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Working Party on Gas

Ad Hoc Group of Experts on the Supply and Use of Gas

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**EXISTING STANDARDS AND REGULATIONS ON PERMISSIBLE
CONCENTRATIONS OF HARMFUL COMPONENTS IN GASEOUS FUELS
AND GASEOUS FUELS COMBUSTION PRODUCTS**

Draft consolidated report, prepared by the delegation of Poland

In total, thirteen countries replied to the questionnaire, namely:

- Armenia
- Austria,
- Bosnia and Herzegovina
- Croatia
- Czech Republic
- Hungary
- Poland
- Romania
- Russian Federation
- Slovakia
- Spain
- Turkey
- Yugoslavia

Comments:

Most of the replies to the questionnaire were received from the countries, which were in the past members of the Council for Mutual Economic Assistance. Of the countries that have responded to the questionnaire are at present changing their economy rules aiming to market economy. Many of them are among European Union accessing countries – they undergo fundamental changes of legal regulations and also those regarding environment, health and safety in order to harmonize their legislation with that of the European Union.

Some countries (Austria, Bosnia and Herzegovina) responded only for questions dealing with natural gas purity requirements.

In many questionnaires an answer “NO” was missing – in these cases a lack of answer has been stated, even though one could have assumed that the answer was “NO”.

A few replies that seemed to be mistaken or not clear enough have been skipped in order to avoid improper interpretation.

A. Environmental aspects of gaseous fuels use:
Permissible content of pollutants in gaseous fuels.

Question 1.1

Are there any regulations regarding the quality of *natural gas*?

Armenia	YES	???? 5542-87
Austria,	YES	ÖVGW-Directive G31 (Erdgas in Österreich)
Bosnia and Herzegovina	YES	NEN 1091
Croatia	YES	INA N 02-020/97
Czech Republic	YES	CSN 386110
Hungary	YES	MSZ 1648
Poland	YES	PN-87/C-96001
Romania	YES	STAS 3317/1967
Russian Federation	YES	???? 5542-87; ??? 51-40-93
Slovakia	No answer	
Spain	YES	State Regulations
Turkey	YES	Botas Code of Practice
Yugoslavia	YES	JUS H.F1.001 (1989)

Comments:

Natural gas quality is under regulation in almost all countries answering the questionnaire. Most often regulations are given in national standards, sometimes in technical Code of practice or in state regulations.

Some countries referred to their national standards adopted in the late eighties (Armenia, Russian

Federation, Poland, Yugoslavia and Hungary). Many changes occurred since that time, both in political and economic conditions, as well as in energy technologies related to gas processing (purification), role of natural gas in the energy balance, gas market restructuring and new discoveries of natural gas properties. It is likely that these standards and regulations will be changed in the near future – for example in Poland new Polish Standards on natural gas quality have already been prepared and are expected to be approved in 2002/2003.

Question 1.2

Are there any regulations regarding the quality of *liquefied petroleum gases (LPG)*?

Armenia	YES	???? 20448-90
Austria,	No answer	
Bosnia and Herzegovina	No answer	
Croatia	YES	INA N 02-007/97
Czech Republic	No answer	
Hungary	YES	MSZ 1601:1995; MSZ EN 589:1994
Poland	YES	PN-C-96008:1998
Romania	No answer	
Russian Federation	No answer	
Slovakia	No answer	
Spain	YES	State Regulations
Turkey	No answer	
Yugoslavia	YES	JUS B.H2.130; JUS B2.132; JUS B.H2.134 (1962)

Comments:

Since not many countries have answered the question on LPG quality regulations, it can be assumed that the LPG quality is not as highly regulated as that for natural gas.

It is probably because of different role that play natural gas and LPG on the energy market.

If regulations on LPG quality exist in some of the countries, they are mostly given in national standards issued in nineties.

Question 2.1

Regulations on pollutants in natural gas and pollutant permissible concentrations**Permissible concentrations of sulphur and sulphur compounds**

Country	H ₂ S	S _{H2S}	R-SH	S _{R-SH}	Others	S _t
Armenia	20 mg/m ³	n.a.	n.a.	36 mg/m ³	n.a.	n.a.
Austria,	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bosnia and Herzegovina	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Croatia	20 mg/m ³	NO	NO	70 mg/m ³	NO	100 mg/m ³
Czech Republic	7 mg/m ³	NO	NO	NO	NO	100 mg/m ³
Hungary	20 mg/m ³	NO	NO	NO	NO	100 mg/m ³
Poland	20 mg/m ³ ***	19 mg/m ³	NO	NO	NO	40 mg/m ³
Romania	2 mg/m ³	n.a.	n.a.	5.3 mg/m ³	n.a.	100 mg/m ³
Russian Federation	2 mg/m ³ * 7 mg/m ³ **	NO	NO	36 mg/m ³ * 16 mg/m ³ ***	NO	NO
Slovakia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Spain	= 1.5 mg/m ³	NO	NO	NO	NO	NO
Turkey	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Yugoslavia	5 mg/m ³	n.a.	n.a.	6 mg/m ³	n.a.	120 mg/m ³

