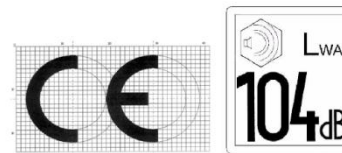




Machinery noise limits and incentives for noise reduction

Michael Dittrich, TNO

BUY QUIET SYMPOSIUM
HAMBURG, 25 August 2016





Content

- Noise limits for sources
 - Justification for noise emission limits
 - Trends in environmental noise
 - Effect of limits in practice
 - Relation with national and local regulation
 - Limit setting and revision
 - Current status EU environmental noise limits
- Outdoor machinery: ODELIA Study
 - Machine types, methodology, databases, trends, limit proposals and justification
- Incentives and initiatives (Netherlands)
- Combining noise reduction with other benefits
- Conclusions



Justification for noise limits

- **DG Environment on Environmental Noise:**

- Prolonged exposure to noise can lead to serious **health effects** such as sleep disturbance, cardiovascular diseases, annoyance, cognitive impairment, mental health problems and tinnitus.
- **Loss of productivity** of workers
- Burden on **health care systems**
- Substantial depreciation of **property value**

- **EU noise policy**

In its Environment Action Programme to 2020, the EU committed to significantly decrease noise pollution in the Union, moving closer to levels recommended by the World Health Organisation, by 2020.

This will require, in particular:

- implementing an updated Union noise policy aligned with the latest scientific knowledge
- measures to reduce noise at source
- improvements in city design



Trends in environmental noise

- Noise disturbance and sensitivity has increased due to:
 - growth of all types of traffic
 - population increase especially in urban areas
 - numbers of vehicles and machines, in combination with further automation
 - new infrastructure projects and urban (re)development
 - growth in recreational activity such as events
 - wider availability of low cost equipment
 - stronger public awareness and reaction, need for quiet areas
 - a shift in working patterns with more people able to work from home
- Outdoor equipment noise is not tied to roads only and although temporary can often be loud and close to dwellings and sensitive buildings



Effect of limits in practice

- A real cost-effective way to reduce noise at source
- Provide means to tackle excessive noise
- Provide a minimum requirement
- Design target for manufacturers, focuses effort
- Reference point for the purchaser and user
- Complementary to national and local regulation, filling gaps such as neighbourhood noise (consumer products)
- Effect can be increased by incentives and awareness



Relation with national and local regulation

EU Regulation

Noise limits at source
and labeling

National Regulation / Act

Noise limits at receiver
Time/place of activity or
ban

Local Regulation

Noise limits at receiver
Time/place/noise level
of activity or ban
Local permits

Enforcement



**Self-regulation and
complaints**



Limit setting and revision

- Well-founded **need**: how frequent is the source, what is the extent of disturbance, duration, level, distance, situations?
- New limits: **Starting point**? Measurement conditions?
'Eliminate excessive noise' = exclude certain noisy types
- **Measurement data** available? Importance of databases
- Revision: how much noise reduction?
Technical and economic feasibility, use of databases
- EU limits are a means to **control excessive noise**
(illegal or faulty exhausts)
- **Decision process**: often a compromise – not optimal
- **Economic impact**, performance trade-offs
- Limit revision can take **years**



EU Limits for environmental noise sources

- Road vehicles 540/2014/EU
- L-cat vehicles (motorcycles, mopeds, quads) - 168/2013/EU
- Tyres - 661/2009/EC , Labelling:1222/2009/EC
- Rail vehicles - TSI Noise 1304/2014/EU
- Aircraft - 2006/93/EC
- Outdoor Machinery – 2000/14/EC
- Recreational Craft - 2013/53/EU
- Tractors - 2015/96/EU
- Aircos and fans/ Ecodesign 206/2012/EU



EU Noise Regulation

	Road traffic noise	Railway noise	Aircraft noise	Industrial noise	Other
At receiver	END Mapping	END Mapping	END Mapping	END Mapping	None
At source	Vehicle limits, (accelerating+ constant speed) 2/3 - wheeler and Quad limits (accelerating) Tyre limits (constant speed)	TSI Rail Vehicle limits (stationary, constant speed, accelerating)	ICAO noise limits (lateral, flyover, approach)	(OND, some sources) (full load or defined cycle)	OND, Tractors, Ecodesign, Recreational craft (accelerating, full load or defined cycle)
	L_{Urban} L_{pAFmax}	$L_{pAeq,T}$ $L_{pAeq,Tp}$ L_{pAFmax}	EPNdB	L_{WA}	L_{WA} L_{pASmax}



Outdoor Machinery – ODELIA Study (2015)

Outdoor Equipment Noise Limit Assessment

Study of the suitability of the current scope and limit values of Directive 2000/14/EC relating to the noise emission in the environment by equipment for use outdoors
For European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

- Assessment of:
 - Current limit values Art. 12 equipment
 - New limits for Article 13 equipment
 - New equipment types
 - Updated or new test methods
- Provide evidence in support of proposals
- What has changed since 2007/Nomeval Study?
- Study proposals not binding for the Commission, but input to the revision process





