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Draft new Regulation on uniform provisions concerning the approval of specific LPG (liquefied petroleum gases) or NG (compressed natural gas/bio-methane/liquefied natural gas) dual fuel retrofit systems to be installed in heavy duty vehicles, agricultural and forestry tractors and non road mobile machinery equipped with Compression Ignition engines.

Submitted by the experts from AEGPL

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Regulation No. xx

Draft new Regulation on uniform provisions concerning the approval of specific LPG (liquefied petroleum gases) or NG (compressed natural gas/bio-methane/liquefied natural gas) dual fuel retrofit systems to be installed in heavy duty vehicles, agricultural and forestry tractors and non road mobile machinery equipped with Compression Ignition engines.

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1. Purpose

This regulation provides a harmonized method for the classification, evaluation and approval of dual fuel retrofit systems for specific use of LPG or NG (compressed natural gas/bio-methane/liquefied natural gas) in heavy duty vehicles, agricultural and forestry tractors and non road mobile machinery¹ equipped with Compression Ignition engines.

2. Scope

2.1. This Regulation applies to

- (a) specific LPG retrofit systems for use of LPG (liquefied petroleum gases)
 - (b) specific NG retrofit systems for use of CNG (compressed natural gas or biomethane) or LNG (liquefied natural gas)
- to allow dual fuel operation of compression ignition engines.

2.2 This Regulation applies to dual fuel retrofit systems intended to be fitted on vehicles of categories M1 with mass exceeding 2610kg, M2, M3 and N², with the exception of:

- (a) Vehicles type-approved pursuant to Regulation No. 83
- (b) Vehicles with engines type-approved pursuant to Regulation No. 49, 00 or 01 or 02 series of amendments,
- (c) Vehicles with engines type-approved pursuant to Regulation No. 49, 03 or 04 or 05 series of amendments, in accordance with row A of table 1 and 2 of par. 5.2.1. of the those regulation,
- (d) Vehicles type-approved pursuant to EC Directive 70/220/EEC,
- (e) Vehicles with engines type-approved pursuant to EC Directive 88/77/EEC up to and including the amending Directive 96/1/EC.
- (f) Vehicles with engines type-approved pursuant to EC Directive 88/77/EEC including the amending Directive 2001/27/CE, in accordance with row A of table 1 and 2 of par. 6.2.1. of the same directive,
- (g) Vehicles with engines type-approved pursuant to EC Directive 2005/55/EC in accordance with row A of table 1 and 2 of par. 6.2.1. of the same directive.

3. Definitions

For the purposes of this Regulation the definitions listed in par. 2 of annex 11 of regulation no. 49 05 series of amendment and par. 2 of annex 15 of regulation no. 49 06 series of amendment shall apply.

The following definitions also apply:

¹ Provisions for agricultural and forestry tractors and non road mobile machinery are not implemented yet. Therefore the approval of a retrofit system intended to be fitted in these applications according to the present regulation is not allowed and is subjected to the drafting of these provisions.

² -As defined in Annex 7 to the Consolidated Resolution on the Construction of Vehicles (R.E.3), (document TRANS/WP.29/78/Rev.1/Amend.2, as last amended by Amend.4).

