; viscosity index; Noack; pour point; unsaturates.

A.4.3 Base Oil Interchange Examples

Example BOI 1: ACEA A3/B4 VGRA + BOI

Question : A 10W-30 ACEA A3/B4 formulation blended with Group I base stocks and 30% Group III base stock with a non-dispersant viscosity modifier (VM) is being developed. As part of the test programme, the plan for the DV6C engine test is to run it as a 15W-40 in Group I base stocks. Viscometric adjustments between both grades are done through the base oil blend and the VM level is lower in the final formulation compared to the tested formulation. Is this allowed?

Answer : **Yes, it is allowed**

In Table A.2, it can be seen that for DV6C engine test, VGRA are considered in Guideline VGRA.1 (non-dispersant VM) and BOI in Guideline BOI.2.

It is intended to change 30% Group I base stock to 30% Group III base stock. In Guideline BOI.2, the test on the interchanged formulation is not required.

It can be seen in Guideline VGRA.3 that a 15W-40 tested formulation can be read-across to a 5W-20, 10W-30, 20W-40 or 20W-50 final formulation if the VM concentration increase in the read-across viscosity grade versus the tested viscosity grade is lower than 15% mass fraction relative. In this case, going from 15W-40 in the tested formulation to 10W-30 in the final formulation, there is a reduction in the VM level which is allowed when following the footnote in Guideline VGRA.1.

Therefore, this BOI change and the VGRA change are permitted for the DV6C test.

Example BOI 2: Group III ➔ Group III BOI on PCMO

Question: An engine oil has been developed which meets the requirements of ACEA C3-16. This engine oil uses a base stock blend composed of full **Group III slate A** with a Noack of 10.6 mass%. What testing is required to substitute this blend for a new base stock blend composed of full **Group III slate B** with a Noack of 10.0 mass%, all viscometrics being maintained equal between formulations with slate A and slate B?

Answer : For a ACEA C3-16, Table A.2 details the necessary engine tests and the corresponding BOI tables to be considered for an interchange of greater than 10% Group III to Group III in the finished formulation:

- Guideline BOI.1 for M271Evo : run test.
- Guideline BOI.2 for DV6C: run tests.
- Guideline BOI.3 for M111 Fuel Economy: as the KV40 and the HTHS of the new base stock blend are equal to those of the original, M111 FE testing is not required.
- Guideline BOI.4 for OM646LA: run test.
- Guideline BOI.5 for VW TDI and OM646LA Bio: run both tests.
- API 1509 Appendix E on BOI for Sequence VG confirms that this is not required for Group III to Group III interchange.

In summary, run DV6C, OM646LA, M271Evo, VW TDI and OM646LA Bio engine tests.

Run also all ACEA C3-16 laboratory bench tests on the final formulation – no read-across is permitted.

Run the above testing as an ATIEL Programme Extension, referencing the ATC Candidate Data Pack for the original formulation. The test data for the new formulation must then be documented in a final ACEA Performance Data Set.

Example BOI 3: Group II➔ Group II BOI on HDDO

Question: An engine oil has been developed that meets the requirements of ACEA E7-16. This engine oil uses a base stock blend composed of full **Group II slate A**. What testing is required to substitute this blend for a new base stock blend composed of full **Group II slate B** with higher saturates content?

Answer: For a ACEA E7-16, Table A.3 details the necessary engine tests and the corresponding BOI tables to be considered for an interchange of greater than 10% Group II to Group II in the finished formulation :

- Guideline BOI.4 for OM646LA: run test.
- Guideline BOI.5 for OM501LA and OM646LA Bio: run both tests.
- API 1509 Appendix E for Mack-T-8E/Cummins ISM/Mack T12.

  Mack-T-8E: confirms that testing is not required for Group II to Group II interchange if the base oil saturates are greater than or equal to the original oil. A comparison of the saturates is to be conducted (see API example).

  Cummins ISM: confirms that same applies for the Cummins ISM if only one passing engine test is available on this technology. If more than one passing Cummins ISM engine test is available on this technology, note that API permits interchange, provided key base oil properties fall within the range of passing oils tested.

  Mack T12: If only one Mack T-12 engine test is available, interchange is detailed in Appendix E. A comparison of the BOV at 100°C and saturates must be conducted and the interchange is only permitted if these are equal to or greater than the original formulation. If more than one passing Mack T-12 engine test is available on this technology, note that API permits interchange, provided key base oil properties fall within the range of oils tested.

Run all ACEA E7-16 laboratory bench tests on the final formulation – no read-across is permitted.

Run the above testing as an ATIEL Programme Extension, referencing the ATC Candidate Data Pack for the original formulation. The test data for the new formulation must then be documented in a final ACEA Performance Data Set.

Examples of restricted application of the guidelines by the lubricant developer

Example BOI 4:

Question: In the development process of an engine oil, the original candidate did not pass the VW TDI engine test unless 30% Group III was introduced in the base oil blend. As Guideline BOI.5 allows 10% interchange of Group III by Group II, can this interchange be done without running the test?

Answer: As the 30% content of Group III was required to pass the test, **no Group III can be removed from the final formulation** (see 6.5.2: Application of BOI guidelines – Exception). Guideline BOI.5 guidelines on these replacements cannot apply further except where the relevant engine tests have been re-run and passed on the final base stock blend to be promoted, assuring that the compliance with the ACEA Oil Sequence is maintained.

However, it remains possible to proceed to a Group III to Group III interchange by application of the guidelines in Guideline BOI.5.

Example BOI 5:

Question: In the development of an engine oil blended with a mixture of Group IV and Group III base stocks, a failing VW TDI test result was obtained at 15% Group IV. The Group IV content was therefore increased in the test oil to 30% and a passing result was obtained. As Guideline BOI.5 allows 10% substitution of Group IV by Group III, is it permitted to define the final oil with 20% Group IV?

Answer: As the 30%m content of Group IV was introduced in order to pass the test, the use of 20% Group IV in the final oil **is not permitted** unless a passing VW TDI data is available to support a system representative of the final oil at 20% Group IV.

Example BOI 6:

Question: In the development of an ACEA E6 engine oil, a failing OM501LA test result was obtained in full Group III. Group IV was therefore introduced in the test oil up to 10% and a passing result was obtained. As Guideline BOI.5 allows 10% substitution of Group IV by Group III, is it permitted to define the final oil with 0% Group IV?

Answer: As the 10%m content of Group IV was introduced in order to pass the test, the decrease of Group IV content in the final oil **is not permitted** unless a passing OM501LA data is available to support a system representative of the final oil with no Group IV.

Cumulative Substitutions

Example BOI 7 : Cumulative substitution

Question 1: An engine oil has been developed with a blend of Group II base stock and 20% PAO. An interchange is considered based on the replacement of the 20% PAO and 20% of Group II by 40% Group III. Is this BOI allowed without running a VW TDI engine test?

Answer: **No, a VW TDI test is required.**

Guidelines in Guideline BOI.5 show that 20% Group II can be interchanged by 20% Group III and that 20% Group IV can be interchanged by 20% Group III also. Both interchanges can be allowed individually.

But together, these two interchanges introduce 40% of a new Group III slate in the formulation, which exceeds the 30% limit reported in the table for interchange to Group III.

The engine test could be waived if the interchange Group III does not exceed 30%, for example replacing 20% PAO and 10% Group II.

Question 2: The lubricant manufacturer produces this formulation with a replacement of 20% Group II by 20% Group III, which is permitted without re-run of the VW TDI test in the guidelines in Guideline BOI.5. This formulation is documented in a final ACEA Performance Data Set. Now, the lubricant marketer is considering a second change from 20% PAO to 20% Group III. Is a VW TDI test required with the modified formulation?

Answer: It is explained in 6.5.2 (Base stocks from more than one Group) that *"Every permitted interchange must be done with reference to an effective engine test measurement with the initial base stock slate and not to a previous BOI read-across data"*

In this example, two successive base oil interchanges are discussed:

- the first from Group II to Group III, which is permitted and already documented.
- the second from Group IV to Group III. As this second interchange is not based on real data, but on first "interchange" data, this is not permitted.