NO – no regulations

n.a. – no answer

* natural gas for industrial and household purposes

** natural gas in gas transmission grid

*** according to regulations is newly prepared standard 7 mg/m³**Comments:**

In most of the countries answering the questionnaire there are regulations on permissible concentrations of hydrogen sulphur – one can observe two levels of upper limit:

- a few milligrams per cubic meter (2 mg/m³ – 7 mg/m³) and
- 20 mg/m³

The first limit reflects the currently existing possibilities to purify natural gas and is specified in standards issued in the nineties of the last century. The second value (relatively high) is usually specified in standards published in the eighties and is uniform for the former countries of the Council for Mutual Economic Assistance.

Regulations on permissible concentrations of sulphur contained in alkanothiols are rare and more differentiated (from 5 mg/m³ up to 70 mg/m³). The upper level seems to be rather high.

In case the total sulphur content (S_t) is under regulation, the upper limit value is most often at the level of 100 mg/m³. Only for Croatia this limit is close to the sum of permissible sulphur concentration in hydrogen sulphide H₂S (19 mg/m³) and in alkanthiols R-SH (70 mg/m³). For other countries the limit

value for total sulphur is much higher than the sum of permissible sulphur concentration in hydrogen

sulphide H_2S (not more than 19 mg/m^3) and in alkanthiols R-SH (not more than 36 mg/m^3). The low limit values for permissible concentrations of H_2S and R-SH reflect the high efficiency of natural gas desulphurization plants. The relatively high limit value for total sulphur has probably been established taking into account the temporary concentrations. At present this limit seems to be not fully justified and it is worthwhile to consider possibility of lowering it.

Question 2.2

Permissible concentrations of other non-sulphur polluting substances

Country	Hg	Other contaminants
Armenia	No answer	No answer
Austria,	No answer	No answer
Bosnia and Herzegovina	No answer	No answer
Croatia	$10 \mu\text{g/m}^3$	particulate matter 15 mg/m^3
Czech Republic	NO	No answer
Hungary	NO	particulate matter 5 mg/m^3 oxygen 0.2 % v/v
Poland	$30 \mu\text{g/m}^3$	particulate matter
Romania	No answer	No answer
Russian Federation	NO	particulate matter 1 mg/m^3
Slovakia	No answer	No answer
Spain	NO	$\text{NH}_3 = 15 \text{ mg/m}^3$ $\text{CO} < 3.5 \text{ } (\%)$
Turkey	No answer	No answer
Yugoslavia	No answer	No answer

Comments:

All answers proved that natural gas of pipeline quality is a very clean fuel. The only heavy metal that is present in some natural gas reservoirs is removed to the fully safe level of $30 \mu\text{g/m}^3$. No regulations on other heavy metals and on radionuclides is pointed out that these contaminants are not subjects of concern as their concentration level in natural gas is similar to that in the ambient air.

Particulates ("solid", "dust" etc.) are often limited and could have hazardous effect primarily on measuring and control devices in gas grid, rather than on human health or environment.

Question 2.3

Regulations on pollutants in LPG and pollutant permissible concentrations

Country	H ₂ S	Alkanthiols	Total sulphur	Others contaminants
Armenia	0.003 %	0.0012 %	n.a.	n.a.
Austria,	n.a.	n.a.	n.a.	n.a.
Bosnia and Herzegovina	n.a.	n.a.	n.a.	n.a.
Croatia	YES *	NO	YES *	YES *
Czech Republic	n.a.	n.a.	n.a.	n.a.
Hungary	10 mg/kg	NO	200 mg/kg	free of water, free of mineral acids, free of alkali
Poland	free of H ₂ S	19 mg/m ³	0.005 % m/m	free of ammonia
Romania	n.a.	n.a.	n.a.	n.a.
Russian Federation	n.a.	n.a.	n.a.	n.a.
Slovakia	n.a.	n.a.	n.a.	n.a.
Spain	= 1 b	NO	100 mg/m ³	NO
Turkey	n.a.	n.a.	n.a.	n.a.
Yugoslavia	n.a.	n.a.	50 mp/kp	oil 50 mp/kp

NO – no regulations

n.a. – no answer

* permissible concentrations not specified in the questionnaire – limits are different for LPG's of different types (propane, butane, propane-butane) and purposes (commercial, automotive, special)

Comments:

Regulations on LPG pollutant concentrations are rare and less uniform in respect of concentration levels and limit determination ways (mg/kg, mg/m³, %). Sulphur and sulphur compounds are, basically, the only pollutants under regulations. It seems to be doubtful whether market products are really under control in some countries responding to the questionnaire.

