

Article 12

## SIGNATURE

1. The present Protocol shall be open for signature at Oslo from 13 June 1994 until 14 June 1994 inclusive, then at the United Nations Headquarters in New York until 12 December 1994 by States members of the Commission as well as States having consultative status with the Commission, pursuant to paragraph 8 of Economic and Social Council resolution 36 (IV) of 28 March 1947, and by regional economic integration organizations, constituted by sovereign States members of the Commission, which have competence in respect of the negotiation, conclusion and application of international agreements in matters covered by the Protocol, provided that the States and organizations concerned are Parties to the Convention and are listed in Annex II.

2. In matters within their competence, such regional economic integration organizations shall, on their own behalf, exercise the rights and fulfil the responsibilities which the present Protocol attributes to their member States. In such cases, the member States of these organizations shall not be entitled to exercise such rights individually.

Article 13

## RATIFICATION, ACCEPTANCE, APPROVAL AND ACCESSION

1. The present Protocol shall be subject to ratification, acceptance or approval by Signatories.

2. The present Protocol shall be open for accession as from 12 December 1994 by the States and organizations that meet the requirements of article 12, paragraph 1.

Article 14

## DEPOSITARY

The instruments of ratification, acceptance, approval or accession shall be deposited with the Secretary-General of the United Nations, who will perform the functions of Depositary.

Article 15

## ENTRY INTO FORCE

1. The present Protocol shall enter into force on the ninetieth day following the date on which the sixteenth instrument of ratification, acceptance, approval or accession has been deposited.

2. For each State and organization referred to in article 12, paragraph 1, which ratifies, accepts or approves the present Protocol or accedes thereto after the deposit of the sixteenth instrument of ratification, acceptance, approval or accession, the Protocol shall enter into force on the ninetieth day following the date of deposit by such Party of its instrument of ratification, acceptance, approval or accession.

#### Article 16

##### WITHDRAWAL

At any time after five years from the date on which the present Protocol has come into force with respect to a Party, that Party may withdraw from it by giving written notification to the Depositary. Any such withdrawal shall take effect on the ninetieth day following the date of its receipt by the Depositary, or on such later date as may be specified in the notification of the withdrawal.

#### Article 17

##### AUTHENTIC TEXTS

The original of the present Protocol, of which the English, French and Russian texts are equally authentic, shall be deposited with the Secretary-General of the United Nations.

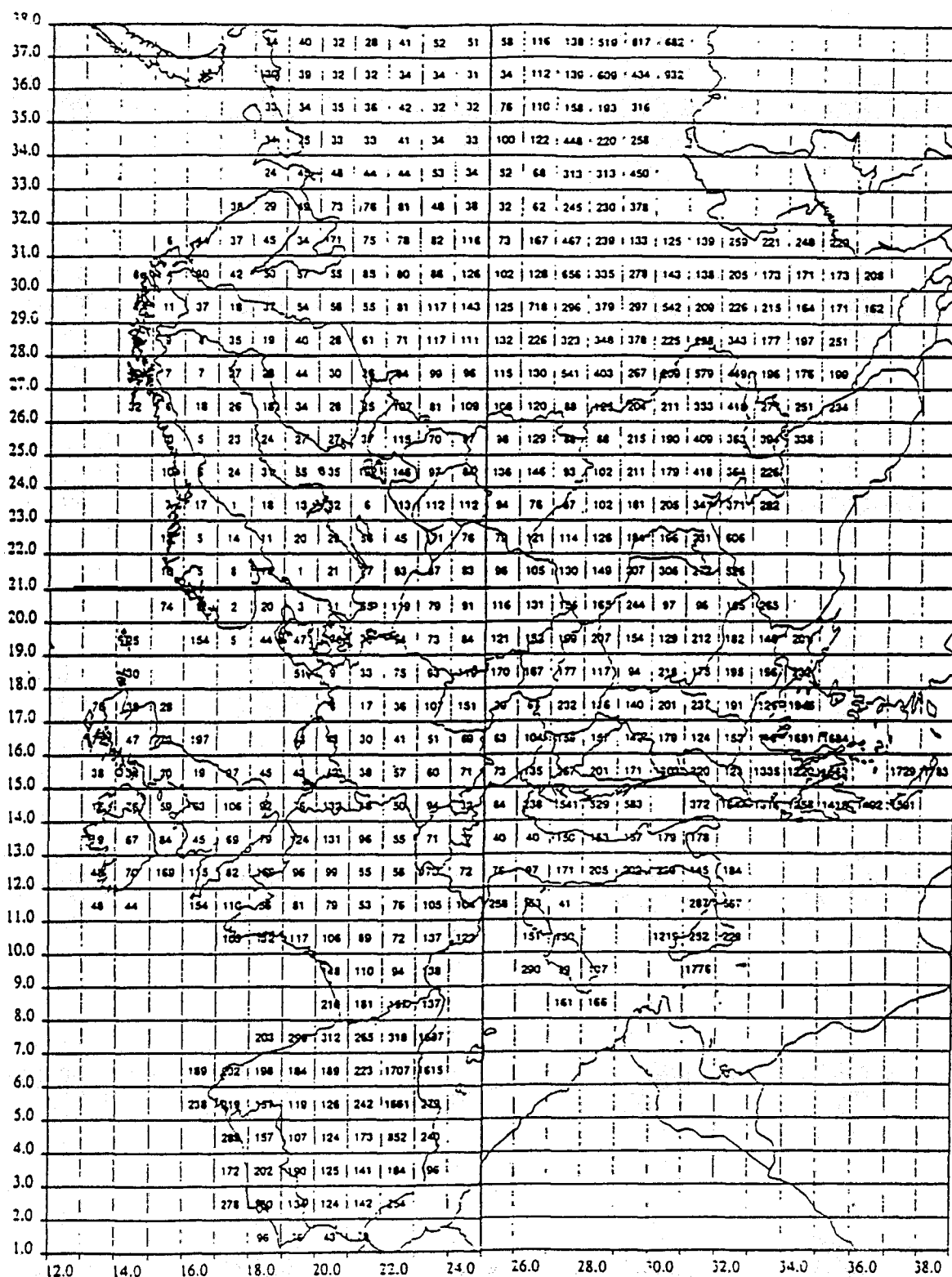
IN WITNESS WHEREOF the undersigned, being duly authorized thereto, have signed the present Protocol.