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- 3.1. “*Heavy duty engine application*” means an heavy duty vehicle, agricultural and forestry tractor and non-road mobile machinery, as specified in the scope of the present regulation, using an heavy duty diesel engine for its operation.
- 3.2. “*Diesel mode*” means the operating mode of a dual-fuel engine during which the engine does not use any gaseous fuel for any engine operating condition.
- 3.3. “*Dual fuel mode*” means the operating mode of a dual-fuel engine during which the engine simultaneously uses diesel fuel and a gaseous fuel at some engine operating conditions.
- 3.4. “*Heavy Duty Dual Fuel (HDDF) retrofit system*” means a retrofit system intended to be installed in heavy duty engine applications permitting the operation in dual fuel mode.
- 3.5. “*Specific Heavy Duty Dual Fuel (HDDF) retrofit system*” means HDDF retrofit systems which do not differ in such respect as:
- 3.5.1. System manufacturer (responsible for retrofit approval application);
- 3.5.2. Dual fuel retrofit system type
- 3.5.3. Pressure regulator/vaporiser type by the same manufacturer;
- 3.5.4. Gas fuelling system type by the same manufacturer (i.e. induction mixer, injector device, vapour or liquid, single or multi-point injection system);
- 3.5.5. Sensors and actuators set types;
- 3.5.6. The fuel container type (i.e. LPG liquid take off / vapour pressure, LPG vapour take off, LPG liquid take off / pressurized by pump, pressurized CNG take off), the safety devices and fuel container accessories, as required by Regulation No. 67, 01 series of amendments, or Regulation No. 110, where applicable (i.e. relief valve);
- 3.5.7. Fuel container fitting devices;
- 3.5.8. ECU type by the same manufacturer;
- 3.5.9. Basic software principles and control strategy;
- 3.5.10. Installation manual;
- 3.5.11. End-user manual.
- 3.6. “*Dual-fuel engine*” means an engine that, after the installation of an HDDF retrofit system, can simultaneously operate with diesel fuel and a gaseous fuel, both fuels being metered separately, where the consumed amount of one of the fuels relative to the other one may vary depending on the operation.
- 3.7. “*Dual fuel retrofit system type*” means the dual fuel type as defined in par 2. of annex 11 of regulation 49 05 series of amendments or par. 2. of annex 15 of regulation 49 06 series of amendments, as applicable, resulting from the operation of the HDDF retrofit system installed on the parent engine.
- 3.8. “*System manufacturer*” means the person or body who is responsible to the approval authority for all aspects of the type-approval of the retrofit system and for ensuring conformity of production.
- 3.9. “*Original engine*” means an engine before the installation of the HDDF retrofit system.

- 3.10. “*The engine family*” is a set of engines sharing relevant characteristics regarding the installation and the operation of the retrofit system. The family definition is based on the original engine characteristics.
- 3.10.1 “*The parent engine*” means an engine that is selected to act as the engine, on which the requirements of this Regulation are going to be demonstrated, and to which the members of a family refer.
- 3.10.2. “*A member of the family*” is an engine belonging to the same family of the parent engine.
- 3.11. “*Application range*” means the set of engines on which the type approved HDDF LPG and NG retrofit system can be installed.
- 3.12. “*Installer*” means an organization which can assume technical responsibility for the correct and safe installation of the approved HDDF LPG and NG retrofit system, in conformity with respectively paragraphs 6.1.1.3. and 6.2.1.3. of this Regulation.
- 3.13. “*Engine baseline emission*” means the emissions of a given engine or engine system without the retrofit system.
- 3.14. “*Engine system*” means the engine, the emission control system and the communication interface (hardware and messages) between the engine system electronic control unit(s) (ECU) and any other powertrain or vehicle control unit;
- 3.15. “*ESC*” means a test cycle consisting of 13 steady state modes to be applied in accordance with the relevant series of amendments to Regulation No. 49;
- 3.16. “*ETC*” means a test cycle consisting of 1800 second-by-second transient modes defined in, and to be applied in accordance with the relevant series of amendments to Regulation No. 49;
- 3.17. “*Scan-tool*” means an external test equipment used for off-board communication with the NCD system.
- 3.17.1 “*Generic scan-tool*” means a scan-tool, which is publicly available, and which shall be capable to read failure messages.
- 3.17.2. “*Proprietary scan-tool*” means a scan-tool, which is used only by the REC manufacturer and its authorized dealership, and which shall be capable to read failure messages and to enable an engine start after activation of the operator inducement system.
- 3.18. “*WHSC*” means a test cycle consisting of 13 steady state modes defined in, and to be applied in accordance with the relevant series of amendments to Regulation No. 49;
- 3.19. “*WHTC*” means a test cycle consisting of 1800 second-by-second transient modes defined in, and to be applied in accordance with the relevant series of amendments to Regulation No. 49;
- 3.20. “*Euro IV engine*” means an engine approved regarding exhaust emissions according to row B1 of table 1 and 2 of par. 5.2.1. of regulation 49 03, 04 or 05 series of amendments, or according to row B1 of table 1 and 2 of par. 6.2.1. of Directive 88/77/EEC including the amending Directive 2001/27/CE.
- 3.21. “*Euro V engine*” means an engine approved regarding exhaust emissions according to row B2 of table 1 and 2 of par. 5.2.1. of regulation 49 03, 04 or 05 series of amendments, or according to row B2 of table 1 and 2 of par. 6.2.1 of Directive 88/77/EEC including the amending Directive 2001/27/CE.

