Convention on Long-Range Transboundary Air Pollution

45th Working Group on Strategies and Review – 31 August 2009 to 4 September 2009

Technical Annex prepared by EGTEI

Suggested Technical Annex V

to the Gothenburg Protocol

Annex V

LIMIT VALUES FOR EMISSIONS OF NITROGEN OXIDES FROM STATIONARY SOURCES

1. Section A applies to Parties other than Canada and the United States of America, section B applies to Canada and section C applies to the United States of America.

A. Parties other than Canada and the United States of America

2. For the purpose of section A, limit value means the quantity of a gaseous substance contained in the waste gases from an installation that is not to be exceeded. Unless otherwise specified, it shall be calculated in terms of mass of pollutant per volume of the waste gases (expressed as mg/m3), assuming standard conditions for temperature and pressure for dry gas (volume at 273.15 K, 101.3 kPa). With regard to the oxygen content of exhaust gas, the values given in the tables below for each source category shall apply. Dilution for the purpose of lowering concentrations of pollutants in waste gases is not permitted. Limit values generally address NO together with NO_2, commonly named NOx, expressed as NO_2. Start-up, shutdown and maintenance of equipment are excluded.

3. Emissions shall be monitored[a] in all cases. Compliance with limit values shall be verified. The methods of verification can include continuous or discontinuous measurements, type approval, or any other technically sound method. In case of continuous measurements, compliance with the emission standards is achieved if the validated [daily/monthly][b] emission average does not exceed the limit values. In case of discontinuous measurements or other appropriate determination procedures, compliance with the emission standards is achieved if the mean value based on an appropriate number of measurements under representative conditions does not exceed the value of the emission standard. The inaccuracy of the continuous and discontinuous measurement methods may be taken into account for verification purposes.

4. Sampling and analysis of relevant polluting substances and measurements of process parameters, as well as the quality assurance of automated measuring systems and the reference measurement methods to calibrate those systems, shall be carried out in accordance with CEN standards. If CEN standards are not available, ISO standards, national or international standards which will ensure the provision of data of an equivalent scientific quality shall apply.

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[a] Monitoring is to be understood as an overall activity, comprising measuring or calculating of emissions, mass balancing, etc. It can be carried out continuously or discontinuously.

[b] One option is to define the ELVs as daily averages, another option is to define the ELVs as monthly averages; shorter averaging periods can be considered as being more strict.

5. Special provisions for combustion plants with a rated thermal input exceeding 50 MWth and for combustion plants when combined to a common stack with a total rated input exceeding 50 MWth:

5.1 The competent authority may grant derogation from the obligation to comply with the emission limit values provided for in paragraph 5 in the following cases:
[a) for combustion plants using [only/mainly] gaseous fuel who have to resort exceptionally to the use of other fuels because of a sudden interruption in the supply of gas and for this reason would need to be equipped with a waste gas purification facility]
[b) for combustion plants not operated more than XXX operating hours, starting from DATE and ending no later than DATE]
[c) for existing combustion plants using solid or liquid fuels not operated more than 1500 operating hours per year as a rolling average over a period of five years; instead following emission limit values apply:
for solid fuels: [option 1 and 2 = 450 mg/Nm³; option 3 = 600 mg/Nm³][1]
for liquid fuels: [option 1, 2 and 3 = 450 mg/Nm³][1]]

5.2 Where a combustion plant is extended by at least 50MW, the emission limit value specified in paragraph 7 for new installations shall apply to the extensional part and to the part of the plant affected by the change.

5.3 Parties shall ensure that provisions are made in the permits for procedures relating to malfunction or breakdown of the abatement equipment.

5.4 In the case of a multi-fuel firing combustion plant involving the simultaneous use of two or more fuels, the competent authority shall provide rules for setting the emission limit values

6. Mineral oil refineries complying with the overall NO_X limit value set in table 1 may be exempted from compliance with the individual NO_X limit values provided in this annex. Following alternative bubble NO_X limit value may be used, referring to the sum of the emissions from all combustion plants and process installations expressed as an average concentration and at a reference oxygen content of [3%]:

Table 1. Suggested options for limit values for NOx emissions released from refineries using the bubble concept

	Suggested ELV for NO_x [mg/Nm³]							
	Option 1[1/]			Option 2[1/]			Option 3[1/]	
		Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
Mineral oil refinery	150	cf. footnote		300	cf. footnote		400	

__BREF__: The TWG has not been able to identify a single range of emissions associated with the application of BAT under the bubble concept (see reasons within the introduction to BAT for Reduction of Emissions to Air). However, several benchmarks were identified:

For the concentration bubble approach (all in mg/Nm3 and @ 3% O2):
- One Member State proposed that the full implementation of BAT results in a bubble of 70 - 150 (daily average).
- One Member State proposed that the implementation of BAT results in a bubble of 100 - 200 (monthly average) based on calculation in Annex V.
- One Member State proposed that the implementation of BAT results in a bubble of 150 (monthly average) and 200 daily.
- Two Member States proposed a bubble range of 250 – 450 (monthly average) based on current practice.
- Industry proposed a bubble range of 200 – 500 (yearly average) based on current European refinery performance.

For the load bubble approach (all in t NOx/Mt of throughput):
- One Member State proposed a bubble range of 20 – 150 (yearly average) based on the upper quartile of specific emissions from 40 existing EU refineries.
- One Member State proposed that the full implementation of BAT results in a bubble range of 80 – 170 (daily average)

Oxygen reference: dry basis, 3% for combustion, 15 % for gas turbines

7. Combustion plants (boilers and process heaters) with a rated thermal input exceeding 50 MWth or combustion plants when combined to a common stack with a total rated input exceeding 50 MWth[c]:

Table 2. Suggested options for limit values for NO_x emissions released from boilers [and process heaters] a/

[c] Individual combustion plants below 15 MWth shall not be considered to calculate the total rated input.

Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	**Techniques**		**Upper BAT AEL**	**Techniques**		**Legislation**
Solid fuels	50-100	New plants: 250 (coal, lignite) 200 (biomass, peat)	Coal, lignite (grate): 200 Coal Coal (PC): 90 Coal, lignite (FBC): 200 Lignite (PC): 200 Biomass, peat (grate): 170 Biomass, peat (PC): 150 Biomass, peat (FBC): 150	Pm and or SNCR Combination of Pm (such as air and fuel staging, low NOx burner, etc.), SNCR or SCR as an additional measure Combination of Pm (such as air and fuel-staging) Combination of Pm (such as air and fuel-staging) Spreader-stoker Combination of Pm (air and fuel staging, low NOX burner, etc.) or SCR Combination of Pm (air distribution or by flue-gas recirculation)	New plants: 300 (coal, lignite) (pulverised lignite: 450) 250 (biomass, peat)	Coal, lignite (grate): 300 Coal (PC): 300 Coal, lignite (FBC): 200 Lignite (PC): 450 Biomass, peat (grate): 250 Biomass, peat (PC): 250 Biomass, peat (FBC): 250	Same as for option 1	New plants: 400 (coal, lignite) (pulverised lignite 450) 400 (biomass, peat)	EU-LCPD:(licence before 2002): 600; EU-LCPD:(licence after 2002): 400 UNECE-GP: 400 EU-IED (permit before 2014): Lignite (PC): 450; Other: 300 EU-IED (permit after 2014): Coal, lignite: 300; lignite (PC): 400; Biomass, peat: 250

Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
		Existing plants: 250 (coal, lignite) 250 (biomass, peat)	Coal, lignite (grate): 200 Coal (PC): 90 Coal, lignite (FBC): 200 Lignite (PC): 200 Biomass, peat (grate): 200 Biomass, peat (PC): 150 Biomass, peat (FBC): 150	Pm and or SNCR Combination of Pm (such as air and fuel staging, low NOx burner, etc.), SNCR or SCR as an additional measure Combination of Pm (such as air and fuel-staging) Combination of Pm (such as air and fuel-staging) Spreader-stoker Combination of Pm (air and fuel staging, low NOX burner, etc.) or SCR Combination of Pm (air distribution or by flue-gas recirculation)	Existing plants: 300 (coal, lignite) (pulverised lignite: 450) 300 (biomass, peat)	Coal, lignite (grate) Coal (PC): 300 Coal, lignite (FBC): 300 Lignite (PC): 450 Biomass, peat (grate): 300 Biomass, peat (PC): 300 Biomass, peat (FBC): 300	Same as for option 1	Existing plants: 600 (coal, lignite) 600 (biomass, peat)	EU-LCPD:(licence before 2002): 600 EU-LCPD:(licence after 2002): 400 UNECE-GP: in general: 650; less than 10% volatile compounds: 1300 EU-IED (permit before 2014): Lignite (PC): 450; Other: 300 EU-IED (permit after 2014): Coal, lignite: 300; lignite (PC): 400; Biomass, peat: 250

Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
	100-300	New plants: 150 (coal, lignite) 150 (biomass, peat)	Coal (PC): 90 Lignite (PC): 100 Coal, lignite (FBC): 100 Biomass, peat (PC): 150 Biomass, peat (FBC): 150	Combination of Pm (air and fuel-staging, low NOx burner, reburning, etc), in combination with SCR or combined techniques Combination of Pm (air and fuel-staging, low NOx burner, reburning, etc.) Combination of Pm (air and fuel-staging), if necessary, together with SNCR Combination of Pm (such as air and fuel staging, low NOX burner) if necessary SNCR and/or SCR Combination of Pm (such as air distribution or by flue-gas recirculation)	New plants: 200 (coal, lignite) 200 (biomass, peat)	Coal (PC): 200 Lignite (PC): 200 Coal, lignite (FBC): 200 Biomass, peat (PC): 200 Biomass, peat (FBC): 200	Same as for option 1	New plants: 200 (coal, lignite) 300 (biomass, peat)	EU-LCPD:(licence before 2002): 600 EU-LCPD:(licence after 2002): Biomass: 300; other 200 UNECE-GP: 300 EU-IED (permit before 2014): Biomass, peat: 250; Other: 200 EU-IED (permit after 2014): 200

Fuel type	**Thermal input [MWth]**	**Suggested ELV for NO_x [mg/Nm^3]**[b/]							
		Option 1[1/]			**Option 2**[1/]			**Option 3**[1/]	
			Lower BAT AEL	**Techniques**		**Upper BAT AEL**	**Techniques**		**Legislation**
		Existing plants: 200 (coal, lignite) 200 (biomass, peat)	Coal (PC): 90 Lignite (PC): 100 Coal, lignite (FBC): 100 Biomass, peat (PC): 150 Biomass, peat (FBC): 150	Combination of Pm (air and fuel-staging, low NOx burner, reburning, etc), in combination with SCR or combined techniques Combination of Pm (air and fuel-staging, low NOx burner, reburning, etc.) Combination of Pm (air and fuel-staging), if necessary, together with SNCR Combination of Pm (such as air and fuel staging, low NOX burner) if necessary SNCR and/or SCR Combination of Pm (such as air distribution or by flue-gas recirculation)	Existing plants: 200 (coal, lignite) 250 (biomass, peat)	Coal (PC): 200 Lignite (PC): 200 Coal, lignite (FBC): 200 Biomass, peat (PC): 250 Biomass, peat (FBC): 250	Same as for option 1	Existing plants: 600 (coal, lignite) 600 (biomass, peat)	EU-LCPD:(licence before 2002): 600 EU-LCPD:(licence after 2002): Biomass: 300; other 200 UNECE-GP: in general: 650; less than 10% volatile compounds: 1300 EU-IED (permit before 2014): Biomass, peat: 250; Other: 200 EU-IED (permit after 2014): 200