DONE at ... this ... .

## Аспект I

## CRITICAL SULPHUR DEPOSITION

(5-percentile in centigrams of sulphur per square metre per year)



## Annex II

## SULPHUR EMISSION CEILINGS AND PERCENTAGE EMISSION REDUCTIONS

The sulphur emission ceilings listed in the table below give the obligations referred to in paragraphs 2 and 3 of article 2 of the present Protocol. The 1980 and 1990 emission levels and the percentage emission reductions listed are given for information purposes only.

	Emission levels		Sulphur emission ceilings <sup>1/</sup>			Percentage emission reductions		
	kt SO <sub>2</sub> per year		kt SO <sub>2</sub> per year			(base year 1980 <sup>2/</sup> )		
	1980	1990	2000	2005	2010	2000	2005	2010
Austria	397	90	78			80%		
Belarus	740		456	400	370	38%	46%	50%
Belgium	828	443	248	232	215	70%	72%	74%
Bulgaria	2050	2020	1374	1230	1127	33%	40%	45%
Canada - national	4614	3700	3200			30%		
- SOMA	3245		1750			46%		
Croatia	150	160	133	125	117	11%	17%	22%
Czech Republic	2257	1876	1128	902	632	50%	60%	72%
Denmark	451	180	90			80%		
Finland	584	260	116			80%		
France	3348	1202	868	770	737	74%	77%	78%
Germany	7494	5803	1300	990		83%	87%	
Greece	400	510	595	580	570	0%	3%	4%
Hungary	1632	1010	898	816	653	45%	50%	60%
Ireland	222	168	155			30%		
Italy	3800		1330	1042		65%	73%	
Liechtenstein	0.004	0.201	0.1			75%		
Luxembourg	24		10			58%		
Netherlands	466	207	106			77%		
Norway	142	54	34			76%		
Poland	4100	3210	2583	2173	1397	37%	47%	66%
Portugal	266	284	314	304	295	0%	3%	
Russian Federation <sup>1/</sup>	7161	4460	4440	4297	4297	38%	40%	40%
Slovakia	843	539	337	295	240	60%	65%	72%
Slovenia	235	195	130	94	71	45%	60%	70%
Spain	3319	2316	2143			35%		
Sweden	507	130	100			80%		
Switzerland	126	62	60			52%		
Ukraine	3850		2310	2118	1696	40%	45%	56%
United Kingdom	4898	3780	2449	1470	980	50%	70%	80%
European Community	25513		9608			62%		

## Notes

1/ If, in a given year before 2005, a Party finds that, due to a particularly cold winter, a particularly dry summer and an unforeseen short-term loss of capacity in the power supply system, domestically or in a neighbouring country, it cannot comply with its obligations under this annex, it may fulfil those obligations by averaging its national annual sulphur

emissions for the year in question, the year preceding that year and the year following it, provided that the emission level in any single year is not more than 20% above the sulphur emission ceiling.