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- 3.22. “*EEV engine*” means an engine approved regarding exhaust emissions according to row C of table 1 and 2 of par. 5.2.1. of regulation 49 03, 04 or 05 series of amendments, or according to row C of table 1 and 2 of par. 6.2.1 of Directive 88/77/EEC including the amending Directive 2001/27/CE.
- 3.23. “*Euro VI engine*” means an engine approved regarding exhaust emissions according to regulation 49 06 series of amendments.

4. Application for approval

- 4.1. The application for type approval of a specific retrofit system shall be submitted by the system manufacturer or by his duly accredited representative.
- 4.2. It shall be accompanied by the under-mentioned documents in triplicate and by the following details:
- 4.2.1. Description of the retrofit system comprising all the relevant details, included the approval numbers of each component referred to in Annex 7A to this Regulation for LPG system and Annex 7B to this Regulation for NG system;
- 4.2.2. Description of the parent engine on which the requirements of this Regulation are going to be tested;
- 4.2.3. Description of all modifications applied to the original parent engine;
- 4.2.4. Verification of compliance with the specifications prescribed in paragraph 6 of this Regulation;
- 4.3. Installation manual(s) for the HDDF retrofit system.
- 4.4. End-user manual.
- 4.5. A sample of the specific retrofit system, properly installed in the parent engine application(s).

5. Markings and labels

- 5.1. The sample(s) of a specific retrofit system submitted to type approval shall be accompanied by a plate or its drawing with the trade name or mark of the retrofit manufacturer and the type, as indicated in Annexes 6A and 6B.
- 5.2. All retrofit systems, installed in the vehicle belonging to the family, as defined in paragraph 2., shall be identified by a plate, in which the approval number, and the technical specifications, as required in Annexes 6A and 6B shall be placed. This plate has to be permanently fixed to the structure of the vehicle and shall be clearly readable and indelible.

6. Approval

- 6.1. An approval number shall be assigned to each type of the retrofit system approved. Its first two digits (at present 00 according to the Regulation in its original form) shall indicate the series of amendments incorporating the most recent major technical amendments made to the Regulation at the time of issue of the approval. The same Contracting Party shall not assign the same type approval number to another type of retrofit system.

- 6.2. Notice of approval or of refusal or of extension of approval of a retrofit system type/part pursuant to this Regulation shall be communicated to the Parties to the Agreement applying this Regulation, by means of a form conforming to the model in Annexes 5A and 5B to this Regulation.
- 6.3. An international approval mark shall be affixed in the plate as indicated in Annexes 6A and 6B, to all retrofit systems, conforming to a type approved under this Regulation, in addition to the mark prescribed in this paragraph 5.2. This approval mark shall consist of:
- 6.3.1. A circle surrounding the letter “E” followed by the distinguishing number of the country which has granted the approval;
- 6.3.2. The number of this Regulation, followed by the letter “R”, a dash and the approval number to the right of the circle defined in paragraph 5.5.1. The approval number consists of the retrofit system type approval number, which appears in the communication form for this type (see paragraph 5.2. and Annexes 6A and 6B) preceded by two figures indicating the latest series of amendments to this Regulation.
- 6.4. The approval mark shall be clearly readable and be indelible.
- 6.5. Annexes 6A and 6B to this Regulation give examples of the arrangement of the aforesaid plate with approval mark.
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7. Conformity of production

The conformity of production procedures shall comply with those set out in the 1958 Agreement, appendix 2 (E/ECE/324 - E/ECE/TRANS/505/Rev.2).