Therefore, **a VW TDI engine test is required to validate the second interchange**. This engine test could be waived only if a real passing test data was available for the formulation with the first interchange.

Question 3: A EP6 CDT test has been run and passed on an engine oil containing 30% of group II in addition to 20% of Group III and 20% of Group IV. Looking at BOI Guideline 5, we see that:

- Group II can be interchanged with Group I up to 10%
- Group III can be interchanged with Group I up to 10%
- Group IV can be interchanged with Group I up to 10%

Is it possible to use this test result to support an engine oil, containing 30% of group I, 20% of group II, 10% of group III and 10% of PAO?

Answer: **No, it's not allowed**

It is explained in 6.5.2 (Base stocks from more than one Group) that *"Every permitted interchange must be done with reference to an effective engine test measurement with the initial base stock slate and not to a previous BOI read-across data"*

Consequently, even if those three BOI are allowed individually, they can't be simultaneously applied without an intermediate pass result on a formulation comprising at least two of the targeted interchanges.

Question 4: A EP6 CDT test has been run and passed on an engine oil containing 30% of group II in addition to 20% of Group III and 20% of Group IV. Looking at BOI Guideline 5, we see that:

- Group II can be interchanged with Group I up to 10%
- Group III can be interchanged with Group I up to 10%

Is it possible to use this test result to support an engine oil, containing 10% of group I, 25% of group II, 15% of group III and 20% of PAO?

Answer: **Yes, it's allowed**

The engine test could be waived. Even if we apply here two BOI simultaneously, as the overall amount of interchange does not exceed 10%, the BOI is acceptable.

Therefore, a EP6CDT engine test is not required to validate the overall interchange

Question 5: The lubricant manufacturer produces a formulation with a mix of 30% of a group II slate A and 40% of a group II slate B. Now the lubricant marketer is considering changing the formulation by switching 15% of group II A and 15% of group II B by 30% of group III. Is a M271EVO test required with the modified formulation?

Answer: It's explained in §6.5.2 that "When base stocks from different slates of the same base stock group are interchanged simultaneously, the overall amount interchanged must remain lower or equal to the permitted maximum values shown in BOI guidelines in Appendix A"

The BOI Guidelines state that a BOI Group II to Group III is permitted without further engine test as long as the interchanged amount is lower or equal to 30%.

Therefore, a **M271EVO engine test is not required to validate the overall interchange.**

A.5 Emergency temporary derogation of the ATIEL base stock interchange guidelines for unlinked slates *(CoP 6.5.4)*

A.5.1 Scope

This Section details the circumstances and conditions under which it may be appropriate for an emergency, temporary derogation of the existing ATIEL base stock interchange guidelines for unlinked slates.

The use of such temporary derogation must be applied in true *force majeure* situations, as defined in A.5.2, where the shortage of base stocks is beyond the lubricant marketer's control. The derogation is not intended for use, nor should it be used, in other situations where shortage of base stocks might arise for other, purely commercial reasons.

The derogation of the base stock interchange guidelines applies for a maximum of 90 days and can be initiated by any *force majeure* situation including, but not limited to, those arising from base stock or additive supply.

The temporary derogation attempts to find a balance between rigidly adhering to the Base Oil Interchange guidelines (Section 6.5) (which might be impossible for those faced with a force majeure situation) and allowing too much flexibility (which could introduce serious risk to product quality if untested product formulations would be marketed. In effect, the derogation allows a marketer faced with a *force majeure* situation to market, on a temporary basis, a product while the base stock interchange data is being generated. The testing requirements, however, are identical to those that would normally have to be carried in non-*force majeure* situations, the only difference being that in the latter situation, the data must be generated before the product is marketed.

The use of this temporary derogation should be seen as a last resort after all other alternatives have been rigorously pursued and documented.

Even with the use of this temporary derogation, the quality of affected products and the claims made for them remain the sole responsibility of the lubricant marketer. ACEA performance claims are self-certifying and no change to that situation is implied or given by this temporary derogation. ATIEL will accept no responsibility for any issues or claims arising from the use of this temporary derogation.

The temporary derogation does not take any responsibility for OEM performance claims made on products impacted by this temporary derogation. Separate discussions are necessary with individual OEMs.

A.5.2 Force Majeure

Force majeure refers to a situation of material unavailability that is beyond the control of the lubricant marketer and involves failure to perform contractual obligations.

The restriction must make it impossible for those lubricant marketers to continue selling their products resulting in a significant disruption in availability of suitable products in the market.

The material unavailability must be caused by an unforeseeable event such as, but not necessarily restricted to, explosion, fire, legal action, act of terrorism, act of God or extreme weather event that is beyond the control of the lubricant marketer.

Force majeure does not apply to a situation referred to as commercial hardship where the marketer has failed to obtain supplies of suitable base stocks because of negligence, or failure to use good business practice or where, for example, as a result of market economics, it becomes harder or more expensive, but not impossible, to procure the necessary base stocks. Companies in this situation can attempt to alleviate their problems by means other than derogation, such as through discussions with their additive and base stock suppliers, or by temporarily revising the claims made the product or by selling alternative products.

A.5.3 Guidelines

Lubricant marketers wishing to make use of the emergency temporary derogation must supply the ATIEL Secretary General with the information detailed in A.5.4. A database must also be created containing the information detailed in A.5.5 ATIEL reserves the right to add additional requirements for specific situations if it sees fit.

Lubricant marketers must complete the derogation template letter shown in Appendix D.3 and send it to the ATIEL Secretary General (info@atiel.eu).

The ATIEL Secretary General will not review this information on a case-by-case basis, nor will it be circulated within ATIEL or to third parties. The ATIEL Secretary General will, however, publish a list on the public section of the ATIEL website (www.atiel.org), detailing the names of the companies applying the derogation and the derogation period. The ATIEL Secretary General will also send a copy of this list to the Secretary General of ACEA for their information.

Marketers making use of this derogation must draw the attention of their internal and external auditors to its use and must provide all necessary data requested as part of any such audit.

A.5.4 Information to be sent to ATIEL in support of a derogation

A marketer applying this derogation shall send the following information by registered mail to the ATIEL Secretary General:

a) The dates when the use of the derogation becomes effective and when it ceases, up to a maximum period of 90 days. The relevant dates are those when manufacturing commences and ceases.

b) A monthly report within the 90-day period on the steps being taken to rectify the material unavailability and steps being taken to add missing results to the data package.

c) Confirmation that the quality of the product to be marketed is sufficient to support the claims made for it.

d) A detailed description of the industry-wide material unavailability together with documentation of *force majeure* declaration by suppliers.

e) A detailed description of the actions already taken to find alternative sources of base stocks that would obviate the need for this derogation or to find alternative sources of finished products. Documentation shall be provided why these alternatives cannot be applied and why the removal of ACEA performance claims is not appropriate as a short-term measure.

f) An explanation of why the current base stock interchange guidelines cannot be applied to provide the necessary relief.

g) Details of the specific relaxation proposed for subject formulations.

A.5.5 Data Set required in support of a derogation

In addition to the information detailed in A.5.4, the lubricant marketer applying this derogation must prepare a database, as detailed below, which is to be made available to its internal and external auditors. The database must contain the following information:

a) Details of all missing test data for the standard candidate data package and the test work planned to close these gaps in the candidate data package as quickly as possible. Testing must be completed even after the use of the provision has ended.

b) Details of which base stocks are currently used to comply with the ATIEL Code of Practice and the alternatives proposed under this derogation.

c) A list of all products and re-brands impacted using this derogation, together with marketing territories and channels of trade.

d) Details of laboratory test results for base stocks and finished products using the current and proposed base stocks (Section 6.5 provides guidance on how interchange between base stocks should be assessed).

e) Evidence of performance claims (and proposed changes) made for impacted products in labels and product data sheets.

f) Details of engine test data to support the claims to be made, highlighting gaps in the data set, together with a plan and timeline to show that the missing data will be obtained and then reported. If passing data is not obtained under the existing industry protocols, the lubricant marketer must notify the ATIEL Secretary General accordingly, cease making use of this derogation and advise what other corrective action is to be applied.