Equipment in 2000/14/EC

57 equipment types all with L_{WA} sound power label
22 of these with noise limit



Proposed new types

Noise from industry, construction, maintenance, cleaning,
goods handling, neighbourhood (consumer products)



Methodology

- Review of documents and papers: NOMEVAL(2007), WG7 Paper (2010), Industry, NoBo and other stakeholder inputs
- Analysis of available databases
- Limit analysis for article 12 and 13 equipment and scope check for new types
- Application of decision flow charts for each equipment type applying criteria and justifying proposals
- Revision proposals for test codes where necessary
- Limits are typically of the form

$$L_{WAguar} \leq A + B \lg P \text{ or } A + B.P$$

with P= mechanical or electrical power in KW

$$\text{and } L_{WAguar} = L_{WAmeas} + K$$



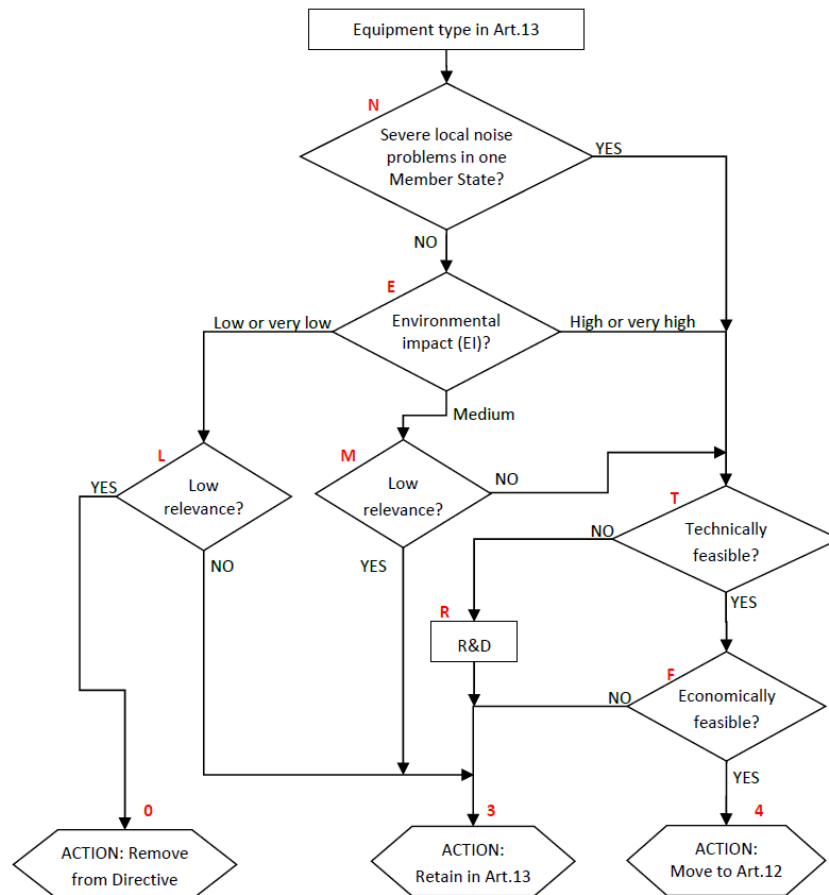
Methodology – Criteria for limit changes

- Evidence from databases , public domain and statistical analysis
- Member state requests
- High or medium environmental impact
- Acceptable economic impact
- Within technical progress and feasibility
- Suitable test method available