B. Environmental aspects of gaseous fuels use: Requirements on the odorisation

Question 1.1

Requirements on odorisation of natural gas

Country	1. Regulations	2. Requirements and odourisation level	3. Control of odourisation level regulated
Armenia	YES State regulations	YES ГОСТ 5542-87, Required level not described in questionnaire	YES ГОСТ 22387.5-77, Control procedure not described in questionnaire
Austria,	YES ÖVGW-Directive G79 ("Gasodorierung")	YES ÖVGW-Directive G79 ("Gasodorierung"). Required level not described in questionnaire	YES ÖVGW-Directive G79 ("Gasodorierung"). Requirements on control procedures not described in questionnaire
Bosnia and Herzegovina	YES NEN 1091	YES Required only in distribution. Odour detectable for mixture natural gas/air containing 1% of natural gas of calorific value $H_u=34 \text{ MJ/m}^3$	YES Responsible are distribution companies and odorant manufacturers
Croatia	YES German standard DVGW-G-2800 is applied	YES Minimum required level 8 mg/m^3 DG for THT, 3 mg/m^3 DG for EM (ethylmercaptane)	YES Recommended methods are GC (gas chromatography) and Drager tubes. No regulations on odourisation control other than liability to control perform.
Czech Republic	YES ČSN 385550	YES ČSN 385550 Required level not described in questionnaire	YES ČSN 385550 Requirements on control procedures not described in questionnaire
Hungary	YES MSZ 1648 and MOW Code of Practice	YES MSZ 1648 and MOW Code of Practice Required level not described in questionnaire	YES MSZ 1648 and MOW Code of Practice Requirements on control procedures not described in questionnaire
Poland	YES PN-87/C-96001 Regulations of Ministry of Economy, POGC Code of Practice ZN-G-501(2001) ZN-G-502(2001) ZN-G-503(2001) ZN-G-504(2001) ZN-G-508(2001)	YES PN-87/C-96001 Regulations of Ministry of Economy, POGC Code of Practice ZN-G-501(2001) For gas/air mixture odour well detectable (olfactory detection) when gas in air concentration of: 1 % for gas of upper calorific value not less than 30 MJ/m^3 , 1.5 % for gas of upper calorific value in the range of $16-27 \text{ MJ/m}^3$	YES PN-87/C-96001 Regulations of Ministry of Economy, POGC Code of Practice ZN-G-504(2001) ZN-G-508(2001) Odourisation of gas delivered to gas consumers should be checked not rarelier than once per 14 days
Romania	YES SR 13406:1998	YES ROMGAZ Code of Practice, SF1/20.10.1995 Odour of gas should be well detectable by human olfactory	YES ROMGAZ Code of Practice, SF1/20.10.1995 Requirements on control procedures not described in

Country	1. Regulations	2. Requirements and odourisation level	3. Control of odourisation level regulated
		system. Odourisation intensity 0.8-10 mg/m ³	questionnaire
Russian Federation	YES ГОСТ 5542-87 * ОСТ 51-40-93 **	YES Odorant concentration: * 36 mg/m ³ (gas for households) ** 16 mg/m ³ (gas in transmission grid)	YES ГОСТ 22387.2-97 Requirements on control procedures not described in questionnaire
Slovakia	YES STN 385550	YES STN 385550 Required level not described in questionnaire	YES STN 385550 Requirements on control procedures not described in questionnaire
Spain	YES State regulations	YES State regulations Gas/air mixture of gas concentration of 1/5 of lower flammability level has to have odour enabling detection of only leak.	NO
Turkey	NO	YES Odorant concentration of 15 mg/m ³	YES Company Code of Practice. Requirements on control procedures not described in questionnaire
Yugoslavia	YES JUS H.F.001	YES Odourisation according to equipment and odorant manufactures. Final concentration of sulphur within the permissible limits for natural gas	YES JUS H.F.8.503 Requirements on control procedures not described in questionnaire

Comments:

Odourisation of natural gas – the main measure to ensure safety of its distribution and utilization, is highly regulated. In many cases even multilevel regulations exist: given in state, legal acts, in national standard and in company codes of practice.

Usually the odorant concentration is within 10 to 30 mg/m³ depending on odorant type and natural gas calorific value. Organic sulphur compounds used as odorants do not contribute substantially in sulphur content.

Olfactory detection is the base for establishing the odourisation practice. Gas/air mixture under investigations have gas concentrations of 20 % of lower flammability limit.