The reason for exceedance in any given year and the method by which the three year average figure will be achieved, shall be reported to the Implementation Committee.

2/ For Greece and Portugal percentage emission reductions given are based on the sulphur emission ceilings indicated for the year 2000.

3/ European part within the EMEP area.

### Annex III

#### DESIGNATION OF SULPHUR OXIDES MANAGEMENT AREAS (SOMAs)

The following SOMA is listed for the purposes of <sup>the present</sup> ~~this~~ Protocol:

#### Southeast Canada SOMA

This is an area of 1,000,000 km<sup>2</sup> which includes all the territory of the provinces of Prince Edward Island, Nova Scotia and New Brunswick, all of the territory of the province of Quebec south of a straight line between Havre-St. Pierre on the north coast of the Gulf of Saint Lawrence and the point where the Quebec-Ontario boundary intersects the James Bay coastline, and all the territory of the province of Ontario south of a straight line between the point where the Ontario-Quebec boundary intersects the James Bay coastline and Nipigon River near the north shore of Lake Superior.

Annex IV

TECHNICAL ANNEX ON CONTROL TECHNOLOGIES FOR SULPHUR EMISSIONS  
FROM STATIONARY SOURCES

I. INTRODUCTION

1. The aim of this annex is to provide guidance for the ~~Parties to the Convention in~~ identifying sulphur control options and technologies for giving effect to the obligations of the present Protocol.
2. The annex is based on information on general options for the reduction of sulphur emissions ~~reduction~~ and in particular on emission control technology performance and costs contained in official documentation of the Executive Body and its subsidiary bodies. ~~for example, the Nuremberg Seminar proceedings.~~
3. Unless otherwise indicated, the sulphur reduction measures listed are considered, on the basis of operational experience of several years in most cases, to be the most well-established and economically feasible best available technologies. However, the continuously expanding experience of low-emission measures and technologies at new plants as well as of the retrofitting of existing ones plants will necessitate the regular ~~expansion and amendment review~~ review of the this annex.
4. Although the annex lists a number of measures and technologies spanning a wide range of costs and efficiencies, it cannot be considered as an exhaustive statement of control options. Moreover, the choice of control measures and technologies for any particular case will depend on a number of factors, including current legislation and regulatory provisions and, in particular, control technology requirements, primary energy patterns, industrial infrastructure, economic circumstances and the specific in-plant conditions.
5. The annex mainly addresses the control of SO<sub>x</sub> oxidized sulphur emissions considered as the sum of sulphur dioxide (SO<sub>2</sub>) and sulphur trioxide (SO<sub>3</sub>) expressed as SO<sub>2</sub>. The share of sulphur emitted either as SO<sub>x</sub> sulphur oxides or other S sulphur compounds from non-combustion processes and other sources is small compared to SO<sub>x</sub> sulphur emissions from combustion.
6. When measures or technologies are planned for SO<sub>x</sub> sulphur sources emitting other components, in particular nitrogen oxides (NO<sub>x</sub>), particulates, heavy metals and volatile organic compounds (VOCs), it is worthwhile to consider them in conjunction with pollutant-specific control options in order to maximize the overall abatement effect and minimize the impact on the environment and, especially, to avoid the transfer of air pollution problems to other media (such as waste water and solid waste).

II. MAJOR STATIONARY SOURCES FOR SO<sub>x</sub> SULPHUR EMISSIONS

7. Fossil fuel combustion processes are the main source of anthropogenic SO<sub>x</sub> sulphur emissions from stationary sources. In addition, some non-combustion processes may contribute considerably to the emissions. The major stationary source categories of SO<sub>x</sub> emissions, based on EMEP/CORINAIR'90, include:

~~\*/~~ As prepared by the Working Group on Technology (EB.AIR/R.65 and Corr.1).