Appendix B

Guidelines for Base Stock Manufacturers Quality Assurance

Issue Number 22, October 2021

This issue supersedes all previous issues.
All new engine lubricant developments initiated after the date of this issue must use this issue.

Contents

B.1 Base stock manufacturers' responsibilities

B.2 Guidelines for base stock quality assurance

B.3 Feedstock approval procedures

B.4 Refining process control

B.5 Routine quality control and auditing

B.6 Guidelines for linking base stock slates and for using linked slates

B.1 Base stock manufacturers' responsibilities

The Code requires base stocks to be produced in manufacturing plants accredited to internationally recognised, auditable quality management systems such as ISO 9001 or equivalent.

Base stock manufacturers and partner groups remain responsible for detailed operating procedures and specifications.

If the base stock quality changes, the base stock manufacturer shall inform the lubricant marketers involved so that the experts can assess the testing, if any, that needs to be carried out to ensure that the finished lubricants using this base stock slate always meet all specifications and performance levels claimed in the marketplace.

B.2 Guidelines for base stock quality assurance

The ATIEL Guidelines for base stock quality assurance are divided into four main sections:

- feedstock approval procedures (B.3)
- refining process control (B.4)
- routine quality control and auditing (B.5)
- guidelines for linking base stock slates and for using linked slates (B.6)

These guidelines emphasise the need for base stock manufacturers to:

- have routine access to technical expertise that enables sound judgements to be made on quality assurance matters.
- maintain documented, externally auditable quality management procedures and verify compliance with these procedures.

B.3 Feedstock approval procedures

B.3.1 General

Feedstock shall be screened for general suitability using verifiable evaluation procedures. Base stocks shall then be produced from suitable feedstocks and evaluated for approval.

Procedures shall be in place to determine the maximum acceptable proportions of unapproved feedstock, experimental fractions and other unapproved materials that may enter the commercial pool of approved materials.

B.3.2 Feedstock screening

A chemical and physical characterisation of candidate feedstock shall be carried out and the results appraised using a database derived from previous feedstock evaluations. An expert assessment shall then be made of the nature of the feedstock and its potential as a source for base stock production.

B.3.3 Making base stocks for approval

A series of intermediate fractions is made from the feedstock. Base stocks shall be produced from these intermediate fractions using targeted characteristics set jointly by base stock and formulation experts.

If physical and chemical analyses of the base stocks indicate a need to modify targeted characteristics, the base stock manufacturer shall produce new samples under modified processing conditions.

B.3.4 Evaluating candidate base stocks for approval

The evaluation shall include a study of the following.

a) Intrinsic properties of the base stocks, such as, but not necessarily limited to:

- chemical composition
- contamination arising from feedstock and processing impurities
- volatility
- viscosity
- inherent oxidation stability
- deposit forming tendencies
- pour point.

b) Performance in blended lubricants, such as, but not necessarily limited to:

- high-temperature deposit formation
- low-temperature sludge formation
- detergency/deposit control
- soot-handling
- foaming behaviour
- oxidation behaviour
- elastomer compatibility
- finished-lubricant viscometry
- homogeneity and stability of formulations.

B.3.5 Approval of feedstock

A feedstock can be approved if base stocks made from it have been demonstrated to be suitable for formulating engine lubricants for which ACEA Oil Sequence claims are to be made. Formal approval shall be the joint responsibility of manufacturing and product experts.

Base stocks that have been approved under the provisions of these guidelines may be commingled without further testing, consistent with the provisions of this Appendix.

Base stock manufacturers shall maintain a register of the approval status of various feedstocks and corresponding processing conditions.

The approval status shall be reviewed periodically.

B.3.6 Mixtures of feedstocks

Mixtures of feedstocks at the manufacturing plant can arise from, but are not limited to:

a) the intentional scheduling of mixtures.
b) the cross-contamination that can occur during feedstock changeovers.
c) accidental mixing.

A mixed feedstock may be approved even though the feedstock components are not themselves approved. Approved feedstocks may be mixed in all proportions up to the maximum approved limits for each feedstock component.

B.4 Refining process control

B.4.1 Procedures

The primary aim of refining process control is to ensure that base stocks are reliably and consistently manufactured according to approved processing conditions and base stock specifications. All relevant steps, from feedstock approval to base stock despatch, shall be reflected in documented, auditable, quality management procedures.

These procedures shall define action to be taken if it is planned to make significant changes to approved processing conditions.

B.4.2 Changes to operating conditions

Significant changes of operating conditions are defined as changes that are outside the ranges of conditions specified at the time of the feedstock or base stock approval. To safeguard base stock quality, assessment of the significance of processing changes and actions to be taken shall be undertaken by appropriate experts.

Changes typically considered to be significant include, but are not limited to:

- change of solvent type.
- change of catalyst or catalyst type.
- change of reactor operating conditions beyond predefined acceptable range.
- change of process sequence.
- change in non-approved feedstock.
- unacceptable variations of approved feedstock quality.
- unacceptable contamination of feedstock.

B.5 Routine quality control and auditing

B.5.1 Purpose

Routine quality control shall be carried out to confirm that base stock production remains within approved specifications. It is important to recognise that routine quality control tests are indicators of consistency and not absolute measures to predict base stock and lubricant performance.

B.5.2 Procedures

Written, auditable, quality management procedures relating to base stock quality control shall:

a) embody the approved quality control specifications of the base stocks to be produced.
b) define responsibilities for maintaining the integrity of those specifications.
c) define testing frequencies and sampling requirements.
d) embody a requirement routinely to report and interpret quality control test results and statistical assessments.
e) define action to be taken in the event of non-conformances.

Such procedures shall be auditable.

B.5.3 Quality control tests

Quality control tests for base stocks, and ranges of acceptable results in those tests, shall be defined at the time of approving a feedstock. Test requirements may later be amended to reflect changing industry requirements, subject to the agreement of relevant manufacturing and product experts.

Tests will vary from manufacturer to manufacturer and may include, but are not limited to:

- density
- colour
- refractive index
- spectroscopic analysis
- viscosity
- viscosity index
- flash point
- pour point
- chemical composition
- detection of contaminants.

In some cases, standard industry test methods may be used, but it is common for specific manufacturers to use proprietary methods to examine certain parameters.

B.5.4 Auditing

Base stock manufacturing plants shall undergo regular auditing by an independent, appropriately accredited (ISO 9001 or equivalent) auditor.

B.6 Guidelines for linking base stock slates and for using linked slates

B.6.1 Linking slates

B.6.1.1 Pre-qualification for linking slates

Each of the base stock slates to be linked shall already have been used in engine oil formulations qualified against the appropriate ACEA Oil Sequences for which the linked slates are intended.

Parties wishing to link slates from different base stock manufacturers shall obtain a written statement from each manufacturer that the base stocks involved will be of consistent quality.

B.6.1.2 Requirements for the linkage programme

The base stocks to be tested in the linkage qualification programme shall be suitable for formulating engine lubricants.

To qualify for linking slates, passing results shall be obtained, separately for each of the slates to be linked, in applicable tests in the ACEA Oil Sequences for which linking is intended. The applicable tests are those defined in Tables A.2 and A.3 for the Sequence concerned. Qualification tests shall be carried out in accordance with the ATC, ACC or JASO Codes of Practice as applicable.

Base stocks from each slate to be linked shall be separately evaluated using performance additive packages and SAE J300 viscosity grades agreed by the partners. The SAE J300 viscosity grade of formulations evaluated shall be multigrade and the same for each specific test comparison conducted but may vary between tests. The viscosity modifier concentration may be varied by up to 15 mass % relative to meet viscosity requirements.