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Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm^3][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
	>300	New plants: 100 (coal, lignite) 100 (biomass, peat)	Coal (PC): 90 Lignite (PC): 50 Coal, lignite (FBC): 50 Biomass, peat (PC): 50 Biomass, peat (FBC): 50	Combination of Pm (air and fuel-staging, low NOx burner, reburning, etc.), in combination with SCR or combined techniques Combination of Pm (such as air and fuel-staging, low NOx burner, reburning, etc) Combination of Pm (such as air and fuel-staging) Combination of Pm (air and fuel staging, low NOX burner), if necessary SNCR and/or SCR Combination of Pm (air distribution or by flue-gas recirculation), if necessary SNCR and/or SCR	New plants: 150 (coal, lignite) 150 (biomass, peat)	Coal (PC): 150 Lignite (PC): 200 Coal, lignite (FBC): 150 Biomass, peat (PC): 150 Biomass, peat (FBC): 150	Same as for option 1	New plants: 200 (coal, lignite) 200 (biomass, peat)	EU-LCPD:(licence before 2002, <500MW): 600 EU-LCPD:(licence before 2002, >500MW): until 2016: 500; after 2016: 200 EU-LCPD:(licence after 2002): 200 UNECE-GP: 200 EU-IED (permit before 2014): 200 EU-IED (permit after 2014): 150; Lignite (PC): 200

Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]								
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
		Existing plants: 100 (coal, lignite) 100 (biomass, peat)	Coal (PC): 90 Lignite (PC): 50 Coal, lignite (FBC): 50 Biomass, peat (PC): 50 Biomass, peat (FBC): 50	Combination of Pm (air and fuel-staging, low NOx burner, reburning, etc.), in combination with SCR or combined techniques Combination of Pm (such as air and fuel-staging, low NOx burner, reburning, etc) Combination of Pm (such as air and fuel-staging) Combination of Pm (air and fuel staging, low NOX burner), if necessary SNCR and/or SCR Combination of Pm (air distribution or by flue-gas recirculation), if necessary SNCR and/or SCR	Existing plants: 200 (coal, lignite) 200 (biomass, peat)	Coal (PC): 200 Lignite (PC): 200 Coal, lignite (FBC): 200 Biomass, peat (PC): 200 Biomass, peat (FBC): 200	Same as for option 1	Existing plants: 200 (coal, lignite) 200 (biomass, peat)	EU-LCPD:(licence before 2002, <500MW): 600 EU-LCPD:(licence before 2002, >500MW): until 2016: 500; after 2016: 200 EU-LCPD:(licence after 2002): 200 UNECE-GP: in general: 650; less than 10% volatile compounds: 1300 EU-IED (permit before 2014): 200 EU-IED (permit after 2014): 150; Lignite (PC): 200

Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
Liquid fuels	50-100	New plants: 250	150	Combination of Pm (air and fuel staging, low-NOx burner, etc.) For LFO firing NOX <300 mg/Nm3 For HFO firing with max 0,2 % N in fuel oil NOX <360 mg/Nm3 For HFO firing with max 0,3 % N in fuel oil NOX <450 mg/Nm3 SCR SNCR in case of HFO firing	New plants: 300	300	Same as for option 1	New plants: 400	EU-LCPD:(licence before 2002): 450 EU-LCPD:(licence after 2002): 400 UNECE-GP: 400 EU-IED (permit before 2014): 450 EU-IED (permit after 2014): 300
		Existing plants: 300	150	Combination of Pm (air and fuel staging, low-NOx burner, etc.) For LFO firing NOX <300 mg/Nm3 For HFO firing with max 0,2 % N in fuel oil NOX <360 mg/Nm3 For HFO firing with max 0,3 % N in fuel oil NOX <450 mg/Nm3 SCR SNCR in case of HFO firing	Existing plants: 450	450	Same as for option 1	Existing plants: 450	EU-LCPD:(licence before 2002): 450 EU-LCPD:(licence after 2002): 400 UNECE-GP: 450 EU-IED (permit before 2014): 450 EU-IED (permit after 2014): 300

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Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	**Techniques**		**Upper BAT AEL**	**Techniques**		**Legislation**
	100-300	New plants: 100	50	Combination of Pm (air and fuel staging, low-NOx burner, reburning, etc) in combination with SNCR, SCR or combined techniques	New plants: 150	150	Same as for option 1	New plants: 200	EU-LCPD:(licence before 2002): 450 EU-LCPD:(licence after 2002): 200 UNECE-GP: 300 EU-IED (permit before 2014): 200 EU-IED (permit after 2014): 150
		Existing plants: 150	50	Combination of Pm (air and fuel staging, low-NOx burner, reburning, etc) in combination with SNCR, SCR or combined techniques	Existing plants: 200	200	Same as for option 1	Existing plants: 450	EU-LCPD:(licence before 2002): 450 EU-LCPD:(licence after 2002): 200 UNECE-GP: 450 EU-IED (permit before 2014): 200 EU-IED (permit after 2014): 150

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Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
	>300	New plants: 80	50	Combination of Pm (air and fuel staging, low-NOx burner, reburning, etc) in combination with SCR or Combined techniques	New plants: 100	100	Same as for option 1	New plants: 200	EU-LCPD:(licence before 2002, <500MW): 450 EU-LCPD:(licence before 2002, >500MW): 400 EU-LCPD:(licence after 2002): 200 UNECE-GP: 200 EU-IED (permit before 2014): 150 EU-IED (permit after 2014): 100
		Existing plants: 100	50	Combination of Pm (air and fuel staging, low-NOx burner, reburning, etc) in combination with SCR or Combined techniques	Existing plants: 150	150	Same as for option 1	Existing plants: 400	EU-LCPD:(licence before 2002, <500MW): 450 EU-LCPD:(licence before 2002, >500MW): 400 EU-LCPD:(licence after 2002): 200 UNECE-GP: 350 EU-IED (permit before 2014): 150 EU-IED (permit after 2014): 100

Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
Natural gas	50-300	New plants: 80	50	Low-NOx burners or SCR or SNCR	New plants: 100	100	Same as for option 1	New plants: 150	EU-LCPD:(licence before 2002): 300 EU-LCPD:(licence after 2002): 150 UNECE-GP: 150 EU-IED (permit before 2014): 100 EU-IED (permit after 2014): 100
		Existing plants: 80	50	Low-NOx burners or SCR or SNCR	Existing plants: 100	100	Same as for option 1	Existing plants: 300	EU-LCPD:(licence before 2002): 300 EU-LCPD:(licence after 2002): 150 UNECE-GP: 350 EU-IED (permit before 2014): 100 EU-IED (permit after 2014): 100

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Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	**Techniques**		**Upper BAT AEL**	**Techniques**		**Legislation**
	>300	New plants: 60	50	Low-NOx burners or SCR or SNCR	New plants: 100	100	Same as for option 1	New plants: 100	EU-LCPD:(licence before 2002; <500MW): 300 EU-LCPD:(licence before 2002; >500MW): 200 EU-LCPD:(licence after 2002): 100 UNECE-GP: 100 EU-IED (permit before 2014): 100 EU-IED (permit after 2014): 100
		Existing plants: 80	50	Low-NOx burners or SCR or SNCR	Existing plants: 100	100	Same as for option 1	Existing plants: 200	EU-LCPD:(licence before 2002; <500MW): 300 EU-LCPD:(licence before 2002; >500MW): 200 EU-LCPD:(licence after 2002): 100 UNECE-GP: 350 EU-IED (permit before 2014): 100 EU-IED (permit after 2014): 100

Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][b/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
Other gaseous fuels [c/]	>50	New plants: 200		Refinery gas: - high thermal efficiency designs with good control systems - low-NOx burners technique - flue gas circulation in boilers - SCR or SNCR.	New plants: 200		Same as option 1	New plants: 200	EU-LCPD:(licence after 2002): 200 UNECE-GP: 200
		Existing plants: 300		Refinery gas: - high thermal efficiency designs with good control systems - low-NOx burners technique - flue gas circulation in boilers - SCR or SNCR.	Existing plants: 300		Same as option 1	Existing plants: 300	EU-LCPD:(licence after 2002): 200 UNECE-GP: 350

a/ In particular, the limit values shall not apply to:

- Plant where the combustion process is an integrated part of a specific production, for example the coke oven used in the Iron and Steel industry and glass and ceramics production plants;
- Plant in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials;
- Post-combustion plants designed to purify the waste gases by combustion which are not operated as independent combustion plants;
- Facilities for the regeneration of catalytic cracking catalysts;
- Facilities for the conversion of hydrogen sulphide into sulphur;
- Reactors used in the chemical industry;
- Coke battery furnaces;
- Cowpers;
- [Recovery boilers for black liquor within installations for the production of pulp]
- Waste incinerators; and
- Plant powered by diesel, petrol or gas engines or by combustion turbines, irrespective of the fuel used.

b/ These values do not apply to combustion plants running less than 500 hours a year. The O_2 reference content is 6% for solid fuels and 3% for others.

c/ including refinery gases, coke oven gases, blast furnace gases, BOF gases

8. Onshore combustion turbines with a rated thermal input exceeding 50MWth: the NO_x limit values expressed in mg/Nm³ (with an O_2 content of 15%) are to be applied to a single turbine. The limit values in table 2 apply only above 70% load.

Table 3. Suggested options for limit values for NO_x emissions released from onshore combustion turbines (including CCGT)

Fuel type	Thermal input [MWth]	Suggested ELV for NO_x [mg/Nm³][a/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
Liquid fuels (light and medium distillates)	>50	New plants: 50		injection of water or steam dry low NOX premix burners (DLN) where technology is available on the market for the use in gas turbines burning liquid fuels	New plants: 100		Same as for option 1	New plants: 120	EU-LCPD:(licence after 2002): 120 UNECE-GP: 120 EU-IED (permit after 2014): 50
		Existing plants: 90		injection of water or steam	Existing plants: 120		Same as for option 1	Existing plants: 120	EU-LCPD:(licence after 2002): 120 UNECE-GP: 200 EU-IED (permit after 2014): 50
Natural gas[b/]	>50	New plants: 50	20	Dry low-NOx premix burners (standard equipment for new gas turbines) or SCR	New plants: 50	50	Same as for option 1	New plants: 50	EU-LCPD:(licence after 2002): 50 UNECE-GP: 50 EU-IED (permit before 2014): 50 EU-IED (permit after 2014): 50

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Fuel type	Thermal input [MWth]	Suggested ELV for NOx [mg/Nm³][a/]							
		Option 1[1/]			Option 2[1/]			Option 3[1/]	
			Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
		Existing plants: 50	50	Water and steam injection or SCR	Existing plants: 90	90	Water and steam injection or SCR	Existing plants: 120	EU-LCPD:(licence after 2002): 50 UNECE-GP: 150 EU-IED (permit before 2014): 100 EU-IED (permit after 2014): 50
Other gases[c/]		New plants: 50		[LCP_BREF: Gas-fired turbines (gas not specified):Dry low-NOx premix burners (standard equipment for new gas turbines) or SCR]	New plants: 50		Same as option 1	New plants: 50	EU-LCPD:(licence after 2002): 120 EU-IED (permit before 2014): 90 EU-IED (permit after 2014): 50
		Existing plants: 75		[LCP_BREF: Gas-fired turbines (gas not specified): Water and steam injection or SCR]	Existing plants: 120		Same as option 1	Existing plants: 120	EU-LCPD:(licence after 2002): 120 EU-IED (permit before 2014): 90 EU-IED (permit after 2014): 50

a/ O_2 content of 15%. Gas turbines for emergency use that operate less than 500 hours per year are not covered. The ELVs apply only above 70% load
b/ Natural gas is naturally occurring methane with not more than 20% (by volume) of inerts and other constituents.
c/ [e.g. for supplementary firing with other gases]