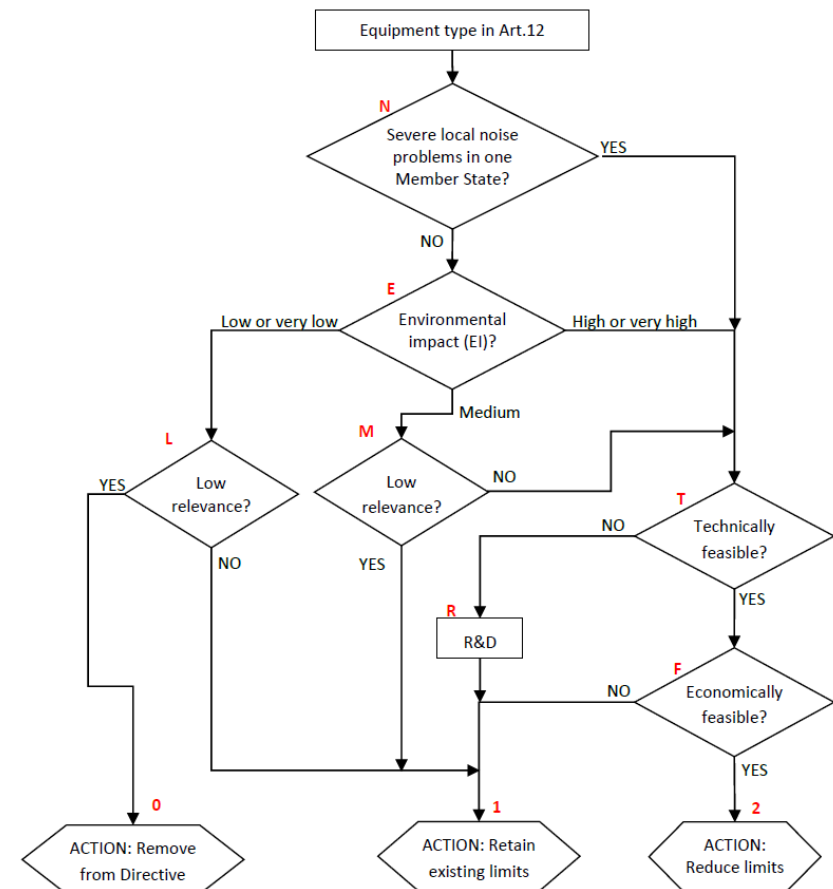


Methodology - Decision charts

Decision flow chart for noise limits: equipment currently in Art.13



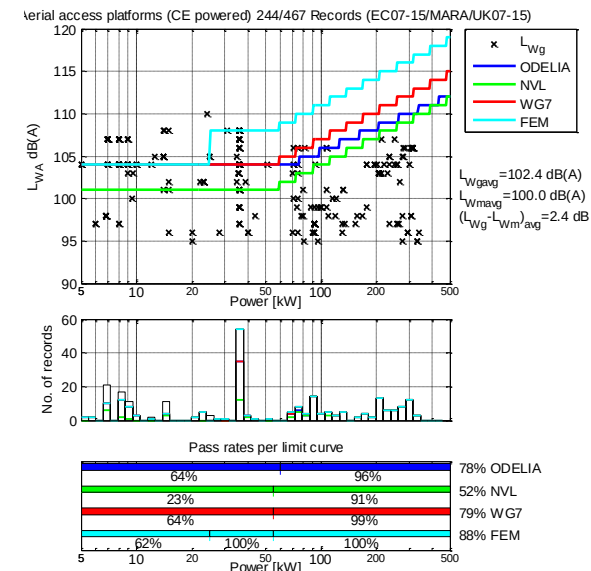
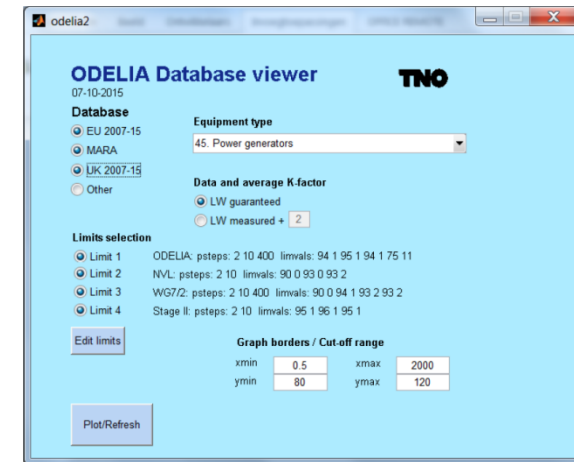
Decision flow chart for noise limits: equipment currently in Art.12





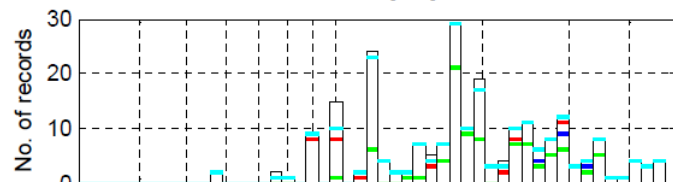
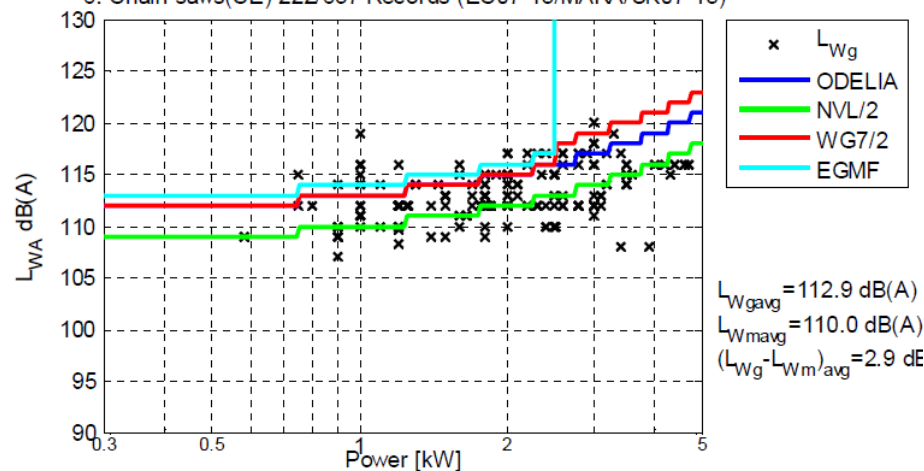
Available databases