- (i) Public power, cogeneration and district heating plants:
  - (a) Boilers;
  - (b) Stationary combustion turbines and internal combustion engines;
- (ii) Commercial, institutional and residential combustion plants:
  - (a) Commercial boilers;
  - (b) Domestic heaters;
- (iii) Industrial combustion plants and processes with combustion:
  - (a) Boilers and process heaters;
  - (b) Processes, e.g. metallurgical operations such as roasting and sintering, coke oven plants, processing of titanium dioxide (TiO<sub>2</sub>) etc.;
  - (c) Pulp production;
- (iv) Non-combustion processes, e.g. sulphuric acid production, specific organic synthesis processes, treatment of metallic surfaces;
- (v) Extraction; processing and distribution of fossil fuels;
- (vi) Waste treatment and disposal, e.g. thermal treatment of municipal and industrial waste.

8. Overall data (1990) for the ECE region indicate that about 88% of total SO<sub>2</sub> sulphur emissions originate from all combustion processes (20% from industrial combustion), 5% from production processes and 7% from oil refineries. The power plant sector in many countries is the major single contributor to SO<sub>2</sub> sulphur emissions. In some countries, the industrial sector (including refineries) is also an important SO<sub>2</sub> emitter. Although emissions from refineries in the ECE region are relatively small, their impact on SO<sub>2</sub> sulphur emissions from other sources is large due to the sulphur in the oil products. Typically 60% of the sulphur intake - present in the crudes - remains in the products, 30% is recovered as elemental sulphur and 10% is emitted from refinery stacks.

### III. GENERAL OPTIONS FOR REDUCING SO<sub>2</sub> REDUCTION OF SULPHUR EMISSIONS FROM COMBUSTION

9. General options for SO<sub>2</sub> reduction of sulphur emissions are:

- (i) Energy management measures: <sup>1</sup>
  - (a) Energy saving

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<sup>1</sup> Options (i) (a) and (b) ~~(a-b)~~ are integrated in the energy structure and policy of a Party. Implementation status, efficiency and costs per sector are not considered here.

~~10.~~ The rational use of energy (improved energy efficiency/process operation, co-generation and/or demand-side management) usually results in a reduction in  $SO_x$  sulphur emissions.

(b) Energy mix

~~11.~~ In general,  $SO_x$  sulphur emissions can be reduced by increasing the proportion of non-combustion energy sources (i.e., hydro, nuclear, wind, etc.) to the energy mix. However, further environmental impacts have to be considered.

(ii) Technological options:

(a) Fuel switching

~~12.~~ The  $SO_2$  emissions during combustion are directly related to the sulphur content of the fuel used.

~~13.~~ Fuel switching (e.g. from high to low sulphur coals and/or liquid fuels or from coal to gas) leads to lower  $SO_x$  sulphur emissions, but there may be certain restrictions, such as the availability of low sulphur fuels and the adaptability of existing combustion systems to different fuels. In many ECE countries, some coal or oil combustion plants are being replaced by gas-fired combustion plants. Dual fuel plants may facilitate fuel switching.

(b) Fuel cleaning

~~14.~~ Cleaning of natural gas is state of the art technology and widely applied for operational reasons.

~~15.~~ Cleaning of process gas (acid refinery gas, coke oven gas, bio-gas, etc.) is also state of the art technology.

~~16.~~ Desulphurization of liquid fuels (light and middle fractions) is state of the art technology.

~~17.~~ Desulphurization of heavy fractions is technically feasible, nevertheless, the crude properties should be kept in mind. Desulphurization of atmospheric residue (bottom products from atmospheric crude distillation units) for the production of low S sulphur fuel oil is not, however, commonly practised; processing low sulphur crude is usually preferable. Hydro-cracking and full conversion technology have matured and combine high sulphur retention with improved yield of light products. The number of full conversion refineries is as yet limited. Such refineries typically recover 80 to 90% of the sulphur intake and convert all residues into light products or other marketable products. For this type of refinery, energy consumption and investment costs are increased. Typical S sulphur content for refinery products is given in table 1 below.



Table 1

Sulphur content from refinery products  
(S content (%))

	Typical present values	Anticipated future values
Gasoline	0.1	0.05
Jet kero	0.1	0.01
Diesel	0.05 - 0.3	< 0.05
Heating oil	0.1 - 0.2	< 0.1
Fuel oil	0.2 - 3.5	< 1
Marine diesel	0.5 - 1.0	< 0.5
Bunker oil	3.0 - 5.0	< 1 (coastal areas) < 2 (high seas)

~~18.~~ Cleaning of Current technologies to clean hard coal with currently applied technologies can remove achieve an approximately 50% removal of the inorganic sulphur (depending on coal properties) but none of the organic sulphur. More effective technologies are being developed which, however, involve higher specific investment and costs. Thus sulphur removal efficiency by coal cleaning is limited compared to flue gas desulphurization. There may be a country-specific optimization potential for the best combination of fuel cleaning and flue gas cleaning.