9. Cement production:

Table 4. Suggested options for limit values for NO_x emissions released from cement production [a/]

	Suggested ELV for NO_x [mg/Nm³]							
	Option 1[1/]			Option 2[1/]			Option 3[1/]	
		Lower BAT AEL	Techniques		Lower BAT AEL	Techniques		Legislation
New installations								
- preheater kilns	300	200	Combination of: primary measures, staged combustion, SNCR, SCR, with an efficiency permitting to achieve these levels	400	400	Combination of: primary measures, staged combustion, SNCR, SCR, with an efficiency permitting to achieve these levels	500	UNECE-GP: 500
- other kilns	400	400	Combination of: primary measures, staged combustion, SNCR, SCR, with an efficiency permitting to achieve these levels	800	800	Combination of: primary measures, staged combustion, SNCR, SCR, with an efficiency permitting to achieve these levels	800	UNECE-GP: 800
Existing installations	400	Same as new installations	Combination of: primary measures, staged combustion, SNCR, SCR, with an efficiency permitting to achieve these levels	800	800	Combination of: primary measures, staged combustion, SNCR, SCR, with an efficiency permitting to achieve these levels	1200	UNECE-GP: 1200

a/ Installations for the production of cement clinker in rotary kilns with a capacity >500 Mg/day or in other furnaces with a capacity >50 Mg/day. The O_2 reference content is 10%.

13. Stationary engines

The emission limit values in table below are proposed in 15 % reference oxygen content because this corresponds to the actual operational conditions of stationary engines.

The limit value of, for instance:
• 190 mg NO_x/Nm^3 in 15 % O_2 corresponds to the limit of 500 mg NO_x/Nm^3 in 5 % O_2,
• 95 mg NO_x/Nm^3 in 15 % O_2 corresponds to 250 mg NO_x/Nm^3 in 5 % O_2 and
• 225 mg NO_x/Nm^3 in 15 % O_2 corresponds to 600 mg NO_x/Nm^3 in 5 % O_2**.**

Table 5. Suggested options for limit values for NO_x emissions released from new stationary engines

ENGINE TYPE, POWER, FUEL SPECIFICATION	**ELV 1 (a) (b) (c)**	**ELV 2(a) (b) (c)**	**ELV 3(a)**
GAS ENGINES > 1 MW_{th} Spark ignited (=Otto) engines all gaseous fuels	35	95	190
DUAL FUAL ENGINES > 1 MW_{th} In gas mode (all gaseous fuels)	35 (e)	190(e)	380(e)
In liquid mode (all liquid fuels)			
1-20 MW	225	750	[1850] [2000]
>20 MW	225(e)	450	[1850] [2000]

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DIESEL ENGINES > 5 MW_{th} (compression ignition)			
Slow (< 300 rpm)/ Medium (300-1200 rpm)/ speed			[1300] (d)
5-20 MW			[1600]
HFO and bio-oils	225	[450] [750]	[1300] (d)
LFO and NG	150	190	[1600]
>20 MW			
HFO and bio-oils	190	[225] [450]	[750] [1850]
LFO and NG	150	190	[750] [1850]
High speed (>1200 rpm)	[130] [150]	190	[750] _ [900]

The oxygen reference content is 15%

(a) These values do not apply to engines running less than 500 hours a year.
(b) Where SCR cannot currently be applied [for certain geographical areas, like remote islands] or the unavailability of good fuel or raw material quality not guaranteed, a transition period of [x] yrs can be granted. During this transition period the upper value of ELV3 can be applied.
(c) A flexibility option for engines running between 500 to1500 operational hours per year is to apply [the upper values of ELV3] [achievable with primary measures].
(d) Limit of primary measures under development (Currently only first laboratory tests done on some engine type.)
(e*)* A derogation from the obligation to comply with the emission limit values can be granted to combustion plants using gaseous fuel which have to resort exceptionally to the use of other fuels because of a sudden interruption in the supply of gas and for this reason would need to be equipped with a waste gas purification facility. The exception time period shall not exceed 10 days except where there it is an overriding need to maintain energy supplies.

[Since engines running with higher energy efficiency consume less fuel and emit therefore less CO_2 and since higher efficiency of the engines can lead to higher temperatures and therefore to higher NO_X concentrations in the flue gases, a NO_X bonus using the formula [ELV x actual efficiency / reference efficiency] could be justified[d].]

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[d] See e.g. U K “Environmental Protection Act 1990, part 1 (1995 revision), PG 1/5 (95): Secretary of state’s Guidance-compression Ignition Engines, 20 – 50 MW Net rated Thermal Input” (prescribes efficiency correction from 40 %).