- Several databases available:
 - EU 2000-2015 (27800 recs), EU 2007-2015 (8245 recs)
 - MARA 2011-2015 (5058 recs) (Italy)
 - UK 2001-2015 (13209 recs)
 - NL MIA/VAMIL 2007-2014 (1400 recs, limited types)
- Useful due to large data content
- Critical analysis required
- Good correspondence between different databases and not much overlap
- Pass rates determined for each limit proposal, for whole and parts of limit curves

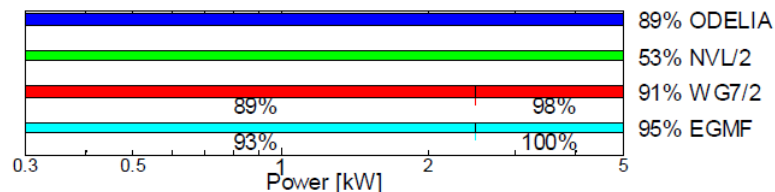


Database examples: chainsaws and power generators

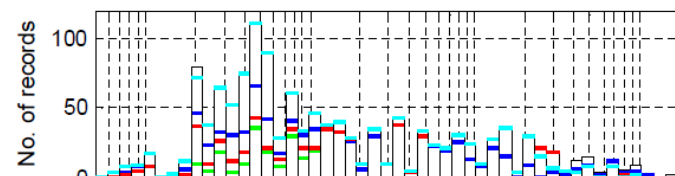
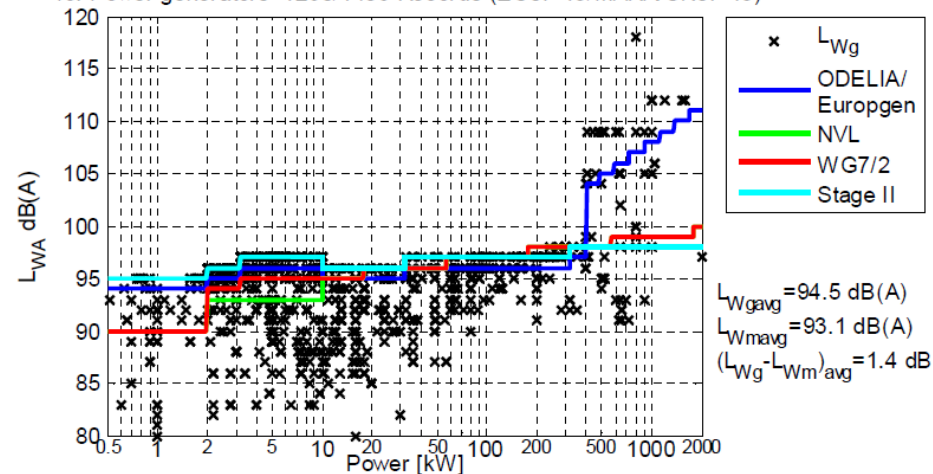
6. Chain saws(CE) 222/637 Records (EC07-15/MARA/UK07-15)



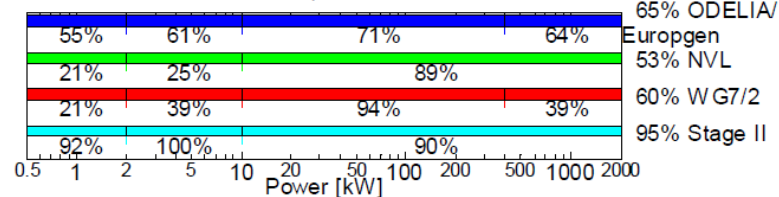
Pass rates per limit curve



45. Power generators 1290/1486 Records (EC07-15/MARA/UK07-15)



Pass rates per limit curve





Re-assessment of Environmental impact

- Methodology as in Nomeval, but new inputs mainly for numbers of equipment and average noise levels, some adjustments for usage time, tonality or other factors.