For qualification tests in each ACEA Oil Sequence, the same performance additive package and viscosity modifier shall be used. For different ACEA Oil Sequences it is preferable, but not essential, to use different performance additive packages. The concentration of individual performance additive packages shall be set at the level normally recommended for the targeted ACEA Oil Sequence.

B.6.1.3 Selection of base stock batches for the linkage programme

The testing shall be carried out on base stock batches representative of typical production within the corresponding base stock slate. The testing cannot be carried out on base stock batches at extreme ends of production or specification where these are known to deliver improved performance compared with typical production material.

B.6.1.4 Use of other base stock Groups in linkage programme

If linkage of **Group I base stock slates** is required, the formulations tested shall not contain base stocks from other groups. However, if this is not feasible, mixtures of Group I with Group II or Group I with Group III may be tested.

If linkage of either **Group II or Group III slates** is required, it is preferable that base stocks from other groups are not used. However, if this is not feasible, mixtures of Group I with Group II or Group I with Group III may be tested. Where such mixtures are used in the testing to link Group II or Group III slates, the only variable between tested formulations shall be the Group II or Group III base stock. All other base stocks shall remain constant.

In the case where an additional base stock from another group has to be added to the mix, interchangeability between linked slates shall be limited up to the concentration of the targeted base stock(s) group used in the formulations tested.

B.6.1.5 Examples of linking slates

Example 1: Linking three Group I slates

Question: Group I base stock slates P, Q and R needed to be linked. All three slates met the pre-qualification requirements (B.6.1.1) and the typical base stocks (B.6.1.3) within each of these slates had been identified.

Slates P, Q and R, each comprise two Group I base stocks. SAE 15W-40 formulations are tested against the requirements of ACEA Categories E9-16 and A3/B4-16 using additive packages S and T at concentration recommended for the targeted ACEA performances. The three formulations contained viscosity modifier G and H respectively. The details of the formulations and of the testing results are summarised in Table B.1.

Are these slates linked with this programme?

Table B.1 Linking three Group I slates

Component [1]		ACEA E7-16			ACEA A3/B4-16		
		Oil #1	Oil #2	Oil #3	Oil #4	Oil #5	Oil #6
Slate P	90 SN	2.3%	—	—	—	—	—
	175 SN	76.6%	—	—	77. 0 %	—	—
Slate Q	100 SN	—	10.6%	—	—	10.0 %	—
	200 SN	—	68.6%	—	—	67.3 %	—
Slate R	150 SN	—	—	68.5%	—	—	66.9 %
	650 SN	—	—	10.8%	—	—	10.0 %
Additive pack S		12.5%	12.5%	12.5%	—	—	—
Additive pack T		—	—	—	13.5 %	13.5 %	13.5 %
Viscosity modifier G		8.6 %	8.3 %	8.2 %	—	—	—
Viscosity modifier H		—	—	—	9.5 %	9.2 %	9.6 %
Formulated oil		100.0 %	100.0 %.	100.0 %	100.0 %	100.0 %	100.0 %
SAE J300 viscosity grade		15W-40	15W-40	15W-40	15W-40	15W-40	15W-40
EP6CDT		—	—	—	Pass	Pass	Pass
Sequence VG		—	—	—	Pass	Pass	Pass[2]
OM646LA		Pass	Pass	Pass	Pass	Pass	Pass
DV6C		—	—	—	Pass	Pass	Pass
VW TDI		—	—	—	Pass	Pass	Pass
OM646LA Bio		-	-	-	Pass	Pass	Pass
Mack T-8E		Pass[2]	Pass	Pass	—	—	—
OM501LA		Pass	Pass	Pass	—	—	—
Cummins ISM		Pass	Pass	Pass	—	—	—
Mack T12		Pass	Pass	Pass	—	—	—
Laboratory Tests[3]		Pass	Pass	Pass	Pass	Pass	Pass

[1] All percentages are mass % of the formulated lubricant.

[2] **Repeated to obtain pass.**

[3] As specified in the ACEA Oil Sequences.

Answer : Despite the fact that it was necessary to repeat the Seq VG test on oil #6 and the Mack T-8E test on oil #1, the testing was successful as all the engine test data met the agreed minimum performance standards.
Therefore, Slates P, Q and R may be considered as linked slates for the tests which were part of this programme.

Example 2: Linking two Group III slates

Note B.1: This example would also be applicable to linking Group II base stock slates.

Question: Group III base stock slates D and E needed to be linked. Both slates met the pre-qualification requirements (B.6.1.1) and the typical base stocks (B.6.1.3) within each of these slates had been identified.

It was agreed to test Slates D and E against the requirements of ACEA Categories C3-16 and E6-16 using SAE 5W-30 and 10W-40 formulations. Additive package X was used at 13 mass % for ACEA C3-16. Additive package Y was used at 21 mass % for ACEA E6-16 testing. The details of the formulations and of the testing results are summarised in Table B.2. All results with slate E were closer to the limits than with slate D.

Are these slates linked with this programme?

Table B.2 Linking two Group III slates

Component (1)	ACEA C3-16		ACEA E6-16	
	Oil #1	Oil #2	Oil #3	Oil #4
Slate D Group III (4 mm^2/s)	32.7 %	—	15.8 %	—
Group III (6 mm^2/s)	40.0 %	—	55.0 %	—
Slate E Group III (4 mm^2/s)	—	34.0 %	—	17.9 %
Group III (6 mm^2/s)	—	39.1 %	—	53.0 %
Additive pack X	13.0 %	13.0 %	—	
Additive pack Y	—	—	21.0 %	21.0 %
Viscosity modifier M	14.3 %	13.9 %	8.2 %	8.1 %
Formulated oil	100.0 %	100.0 %	100.0 %	100.0 %
SAE J300 viscosity grade	5W-30	5W-30	10W-40	10W-40
EP6CDT	Pass	Pass	—	—
Sequence VG	Pass	Pass	—	—
OM646LA	Pass	Pass	Pass	Pass
DV6C	Pass	Pass	—	—
M111	Pass	Pass	—	—
VW TDI	Pass	Pass	—	—
OM646LA Bio	Pass	Pass	Pass	Pass
Mack T-8E	—	—	Pass	Pass
OM501LA	—	—	Pass	Pass
Mack T12	—	—	Pass	Pass
Laboratory tests(2)	Pass	Pass	Pass	Pass

(1) All percentages are mass % of the formulated lubricant. (2) As specified in the ACEA Oil Sequences

Answer : Even if it was assessed that results with slate E were closer to the limits than with slate D in all tests, the testing was successful as the engine test data met the minimum performance standards with passing results in all tests at the first attempt.

Therefore, Slates D and E may be considered as linked slates for the tests which were part of this programme. As the final base oil blends were composed 100% with the tested slates, there will be no limitation in the Group III content that may be interchanged in future application of these linked slates (B.6.1.4).

B.6.2 Using linked slates

B.6.2.1 BOI within linked slates

Once the linking demonstration has been successful in accordance with the guidelines given in B.6.1, base stocks from linked slates may be used interchangeably in all relevant, previously validated formulations provided:

a) all the engine tests and their actual limits, for the corresponding ACEA Categories, were considered in the original linking programme or in complementary linkage maintenance programmes.

b) the formulation development was based on the most severe slate from the linked slates (B.6.2.3).

c) performance additive concentration rates are set at the levels originally used.

d) concentrations of Group I or Group II or Group III base stocks, or both do not exceed those originally approved (B.6.1.4).

Compliance with the requirements of the relevant ACEA Oil Sequences may be claimed for such formulations when using base stocks from a linked slate in place of the original base stocks.

B.6.2.2 Extension of linked slates to others ACEA Oil Categories

Application of the base stock interchangeability between linked slates shall be limited to lubricants relevant to ACEA Oil Categories where the engine test requirements are completely covered in the linkage demonstration.