11. Production and processing of metals:

Table 6. Suggested options for limit values for NO_x emissions released from primary iron and steel [a/] production

Plant type	Suggested ELV for NO_x [mg/Nm³][b/]							
	Option 1[1/]			Option 2[1/]			Option 3[1/]	
		Lower BAT AEL	Techniques		Upper BAT AEL	Techniques		Legislation
Sinter plants: New installation	[…[c/]]	c/	waste gas recirculation - waste gas denitrification, applying- regenerative activated carbon process - selective catalytic reduction Due to the high cost waste gas denitrification is not applied except in circumstances where environmental quality standards are not likely to be met.	400	c/	Same as for option 1	400	UNECE-GP: 400
Sinter plants: Existing installation	[…[c/]]	c/	waste gas recirculation - waste gas denitrification, applying- regenerative activated carbon process - selective catalytic reduction Due to the high cost waste gas denitrification is not applied except in circumstances where environmental quality standards are not likely to be met.	400	c/	Same as for option 1	400	UNECE-GP: 400

a/ Production and processing of metals: metal ore roasting or sintering installations, installations for the production of pig iron or steel (primary or secondary fusion) including continuous casting with a capacity exceeding 2.5 Mg/hour, installations for the processing of ferrous metals (hot rolling mills > 20 Mg/hour of crude steel).

b/ As an exemption to paragraph 3, these ELVs should be considered as averaged over a substantial period of time

c/ SCR is considered as part of the BAT in the European Reference document but no BAT-AEL is reported.

12. Nitric acid production:

Table 7. Suggested options for limit values for NO_x emissions from nitric acid production excluding acid concentration units

Type of installations	Suggested ELV for NO_x [mg/Nm³]							
	Option 1[1/]			Option 2[1/]			Option 3[1/]	
		Lower BAT AEL	Techniques		Lower BAT AEL	Techniques	ELV	Legislation
New installations	40 Based on a consensus of the EGTEI group	10	Association of different techniques permitting to achieve these levels: optimisation of the absorption stage, combined NO_x and N_2O abatement technique , SCR, addition of H_2O_2 to the last absorption stage	154	154	Association of different techniques permitting to achieve these levels: optimisation of the absorption stage, combined NO_x and N_2O abatement technique , SCR, addition of H_2O_2 to the last absorption stage	200 Based on a consensus of the EGTEI group	UNECE-GP: 350
Existing installations	100 Based on a consensus of the EGTEI group	Same as new installations	Association of different techniques permitting to achieve these levels: optimisation of the absorption stage, combined NO_x and N_2O abatement technique , SCR, addition of H_2O_2 to the last absorption stage	185	185	Association of different techniques permitting to achieve these levels: optimisation of the absorption stage, combined NO_x and N_2O abatement technique , SCR, addition of H_2O_2 to the last absorption stage	200 Based on a consensus of the EGTEI group	UNECE-GP: 450

B. Canada [3/]

13. Limit values for controlling emissions of nitrogen oxides (NOx) from new stationary sources in the following stationary source categories will be determined on the basis of available information on control technology and levels including limit values applied in other countries and the following documents:

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(a) Canadian Council of Ministers of the Environment (CCME). National Emission Guidelines for Stationary Combustion Turbines. December 1992. PN1072;

(b) Canada Gazette, Part I. Department of the Environment. Thermal Power Generation Emissions - National Guidelines for New Stationary Sources. May 15, 1993. pp. 1633-1638; and

(c) CME. National Emission Guidelines for Cement Kilns. March 1998. PN1284.

C. United States of America [2/]

14. Limit values for controlling emissions of NOx from new stationary sources in the following stationary source categories are specified in the following documents:

(a) Coal-fired Utility Units - 40 Code of Federal Regulations (C.F.R.) Part 76;
(b) Electric Utility Steam Generating Units - 40 C.F.R. Part 60, Subpart D, and Subpart Da;
(c) Industrial-Commercial-Institutional Steam Generating Units - 40 C.F.R. Part 60, Subpart Db;
(d) Nitric Acid Plants - 40 C.F.R. Part 60, Subpart G;
(e) Stationary Gas Turbines - 40 C.F.R. Part 60, Subpart GG;
(f) Municipal Waste Combustors - 40 C.F.R. Part 60, Subpart Ea, and Subpart Eb; and
(g) Hospital/Medical/Infectious Waste Incinerators - 40 C.F.R. Part 60, Subpart Ec.

Note

1/ The definitions of option 1, option 2 and option 3 are as follows. These options were designed to leave maximum flexibility for discussion at the WGSR. Options for ELVs are as follows:

- Option 1: ELV1 is a demanding but technically feasible option with the objective of achieving a high level of reduction. The ELV1 is based on a value between the lower and upper BAT AEL, (where it is available),
- Option 2: ELV2, while technically demanding, pays greater attention to the costs of the measures for achieving reduction. The ELV2 is a value based on the upper BAT AEL (where it is available),
- Option 3: ELV 3 represents current [good] practices based on the legislation of a number of Parties to the Convention.

2/ Up to now, no information has been provided by North America, then part B and C of the annex have not been modified yet.

ANNEX: JUSTIFICATIONS FOR THE OPTIONS FOR “STATIONARY ENGINES”

TABLE 8. PROPOSED ELVs

ENGINE TYPE, POWER, FUEL SPECIFICATION	ELV 1	ELV 2	ELV 3
GAS ENGINES > 1 MW_{th} Spark ignited (=Otto) engines all gaseous fuels	35 – SCR with high efficiency	95 - enhanced lean burn	190 - lean burn
DUAL FUAL ENGINES > 1 MW_{th} In gas mode (all gaseous fuels)	35 - SCR with high efficiency	190 - enhanced lean burn	380 - lean burn
In liquid mode (all liquid fuels) 1-20 MW	225 - SCR with high efficiency	750 - SCR with moderate efficiency	[1850] [2000] with primary measures depending on fuel and engine design
>20 MW	225 ˉ SCR with high efficiency	450 – SCR with moderate efficiency	[1850] [2000] – with primary measures depending on fuel and engine design