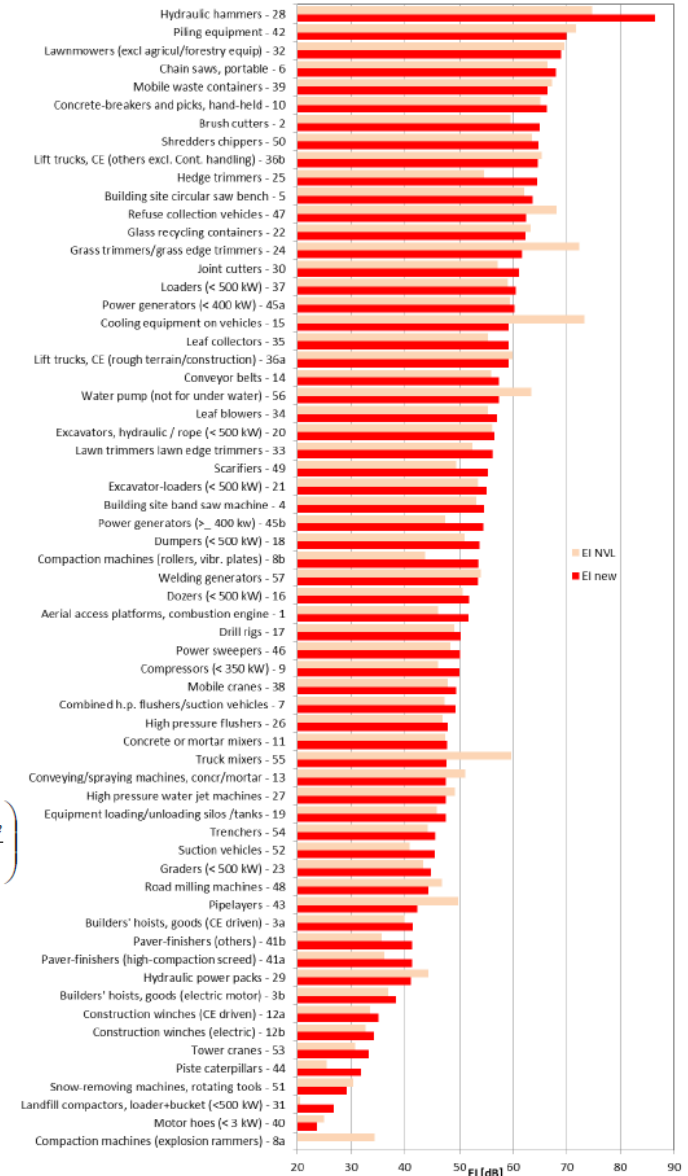
Table 1: Rating ranges of the Environmental impact indicator as used in the Nomeval study

Rating	Range of environmental impact indicator EI in dB
Very low	<37
Low	37-46
Medium	47-56
High	57-67
Very high	>67

$$L_{WA, rated, year, eq} = L_{WA, guaranteed} + C_{evening/night} + C_{tonal/imp} + C_{intermittent} + C_{opcon} + 10 \lg \left(\frac{n_{months} n_{days} t_{dayuse}}{364 \cdot 24 \cdot 60} \right)$$

$$EI_{equip, situ} = 10 \lg \left(\frac{364 \cdot \sum_{i=1}^{i_{max}} N_{equip, situ} D_{equip, situ, i} 10^{L_{i, i}/10}}{\sum_{equip, situ} (N_{equip, situ} \sum_{i=1}^{i_{max}} D_{situ, i})} \right)$$

$$EI_{equip} = 10 \lg \left(\sum_{situ} 10^{EI_{equip, situ}/10} \right)$$





Current trends - Technology and Market

(changes in the past decade)

- Quieter equipment on offer
- Noise information in product data on internet (also checked)
- More low cost consumer equipment
- More electrically powered equipment and improving battery performance and energy density
- More 4-stroke CE equipment, also handheld
- Power management, such as presence switches on water jet cleaners
- Shredders: Worm drive version with lower noise emission
- Generators: super quiet versions on the market
- Trimmers: quiet trimmer lines (spiral)
- Quiet leafblowers: www.leafblownoise.com
- Hybrid powered equipment (still small percentage)



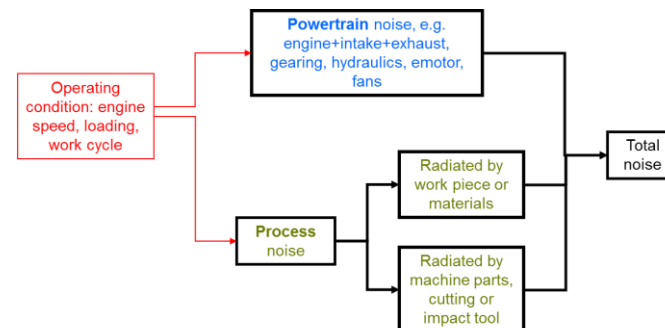
General justification for OND noise limits

- Noise limits are to ensure that:
 - excessive and unnecessary noise is avoided, within reasonable technical and economic means
 - outdoor equipment has appropriate noise limits just like all the other sources
 - a uniform approach across Europe is applied to reduce noise pollution in the environment
 - benefits are for users and exposed inhabitants, workers, people resting, at recreation and in quiet areas
 - for home equipment such as gardening tools, neighbourhood noise is reduced for a large number of people
 - noise is taken into account in the design process, which is highly cost effective
 - they complement local regulations and permits



Considerations for limit proposals

- Article 13: Restrict highest 30-50% of noise levels
- Article 12: Reduce limits considering environmental impact, technical feasibility and databases
- Mostly single stage limits for 2021
- Separate limits for electric and CE powered equipment
- Some proposals for renaming and combination of equipment
- 2014 EU Truck noise limits are taken into account
- For dual engine equipment (truck+machine) powers are added
- Process noise can partly be reduced by the noise limits



