

## **Impact Study on Mobile Cranes**

**Emissions Inventory and Impact Assessment**

**Directive 97/68/EC: Projection into a Change from Stage IV to V  
and Transition from Stage III A to III B and III B to IV**

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## Executive Summary

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With the proposal [COM (2014) 581] for a renewal of the present Directive 97/68/EC regarding emission limit values for combustion engines in non-road mobile machinery, the European Commission envisages a new stage (Stage V) with more stringent limit values for exhaust gas emissions. The mandatory application date within the engine power range 130 – 560 kW of the Stage V is 1 January 2019. Machine manufacturers, who install these engines into their machines, have 12 months' time from this date to adapt their machines to the new Stage V engines, followed by 6 months sell-off period. Previous transition regulations allowed the machine manufacturers considerably more time and flexibility for the adaptation of their machines.

The shorter adaptation time confront the manufacturers of mobile cranes with problems. Due to technical reasons these consider themselves not in a position to convert their diverse product portfolio to a new emission stage within 12 months. The engines are deeply integrated in the machines. That has the consequence that for any changes to the engine and exhaust gas aftertreatment system; the mobile cranes must go through a technically complex and time consuming redesign. To predict both, the necessary expenditure and the environmental impact for the conversion to the Stage V, the initial conversion of the all-terrain crane from Stage III A to III B and from Stage III B to IV was exemplarily investigated. The data for the study were collected from the four largest European mobile crane manufacturers. Jointly they have a market share of 94 % for all-terrain cranes in Europe.

The results show, that the manufacturers with their existing resources were up to now in a position to convert approximately 40 all-terrain crane models within 4.5 years. This timeframe includes the conception phase without having a new engine available. The time from when serial engines are available for the manufacturers, where no more changes need to be made, is decisive for the conversion period. Based on experience, these completed engines are available approximately 6 to 3 months prior to expiry of the old stage. From this date, the manufacturers need more than two years to adapt all of their models to the new engines and exhaust gas aftertreatment systems for the superstructures and the carriers. The costs for this amount to 37.76 million € for the conversion from Stage III A to III B. For the conversion from Stage III B to IV until the end of the conversion phase beginning of 2016, they will amount to 56.79 million €, according to the manufacturers' estimates.

Calculations for the emission inventory of all-terrain cranes show that in Europe their share of total nitrogen oxide and particle emission from non-road mobile machinery is relatively low. In the year 2020, all-terrain cranes are responsible for a share of 0.38 % of the nitrogen oxide emission of mobile machines and devices. The same

applies to the particle emission; here in the year 2020 all-terrain cranes will contribute 0.57 % to the total particulate emission of mobile machines and devices.

To investigate the impact of an extension of the transition period at all-terrain cranes on the environment, health and society for the conversion to Stage V and to quantify the necessary economic effort, different scenarios were generated and compared. Initial data for the pending changes to the engine and exhaust gas aftertreatment system were collected from the three engine manufacturers, representing 100 % of the suppliers for all-terrain crane engines to the considered manufacturers. According to the information provided by the engine manufacturers, a diesel particle filter will be added, which up to now, is installed on no engine exhaust gas aftertreatment for European mobile cranes. The volume of the present exhaust gas aftertreatment system will increase by about 20 % and the weight will rise by up to 100 kg. The serial production of the new engines is planned from the middle of 2018. Thus earliest availability of completed engines is mid / end of 2018 for the crane manufacturers.

Based on this data, the mobile crane manufacturers forecasted necessary design adaptations for their all-terrain cranes. According to the manufacturers, a time period of approximately 3 years from the availability of serial engines for the conversion to Stage V is needed to perform the estimated alterations. As both the design work and the necessary time needed are of a similar level as for the conversion from Stage III A to III B, the companies expect cost burden in a similar amount of 34.06 million €.

The following scenarios were generated based on the prognosis of the manufacturers in order to calculate and compare the impact of these scenarios on the environment and health / society within the frame of a Trend Impact Analysis and a Cost Effectiveness Analysis for the time horizon 2020 to 2050:

**Scenario 1:** Business-As-Usual-Scenario (BAU) without implementation of Stage V, serves as a benchmark for the following scenarios with implementation of Stage V.

**Scenario 2:** Implementation of Stage V with a compulsory transition phase of 12 months according to [COM (2014) 581] and a conversion time frame, ideally of 12 months, with the result that from 2020 only cranes with Stage V are sold in the European Union.

**Scenario 3:** Implementation of Stage V with a transition phase of 36 months for mobile cranes and a conversion time frame in the normal case of 36 months, with the result that from 2020, one third of the cranes are sold with Stage V and two thirds with Stage IV in the European Union; from 2021, two thirds are sold with Stage V and one third with the Stage IV; from 2022 all cranes are sold with Stage V.

**Scenario 4:** Implementation of Stage V with a compulsory transition phase of 12 months according to [COM (2014) 581], and a conversion time frame in the normal

case of 36 months with the result, that from 2020, one third of the cranes are sold with Stage V and none with the Stage IV are sold in the European Union; from 2021 two thirds of the cranes with Stage V and none with Stage IV; from 2022 all cranes with Stage V. Non-converted crane models are not available in the years 2020 and 2021.

The calculations of the Trend Impact Analysis on the impacts on the environment show for the scenarios that the duration of the transition phase for the implementation of the Stage V can have significant implications regarding the emissions. With a too short time frame, as in Scenario 4, not all cranes can be converted by the end of the transition phase and thus cannot be sold. This means that old machines with higher exhaust emission cannot be replaced by newer ones and thus must stay longer in the population. In the short term, emissions would therefore even increase in the early stages of Stage V. This issue is confirmed by the particle emissions calculated for each year. These are, in the year 2020 for Scenario 2 at 347 t which corresponds to a share of 0.57 % of the total particle emission from mobile machinery and devices; for Scenario 3 are 348 t with a share of likewise 0.57 %; and for scenario 4 are 366 t with a share of 0.61 %. The differences between a transition phase of three years compared with one year are only marginal. Finally, the same low particle emission level of 18 t in the year 2050 is maintained with all conversion scenarios.

By the continuous reduction of the particle emission from diesel engines other sources of particle emission like tyre abrasion, brake wear, etc. will constitute the dominant emission sources in the future. Already today the particulate matter emissions from the tyre abrasion for a modern all-terrain crane with Stage IV shows a similar high value like the engine-generated particulate matter emissions from the travel operation.

The Cost Effectiveness Analysis shows, that the cost-benefit-ratio for the introduction of an emission Stage V for all-terrain cranes for the scenarios 2, 3 and 4 is negative – by more than minus 70 %. Here the engine and mobile crane manufacturers accrue the costs of 66 million €. The generated benefit is to be the avoidance of emitted air particulate matter. The real benefit here is achieved by prevention of health costs for the society caused by particle emissions. In comparison to the arising costs, this benefit for the society (avoided damage costs) is relatively low with 17 for scenario 2 and 16 million € for scenario 3 as well with about 6 million € for scenario 4. It must be recognized, however, that the time frame for the transition phase as in scenario 4 has a high impact on the social benefit.

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