DIESEL ENGINES > 5 MW_{th} (compression ignition) *Slow (< 300 rpm) / Medium (300-1200 rpm)/ speed*			
5-20 MW HFO and bio-oils	225 SCR with high efficiency	[450] [750] SCR with moderate efficiency	[1300] (d) [1600] primary measures
LFO and NG	150 SCR with high efficiency	190 SCR with high efficiency	[1300] (d) [1600] primary measures
>20 MW HFO and bio-oils	190 SCR with high efficiency	[225] SCR with high efficiency [450] SCR with moderate efficiency	[750] SCR [1850] primary measures
LFO and NG	150 SCR with high efficiency	190 SCR with high efficiency	[750] SCR [1850] primary measures
High speed (>1200 rpm)	[130] [150] SCR with high efficiency	190 SCR with high efficiency	[750] [900] primary measures

GAS ENGINES

SG-type engine

ELV1
The emission limit value of 35 mg NO_x/Nm^3 is based on the best available technical measures (cost not in main focus) to reduce NO_x emissions from new stationary engines. The new emission limit for the spark ignition engine requires the use of SCR and an availability of a fuel of an adequate quality. The driving force for application of SCR is often the need to improve local air quality especially in severely degraded air-sheds, to comply with the high reduction targets of NO_x emissions. In application of SCR on gas engines caution should be taken especially on part loads in order not to overheat ("destroy") the SCR.

ELV2
The proposed NO_x ELV of 95 mg /Nm^3 for SG-type gas engines is consistent with the use of enhanced lean burn principle (primary measures) and is a part of BAT. For a spark ignition engine (SG) enhanced lean burn can cause an increase in fuel consumption (up to 3% in fuel consumption and corresponding CO_2 emission), and unburned gaseous emissions such as CO emissions and a lower flue gas temperature (detrimental for CHP applications) compared to "normal" lean burn. Certain gas (e.g. some bio gases) compositions set also limitations on the achievable NO_x-level to 95 mg NO_x/Nm^3 (15 % O_2) but possible fluctuations of gas composition and contaminations may have to be considered when defining emission limit values if achievable or not.

ELV3
The proposed ELV of 190 mg NO_x/Nm^3 is consistent with the use of the lean burn principle (corresponding with primary measures), also representing BAT. This level can be achieved by standard lean burn engines. The proposed ELV of 190 mg/Nm^3 can also be achieved by rich burn engines equipped with a 3-way catalyst (NSCR).

DUAL FUEL ENGINES (DF)

Dual fuel engines in gas mode

ELV1
The emission limit value of 35 mg NO_x/Nm^3 is based on the best available technical measures (cost not in main focus) to reduce NO_x emissions from new dual fuel engines in gas mode. The proposed emission limit value requires the use of SCR and an availability of a fuel of an adequate quality. The driving force for application of SCR is often the need to improve local air quality especially in severely degraded air-sheds to comply with the high reduction targets of NO_x emissions. In application of SCR on DF-type of engines in gas mode caution should be taken especially on part loads in order not to overheat ("destroy") the SCR.

ELV2
The emission limit value of 190 mg NO_x/Nm^3 for dual fuel (DF) gas engines in gas mode, can be complied with the enhanced lean-burn principle (primary measures) of the engine, representing BAT.

ELV 3
The emission limit value of 380 mg NO_x/Nm^3 for dual fuel (DF) gas engines in gas mode, can be complied with the lean-burn principle (primary measures) of the engine with optimum fuel consumption and lowest unburned gaseous emissions of CO, etc., which is according to the IPPC principle and have been considered to represent also BAT for DF engines in gas mode. The limit value of 380 mg NO_x/Nm^3 (15 % O_2) for DF engines in gas mode has following additional advantages (besides those listed above) compared to the limit value of 190 mg NO_x/Nm^3: … higher flue gas temperature, easier to tune at site (DF engine is sensitive to differences in gas compositions).

<u>Dual fuel engines in liquid mode</u>

ELV1
A dual fuel engine has been developed for countries where natural gas is available. It is optimized for gaseous operation (has a lower compression ratio in comparison to a modern diesel engine) and has therefore in the liquid mode/back-up mode, higher NO_x emissions compared to a modern diesel engine. The dual fuel engines are usually only operated by liquid fuels in special cases like in the interruption of gas supply. They can however also be operated for a longer time in liquid mode (e.g. at a power plant when there is immediate power need before a gas terminal or a gas pipe line is ready). The proposed emission limit value of 225 mg NO_x/Nm^3 for long time main operation use of liquid fuels are used as the main fuel for a longer period of time, can be achieved by the use of a SCR (cost not in main focus) with an efficiency of near 90 %.

ELV2
The emission limit values of 750 mg NO_x/Nm^3 for the smaller DF engines in liquid mode (< 20 MW_{th}) can be achieved by the use of a SCR with an efficiency of 60 to 65 %.
The emission limit values of 450 mg NO_x/Nm^3 for the larger DF engines in liquid mode (> 20 MW_{th}) can be achieved by the use of a SCR with an efficiency of 75 to 80 %.

ELV 3
The emission limit values of 1850 and 2000 mg NO_x/Nm^3 for DF engines in liquid mode are achievable with primary measures like an optimized low-NO_x engine depending on fuel and engine design. Application of the limit value of 1850 mg NO_x/Nm^3 means higher fuel consumption and loss of efficiency compared to the ELV of 2000 mg NO_x/Nm^3.

DIESEL ENGINES

For diesel engines the ELVs are proposed by taking into account the capacity of the engine.

ELV1
<u>Slow (< 300 rpm) / Medium (300-1200 rpm)/ speed diesel engines</u>
When using heavy oil and bio-oils the emission limit value of 225 mg NO_x/Nm^3 for diesel engines <u>from 5 to 20 MW</u> and 190 mg NOx/Nm^3 for diesel engines of <u>more than 20 MW</u> can only be achieved by the use of a SCR ((cost not in main focus) with an efficiency of respectively about 85 % and 90% depending on the engine type.