For other ACEA Oil Categories, the linkage of slates shall be validated on the engine tests that are specific to these Categories. The guidelines given in B.6.1 shall apply for the programme with these engine tests (see examples in B.6.2.5).

The same validation shall be carried out when ACEA updates existing Categories with new engine tests or increased severity of existing ones (B.6.3.1).

B.6.2.3 Development of new engine lubricants with linked slates

The most severe base stock slate from the linked slates identified for each engine test shall be used in development of new engine lubricants to meet existing ACEA Oil Sequences. If, in a particular test in the linking programme, base stocks are observed to have equivalent performance, it is permitted to use any of the base stocks concerned for future development work in that test (see examples in B.6.2.5).

Within any slate, base stock batches shall be selected in accordance with the principle of “representative of typical production” as given in B.6.1.3.

Additive concentration in marketed formulations shall be set at the level established during development as necessary to pass all the relevant qualification tests.

B.6.2.4 Selection of the most severe slate

The most severe base stock slates from the linked slates can be identified experimentally for each engine test by analysis of the linking slate programme results (see examples in B.6.2.5).

Guidelines based on state-of-the-art expertise can also help in selecting the more severe slate that should be applied for different engine tests. Industry experience is described hereafter and offers illustrative, but not exhaustive, guidance that should be considered in selection of base stock slates and batches.

Guidance for more severe base stocks for Group I slates

- **Oxidation engine tests such as the TU-5JP-L4**

  Generally, the higher the sulphur concentration in the base stock, the better the oxidation performance in a hot, dry, oxidation engine tests. For such engine tests, therefore, the most severe Group I base stock, based on sulphur considerations alone, will generally be that with the lowest sulphur concentration within a manufacturer's slate.

  Another important factor to consider is aromatic content when selecting the most severe base stock.

  Group I base stocks can be broadly divided into three categories characterised by whether the sulphur concentration is high, medium or low:

  - High to medium sulphur concentrations usually depend on the source of the crude oil feedstock. For example, Middle East crudes are typically in the high category, whereas those from the North Sea are usually medium.
  - Hydro-processing or hydro-finishing usually result in low sulphur concentrations (for example, < 900 ppm mass fraction).

- **Soot dispersancy engine tests**

  Experience shows that the most severe Group I base stocks in soot dispersancy engine tests such as the Mack T-8E or Cummins ISM are those with the highest concentrations of polar molecules.

  Polar compounds arise from the presence of aromatic molecules and those containing hetero-atoms such as nitrogen and sulphur. The concentration of polar molecules can be measured by IP 368.

  It should be noted that the oxidation engine test and the soot dispersancy engine test will then have opposed severest base stock requirements.

Guidance for more severe base stocks for Group II and Group III slates

- **Oxidation engine tests**

  A higher VI version of a given Group II or Group III base stock slate will normally have a lower concentration of volatile 'light ends' and hence better volatility performance in tests such as the Noack Evaporation Loss test. Other factors being equal, therefore, such base stocks will undergo a lower viscosity increase in an oxidation engine test because of the lower loss of 'light ends'. The most severe base stock in oxidation tests is therefore that with a VI in the lower band.

  As part of good practice when formulating oils for performance in oxidation engine tests, use base stocks with VI in the lower band in the original development.

  Group II and Group III base stocks with VI in the higher band can be used to achieve better cold crank simulator viscosity and volatility performance.

  The performance of a Group II and Group III base stock in oxidation engine tests is also affected by the concentration of saturates (paraffinic and poly-naphthenic molecules). Saturate concentration at a given VI should also be considered when assessing the performance of base stocks in oxidation tests.

- **Wear tests**

  Base stock selection shall be based on the one with the base oil blend of lower possible KV100 within the grade. For example, for OM646LA, it has been demonstrated statistically that, if the base oil viscosity (KV100°C) of the candidate oil is equal to or higher than the tested formulation, the engine test result is equal or better, within the precision of these methods.

B.6.2.5 Examples of using linked slates

Example 1: using Group I linked slates

Slates P, Q and R may be considered as linked slates for the tests that were part of this programme (reported in Table B.1).

Can these linked slates be used interchangeably for lubricants meeting the requirements of ACEA Categories E9? (see Table A.3)

The first step to extend the linkage coverage is to demonstrate that slates P, Q and R are "E9-2016 capable"

As the chemical windows for E7-2016 and E9-2016 and the severity of specific laboratory tests are not the same, it may not be possible to use the E7-2016 program to support that condition.

- If the oils previously run for the E7-2016 linkage program are compatible with E9-2016, no further lab tests are required.
- If t's not the case it's mandatory to run an additional program

In the case further tests are required, slate P, Q, R will have to be used in a E9-2016 environment.

- Some laboratory tests are more severe for E9-2016 than for E7-2016 (HTCBT, Oxidation with biodiesel…) will have to be run to meet the E9-2016 requirements.
- All engine tests necessary for an E9-16 Oil Category were considered and validated during the E7-2016 program, except for OM646 bio. Consequently, the extension of the linkage requires a complementary testing programme with the three slates on OM646bio in an E9 formulation.

Therefore, it's only when those extra validations and tests will be complete that slates P, Q and R will also be declared interchangeable for E9 lubricants.

Can these linked slates be used interchangeably for lubricants meeting the requirements of ACEA Categories A5/B5? (see Table A.2)

The engine tests necessary to qualify for an ACEA A5/B5-16 Category are the same, with same severity, as for A3/B4-16 plus a Fuel Economy test M111. The linking programme was based on a A3/B4 formulation with all engine tests validated. Therefore, extension of interchangeability to A5/B5 requires a complementary testing programme with the three slates on M111 in an A5/B5 formulation.

How to choose the more severe slates for development of new light duty and heavy-duty engine oils meeting ACEA specifications?

In this example, it was assessed that it was necessary to repeat the Seq VG test on oil #6 (with slate R) and the Mack T-8E test on oil #1 (with slate P). It follows that:

- Slate P base stocks are the most severe in Mack T-8E testing between these three slates.
- Slate R base stocks are the most severe in Sequence VG testing between these three slates.

In all other tests, the performance of each base stock was considered equivalent.

For any new development of light duty lubricant, P, Q and R slates can be used equally on all tests except on Sequence VG, which shall be run with slate R.

If M111 test is necessary, run it on the three slates, because it was not part of the initial linkage programme. If all the results pass, this may be considered as the demonstration that the linkage applies also to M111 test for future needs.

For any new development of heavy-duty lubricant, P, Q and R slates can be used equally on all tests except on Mack T-8E, which shall be run with slate P.

Example 2: Using Group III linked slates

Slates D and E may be considered as linked slates for the tests that were part of this programme (reported in Table B.2).

Can these linked slates be used interchangeably for lubricants meeting the requirements of ACEA Categories E9? (see Table A.3)

The engine tests necessary to qualify for an ACEA E9-16 Category are the same, plus a wear test Cummins ISM. The linking programme was based on a E6 formulation, with all engine tests validated. Therefore, extension of interchangeability to E9 requires a complementary testing programme with the two slates on Cummins ISM in an E9 formulation. Also need to ensure the more stringent limits for the Mack T12 and OM 646 Bio are met.

> *Note B.3: Considering OM646LA and OM501LA tests, their limits in ACEA 2016 Oil Sequences are more severe for E6 Category than for E9 Category. Therefore, if the linkage programme had been run on a E9 Category rather than a E6, the interchangeability extension from E9 to E6 Category should have required both tests to be re-run in an E6 formulation with the most severe slate for these tests.*

Can these linked slates be used interchangeably for lubricants meeting the requirements of ACEA Categories C2? (see Table A.2)

The engine tests necessary to qualify for an ACEA C2-16 Category are the same, with same limits, as for C3-16 Category except that M111 test has a more severe limit in C2 and VW TDI has a more severe limit in C3. The linking programme was based on a C3 formulation with all engine tests validated. Therefore, extension of interchangeability to C2 needs to re-run only a M111 test in a C2 formulation with the most severe slate for this test versus the C2 specified limit.