Question 1.2Requirements on odourisation of LPG

Country	1. Regulations	2. Requirements and odorisation level	3. Control of odorisation level regulated
Armenia	YES State regulations	YES ГОСТ 20448-90, Required level not described in questionnaire	YES ГОСТ 22387.5-77, Control procedure not described in questionnaire
Austria,	No answer	No answer	No answer
Bosnia and Herzegovina	No answer	No answer	No answer
Croatia	YES JUS SL 20/71 Company code of practice	YES JUS SL 20/71 Company code of practice Odour of gas after odorisation should be detectable by human olfactory system	YES JUS SL 20/71 Company code of practice Control procedure not described in questionnaire
Czech Republic	No answer	No answer	No answer
Hungary	YES MSZ 1601:1995 MSZ EN 589:1994	YES MSZ 1601:1995 MSZ EN 589:1994 Required level not described in questionnaire	YES, MSZ 1601:1995 MSZ EN 589:1994 Requirements on control procedures not described in questionnaire
Poland	YES PN-C-96008:1998	YES Odour of gas after odorisation should be detectable by human olfactory system	YES PN-C-96008:1998 Checking for LPG batch (contented of one vessel used for transportation or for storage)
Romania	No answer	No answer	No answer
Russian Federation	No answer	No answer	No answer
Slovakia	No answer	No answer	No answer
Spain	YES State regulations	YES odorisation should ensured that any leak can be detected by human olfactory system at gas in gas/air mixture concentrations of 1/5 lower flammability level	NO
Turkey	No answer	No answer	No answer
Yugoslavia	YES JUS H.F1.001	NO Odorisation performed according to instruction of equipment and odorant manufactures. Total sulphur content after odorisation within the limits permitted for LPG	NO

Comments:

Regulations on liquid petroleum fuels odorisation, if any, are less frequent and often less strict than those on natural gas. Usually they are included into company's codes of practice or in standards and not in state regulations. From answers given to the questionnaire it is difficult to learn whether they

are uniform or distinctly differentiated. It seems to be advisable to strengthen control procedures for LPG odorisation, since LPG leaks can cause as serious danger of fire and/or explosion as those of natural gas.

C. Environmental aspects of gaseous fuels use:

Permissible emission of NO_x and CO from natural gas and LPG combustion

Questions 1.1 and 1.2.

Regulation on NO_x and CO emissions from natural gas and LPG fuelled turbines, engines, industrial boilers and industrial burners

Country	Regulation on permissible concentration of pollutants in flue gases
Armenia	NO – for gas turbines and engines YES – for industrial boilers and burners Limits are given by: <ul style="list-style-type: none"> • Regulation of Ministry of Environment on maximum permissible emission, • Standards containing requirements for equipment
Austria,	No answer
Bosnia and Herzegovina	No answer
Croatia	YES – for every kind of equipment State regulations – Decree on limit values of pollutant emission from stationary sources into air (NN 140/97) NO _x – 150 mg/m ³ for turbine power ≤ 100MW NO _x – 100 mg/m ³ for turbine power > 100MW CO – 100 mg/m ³ for turbines NO _x – 2000 mg/m ³ for Diesel motors ≤ 3MW up to 1000 hr of operation/year NO _x – 4000 mg/m ³ for Diesel motors >3MW up to 1000 hr of operation/year NO _x – 1000 mg/m ³ for Diesel motors of more than 1000 hr of operation/year NO _x – 500 mg/m ³ for other motors of more than 1000 hr of operation/year CO – 650 mg/m ³ NO _x – 200 mg/m ³ for small and medium size boilers NO _x – 350 mg/m ³ for large boilers CO – 100 mg/m ³ for all boilers NO _x – 200 mg/m ³ for burners (daily average) 400 mg/m ³ for burners (30 min. average) CO – 50 mg/m ³ for burners (daily average) 100 mg/m ³ for burners (30 min. average)
Czech Republic	YES – turbines, engines, boilers NO – for burners State regulations on permissible emissions from stationary pollution sources into air and on air protection (117/1999 Coll) NO _x – 350 mg/m ³ for gas turbines of < 60000 m ³ /h NO _x – 300 mg/m ³ for gas turbines of ≥ 60000 m ³ /h CO – 100 mg/m ³ for turbines NO _x – 500 mg/m ³ for engines of thermal output of < 0.2 MW