When using light fuels oil and natural gas the emission limit value of 150 mg NO_x/Nm^3 can only be achieved by the use of a SCR (cost not in main focus) with an efficiency of more than 90%.

<u>High speed (>1200 rpm) diesel engines</u>

The emission limit value of 130 and 150 mg NO_x/Nm^3 for high speed diesel engines can only be achieved by the use of a SCR (cost not in main focus) with an efficiency of respectively more than 85% and more than 80 %.

ELV2

<u>Slow (< 300 rpm) / Medium (300-1200 rpm)/ speed diesel engines</u>

<u>5-20 MW</u>

For the smaller engine capacities (5 - 20 MW) the ELVs of 450 mg/Nm^3 or 750 mg/Nm^3 when heavy fuel oil and bio-oils are used, assume the application of a SCR with an efficiency of respectively more than 70 % and more than 50 %. When light fuel oil and natural gas is used, the ELV of 190 mg/Nm^3 can only be achieved with a SCR having a reduction efficiency of 85 to 90 %.

The NO_x value of 750 mg/Nm^3 (15 % O_2) is in line with emission ruling in several EU states (e.g. Italy, France), this value will give a better economic performance of the SCR. Major part of the operational cost of the SCR is due to the reagent consumption, i.e. a lower NOx limit means also a higher reagent consumption need and thus a higher cost.

<u>> 20 MW</u>

For the larger engine capacities (> 20 MW) when heavy fuel oil and bio-oils are used, the ELV of 225 mg NO_x/Nm^3 assumes the application of a SCR with a reduction efficiency of more than 85 % and the ELV of 450 mg NO_x/Nm^3 can be achieved with a SCR with a lower reduction efficiency of more than 75 % (and reagent need and thus lower operational cost). When light fuel oil and natural gas is used, the ELV of 190 mg NOx/Nm^3 can only be achieved with a SRC having a reduction efficiency of 90 %.

<u>High speed (>1200 rpm) diesel engines</u>

The emission limit value of 190 mg NO_x/Nm^3 for high speed diesel engines can only be achieved by the use of a SCR with a moderate reduction efficiency of near 80 %.

ELV3

<u>Slow (< 300 rpm) / Medium (300-1200 rpm)/ speed diesel engines</u>

<u>5-20 MW</u>

When using heavy fuel oil, bio-oils, light fuel oil or natural gas the emission limit value of 1 300 and 1600 mg NO_x/Nm^3 for diesel engines from 5 MW to 20 MW can be reached by using primary measures like an optimized low-NO_x engine.

The NO_x level of 1300 mg/Nm^3 (an efficient “dry” primary method is needed for the future international markets) is an option that allows the use of primary measures, such as “wet methods” or advanced Miller concept. Diesel manufacturers (EUROMOT) have in some preliminary laboratory tests seen that by introducing a new extreme Miller concept that NO_x-levels of 1300 mg/Nm^3 with a lower fuel consumption (and as a consequence lower CO_2 emissions) could be achieved but a lot of engine testing and development work still to be done in order to get this to a commercial level.

<u>> 20 MW</u>

When using heavy fuel oil, bio-oils, light fuel oil or natural gas the emission limit value of 750 mg NO_x/Nm^3 for diesel engines of more than 20 MW can only be complied with the use of a SCR with a reduction efficiency of 60 %, and the ELV of 1850 mg NOx/Nm^3 can be reached by using primary measures like an optimized low-NO_x engine.

High speed (>1200 rpm) diesel engines
The high-speed engines can comply with emission limit values of 750 and 900 mg NOx/Nm^3 by primary measures where the engine is optimized. The value of 900 mg NO_x/Nm^3 (15 % O_2) corresponds to current US Tier 2 requirements. Engineering work would be necessary to achieve an emission limit value of 750 mg NO_x/Nm^3 without secondary measures, which will result in an increase of specific fuel consumption.

The distinction between small and large engine plants is justified since the smaller engines are often installed in sectors which are economically less viable compared to the larger engines installed by the large electricity producers. The cost of SCR with lower efficiencies is less, since the cost of a SCR is mainly determined by the cost of NH_3 or urea (operational cost). To avoid odour emissions of NH_3 the operation of a SCR needs good control and maintenance, which is more easily to be enforced on the larger engine plants.

The application of SCR means for diesel engines that fuels with good quality (like fuels with low sulphur content) are needed and some restrictions to use have to be taken into account. The costs for application of SCR are plant specific and operational and maintenance costs are dependent on the NO_x reduction rate. The impact of applying NO_x emission limit values on fuel consumption quality needs to be considered taking into account the currently rising fuel prices.

The proposed exemptions for new diesel engines operating in isolated areas can be justified because exemptions are meant to be used mainly on islands or remote areas where

1) there is no possibility so far to replace diesel engines with gas engines,
2) the application of SCR in diesel engines using heavy fuel oil is not technically or economically feasible or
3) the application is not feasible due to the peak-load operation and varying loads of engines or other infrastructural reasons (lack of needed reagents, etc).

The exemption is allowed for transitional period of [x] years or until the moment when certain conditions are met to apply SCR, for instance, when low–sulphur fuels and a good infrastructure for SCR, or natural gas are available.

It is expected that more grid stability power plants will be needed due to large increase in renewable energy production (e.g. wind and solar power). These “grid stabilization” plants are expected to operate up to 1500 hr/year, a grid stabilization plant will typically have frequent start-up/shut-down periods and operate on varying loads (therefore SCR is not recommended, see BREF document for more info). Therefore leaner NO_x-emission limits should be justified for these plants operating typically 500-1500 h/year.