If included in the test, process noise is included



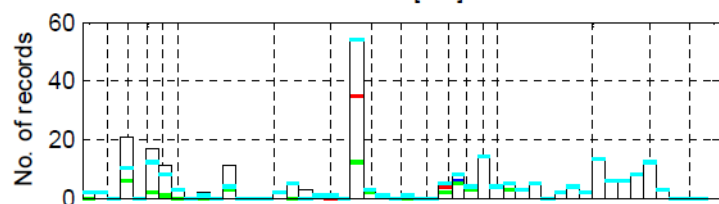
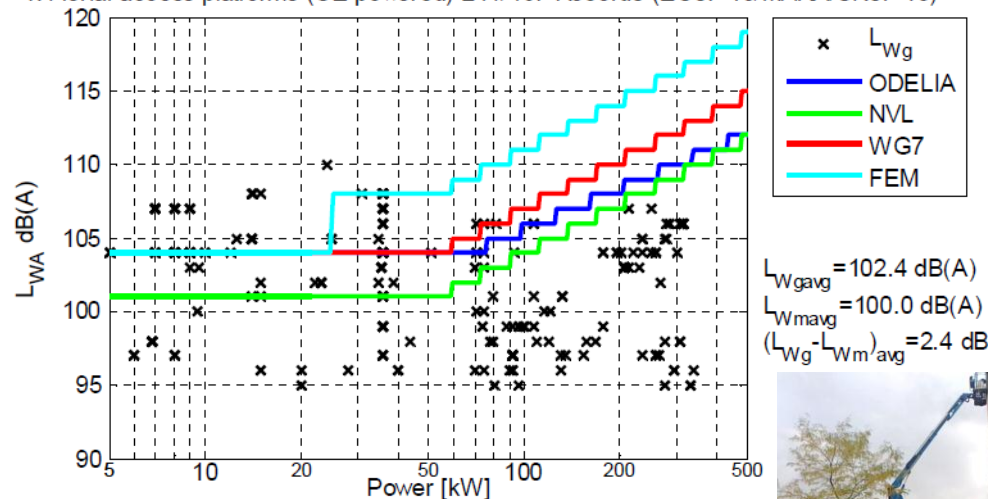
Considerations for limit proposals

- Economic impact of limit changes is small, as
 - Many low noise machines are already on the market
 - Enough technology and know-how is available
 - Limit proposals are not severe
 - Long time scale allows for several product development cycles
 - Noise and emissions requirements should be integrated in early design stage
- Test method issues must be resolved, should not impede limits, re-assess when available
- Also equipment used in permit areas should be subject to limits (e.g. harbours and industrial plants)

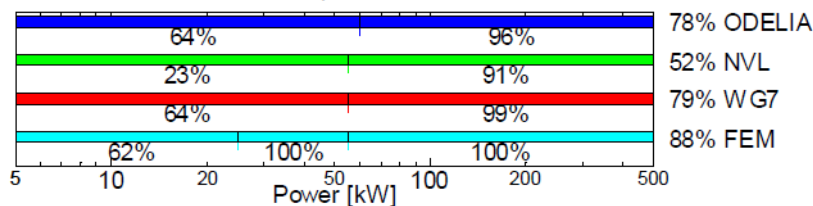


Example

1. Aerial access platforms (CE powered) 244/467 Records (EC07-15/MARA/UK07-15)



Pass rates per limit curve



1. Aerial access platforms with combustion engine

	P≤25 [kW]	25<P≤55 [kW]	P>55 [kW]
Nomeval	101		82+11 lg P
WG7	104		85+11 lg P
FEM	104	108	89+11 lg P
ODELIA	P≤60 [kW]		P>60 [kW]
	104		87+9.3 lg P
Decision code	NEMTF4		

Criteria and justification

Environmental need:

Aerial access platforms often operate close to multi-storey buildings including offices, flats, and sensitive residential buildings, just like mobile cranes.

CE-powered models are mostly for outdoor use.

Limits should exclude unnecessarily high noise levels.

Environmental impact:

Estimated low in Nomeval at 46, but now medium with EI=52 justifying the proposal of a limit value. This is due to:

- a higher average guaranteed sound power level for CE powered machines of 102 dB(A) than used in Nomeval of 94 dB(A);

- (engine) operating time of around 600 instead of 200 hours/year based on FEM data;

- lower machine population, 91000 instead of 200000, based on FEM data.

For CE-powered equipment FEM suggests typical sound power levels of around 104-107 dB(A) for high idle engine speed for 30% of the time and around 90-95 dB(A) at low idle for 70% of the time. For the environmental impact this implied equivalent sound power levels of 99-102 dB(A), but a correction for the loaded condition still has to be taken into account (3 dB) and a penalty for intermittent operation (6 dB).

Technical feasibility:

The proposed limit shows an 78 % overall pass rate for the databases. Space is often available for noise control including encapsulation and suitable mufflers. Power management is commonplace to save fuel. Electric or hybrid powertrains are becoming more common.

Economic impact:

Other remarks:

Considered small as technology is available. CE-powered machines are being gradually replaced by electrical ones, currently estimated at 50% for boom lifts and 75% for scissor lifts. The databases show little relation with the installed power, but data may be missing.





