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GRENDEL

As an alternative to engines with a dedicated type approval for inland ships (Stage V classes IWA and IWP) marinised engines of class NRE with power up to 560 kW and Euro VI truck engines may be installed on inland ships. These engines are usually more compact and have shorter product cycles due to the larger market demand. However, it needs to be ensured that the type approval is not lost due to the marinisation. This fact sheet gives an insight into regulations and technical details as well as economic aspects.

FACT SHEET N° 7

EURO VI TRUCK AND NRE ENGINES

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FACT SHEET
EURO VI TRUCK ENGINES

REGULATIONS

The CESNI Committee regularly publishes in the ES-TRIN the European Standard of Technical Requirements for Inland Waterway Vessels. The uniform requirements contained in ES-TRIN ensure the safety of inland waterway vessels, taking into account both the requirements of Directive 2006/87/EC and the Rhine Vessel Inspection Regulation. References to ES-TRIN are included in the EU and CCNR legal frameworks.

About the use of Euro VI truck and NRE engines for the main propulsion, the CESNI requires the following:

1. An NRE category engine may be used in place of an IWA or IWP category engine if its power output is less than 560 kW. This engine shall comply either with the additional technical requirements for devices for preventing NOx emissions for NRE category engines in appendix 1 of annex IV, or those for IWA or IWP category engines in appendix 2 of annex IV of delegated regulation (EU) 2017/654.
2. An engine with an EU Euro VI certification for heavy goods vehicles under regulation 595/2009/EC or UNECE regulation R49-06 may also be used in place of an NRE category engine provided that a technical service recognised under Regulation (EU) 2016/1628 recognises that this engine complies with the additional technical requirements.

Note 1: These engines shall also meet the requirements of Directive (EU) 2016/1629 or RVIR and the associated ES-TRIN 2017 relevant for the vessel application (especially the specific requirements concerning exhaust gas after treatment systems in Article 9.09).

Note 2: Marinisation may change the engine so that the type approval may need to be revised by the engine manufacturer or a new one issued. In addition, the company that makes the marinisation could, intentionally or unintentionally, become the manufacturer (see questions 17 and 18).

Source and reference for further reading: https://www.cesni.eu/wp-content/uploads/2018/11/FAQ_Engines_en.pdf

TECHNICAL CONCEPT

Euro VI truck engines and NRE can be employed for direct propulsion or for a diesel-electric concept (see Fact Sheet N° 2). Before they are used, however, some changes (referred to as marinisation) must be made, which are also described below.

NRE ENGINES

According to Directive (EU) 2016/1628 category NRE engines are all engines suited to move, or to be moved, by road or otherwise, that not explicitly excluded or included in any other category. These engines with a reference power of less than 560 kW may be used in place of stage V motors of categories IWP and IWA. NRE engines have Stage V emission limits slightly differing from the limits for IWP/IWA engines (identical or more stringent). The table below compares the relevant limits. However, it has to be noted that this comparison is not completely fair since the different engine categories are linked to differing test cycles (ISO 8178). The test cycles define the operating points in terms of engine speed and torque together with weighting factors. For example class IWP-v-4 is approved according to test cycle E3 while NRE engines are tested according to C1.

Emission stage	Engine sub-category	Power range	Ignition type	CO	HC	NO_x	PM	PN	A
		kW		g/kWh	g/kWh	g/kWh	g/kWh	#/kWh	
Stage V	NRE-v-6 NRE-c-6	130≤P≤560	all	3.50	0.19	0.40	0.015	1×10^{12}	1.10
Stage V	IWP-v-3 IWP-c-3	130≤P<300	all	3.50	1.00	2.10	0.100		6.00
Stage V	IWP-v-4 IWP-c-4	P≥300	all	3.50	0.19	1.80	0.015	1×10^{12}	6.00

EURO VI TRUCK ENGINES

The Euro VI heavy duty emission standards were introduced by Regulation No 595/2009/EC. The emission limits, which are stricter than the Stage V values, are meant for the World Harmonized Stationary Cycle (WHSC) and the World Harmonized Transient Cycle (WHTC). Again the comparability of the emission limits is limited by the differing test cycles.

	CO	NMHC	CH_4	NO_x	PM	PN
	g/kWh	g/kWh	g/kWh	g/kWh	g/kWh	
WHSC	1.50	0.13	0.40	0.01		$8.0x10^{11}$
WHTC	4.00	0.16	0.50	0.46	0.01	$6.0x10^{11}$