8. Modification and extension of approval of a HDDF retrofit system

- 8.1. Every modification relevant in the context of this Regulation of the retrofit system shall be notified to the authority, which granted the type approval. The authority will then assess whether or not the retrofit system still complies with the requirements for inclusion in the appropriate family.
- The authority may require a further test report from the technical service responsible for conducting the tests in order to assist in its assessment.
- 8.2. Any modification or extension of the application range, as defined in par. **XX**, is dealt with as a modification or extension of the type approval of the HDDF retrofit system
- 8.3. Where the type-approval authority approves the modification, a reference to the formal notification of that approval shall be included in the installation manual for the retrofit system.
- 8.4. Confirmation or refusal of approval, specifying the alteration, shall be communicated by the procedure specified in paragraph 6 above to the Parties to the 1958 Agreement applying this Regulation.
- 8.5. The competent authority issuing the extension of approval shall assign a series number for such an extension and inform thereof the other Parties to

the 1958 Agreement applying to this Regulation of that number by means of the Communication specified in Annex 5A or Annex 5B to this Regulation.

9. Penalties for non-conformity of production

- 9.1. The approval granted in respect of a type of HDDF retrofit system pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 21 and 22 above are not complied with.
- 9.2. If a Party to the Agreement applying this Regulation withdraws an approval it has previously granted, it shall forthwith so notify the other Contracting Parties applying this Regulation, by means of the Communication specified in Annex 5A or Annex 5B to this Regulation.

10. Production definitely discontinued

- 10.1. If the holder of the approval completely ceases to manufacture a type of retrofit system approved in accordance with this Regulation, he shall so inform the authority which granted the approval. Upon receiving the relevant communication, that authority shall inform thereof the other Parties to the 1958 Agreement applying this Regulation by means of the Communication specified in Annex 5A or Annex 5B to this Regulation.

11. Names and addresses of technical services conducting approval tests and of Administrative departments

- 11.1. The Parties to the Agreement applying this Regulation shall communicate to the United Nations Secretariat the names and addresses of the technical services responsible for conducting approval tests and of the administrative departments which grant approval and to which forms certifying approval or extension or refusal or withdrawal of approval, issued in other countries, are to be sent.

12. General requirements

- 12.1. A specific HDDF retrofit system intended to be fitted on road vehicles, as defined in par. 2.2, is type-approved in accordance with this Regulation if the requirements set out in Annex 1 and 2 are met.
- 12.2. A specific HDDF retrofit system intended to be fitted on non road mobile machinery, agricultural and forestry tractors engines, as defined in par 2.3, is type-approved in accordance with this Regulation if the requirements set out in Annex 3 are met.
- 12.3. The components of NG HDDF retrofit systems shall comply with Regulation no. 110, as applicable.
- 12.4. The components of LPG HDDF retrofit systems shall comply with Regulation no. 67, as applicable.

Annex 1 General requirements for the approval of HDDF retrofit systems intended to be fitted in road vehicles equipped with compression ignition engines.