(c) Advanced combustion technologies

~~19.~~ These combustion technologies with improved thermal efficiency and reduced SO<sub>x</sub> sulphur emissions include: ~~F~~fluidized bed combustion (FBC); ~~B~~bubbling (BFBC), ~~C~~irculating (CFBC) and ~~P~~ressurized (PFBC); ~~I~~ntegrated gasification combined cycle (IGCC); and ~~C~~ombined cycle gas turbines (CCGT).

~~20.~~ Stationary combustion turbines can be integrated into combustion systems in existing conventional power plants which can increase overall efficiency by 5 to 7% leading for example to a significant reduction of in SO<sub>x</sub> emissions. However, major alterations to the existing furnace system become necessary.

~~21.~~ Fluidized bed combustion is a combustion technology for burning hard coal and brown coal, but it can also burn other solid fuels such as petroleum coke and low grade fuels such as waste, peat and wood. Emissions can additionally be reduced by integrated combustion control in the system due to the addition of lime/limestone to the bed material. The total installed capacity of FBC has reached approximately 30,000 MW<sub>th</sub> (250 to 350 plants), including 8,000 MW<sub>th</sub> in the capacity range of greater than 50 MW<sub>th</sub>. By-products from this process may cause problems with respect to use and/or disposal, and further development is required.

~~22.~~ The IGCC process includes coal gasification and combined cycle power generation in a gas and steam turbine. The gasified coal is burnt in the combustion chamber of the gas turbine. SO<sub>x</sub> sulphur emission

control is achieved by the use of state of the art technology for raw gas cleaning facilities upstream of the gas turbine. The technology also exists for heavy oil residues and bitumen emulsions. The installed capacity is presently about 1,000 MW<sub>e</sub> (5 plants).

23. Combined cycle gas turbine power stations using natural gas as fuel with an energy efficiency of approximately 48 to 52% are currently being planned.

(d) Process and combustion modifications

24. Combustion modifications comparable to the measures used for NO<sub>x</sub> emission control do not exist, as during combustion the organically and/or inorganically bound sulphur is almost completely oxidized to SO<sub>2</sub> (a certain percentage depending on the fuel properties and combustion technology is retained in the ash).

25. In this annex dry additive processes for conventional boilers are considered as process modifications due to the injection of an agent into the combustion unit. However, experience has shown that, when applying these processes, thermal capacity is lowered, the Ca/S ratio is high and sulphur removal low. Problems with the further utilization of the by-product have to be considered, so that this solution should usually be applied as an intermediate measure and for smaller units (table 2).

(e) Flue gas desulphurization processes (FGD)

26. These processes aim at removing already formed SO<sub>2</sub> sulphur oxides and are also referred to as secondary measures. The state of the art technologies for flue gas treatment processes are all based on the removal of SO<sub>2</sub> sulphur by wet, dry or semi-dry and catalytic chemical processes.

27. To achieve the most efficient SO<sub>2</sub> ~~reductions~~ emission reductions programme for sulphur beyond the measures listed in (i) (of this paragraph) a combination of technology options identified in (ii) the paragraph should be considered.

28. In some cases options for reducing SO<sub>2</sub> sulphur emissions may also result in the reduction of CO<sub>2</sub> emissions, NO<sub>x</sub> emissions and other pollutants.

29. In the public power, cogeneration and district heating plants, flue gas treatment processes used are, inter alia, the following: Elime/limestone wet scrubbing (LWS); Sspray dry absorption (SDA); Wellman Lord process (WL); Ammonia scrubbing (AS); and Ecombined NO<sub>x</sub>/SO<sub>2</sub> removal processes (Activated Ecarbon Pprocess (AC) and Ecombined catalytic NO<sub>x</sub>/SO<sub>2</sub> removal).

30. In the power generation sector, LWS and SDA cover 85% and 10%, respectively, of the installed FGD capacity.

31. Several new flue-gas desulphurization processes, such as Eelectron Bbeam Edry Sscrubbing (EBDS) and Mark 13A, have not yet passed the pilot stage.