Country	Regulation on permissible concentration of pollutants in flue gases
	<p>NO_x – 650 mg/m³ for engines of thermal output of > 0.2 MW</p> <p>NO_x – 200 mg/m³ for boilers of thermal output of > 0.2 MW</p> <p>CO – 100 mg/m³ for boilers of thermal output of > 0.2 MW</p>
Hungary	<p>YES – turbines, engines, boilers</p> <p>NO – for burners</p> <p>State regulations on emission limits for turbines</p> <p style="padding-left: 40px;">KTM 22/1998 – power over 50MW,</p> <p style="padding-left: 40px;">KTM .../1998 –power 140 kW-50MW</p> <p>engines</p> <p style="padding-left: 40px;">KTM 32/1993</p> <p>boilers</p> <p style="padding-left: 40px;">KTM 22/1998</p> <p>NO_x – 150 mg/m³ for new turbines of thermal input 140kW-300MW</p> <p>CO – 100 mg/m³ for new turbines of thermal input 140kW-300MW</p> <p>NO_x – 500 mg/m³ for 4 strokes gas engines (5% v/v O₂)</p> <p>CO – 650 mg/m³ for 4 strokes gas engines (5% v/v O₂)</p> <p>NO_x – 350 mg/m³ for boilers (3% v/v O₂)</p> <p>CO – 100 mg/m³ for boilers (3% v/v O₂)</p> <p>CO – 0.1 % v/v for burners (?=1)</p>
Poland	<p>YES – for every kind of equipment</p> <p>State regulations – Decrees of Ministry of Environment on pollutants emission from technological processes and operations into the air (1998) and on permissible concentrations of pollutants in air (1998)</p> <p>NO_x – 150 mg/m³ for boilers and burners of output up to 5 MW</p> <p>NO_x – 300 mg/m³ for boilers and burners of output 5MW – 50 MW</p> <p>NO_x – 350 mg/m³ for boilers and burners of output higher than 50MW (all limits for dry flue gases in standard conditions, oxygen concentration – 3% v/v)</p> <p>For gas turbines and gas engines emission should be kept on the level that does not cause the exceeding of permissible pollutant concentration in air:</p> <p>for NO_x:</p> <p style="padding-left: 40px;">0.5 mg/m³ – average 30 min. limit value</p> <p style="padding-left: 40px;">0.15 mg/m³ – average daily limit value</p> <p style="padding-left: 40px;">0.04 mg/m³ – average yearly limit value</p> <p style="padding-left: 40px;">(for national parks all values are lower: 0.09 mg/m³; 0.05 mg/m³; 0.02 mg/m³ respectively)</p> <p>for CO:</p> <p style="padding-left: 40px;">20 mg/m³ – average 30 min. limit value</p> <p style="padding-left: 40px;">5 mg/m³ – average daily limit value</p> <p style="padding-left: 40px;">2 mg/m³ – average yearly limit value</p>
Romania	<p>YES – for CO in flue gases from boilers and burners</p> <p>Decree of Ministry of Environment Protection 462/1993 on permissible emissions of pollutants from stationary sources</p> <p>NO_x – 350 mg/m³ for burners</p> <p>CO – 150 mg/m³ for burners</p>

Country	Regulation on permissible concentration of pollutants in flue gases
Russian Federation	<p>YES – for turbines, engines and boilers</p> <p>Permissible emission limits are specified in standards and company codes of practice</p> <p>NO_x – 300 mg/m³ for turbines (ГОСТ 29328-92; RD 51-0158623-07-95)</p> <p>NO_x – 200 mg/m³ for engines (ГОСТ 24585-81; RD 51-0158623-07-95)</p> <p>NO_x – 85 - 275 mg/m³ for boilers (RD 34.02.305-98)</p> <p>CO – 200 mg/m³ for turbines (ГОСТ 29328-92; RD 51-0158623-07-95)</p> <p>CO – 200 - 230 mg/m³ for engines (ГОСТ 24585-81; RD 51-0158623-07-95)</p> <p>NO_x – 12.4 g/kWh for turbines</p> <p>CO – 8.2 g/kWh for turbines</p>
Slovakia	<p>YES – for turbines, engines and boilers</p> <p>State regulations (309/1991) on protection air against pollutants.</p> <p>Limits of NO_x and CO concentrations in flue gases are determinate.</p> <p>Details are not given in questionnaire.</p>
Spain	<p>YES – for NO_x from turbines, engines, boilers and burners</p> <p>Royal decree on limitation of pollutant emission from combustion installations</p> <p>NO_x – 350 mg/m³ for turbines (1800/1995)</p> <p>NO_x – 350 mg/m³ for boilers</p> <p>NO_x – 350 mg/m³ for burners</p>
Turkey	<p>YES – for NO_x and CO from turbines, engines, boilers and burners</p> <p>State regulations on air quality protection (2/11/1986/19269)</p> <p>Permissible limits for concentration in flue gases:</p> <p>NO_x – 100 mg/m³ for facilities of thermal input < 100 MW</p> <p>NO_x – 500 mg/m³ for facilities of thermal input > 100 MW</p> <p>CO – 100 mg/m³</p> <p>Emission can not cause the exceeding of limit pollutant concentrations in air:</p> <p>CO – 10 000 – 30 000 µg/m³</p> <p>NO – 200 – 600 µg/m³</p> <p>NO₂ – 100 – 300 µg/m³</p>
Yugoslavia	<p>YES – for NO_x and CO from power generating utilities</p> <p>Determinate limits depend on temperature capacity of fire boxes.</p> <p>Details are not given in questionnaire.</p>