- 1.0. This annex describes the general requirements that a HDDF retrofit system, intended to be fitted on road vehicles as defined in par. 2.2 of this regulation, shall comply.
- 1.1. The manufacturer shall declare the dual fuel type of the retrofit system, which results from the installation of the retrofit system on the parent engine.
 - 1.1.1. Only dual fuel retrofit system types 1B, 2B and 3B are permitted to be type-approved in accordance with this regulation.
- 1.2. The HDDF retrofit system shall be tested on the parent engine in accordance to Annex 2.
 - 1.2.1. The application range is defined by the engine family to which the parent engine, as defined in paragraph 1.3, belongs.
 - 1.2.2. The application range may be extended to other engines according the provisions of par. 1.5.
- 1.3. An engine belongs to the same engine family if shares the following criteria features with the parent engine:
 - 1.3.1.
 - (a) engine manufacturer.
 - (b) fuel supply type (electronic yes/no, pump, common rail...)
 - (c) combustion cycle and cooling medium
 - (d) engine baseline emission stage of the applicable Regulation.
 - (e) method of air aspiration (turbocharged or normally-aspirated engine)
 - (f) If the gas fuelling system has a central metering for the whole engine: it has an approved power output between 0.7 and 1.15 times that of the parent engine. If the gas fuelling system as an individual metering per cylinder or groups of cylinders: it has an approved power output per cylinder between 0.7 and 1.15 times that of the parent engine.
 - (g) Water and/or air injection
 - (h) pollution control system:
 - (i) exhaust after treatment system
 - (ii) with or without air injection
 - (iii) with or without exhaust gas recirculation (EGR)
 - 1.3.2. The criteria of paragraph 1.3.1.(a) applies only to engines pursuant to the baseline emission stage in force at the time of the request of HDDF retrofit system type approval.
- 1.4. Operating modes of dual-fuel engines and vehicles
 - 1.4.1. Conditions for a dual-fuel engine to idle using diesel fuel exclusively

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- 1.4.1.1. Type 1B dual-fuel engines shall not idle using diesel fuel exclusively in dual-fuel mode.
- 1.4.1.2. Types 2B and 3B dual-fuel engines may idle using diesel fuel exclusively.
- 1.4.2. Conditions for a dual-fuel engine to warm-up or start using diesel fuel exclusively in dual fuel mode.
- 1.4.2.1. A Type 1B, Type 2B, or Type3B dual-fuel engine may warm-up or start using diesel fuel solely. However, in that case, it shall operate in diesel mode.
- 1.4.2.2. The strategy shall cease to be active when the coolant temperature has reached a temperature of 343 K (70 °C), or within 15 minutes after it has been activated, whichever occurs first.
- 1.4.3. Operability Restriction
- A HDDF retrofit system when operating in a dual-fuel mode shall be designed so as to permit, in case of unavailability of gaseous fuel the switch back to diesel mode. The switch back shall occur as soon as possible in all cases listed in par. 1.4.3.1. of this annex.
- 1.4.3.1. The unavailability of gaseous fuel when operating in dual fuel mode shall provide for the following cases:
- Empty gaseous fuel tank
- When the gas availability in the tank exceed the level that justified the activation of the switch back, the dual-fuel mode may be reactivated.
- Malfunctioning gas supply
- The gas injection system electronics, fuel quantity and timing actuator(s) shall be monitored for circuit continuity (i.e. open circuit or short circuit) and total functional failure when the engine operates in dual-fuel mode.
- As soon as the gas diagnostic system concludes that the malfunction is no longer present or when the OBD information is erased by a scan tool, the dual fuel mode may be reactivated.
- Abnormality of gas consumption
- This case is applicable only to DHHF retrofit systems intended to be fitted on Euro VI or later engines.
- In the case of an abnormality of gas consumption in dual-fuel mode the fault codes due to abnormality of gas consumption shall be stored in the gas ECU. The system manufacturer shall provide specific instructions as to read out the fault codes through the OBD bus.
- As soon as the gas diagnostic system concludes that the malfunction is no longer present or when the OBD information is erased by a scan tool, dual fuel mode may be re-activated.
- 1.4.4. Dual-fuel indicators
- 1.4.4.1. Dual-fuel operating mode indicator
- Dual-fuel engines and vehicles shall have a visual indicator indicating to the driver the mode under which the engine operates (dual-fuel mode, diesel mode, or, when applicable, service mode).

The characteristics and the location of this indicator are left to the decision of the manufacturer and may be part of an already existing visual indication system.

This indicator may be completed by a message display. The system used for displaying the messages referred to in this point may be the same as the ones used for OBD, correct operation of NO_x control measures, or other maintenance purposes.

The visual element of the dual-fuel operating mode indicator shall not be the same as the one used for the purposes of OBD (that is, the MI – malfunction indicator), for the purpose of ensuring the correct operation of NO_x control measures, or for other engine maintenance purposes.