Table 2

SO<sub>x</sub> emissions obtained from the application of technological options  
at fossil fuelled boilers

	Uncontrolled emissions		Additive Injection		Wet Scrubbing 3/		Spray Dry Absorption 2/	
Reduction efficiency			up to 60%		95%		up to 90%	
Energy efficiency (KW <sub>e</sub> /10 <sup>3</sup> m <sup>3</sup> /h)			0.1 - 1		6 - 10		3 - 6	
Total installed capacity (ECE Eur) (MW <sub>e</sub> )					194,000		16,000	
Type of by-product			Mix of Ca salts and fly ashes		Gypsum (sludge/ waste water)		Mix of CaSO <sub>3</sub> * 1/2 H <sub>2</sub> O and fly ashes	
Specific investment (cost ECU(1990)/KW <sub>e</sub> )			20 - 50		60 - 250		50 - 220	
	mg/m <sup>3</sup> 1/	g/KWh <sub>e</sub>	mg/m <sup>3</sup> 1/	g/KWh <sub>e</sub>	mg/m <sup>3</sup> 1/	g/KWh <sub>e</sub>	mg/m <sup>3</sup> 1/	g/KWh <sub>e</sub>
Hard Coal 5/	1,000-10,000	3.5-35	400-4,000	1.4-14	<400 (<200, 1% S)	<1.4 <0.7	<400 (<200, 1% S)	<1.4 <0.7
Brown Coal 5/	1,000-20,000	4.2-84	400-8,000	1.7-33.6	<400 (<200, 1% S)	<1.7 <0.8	<400 (<200, 1% S)	<1.7 <0.8
Heavy Oil 5/	1,000-10,000	2.8-28	400-4,000	1.1-11	<400 (<200, 1% S)	<1.1 <0.6	<400 (<200, 1% S)	<1.1 <0.6

	Ammonia Scrubbing 2/		Wellmann Lord 3/		Activated Carbon 3/		Combined Catalytic 3/	
Reduction efficiency	up to 90%		95%		95%		95%	
Energy efficiency (KW <sub>e</sub> /10 <sup>3</sup> m <sup>3</sup> /h)	3-10		10-15		4-8		2	
Total installed capacity (ECE Eur) (MW <sub>e</sub> )	200		2,000		700		1,300	
Type of by-product	Ammonia Fertilizer		Elemental S Sulphuric acid (99 vol.%)		Elemental S Sulphuric acid (99 vol.%)		Sulphuric acid (70 wt.%)	
Specific investment (cost ECU(1990)/KW <sub>e</sub> )	230-270 4/		200-300 4/		280-320 4/ 5/		320-350 4/ 5/	
	mg/m <sup>3</sup> 1/	g/KWh <sub>e</sub>	mg/m <sup>3</sup> 1/	g/KWh <sub>e</sub>	mg/m <sup>3</sup> 1/	g/KWh <sub>e</sub>	mg/m <sup>3</sup> 1/	g/KWh <sub>e</sub>
Hard Coal 5/	<400 (<200, 1% S)	<1.4 <0.7	<400 (<200, 1% S)	<1.4 <0.7	<400 (<200, 1% S)	<1.4 <0.7	<400 (<200, 1% S)	<1.4 <0.7
Brown Coal 5/	<400 (<200, 1% S)	<1.7 <0.8	<400 (<200, 1% S)	<1.7 <0.8	<400 (<200, 1% S)	<1.7 <0.8	<400 (<200, 1% S)	<1.7 <0.8
Heavy Oil 5/	<400 (<200, 1% S)	<1.1 <0.6	<400 (<200, 1% S)	<1.1 <0.6	<400 (<200, 1% S)	<1.1 <0.6	<400 (<200, 1% S)	<1.1 <0.6

- 1/ Emission in mg/m<sup>3</sup> (STP), dry, 6% oxygen for solid fuels, 3% oxygen for liquid fuels.  
 2/ Liquid applicability for high S fuels.  
 3/ For high S content in the fuel the removal efficiency has to be adapted. However, the possibility to do so may be process specific. Availability of these processes is usually 95%.  
 4/ Specific investment cost relate to small sample of installations.  
 5/ Conversion factor depends on fuel properties, specific fuel gas volume and thermal efficiency of boiler (conversion factors (m<sup>3</sup>/KWh<sub>e</sub>, thermal efficiency: 36%) used: hard coal: 3.50; brown coal: 4.20; heavy oil: 2.80).  
 6/ Specific investment cost include denitrification process.

The table was established mainly for large combustion installations in the public sector. However, the control options are also valid for other sectors with similar exhaust gas.

32. Table 2 above shows the efficiency of the above-mentioned secondary measures based on the practical experience gathered from a large number of implemented plants. The implemented capacity as well as the capacity range are also mentioned. Despite comparable characteristics for several SO<sub>2</sub> sulphur abatement technologies, local or plant specific influences may lead to the exclusion of a given technology.