Comments:

Emission of NO_x and CO from power generation equipment is generally under regulations (in 8 out of 10 countries responding to the questionnaire). There are two types of regulations:

type 1 - emissions should be kept at the level that does not cause exceeding of permissible concentrations of pollutants in the air;

type 2 - emissions should be kept on the level that does not cause the exceeding of permissible concentrations of pollutants in flue gases.

In the second case one can assume that in fact the limitations are of both types 2 and 1, so the requirements are more stringent and always the same, irrespective of the air quality.

For gas turbines requirements are summarized in the table below

Gas turbines			
Country	Type of regulation	NO_x emission limits	CO emission limits
Armenia	NO		
Croatia	2	150 mg/m ³ up to 100 MW, 100 mg/m ³ above 100 MW	100 mg/m ³
Czech Republic	2	350 mg/m ³ below 60000 m ³ /h, 350 mg/m ³ at or above 60000 m ³ /h	100 mg/m ³
Hungary	2	150 mg/m ³ new turbines 140kW-300MW	100 mg/m ³ new turbines 140kW-300MW
Poland	1		
Romania	NO		
Russian Federation	2	300 mg/m ³	200 mg/m ³
Slovakia	1		
Spain	2	350 mg/m ³	NO
Turkey	2	100 mg/m ³ up to 100 MW, 500 mg/m ³ above 100 MW	100 mg/m ³
Yugoslavia	2	depending on temperature capacity of fire boxes	depending on temperature capacity of fire boxes

One can notice that:

- the regulations on maximum permissible concentrations of CO in flue gases are very uniform: 100 mg/m³ (in 4 cases out of 6) and are not differentiated for equipment of different thermal input.
- the requirements on NO_x emission are different in different countries and often different for equipment of different thermal input:
 - up to 100 MW the maximum permissible concentration is set as 100 mg/m³, 150 mg/m³, 300 mg/m³,
 - above 100 MW the maximum permissible concentration is set as 100 mg/m³, 150 mg/m³, 300 mg/m³, 500 mg/m³ and the limit value is sometimes lower (of 50 mg/m³) sometimes higher (500 mg/m³ in comparison with 100 mg/m³) than the one settled for the equipment of lower thermal input.

As technically is easier to keep low NO_x emission in case of equipment of higher thermal input, it seems to be advisable to differentiate requirements depending on thermal input and to set the upper limit at 100 mg/m³ rather than at 300 mg/m³ or 500 mg/m³, at least for the new generation of turbines designed and produced according to new technologies. Another solution would be to subdivide turbines into different classes on the basis on NO_x emission level – such classification is used for example for central heating boilers in European Union standards.

For **gas engines** results are shown in the table below

Gas engines			
Country	Type of regulation	NO_x emission limits	CO emission limits
Armenia	NO		
Croatia	2	500 mg/m ³ above 1000 hr of operation per year	650 mg/m ³
Czech Republic	2	500 mg/m ³ below thermal output of 0,2 MW, 650 mg/m ³ for thermal output at and above 0,2 MW,	
Hungary	2	500 mg/m ³	650 mg/m ³
Poland	1		
Romania	NO		
Russian Federation	2	200 mg/m ³ - 335 mg/m ³	200-230 mg/m ³
Slovakia	1		
Spain	NO		
Turkey	2		

In case of gas engines maximum permissible concentrations of NO_x and CO are close to each other and similar in different countries. Limit values reflect the fact that combustion conditions in engines are worse in comparison with those for burners.

Results for **gas boilers** are listed in the table below

Gas boilers			
Country	Type of regulation	NO_x emission limits	CO emission limits
Armenia	2		
Croatia	2	200 mg/m ³ for small and medium boilers, 350 mg/m ³ for large boilers	100 mg/m ³
Czech Republic	2	200 mg/m ³ for boilers of thermal output above 0,2 MW	100 mg/m ³ for boilers of thermal output above 0,2 MW
Hungary	2	350 mg/m ³	100 mg/m ³
Poland	2	150 mg NO ₂ /m ³ for boilers of thermal output up to 5 MW, 300 mg NO ₂ /m ³ for boilers of thermal output of 5 MW – 50 MW, 350 mg NO ₂ /m ³ for boilers of thermal output above 50 MW	100 mg/m ³ for boilers of output above 1 MW fuelled with natural gas (150 mg/m ³ for boilers of output above 1 MW fuelled with LPG)
Romania	2		