EXHAUST GAS AFTERTREATMENT SYSTEM

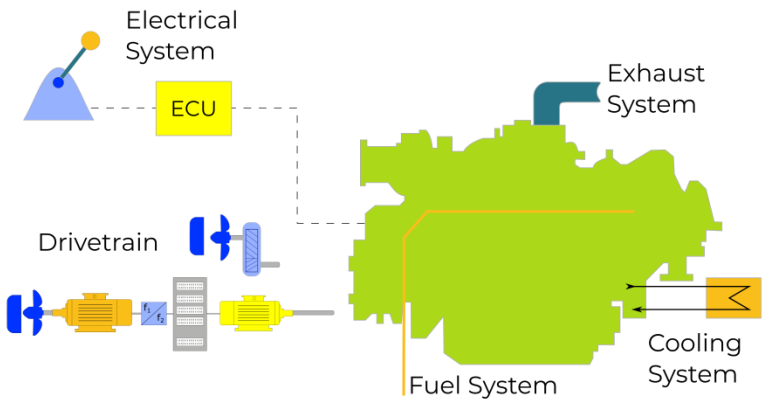
To reach the emission limits listed above all engines need to be equipped with an exhaust gas after treatment system. Most engines are already equipped with these systems by the manufacturers. Details and background information on the after treatment systems can be found in the GRENDEL Fact Sheet N° 3.

MARINISATION

A much discussed topic is the loss of type approval after marinisation. For Euro VI and NRE engines, it is the responsibility of the technical services to determine whether a modification leads to a loss of type approval. It is therefore very important that the marinisation company works closely with the technical services and the original equipment manufacturer (OEM).

Another issue that must be considered when installing a road engine in a ship is the emergency running mode of the road engine. According to ES-TRIN, this mode is not permitted for ships. It must therefore be clarified with the manufacturer beforehand whether the emergency running mode can be switched off or whether the engine has a fire-truck mode, which also does not allow a reduction in performance in the event of a malfunction. Other adjustments, which need to be performed, are described below:

PARTS FOR MARINISATION



ELECTRIC SYSTEMS

Modifications of the electric system include motor control, throttle control, monitoring system. In some cases the software of the engine control unit (ECU) must also be adapted. In contrast to the torque request in truck operation, a speed request is required in on-board operation.

FUEL SYSTEM

The injection lines have to be replaced with a double-walled design.

DRIVETRAIN

A suitable gearbox is required in direct drives to match the propeller and engine characteristics. If the engine power is not sufficient for direct drive, a diesel-electric system is a suitable option.

EXHAUST SYSTEM

Both Euro VI and NRE engines require an exhaust gas after treatment system to reduce PM and NO_x according to the emission limits. For most engines the DPF and SCR systems are provided by the engine manufacturer. The systems are mostly of small size; nevertheless they must be fitted in the engine room.

COOLING SYSTEM

The Euro VI or NRE engine needs to be connected to the water cooling system on board. Also the connection of the charge air cooler with the water cooling circuit is necessary.

ECONOMICS AND ENVIRONMENTAL SUSTAINABILITY

INVESTMENT COSTS

Investment costs are provided for an example with a replacement of a 300 kW engine. Dependant on the operational profile of the vessel, it may be beneficial to go for a diesel-electric installation.

Cost Category	Costs in EUR	Comment
Marinised 300 kW Euro VI truck engine	about 50,000 EUR	
Installation cost	10,000 to 20,000 EUR plus one week at shipyard	Strongly dependant on system
Optional Electric Engine	120 EUR/kW	

OPERATIONAL COSTS

Operational costs for the example above are estimated as follows:

Cost Category	Costs in EUR
AdBlue consumption	approximately 3.5 % per litre diesel
AdBlue costs	0.20-0.50 EUR/l

ENVIRONMENTAL SUSTAINABILITY

Since the Euro VI engines have an on-board SCR and DPF system to reach the latest emission standards, they also emit significantly less air pollutants. In addition, there can also be a saving of diesel in operation. However, this is different for each application. In addition, the engine can be integrated not only as a direct drive but also in a diesel-electric drive concept. Fuel savings can also be achieved here. More information about the diesel-electric drive can be found in the Fact Sheet N° 2.

CONSIDERATIONS FOR DEPLOYMENT

BENEFITS

- Modern technologies
- High emission standards
- Engine and after-treatment in one compact system
- Proven quality and reliability
- Low noise level
- High production numbers

DOWNSIDES

- No long-term experience in marine environment
- Lifetime expectation not confirmed
- High effort for conversion
- Power limits insufficient for many direct drives

DEPLOYMENT EXAMPLES

IJMEER

Operator: de Klerk
Location: Netherlands
In operation: With Euro VI engines since 2018

ⓘ www.deklerkbv.nl/

Source: www.deklerkbv.nl

Vessel type: working boat
ENI: 2325374
Vessel size: 37.58 × 9.12 m (L × W)
Propulsion: 2 × Vink - MX 11 – 240 kW

MS WANTIJ

Operator:
Location: Western Europe
In operation: With Euro VI engines since 2018

ⓘ www.wantij.org

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Vessel type: General Cargo Ship
ENI:02326428
Vessel size: 86 × 9 m
Propulsion: 2 × Vink MX 13 – 355 kW, direct drive

Contact

For further information or suggestions how to improve this fact sheet please do not hesitate to contact:

DST – Development Centre for Ship Technology and Transport Systems
Oststraße 77
47057 Duisburg, Germany

Phone: +49 203 99369 29
Fax: +49 203 99369 70
E-Mail: Friedhoff@dst-org.de
Web: www.dst-org.de