33. Table 2 also includes the usual investment cost ranges of applying the SO<sub>2</sub> sulphur abatement technologies listed in (ii) (c), (d) and (e) of this paragraph. However, when applying these technologies to individual cases it should be noted that investment costs of emission reduction measures will depend amongst other things on the particular technologies used, the required control systems, the plant size, the extent of the required reduction and the time-scale of planned maintenance cycles. The table thus gives only a broad range of investment costs. Investment costs for retrofit generally exceed those for new plants.

#### IV. CONTROL TECHNIQUES FOR OTHER SECTORS

34. The control techniques listed in paragraph 2 (ii) (a) to (e) ~~discussed in section III~~ are not only valid in the power plant sector but also in various other sectors of industry. Several years of operational experience has have been acquired, in most cases, in the power plant sector.

35. The application of sulphur abatement technologies in the industrial sector merely depends on the process's specific limitations in the relevant sectors. Important contributors to sulphur emissions and corresponding reduction measures are presented in the table 3 below.

Table 3

Source	Reduction Measures
Roasting of non-ferrous sulphides	Wet sulphuric acid catalytic process (WSA)
Viscose	Double contact process
Sulphuric acid production	Double contact process, improved yield
Kraft pulp	Variety of process integrated measures

36. In these sectors listed in table 3, process integrated measures, including raw material changes (if necessary combined with sector-specific flue gas treatment), can be used to achieve the most effective SO<sub>2</sub> reduction of sulphur emissions.

37. Reported examples are the following:

- In new Kraft pulp mills, sulphur emission of less than 1 kg S/t pulp AD (air dried) can be achieved; <sup>2</sup>

<sup>2</sup> Control of sulphur-to-sodium ratio is required, i.e. removal of sulphur in the form of neutral salts and use of sulphur free sodium make-up.

- In sulphite pulp mills, 1 to 1.5 kg S/t pulp AD can be achieved;
- In the case of roasting of sulphides removal, efficiencies of 80 to 99% for 10,000 to 200,000 m<sup>3</sup>/h units have been reported (depending on the process);
- For one iron ore sintering plant, an FGD unit of 320,000 m<sup>3</sup>/h capacity achieves clean gas value below 100 mg SO<sub>x</sub>/m<sup>3</sup> at 6% O<sub>2</sub>;
- Coke ovens are achieving less than 400 mg SO<sub>x</sub>/m<sup>3</sup> at 6% O<sub>2</sub>;
- Sulphuric acid plants achieve a conversion rate larger than 99%;
- Advanced Claus plant achieves S recovery of more than 99%.

#### V. BY-PRODUCTS SIDE EFFECTS

38. As efforts to reduce SO<sub>2</sub> sulphur emissions from stationary sources are increased in the countries of the ECE region, the quantities of by-products will also increase.

39. ~~Such Options which would lead to usable by-products should be selected. which would lead to usable by-products.~~ Furthermore, ~~such options should be selected that lead to increased thermal efficiency and minimize the waste disposal issue whenever possible should be selected.~~ Although most by-products are usable or recyclable products such as gypsum, ammonia salts, sulphuric acid or sulphur, factors such as market conditions and quality standards need to be taken into account. Further utilization of FBC and SDA by-products have to be improved and investigated, as disposal sites and disposal criteria limit disposal in several countries.

40. The following side effects will not prevent the implementation of any technology or method but should be considered when several SO<sub>2</sub> sulphur abatement options are possible:

- Energy requirements of the gas treatment processes;
- Corrosion attack due to the formation of sulphuric acid by the reaction of SO<sub>2</sub> sulphur oxides with water vapour;
- Increased use of water and waste water treatment;
- Reagent requirements;
- Solid waste disposal.

#### VI. MONITORING AND REPORTING

41. The measures taken to carry out national strategies and policies for the abatement of air pollution include: legislation and regulatory provisions, economic incentives and disincentives; as well as technological requirements (best available technology).

42. In general, ~~Parties set~~ standards are set, per emission source, according to plant size, operating mode, combustion technology, fuel type and whether it is a new or existing plant. An alternative approach also used is to set a target for the reduction of total SO<sub>2</sub> sulphur emissions from a group of sources and to allow the ~~Parties to choose a~~ choice where to take action to reach this target (bubble concept).