Gas boilers			
Country	Type of regulation	NO_x emission limits	CO emission limits
Russian Federation	2	85 - 275 mg/m ³	
Spain	2	350 mg/m ³	NO

In all regulations the maximum permissible concentrations of NO_x and CO in flue gases are specified. Requirements for CO concentrations are very uniform and rather very strict in comparison with ones given in standards on requirements and testing of boilers of lower thermal output (0,1 % v/v up to 1 MW). Permissible NO_x concentrations in flue gases are more differentiated depending on thermal output and by country (150 mg/m³ – 350 mg/m³) and are more close to requirements given in standard on boilers of lower thermal output.

Very low limit for CO concentration implies high flame temperature and higher rate of NO_x formation. European Union standards introduce the NO_x classes for all heating appliances.

Regulations for gas burners are very similar to those for gas boilers. In many countries emissions are regulated for technological operations and the burners are source of combustion products in most of such operations.

The results for **gas burners** are listed in the table below.

Gas burners			
Country	Type of regulation	NO_x emission limits	CO emission limits
Armenia	2		
Croatia	2	200 mg/m ³ (daily average), 400 mg/m ³ (30 min. average)	50 mg/m ³ (daily average), 100 mg/m ³ (30 min. average)
Hungary	2	NO	0.1% v/v (?=1)
Poland	2	150 mg NO ₂ /m ³ for outputs below 5 MW, 300 mg NO ₂ /m ³ for outputs in range 5MW-50MW, 350 mg NO ₂ /m ³ for outputs above 50 MW	
Romania	2	350 mg/m ³	100 mg/m ³
Russian Federation	NO		
Slovakia	1		
Spain	2	350 mg/m ³	NO
Turkey	2	500 mg/m ³	100 mg/m ³
Yugoslavia	NO		

Question 1.3.

Requirements on monitoring of NO_x and CO emission from power generation facilities

Country	Requirements on monitoring
Armenia	YES – for NO _x and CO from boilers and burners State regulations issued by Ministry of Environment. Details are not given in questionnaire.
Austria	YES Standards ÖNORM M 7535-4, ÖNORM-M7535-7 give requirements on equipment measuring NO and CO concentration. Standards ÖNORM M 9410, ÖNORM M 9411 and ÖNORM M 9412, ÖNORM M 9415-1,2,3 give requirements on measuring equipment and measuring technique used to determination of pollutant emission. Details are not given in questionnaire.
Bosnia and Herzegovina	No answer
Croatia	YES – for NO _x and CO from turbines, engines and boilers State regulations on measurement frequencies that depend on mass flow and boundary flow
Czech Republic	YES – for NO _x and CO from turbines State regulations (117/1999) on emission limits from stationary pollution sources. Details are not given in questionnaire.
Hungary	YES – for NO _x and CO from turbines, engines, burners and boilers for turbines and boilers over 300MW – continuously for turbines and boilers below 300MW – yearly for engines and burners – yearly Regulations in standards: MSZ 21853-9:93; MSZ 21853-8:77
Poland	YES – for NO _x and CO from turbines, engines, burners and boilers For turbines and engines regulations in Polish Standards on in instruction of Main Sanitary Inspector. For boilers and burners state regulation of Ministry of Environment
Romania	YES – for CO from boilers and burners Periodically. Details are not given in questionnaire.
Russian Federation	YES – for NO _x and CO from turbines, engines and boilers Company codes of practice RD 51-164-92 (turbines) RD 34.02.306-96 (boilers)
Slovakia	No answer
Spain	YES – for NO _x from turbines, engines, boilers and burners For plants of power of above 300MW continuous measurements, for the rest of utilities on regular base. Regulation on frequency in Royal Decree 1800/1995. Regulations on precision in technical standards.

Country	Requirements on monitoring
Turkey	YES – for NO _x and CO from turbines, engines, boilers and burners NO _x – continuous measurement if flow rate > 20 kg/h CO – continuous measurement if flow rate > 5 kg/h
Yugoslavia	State regulations in some cases but details are not given in questionnaire.

Comments:

In many countries frequencies of emission controlling measurements are under regulations given in governmental rules (Armenia, Croatia, Poland, Spain) or in standards (Hungary, Russian Federation).