How to choose the more severe slates for development of new light duty and heavy-duty engine oils meeting ACEA specifications?

In this example, it was assessed that the results with slate E were closer to the limits than with slate D in all tests. It follows that slate E is more severe than slate D.

For any new development of light duty lubricant, use slate E as it is the more severe between the linked slates.

For any new development of heavy duty lubricant, use slate E as it is the more severe between the linked slates.

If a Cummins ISM test is necessary, run it on the two slates, because it was not part of the initial linkage programme. If all the results pass, this may be considered as demonstration that the linkage applies also to Cummins ISM test for future needs.

B.6.3 Maintaining the status of linked slates

B.6.3.1 New and revised ACEA Oil Sequences

For new tests or tests with increased severity, the linked status shall be reconfirmed in accordance with the guidelines in B.6.1.

For each new test, the impact of base stocks on lubricant performance shall be assessed to identify the most severe base stock slate to be used in product development involving such tests.

For example, if base stock slates E and F have been linked for C3-2016, with the implementation of C3-2021, extra Seq VH, Seq IVB and M271EVO tests may be required on those two slates in a C3-2021 formulation to maintain the linkage.

B.6.3.2 Adding a new base stock or a new slate to the linked slates

If a new base stock is to be added to a linked base stock slate, experts shall assess the testing, if any, that needs to be carried out to confirm interchangeability.

Apply the guidelines given in B.6.1 guidelines, based on a test-by-test comparison of this new slate with the most severe one within the existing linked slates.

B.6.3.3 Changes in the slate quality

If the base stock quality changes for one of the linked slates, the base stock manufacturer shall inform the parties involved (i.e., the lubricant marketers and/or the lubricant manufacturers and/or members in the partner group) so that the experts can assess the testing, if any, that needs to be carried out to confirm if this modified slate can still be part of the linkage.

Appendix C

Performance Data Set requirements

Issue Number 22, October 2021

This issue supersedes all previous issues.
All new engine lubricant developments initiated after the date of this issue must use this issue.

C.1 Introduction

This Appendix contains checklists and ACEA Performance Data Set forms that may be used to ensure correct documentation of ACEA performance claims.

All lubricant marketers are required to prepare an ACEA Performance Data Set for each formulation making an ACEA performance claim. An example is given in Form C.3. This Data Set is derived from the Candidate Data Package and, if appropriate, the Programme Extension Data, as described in 6.1; the Candidate Data Package and any additional programme extension data contain a complete record of each test development programme conducted under the Code and is required to confirm the performance of an engine lubricant against the relevant ACEA Oil Sequence(s).

Form C.1 Candidate Data Package checklist for ACEA Oil Sequence conformance

Form C.2 Programme Extension Data checklist for ACEA Oil Sequence conformance

Form C.3 ACEA Performance Data Set for ACEA Oil Sequence qualification

Part A: Details of lubricant marketer and engine lubricants

Part B: Laboratory tests

Part C: Engine test results

Part D: Qualification conformance

Form C.1 Candidate Data Package checklist for ACEA Oil Sequence conformance

Conducted by:

Additive package designation:

Viscosity grades:

Lubricant codes:

ATC data package reference number (if available):

	Included in this Data Package	Yes	No
1	Laboratory tests for formulations listed above	☐	☐
2	Formulations for all test lubricants	☐	☐
3	Results of all registered ASTM, JASO and CEC engine tests	☐	☐
4	Test declared 'out of control'	☐	☐
5	Test(s) declared 'not available'	☐	☐
6	Applicable test stand reference data	☐	☐
7	Properties and identity of base stocks used	☐	☐
8	Formulation modifications and read-across documentation	☐	☐
9	Test programme design document	☐	☐

Signed on behalf of (company):

Function:

Authorised name:

Authorised signature:

Date:

Company reference document number:

Form C.2 Programme Extension Data checklist for ACEA Oil Sequence conformance

Checklist for engine lubricant development programme		
Lubricant Code(s): **Viscosity grade(s) covered by this Data Package:**		
Included in this Data package	**Yes**	**No**
1 Form C.1 completed	☐	☐
For formulations developed in the programme extension		
2 Formulations for all test lubricants	☐	☐
3 Results of all laboratory tests on the final candidates	☐	☐
4 Results of all registered ASTM, JASO and CEC engine tests	☐	☐
5 Test has been declared 'out of control'	☐	☐
6 Test(s) declared 'not available'	☐	☐
7 Applicable test stand reference data	☐	☐
8 Properties and identity of base stocks used	☐	☐
9 Read-across documentation (VGRA, VMI, BOI)	☐	☐
Signed on behalf of (company): **Function:** **Authorised Name:** **Authorised Signature:** **Date:** **Company reference document number:**		

COMPANY LOGO OR STAMP	COMPANY CONFIDENTIAL INFORMATION

1.2.1.1.1.1. Form C.3 ACEA performance data set for ACEA Oil Sequence qualification

Part A Details of the lubricant marketer and engine lubricants	
Details of lubricant marketer	
Company:	
Address:	
Contact Person:	Function:
Phone No:	Fax No:
Email address:	
Lubricant details	
Brand Name:	SAE J300 viscosity grade:
Lubricant Code Number:	ACEA performance(1):
Details of any rebrands	
Brand Name(s):	
(1) List each applicable ACEA Oil Sequence category	
Company Document Ref. No.	

COMPANY LOGO OR STAMP	COMPANY CONFIDENTIAL INFORMATION

Form C.3 ACEA Performance Data Set for ACEA Oil Sequence qualification

Part B Laboratory tests

Laboratory test	Parameter	Test method	Units	Test result	Limits
SAE Viscosity	Kinematic viscosity at 100 °C Low-temperature cranking viscosity Low-temperature pumping viscosity	ASTM D445 ASTM D5293 ASTM D4684	mm^2/s mPa.s mPa.s		
Shear Stability	Viscosity after 30 cycles measured at 100 °C	CEC L-14-93 Or ASTM D6278 Or ASTM D7109	mm^2/s		
Shear Stability	Viscosity after 90 cycles measured at 100 °C	ASTM D7109	mm^2/s		
HTHS Viscosity	Viscosity at 150 °C and 10^6 s^{-1} shear rate Viscosity at 100 °C and 10^6 s^{-1} shear rate	CEC L-36-A-90	mPa.s mPa.s		..... Report
Evaporative loss	Weight loss after 1 h at 250 °C	CEC L-40-93 Procedure B	mass %		
TBN		ASTM D2896 ASTM D4739	mg KOH/g		
Sulphur		ASTM D5185 Or ASTM D4951	mass %		
Phosphorus		ASTM D5185 Or ASTM D4951	mass %		
Sulphated Ash		ASTM D874	mass %		
Chlorine		ASTM D6443	mass %		
Oil/Elastomer Compatibility	Max. variation of characteristics after immersion for 7 days in fresh oil without pre-ageing RE-6 Tensile strength Elongation at rupture Volume variation RE-7 Tensile strength Elongation at rupture Volume variation RE-8 Tensile strength Elongation at rupture Volume variation RE-9 Tensile strength Elongation at rupture Volume variation	CEC L-112-16	 % % % % % % % % % % % %		 Report -70 / +20 Report -65 / +15 Report -51 / + 9 Report -65 / +19
Foaming Tendency	Tendency - stability	ASTM D892 Seq. I (24 °C) Seq II (94 °C) Seq. III (24 °C)	 mL mL mL		 10 - nil ..... 10 - nil

High Temp Foaming	Tendency - stability	ASTM D6082 Seq. IV(150 °C)	mL		100 - nil
Oil Oxidation with Biodiesel for Engine Oils operating in the presence of Biodiesel Fuel	Oil Oxidation @ 168h (DIN 51453) Oil Oxidation @ 216h (EOT) (DIN 51453) Viscosity Increase, relative at 168h (Delta KV100) Viscosity Increase, relative at 216h (Delta KV100 at EOT 216h)	CEC L-109-14	A/cm A/cm % %		
Oxidation	Oxidation Induction time (PDSC)	CEC-L-085-99	min		
Low temperature pumpability	MRV Yield stress (MRV at SAE J300 temperatures applicable for the fresh oil viscosity grade)	CEC-L-105-12	mPas Pa		
Corrosion	Copper increase Lead increase Copper strip rating	ASTM D6594	ppm ppm max		
Company Document Ref. No.					