ODELIA limit proposals

New limits for Article 13 equipment

- 1. Aerial access platforms with combustion engine: $P \leq 55 \text{ kW}$: 104, $P > 55 \text{ kW}$: $87 + 9.3 \lg P$
- 2. Brush cutters and 24. Grass trimmers: $P \leq 1.5 \text{ kW}$: $107 + 5.5 \lg P$, $P > 1.5 \text{ kW}$: 115
- 5. Building site circular saw bench: 111
- 6a Chain saws, portable CE powered, including telescopic pruners: $111 + 2P$ (new test code)
- 6b Chain saws, portable electrically powered, including telescopic pruners 100+4P (new test code)
- 7. Combined high pressure flushers and suction vehicles, 26. High pressure flushers and 52. Suction vehicles: $P \leq 55 \text{ kW}$: 108, $P > 55 \text{ kW}$: $89 + 11 \lg P$
- 8a Compaction machines/Explosion rammers: Remove/none on market
- 11. Concrete or mortar mixers: $P \leq 2 \text{ kW}$: 95, $P > 2 \text{ kW}$: $92 + 11 \lg P$
- 13. Conveying and spraying machines for concrete and mortar: $93 + 11 \lg P$
- 15. Cooling equipment on vehicles CE-powered: $104 + 2 \lg P$; Other: $90 + 2 \lg P$
- 17. Drill rigs: a. Percussive 128; b. Non-percussive $P \leq 55 \text{ kW}$: 107, $P > 55 \text{ kW}$: $92 + 10 \lg P$
- 22. Glass recycling containers: Stage I: 100 Stage II: 96
- 24. Grass trimmers/grass edge trimmers: combine with 2. brush cutters.
- 25 Hedge trimmers: CE: 108; Electric: 100.
- 26. High pressure flushers: see 7
- 28. Hydraulic hammers Stage I: $120 + 3 \lg m$; Stage II: $117 + 3 \lg m$
- 30. Joint cutters 111 (include hand held stone cut-off saws)
- 34/35. Leaf blowers and collectors: CE: $P \leq 1.5 \text{ kW}$: 106; $P > 1.5 \text{ kW}$: 109; Electric: 105
- 36. Lift trucks, CE (others): $P \leq 55 \text{ kW}$: 102, $P > 55 \text{ kW}$: $83 + 11 \lg P$
- 39. Mobile waste containers: Stage I: 100 Stage II: 95
- 42. Piling equipment: a. Percussive 132; b. Vibrating or static: 115
- 45d Power generators ($\geq 400 \text{ kW}$): $75 + 11 \lg P_{al}$
- 46. Power sweepers (Rename to Road sweepers): $P \leq 5 \text{ kW}$: 96; $P > 5 \text{ kW}$: $89 + 11 \lg P$
- 47. Refuse collection vehicles: 105 (new test code / workcycle needed)
- 49. Scarifiers, CE powered: $99 + 2 \lg P$ (Electric: Art 13)
- 50. Shredders/chippers: $P \leq 5 \text{ kW}$: 109, $P > 5 \text{ kW}$: 119
- 55. Truck mixers: $P \leq 55 \text{ kW}$: 109, $P > 55 \text{ kW}$: $90 + 11 \lg P$
- 56. Water pump units (include pool pumps):
CE: $P \leq 25$: 109; $P > 25$: $94 + 11 \lg P$; Electric: 99

Limit changes for Article 12 equipment

- 8b. Compaction machines/Vibratory plates: Stage II where possible
- 9. Compressors: $96, 95 + 2 \lg P$ (1 dB reduction for $P < 3 \text{ kW}$)
- 10. Concrete-breakers and picks, $m > 3 \text{ kg}$: 105; $15 \text{ kg} \leq m < 30 \text{ kg}$: $92 + 11 \lg m$; $m > 30 \text{ kg}$: $94 + 9.6 \lg m$
- 32. Lawnmowers: $L \leq 120 \text{ cm}$: $77 + 12 \lg L$; $L > 120 \text{ cm}$: $73 + 15 \lg L$
- 33. Lawn trimmers / lawn edge trimmers: 95
- 36. Lift trucks: $P \leq 55 \text{ kW}$: 102; $P > 55 \text{ kW}$: $83 + 11 \lg P$ (Stage II+1)
- 38. Mobile cranes: $P \leq 55 \text{ kW}$: 100; $P > 55 \text{ kW}$: $81.5 + 11 \lg P$
- 45. Power generators:
 $P_{al} \leq 2 \text{ kW}$: $94 + \lg P_{al}$; $2 < P_{al} \leq 10 \text{ kW}$: $95 + \lg P_{al}$;
 $10 < P_{al} < 400 \text{ kW}$: $94 + \lg P_{al}$; $P_{al} \geq 400 \text{ kW}$: $75 + 11 \lg P_{al}$
- 57. Welding generators, same as for power generators $< 400 \text{ kW}$.