Brief summary is given in table below

Country	Gas turbines		Gas boilers		Gas engines		Gas burners	
	NO _x	CO	NO _x	CO	NO _x	CO	NO _x	CO
Armenia			G	G			G	G
Croatia	G	G	G	G	G	G		
Czech Republic	YES	YES						
Hungary	S	S	S	S	S	S	S	S
Poland			G	G			G	G
Romania				YES				YES
Russian Federation	S	S	S	S	S	S		
Spain	G		G		G		G	
Turkey	YES	YES	YES	YES	YES	YES	YES	YES

G – governmental regulation

S – requirements given in standards

YES – requirements exist but no details in answer for questionnaire

blanc space – no requirements

Questions 2.1 and 2.2

Requirements and standards on concentration from gas appliances – central heating boilers, catering equipment, air heaters, gas cookers, water heaters.

Country	Requirements	Standards
Armenia	YES - for CO from all gas appliances YES - for NO _x from central heating boilers, air heaters NO - for NO _x from catering equipment and water heaters CO concentration in flue gases from air heaters and water heaters below 0.05%, for cookers below 0.01% NO _x concentration in flue gases from gas cookers below 200 mg/m ³	???? 17.2.3.02-78 ???? 20219-93 ???? 10798-93 ???? 19910-94 ???? 11032-80

Country	Requirements	Standards
Austria,	No answer	No answer
Bosnia and Herzegovina	No answer	No answer
Croatia	NO	NO
Czech Republic	No answer	No answer
Hungary	YES – for NO _x and CO from central heating boilers, air heaters, gas cookers, water heaters NO – for NO _x and CO from catering equipment CO concentration in flue gases below 0.1% ($\lambda=1$) for central heating boilers, air heaters and water heaters and below 0.05% v/v ($\lambda=1$) for gas cookers	MSZ EN 297 MSZ EN 625 MSZ EN 613 MSZ EN 30 MSZ 7045
Poland	YES – for CO from all gas appliances (central heating boilers, air heaters, gas cookers, water heaters, catering equipment) YES – for NO _x from central heating boilers, air heaters NO – for NO _x from catering equipment, gas cookers and water heaters CO concentration in flue gases: below 28g/GJ for central heating boilers and air heaters, 0.05% v/v ($\lambda=1$) for gas cookers 0.1% v/v ($\lambda=1$) for water heaters NO _x concentration in flue gases below 35g/GJ for central heating boilers and air heaters,	PN-88/M-35350 PN-86/M-40305 PN-79/M-40300 and technical criteria: KT-13-95 (for air heaters) KG-87 (for gas water storage heaters)
Romania	YES – for CO from all gas appliances (central heating boilers, air heaters, gas cookers, water heaters, catering equipment) NO – for NO _x CO concentration in flue gases: below 0.1% v/v ($\lambda=1$) for all gas appliances	C-31 C-10 A-4 SRGN 26
Russian Federation	YES – for NO _x and CO from central heating boilers and water heaters No answer for the rest of gas appliances (air heaters, gas cookers, catering equipment) Concentration in flue gases from central heating boilers: NO _x 0.05 – 0.20 kg/GJ	OND-90 RD 34.02.306-96 RD 51-167-92
Slovakia	No answer	No answer
Spain	For CO permissible concentrations in flue gases from domestic gas appliances requirements are determined by autonomous communities (50 ppm for Madrid)	
Turkey	No requirements for NO _x and CO concentration in flues gases from gas appliances	
Yugoslavia	No requirements for NO _x and CO concentration in flues gases from gas appliances	

Comments:

Regulations on NO_x and CO concentrations in flue gases from domestic and commercial gas appliances are given in standards or in technical criteria for safety mark. CO concentration in flue gases is generally regulated; regulations on NO_x concentration are frequent for heating appliances and more rare for cookers. Many countries replying to the questionnaire are members of the European Standardization Committee (CEN), so they have uniform regulations: for CO – 0.1 % v/v for all kinds of appliances, for NO_x in flue gases from heating appliances there is the division into 5 classes:

I	260 mg/kWh
II	200 mg/kWh
III	150 mg/kWh
IV	100 mg/kWh
V	70 mg/kWh

Producers of gas appliances, in order to be competitive on the market, have to ensure a low level of NO_x emissions, which are quite harmful for the health.

Question 3.

Main changes in regulations on NO_x and CO emission from gas appliances and future plans.

In most of the countries the existing government regulations have been issued recently, in the late nineties or even in 2000 or 2001. The rapid changes in legislation, especially in the EU accession countries, result in the fact that some of the information contained in replies to the questionnaire is no longer valid, or outdated. The same could also apply to the standards, which are currently being harmonized with EU standards.

In conclusion it can be stated, that the regulations on natural gas purity and odorisation as well as control of pollutants emissions by natural gas fuelled appliances reflect the concern by the countries for environment, safety and health. Therefore, due attention is paid to the development of new technologies in natural gas combustion and emissions measurement techniques.