COMPANY LOGO OR STAMP	COMPANY CONFIDENTIAL INFORMATION

Form C.3 ACEA performance data set for ACEA Oil Sequence qualification

Part C Engine test results – light duty engines

Engine test	Parameter	Test method	Units	Test result	Ref. oil result	Limits
EP6CDT	Piston Cleanliness Turbo charger deposits	CEC L-111-16	merit merit			
Sequence IVB	Average intake lifter volume loss (8 position average) End of test Iron	ASTM D8350	mm^3 ppm			
Sequence VH	Average engine sludge Rocker cover sludge Average piston skirt varnish Average engine varnish Compression ring (hot stuck) Oil screen clogging	ASTM D8256	merit merit merit merit % 			≥ 7.6 ≥ 7.7 ≥ 8.6 ≥ 7.6 none Report
M271 EVO	Engine sludge, average	CEC L-107-19	merit			≥ 8.3
M111	Fuel economy improvement vs reference oil RL 191 (SAE 15W-40)	CEC L-54-96	%			
JASO FE	Fuel economy improvement	JASO FE M366 (Toyota 2ZR-FXE)	%			≥ 0.0
TOYOTA 1KD-FTV	Turbo Charger Compressor Deposit	CEC L-114-19	merit			≥ 25
Sequence IX	Low Speed Pre-Ignition events Average number for 4 iterations Number of events per iteration	ASTM D8291	 Number Number			 ≤ 5 ≤ 8
Sequence X	Chain wear GDI Elongation of timing chain	ASTM D8279	 %			 ≤ 0.085
Company Document Ref. No.						

COMPANY LOGO OR STAMP	COMPANY CONFIDENTIAL INFORMATION

Form C.3 ACEA performance data set for ACEA Oil Sequence qualification

Part C Engine test results - light-duty diesel engines

Engine test	Parameter	Test method	Units	Test result	Ref. oil result	Limits
DV6C	Absolute viscosity increase at 100 °C and 5.5 % soot Piston merit	CEC L-106-14	mm^2/s merit			≤ 0.9xRL248 ≥ 2.5
VW TDI	Piston cleanliness Cylinder-spreading limit No ring sticking, max for any ring	CEC L-117-20	merit merit ASF			≥ RL276 – 5 ≤ 13 0
Company Document Ref. No.						

COMPANY LOGO OR STAMP	COMPANY CONFIDENTIAL INFORMATION

Form C.3 ACEA performance data set for ACEA Oil Sequence qualification

Part C Engine test results - heavy-duty diesel engines

Engine test	Parameter	Test method	Units	Test result	Ref. oil result	Limits
OM646LA		CEC L-099-08				
	Cam wear inlet, average		µm			
	Cam wear outlet, average		µm			
	Tappet wear inlet, average		µm			
	Tappet wear outlet, average		µm			
	Cylinder wear, average		µm			
	Piston cleanliness		merit			
	Bore polishing (13 mm) max value		%			
	Engine sludge, average		merit			
Mack T8-E	Relative viscosity at 4.8 % soot	ASTM D5967				
	1st test					≤ 2.1
	2 test average					≤ 2.2
	3 test average					≤ 2.3
Mack T-11	Min TGA soot @ 4 cSt		%			
	Min TGA soot @ 12 cSt		%			
	Min TGA soot @ 15 cSt		%			
OM501LA		CEC L-101-08				
	Piston cleanliness		merit			
	Bore polishing		%			
	Oil consumption		kg/test			
	Engine sludge		merit			
Cummins ISM		ASTM D7468				
	Merit		Merit			
	Crosshead, weight loss					
	1 test/2 test/3 test average		mg			
	Oil Filter Diff. Press at 150 h					
	1 test/ 2 test/3 test average		kPa			
	Engine sludge					
	1 test/2 test/3 test average		merit			
	Adj. screw weight loss		mg			
Mack T-12	Merit	ASTM D7422				
	Average Liner wear		µm			
	Average top ring weight loss		mg			
	End of test lead concentration, mass fraction		ppm			
	Delta lead 250-300 h, mass fraction		ppm			
	Oil consumption phase 1		g/h			
OM646LA BIO		CEC L-104-16				
	Piston cleanliness		merit			
	Ring sticking		ASF			
	Sludge		merit			
Company Document Ref. No.						

COMPANY LOGO OR STAMP	COMPANY CONFIDENTIAL INFORMATION

Form C.3 ACEA performance data set for ACEA Oil Sequence qualification

Part D Qualification conformance
I hereby attest to using and satisfying the guidelines as defined in ATIEL Code of Practice. Name of Authorised Company Representative: Function: Phone no: Email address: Signature of Authorised Company Representative: Date: Company document reference no:

Appendix D

Templates for Letters of Conformance

Issue Number 22, October 2021

This issue supersedes all previous issues.
All new engine lubricant developments initiated after the date of this issue must use this issue.

Form D.1 Template for the EELQMS Lubricant marketers' Letter of Conformance

(Letter to be sent by e-mail in digital, scanned "PDF"-format to: administrator@sail-europe.eu)

EELQMS
EUROPEAN ENGINE LUBRICANTS QUALITY MANAGEMENT SYSTEM

SAIL
Rue Belliard 40
1040 Brussels
Belgium

From: [Company name]

[Insert current address]

[Insert nominated e-mail address for correspondence][D.1]

Date:

Subject: Participation in the ATIEL European Engine Lubricants Quality Management System: Letter of Conformance

[Name of the participating company], hereinafter referred to as "The Company", duly represented by the undersigned acting for The Company and entities acting under its brand, hereby formally declares to participate in the European Engine Lubricants Quality Management System (EELQMS).

The commitments referred to in this letter apply to all product brands owned or managed by The Company that make ACEA claims:
Please list the brands below #*

*The list should include just the generic brand names over which the company has control and/or ownership and not all product names.

Manufacturers who manufacture products for brands that are owned and managed by separate, independent marketers should not include these brands in the list.

In this respect, for lubricants marketed under the aforementioned brands, that it develops and/or manufactures, The Company undertakes to:

- apply the EELQMS guidelines, and the guidelines of the ATIEL Code of Practice, to develop and manufacture those engine lubricants for which compliance with ACEA Oil Sequences requirements will be claimed;
- inform its auditors of its agreement to implement the EELQMS;
- ensure that its ISO 9001 or equivalent procedures include conformance with the ATIEL Code of Practice and to identify these procedures to ISO 9001 (or equivalent) auditors;
- provide such auditors with the relevant copy(ies) of the ATIEL Code of Practice;
- in case the development process, or parts thereof, are conducted by a third party, require that this third party will apply the EELQMS guidelines, and the guidelines of the ATIEL Code of Practice, to ensure the independent audit of the development process;
- in case the lubricants are manufactured by a third party, require and ensure that this third party complies with the quality requirements for blending included in the ATIEL Code of Practice.

For lubricants that are developed and manufactured by third parties for marketing under its own aforementioned brand(s), The Company remains solely responsible for compliance defined in this letter. In this respect, The Company undertakes to:

- require and ensure that the third parties that are involved in the development process or parts thereof do apply the EELQMS guidelines and the guidelines of the ATIEL Code of Practice, and preferably have signed the lubricant marketers' Letter of Conformance themselves.
- require and ensure that the third parties that are involved in manufacturing or blending processes comply with the quality requirements for blending included in the ATIEL Code of Practice.