Safety alerts always have display priority over the operating mode indication.

1.4.4.1.1. The dual-fuel mode indicator shall be set to diesel emergency mode as soon as a switch back to diesel mode is performed and the indication shall remain as long as the diesel emergency mode is active.

1.4.4.1.2. The dual-fuel mode indicator shall be set for at least one minute on dual-fuel mode or diesel mode as soon as the engine operating mode is changed from diesel to dual-fuel mode or vice-versa. This indication is also required for at least 1 minute at key-on, or at the request of the manufacturer at engine cranking. The indication shall also be given upon the driver's request.

1.4.4.2. Empty gaseous fuel tank warning system (dual-fuel warning system)

A dual-fuel vehicle shall be equipped with a dual-fuel warning system that alerts the driver that the gaseous fuel tank will soon become empty.

The dual-fuel warning system shall remain active until the tank is refuelled to a level above which the warning system is activated.

The dual-fuel warning system may be temporarily interrupted by other warning signals providing important safety-related messages.

It shall not be possible to turn off the dual-fuel warning system by means of a scan-tool as long as the cause of the warning activation has not been rectified.

1.4.4.2.1. Characteristics of the dual-fuel warning system

The dual-fuel warning system shall consist of a visual alert system (icon, pictogram, etc...) left to the choice of the manufacturer.

It may include, at the choice of the manufacturer, an audible signal. In that case, the cancelling of that signal by the driver is permitted

The visual element of the dual-fuel warning system shall not be the same as the one used for the OBD system (that is, the MI – malfunction indicator), for the purpose of ensuring the correct operation of NO_x control measures, or for other engine maintenance purposes.

In addition the dual-fuel warning system may display short messages, including messages indicating clearly the remaining distance or time before the activation of the operability restriction.

The system used for displaying the messages referred to in this paragraph may be the same as the one used for displaying additional OBD messages, messages related to correct operation of NO_x control measures, or messages for other maintenance purposes.

A facility to permit the driver to dim the visual alarms provided by the warning system may be provided on vehicles for use by the rescue services or on vehicles designed and constructed for use by the armed services, civil defense, fire services and forces responsible for maintaining public order.

- 1.5. Extension of the application range
- 1.5.1. The application range may be extended to engines which differ from the parent engine as for one or more of the criteria features set out in subparagraphs from 1.3.1 a) to f).
 - 1.5.1.1. A representative engine which differs from the parent engine only for the criteria of par. 1.5.1. shall comply with the requirements set out in Annex 3.
 - 1.5.1.2. If the requirements of Annex 3 are met, the application range is extended to the engines sharing the criteria features set out in subparagraphs from 1.3.1 a) to f) with the representative engine above. The application range table as defined in the Addendum of Annex 5A or Annex 5B as applicable is updated in order to include also the criteria features of the representative engine.

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Annex 2 Test and requirements for the approval of HDDE retrofit systems intended to be fitted in road vehicles equipped with compression ignition engines.

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Annex 3 General requirements for the approval of HDDF retrofit systems intended to be fitted in agricultural and forestry tractors and non road mobile machinery equipped with compression ignition engines.

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Annex 4 Test and requirements for the approval of HDDE retrofit systems intended to be fitted in agricultural and forestry tractors and non road mobile machinery equipped with compression ignition engines.

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Annex 5A: Communication concerning a type of LPG retrofit system

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**Annex 5A - Addendum: Application range of an approved
LPG retrofit system**

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Annex 5B: Communication concerning a type of NG retrofit system

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**Annex 5B - Addendum: Application range of an approved
NG retrofit system**

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Annex 6A: Arrangement of the LPG retrofit system type approval mark

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Annex 6B: Arrangement of the NG retrofit system type approval mark

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**Annex 7A: Complete list of information for the purpose of
the LPG retrofit system type approval.**

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**Annex 7B: Complete list of information for the purpose of
the NG retrofit system type approval.**

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