Proposed new equipment types

1) Move to Article 13: 3 types

- 107. Portal cranes for harbours and terminals
- 102. Mobile sieve installations (potential limit: 112; $92 + 11 \lg P$)
- 103. Mobile waste breakers (wood, concrete) (potential limit: 112; $92 + 11 \lg P$)

2) Move to Article 12: 10 types

- 108. Vehicle mounted loader cranes (same limits as mobile cranes)
- 109. Walk-behind road sweepers, no aspirators (motorized broom, same limits as road sweeper)
- 110. Street washing machine (same limits as road sweeper)
- 111. Snowmobiles: L_{pASmax} @ 15.2m, accelerating : 78 dB(A) (LWA: 110)
- 115. Telescopic or pole pruner a. CE-powered b. Electric (same limits as chainsaws)
- 117. Straddle carrier and 118. Reach stacker (same limits as lift trucks)
- 119. Handheld stone cut-off saw: $112 + 2 \lg P$
- 120. Stone chainsaw (same limits as chainsaws)
- 121. Swimming pool pumps (same limits as water pumps)
- 122. Air suction refuse vehicles (same limits as High pressure flushers or suction vehicles)



Revision of test codes

- Many test codes need further improvement by CEN WGs, some are in revision process
- Change of test cycle (e.g. more idle time) can affect limit
- Reproducibility is a key requirement, in conflict with the requirement to represent 'real conditions'
- Factors affecting measurement uncertainty:
 - uncertainty method, loading and operating conditions, work cycle, temperature range, process or work piece contribution, environmental correction K2A
- These all need addressing at higher level to make all the standards consistent (task for CEN)
- Tables of test codes for each equipment type and general recommendations are listed in report



ODELIA Study - Conclusions

- Tighter limits are proposed for 9 equipment types
- New limits are proposed for 28 types currently without limits
- 13 new equipment types are proposed to be included in the directive, of which 10 with limits
- Test codes have been reviewed and both general and equipment specific recommendations are made for improvement
- General and specific justifications have been given for each individual limit proposal
- The proposals will be the basic reference for the coming revision of the Regulation,
- but the final EC proposal may differ depending on the impact assessment and the New Legislative Framework.



Incentives and initiatives (Netherlands)

- PIEK programme for quiet goods delivery still working, international application, PIEK certificate, Quiet truck 72 dB(A)
- MIA/VAMIL tax incentive programme for environmentally friendly machinery including noise
- 'Buy the Best tyre' Campaign (www.kiesdebesteband.nl)
Fuel savings, more safety and less noise



QUIZ WAAROM BELANGRIJK? VAKANTIECHECK ZOMERBANDEN BANDENSPIJNING TIPS FAQ

WAAROM ZIJN BANDEN BELANGRIJK?

Banden zijn het enige contact van je auto met de weg en bepalen voor een groot deel de prestaties van je auto. Door te kiezen voor betere en goed opgepompte banden rij je veiliger, zuiniger en stiller.

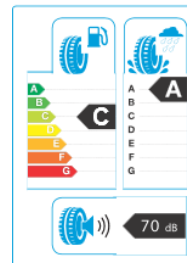


BANDENLABEL

Op alle nieuwe banden voor personen- en bestelwagens zit het Europese bandenlabel. Hiermee kun je de grip, de brandstofefficiëntie en het afroegeluid van banden vergelijken.

LEES MEER

BANDENLABEL





Combining noise reduction with other benefits

- Where noise reduction coincides with other benefits and savings, market acceptance may be good:
 - Power and system management (fuel/energy saving) + less noise
 - Health and Safety: lower noise levels = safer
 - Electric powertrains: higher efficiency, lower exhaust emissions
 - Improved performance: better tools and processes, higher efficiency
 - Environmental permits: easier to comply (Zones, Green procurement)



Conclusions

- Noise emission limits are an effective instrument to reduce environmental noise in a cost-effective manner
- Health benefits and quality of life are key justification for limits
- Noise limits give a minimum requirement and a means to control excessive noise but need to be tighter in many cases to compensate growth effects
- Reference point for manufacturer, purchaser and user
- Complementary to national and local regulation
- Technical progress has been made in the last decade including quieter technologies and better market information
- Acceptance is stronger if other benefits are combined, such as fuel/energy saving, efficiency, safety and performance
- Impact can be increased by incentives and awareness



ODELIA
OutDoor Equipment Noise Limit Assessment

Final Study Report for

European Commission
 Directorate-General for Internal Market, Industry,
 Entrepreneurship and SMEs

 **GROWTH**
 Internal Market, Industry, Entrepreneurship and SMEs

Tender No 414/PP/ENT/119427
 Study on the suitability of the current scope and limit
 values of Directive 2000/14/EC relating to the noise
 emission in the environment by equipment for use
 outdoors

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TÜV NORD Group Germany

IMAMOTER Italy

IMAMOTER
 moving solutions





ODELIA Study final report at:

http://ec.europa.eu/growth/sectors/mechanical-engineering/noise-emissions_en

See also paper at Internoise 2016

Thank you for your attention!