The commitments referred to in this letter will be valid for the calendar year of the registration. The Company is entitled to withdraw from its EELQMS commitments at any time prior to that date, by registered letter to SAIL. Re-validation of the participation in the EELQMS is possible for each subsequent calendar year via SAIL on the basis of the standard Letter of Conformance applicable at that time.

The Company mandates ATIEL to:

- include its company name in the List of Participants in the EELQMS which will be made available by ATIEL to any interested party and published on the SAIL website (www.sail-europe.eu).

The Company agrees that:

Any data provided in confidence to the Company on its products in connection with ATIEL's quality surveys:

- remains the property of ATIEL;
- is only for use in resolving any issues with compliance; *and*
- is therefore not to be used for marketing purposes or external presentations.

The Company is solely responsible for compliance with the obligations defined in this letter. It must not assert, in any way, that any of its automotive lubricants or related products qualify under the ACEA Oil Sequences, unless all tests and analyses of such products carried out prove that they merit the claimed qualifications of the ACEA Oil Sequences and have been performed in strict compliance with and observance of all applicable or relevant procedures.

[Insert signature]

[D1] Future versions of the ATIEL Code of Practice will be uploaded to the ATIEL website and on SAIL website. In addition, SAIL will send a notification to an email address nominated by each signatory of the ATIEL Letters of Conformance. This email address will also be used for provision of additional information relating to the Code.

Form D.2 Template for the Base Stock Manufacturers' Letter of Conformance

(Letter to be sent by e-mail in digital, scanned "PDF"-format to: administrator@sail-europe.eu*)*

SAIL
Rue Belliard 40
Brussels B 1040
Belgium

From: Company name

[Insert current address]

[Insert nominated e-mail address for correspondence][D1]

Date: *[Insert date]*

Subject: ATIEL Base Stock Quality Assurance Guidelines:
Letter of Conformance

[Name of participating company] hereinafter referred to as "The Company", hereby declares its undertaking to implement the ATIEL Guidelines for Base Stock Manufacturers' Quality Assurance as described in Appendix B of the ATIEL Code of Practice.

For the purposes of this Letter of Conformance, The Company represents all associated companies operating under its brand and is duly represented by the undersigned.

The Company in particular undertakes to:

- inform its auditors of its agreement to implement the ATIEL Guidelines for base stock quality assurance and interchange;
- ensure that its ISO 9001 or equivalent procedures include conformance with the ATIEL Code of Practice and to identify these procedures to ISO 9001 (or equivalent) auditors;
- provide such auditors with the relevant copy(ies) of Appendix B of the ATIEL Code of Practice;
- apply the ATIEL Guidelines for Base Stock Manufacturers' Quality Assurance to the production of base stocks by The Company where such base stocks are intended for use in lubricants for which compliance with ACEA Sequences is to be claimed;
- ensure that, where base stocks produced by a third party are re-branded for sale under the brand of The Company and where such base stock are intended for use in lubricants for which compliance with ACEA Sequences will be claimed, the third party concerned has: (a) applied the ATIEL Base Stock Quality Assurance Guidelines to the production of the base stocks supplied and (b) has itself submitted a letter of conformance to ATIEL.

It is understood by The Company that the commitments referred to above:

- will remain valid for the calendar year in which the LoC was registered.

- may be extended for further annual periods by re-validating the Letter of Conformance based on the template letter current at that time.
- may be cancelled at any time by notifying SAIL by registered mail of the withdrawal of any or all of the undertakings made in this Letter of Conformance.

The Company hereby agrees that ATIEL may include its name in a list of companies that have agreed wholly or in part to implement Appendix B of the ATIEL Code of Practice. This list may be made available to ATIEL members or to any interested party and published on the SAIL website (www.sail-europe.eu).

The Company further agrees that it is solely responsible for compliance with the undertakings it makes in this letter. It must not assert, in any way, that base stocks have been produced in compliance with Appendix B of the ATIEL Code of Practice unless all relevant procedures and test have been carried out.

[Insert signature]

Important note:

Base stock manufacturers signing this Letter of Conformance must ensure that all elements of the guidelines are fully implemented from the date of signing the letter.

[D1] Future versions of the ATIEL Code of Practice will be uploaded to the ATIEL website and on the SAIL website. In addition, SAIL will send a notification to an email address nominated by each signatory of the ATIEL Letters of Conformance. This email address will also be used for provision of additional information relating to the Code.

Form D.3 Template for the EELQMS lubricant marketers' derogation from the Letter of Conformance

To: ATIEL ASBL

Rue Belliard 40
Brussels B 1040
Belgium

From: Company name

[Insert current address]

[Insert nominated e-mail address for correspondence][D1]

Subject: Lubricant marketers' Derogation from the Letter of Conformance

[Name of the participating company], hereinafter referred to as "The Company", duly represented by the undersigned acting for The Company and entities acting under its brand, hereby formally declares that, in accordance with the provisions detailed in Appendix A.5 of the ATIEL Code of Practice (hereinafter referred to as Appendix A), it is applying the temporary, emergency derogation of the base stock interchange guidelines as described in Section 6.5. In this respect, *[Name of the participating company]* confirms that:

- the derogation is effective from the date of manufacture of [*date*] and will be withdrawn on the date of manufacture of [*date*], with a maximum period of ninety days;
- the derogation arises from a shortage of base stock beyond the company's control and is as a consequence of a situation of *force majeure*, as defined in A.5.2 of Appendix A;
- the derogation is not as a consequence of commercial hardship, as defined in A.5.2.of Appendix A;
- the use of this derogation is a last resort, all other alternatives having been rigorously pursued and documented;
- It is solely responsible for the quality of affected products and the claims made for them when invoking this derogation;
- the derogation does not change the self-certifying nature of ACEA performance claims;
- ATIEL has no responsibility for any issues or claims arising from the use of this derogation;
- the attention of the internal and external auditors will be drawn to the use of this derogation and all necessary data requested as part of any such audit will be provided;
- a report will be sent to the ATIEL Secretary General every thirty days on the steps being taken to rectify the material impossibility and steps being taken to add missing results to the data package;
- the quality of the product to be marketed is sufficient to support the claims made for it;
- the derogation does not take any responsibility for OEM performance claims made on products impacted by this derogation;
- attached to this letter is supporting evidence, as detailed in A.5.4.d) to g) of Appendix A, of the *force majeure* situation, the actions already taken to find alternative sources of base stocks, an explanation of why the current base stock interchange guidelines cannot be applied, and the specific relaxation proposed for subject formulations;

- if passing engine test data carried out as detailed in A5.5 f) of Appendix A is not obtained, it must cease making use of this derogation and will inform ATIEL Secretary General of the cessation date.

In addition, The Company confirms that it has created a database as detailed in A.5.5 of Appendix A providing details of:

- all missing test data and test work planned to close any gaps;
- the base stocks currently used to comply with the ATIEL Code of Practice and the alternatives proposed under this derogation;
- all products and re-brands impacted by the use of this derogation together with marketing territories and channels of trade;
- chemical and physical data and bench test results for base stocks and finished products using the current and proposed base stocks;
- evidence of performance claims (and proposed changes) made for impacted products in labels and product data sheets;
- engine test data to support the claims to be made, highlighting gaps in the data set, together with a plan and time line to show that the missing data will be obtained and then reported;
- The corrective actions taken if passing engine test data carried out as detailed in A.5.5 f) of Appendix A is not obtained;

The Company mandates ATIEL to:

- include its company name and the period of the derogation involved in a list of those applying this derogation and to make this list available to any interested party (including ACEA) by publishing it on the ATIEL website.

The Company is solely responsible for compliance with the obligations defined in this letter.

[Insert signature]

[D1] Future versions of the ATIEL Code of Practice will be uploaded to the ATIEL website and on the SAIL website. In addition, SAIL will send a notification to an email address nominated by each signatory of the ATIEL Letters of Conformance. This email address will also be used for provision of additional information relating to the Code.