43. The limiting of the SO<sub>2</sub> sulphur emissions to the levels set out in the national framework legislation has to be controlled by a permanent monitoring and reporting system and reported to the supervising authorities.

44. Several monitoring systems, using both continuous and discontinuous measurement methods are available. However, quality requirements vary. ~~among Parties.~~ Measurements are to be carried out by qualified institutes using measuring and / monitoring systems. To this end, a certification system can provide the best assurance.

45. In the framework of modern automated monitoring systems and process control equipment, reporting does not ~~creates no~~ a problem. The collection of data for further use is a state of the art technique; however, data to be reported to competent authorities differ from ~~Party case to case~~ Party. To obtain better comparability, data sets and prescribing regulations should be harmonized. Harmonization is also desirable for quality assurance of measuring and / monitoring systems. This should be taken into account when comparing data. ~~from different Parties.~~

46. To avoid discrepancies and inconsistencies, key issues and parameters, including the following, must be well defined:

- Definition of standards expressed as ppmv, mg/m<sup>3</sup>, g/GJ, kg/h or kg/t of product. Most of these units need to be calculated and need specification in terms of gas temperature, humidity, pressure, oxygen content or heat input value;
- Definition of time over which standards are to be averaged, expressed as hours, months or a year;
- Definition of failure times and corresponding emergency regulations regarding bypass of monitoring systems or shutdown of the installation;
- Definition of methods for backfilling of data missed or lost as a result of equipment failure;
- Definition of the parameter set to be measured. Depending on the type of industrial process, the necessary information may differ. This also involves the location of the measurement point within the system.

47. Quality control of measurements has to be ensured.

## EMISSION AND SULPHUR CONTENT LIMIT VALUES

A. EMISSION LIMIT VALUES FOR MAJOR STATIONARY COMBUSTION SOURCES 1/			
	(i) (MW <sub>th</sub> )	(ii) Emission limit value (mg SO <sub>2</sub> /Nm <sup>3</sup> 2/)	(iii) Desulphurization rate (%)
1. SOLID FUELS (based on 6% oxygen in flue gas)	50-100	2000	
	100-500	2000-400 (linear decrease)	40 (for 100-167 MW <sub>th</sub> ) 40-90 (linear increase for 167-500 MW <sub>th</sub> )
	>500	400	90
2. LIQUID FUELS (based on 3% oxygen in flue gas)	50-300	1 700	
	300-500	1 700-400 (linear decrease)	90
	>500	400	90
3. GASEOUS FUELS (based on 3% oxygen in flue gas)			
Gaseous fuels in general		35	
Liquefied gas		5	
Low calorific gases from gasification of refinery residues, coke oven gas, blast-furnace gas		800	

B. GAS OIL	Sulphur Content (%)
Diesel for on-road vehicles	0.05
Other types	0.2

Notes

1/ As guidance, for a plant with a multi-fuel firing unit involving the simultaneous use of two or more types of fuels, the competent authorities shall set emission limit values taking into account the emission limit values from column (ii) relevant for each individual fuel, the rate of thermal input delivered by each fuel and, for refineries, the relevant specific characteristics of the plant. For refineries such a combined limit value shall under no circumstances exceed 1700 mg SO<sub>2</sub>/Nm<sup>3</sup>.

In particular, the limit values shall not apply to the following plants:

- Plants in which the products of combustion are used for direct heating, drying, or any other treatment of objects or materials, e.g. reheating furnaces, furnaces for heat treatment;
- Post-combustion plants, i.e. any technical apparatus designed to purify the waste gases by combustion which is not operated as an independent combustion plant;
- 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;
- Waste incinerators;
- Plants powered by diesel, petrol and gas engines or by gas turbines, irrespective of the fuel used.

In a case where a Party, due to the high sulphur content of indigenous solid or liquid fuels, cannot meet the emission limit values set forth in column (ii), it may apply such desulphurization rates as are set forth in column (iii) or a maximum limit value of  $800 \text{ mg SO}_2/\text{Nm}^3$  (although preferably not more than  $650 \text{ mg SO}_2/\text{Nm}^3$ ). The Party shall report any such application to the Implementation Committee in the calendar year in which it is made.

Where two or more separate new plants are installed in such a way that, taking technical and economic factors into account, their waste gases could, in the judgement of competent authorities, be discharged through a common stack, the combination formed by such plants is to be regarded as a single unit.

2/  $\text{mg SO}_2/\text{Nm}^3$  is defined at a temperature of 273 K and a pressure of 101.3 kPa, after correction for the water vapour content.