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Your ref	Your letter of	Our ref.	8034 Zurich
		ARUW AST/dav	March 14, 1980.

Re.: IPAI Health Committee
Task Force on Sampling and Analysis

Gentlemen,

I enclose my contribution on

Air Sampling and Analysis

Chapter IV: Limit of Exposure

and at the same time would like to apologize for the delay.

I also have the following remarks to make with regard to this draft:

- particulars for Canada are still missing, but I think these can easily be added.
- Furthermore the Japanese and Australian values are already rather old and at the same time second hand. Here too supplementary data should present no difficulties.
- I have no particulars concerning the South American countries.
- The situation in the U.S.A. is not fully illuminated.

I suggest, therefore, that a decision is taked on basis of this draft as to whether the entire matter should be extended further or whether it should be condensed to allow a better understanding.

./.

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I look forward to receiving your ideas and suggestions; above all I would appreciate receiving a corrected version of Tables I - IV to see how far the data given are correct.

Very truly yours

Alfred

Enclosure

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INTERNATIONAL PRIMARY ALUMINIUM INSTITUTE

THE MEASUREMENT OF EMPLOYEE EXPOSURES IN ALUMINIUM REDUCTION PLANTS

Chapter IV - Limits of Exposure

A. Different Kinds of Limits of Exposure
B. Status of the Limits of Exposure
C. Short Discussion of the TLV and MAC Values of Primary Importance for the Aluminium Industry

Appendix:

The Limit of Exposure in Different Countries: Summary of Airborne Contaminants in the Aluminium Primary Industry

Table I - of Primary Importance
Table II - of Secondary Importance
Table III - of Less Importance
Table IV - Principal Use or Source of Emission

Bibliography

A. Different Kinds of Limits of Exposure

The first lists of permissible concentrations of pollutants at the workplace published date back to the thirties, a fact which is generally unknown. The significance of such lists has increased considerably, particularly in the last few years because more and more importance has been placed on health protection. This rapid development led to state institutions, research centers and universities in various countries concerning themselves with the establishment of limits. It is not surprising, therefore, that today in spite of various efforts, there are no standard terms and values. However, looking more closely, it can be ascertained that the existing limits can be listed according to two main groups

MAC* = maximum admissible or allowable concentration and the

TLV = threshold limit value.

a.) MAC Values

Generally MAC (MAK) concentrations are absolute admissible limits which should not be exceeded at any time during working even if at times lower concentrations prevail.

In the Federal Republic of Germany, the MAC value is defined as follows:

"The MAC value (maximum admissible concentration)[1] is the highest concentration of a working medium in the form of gas, vapor or suspended matter which can be permitted in the air at the workplace, which, according to the present state of knowledge, generally does not adversely affect the health of the personnel even in the case of repeated and long term exposure, but adhering to an average weekly

*German: Maximale Arbeitsplatzkonzentration = MAK

working time of up to 45 hours, and does not cause personnel excessive discomfort."

As a rule the MAC value is integrated as an average for one working day.

In the case of transgressions of the MAC value, the particular circumstances have to be taken into account, however, as the MAC value alone does not allow direct conclusions as to a possible risk. The MAC value list is revised every year according to the latest know-how which is elaborated systematically, and republished. Furthermore, the MAC values are partially explained and substantiated[2]. However, this documentation is being continuously completed.

In the case of the U.S.S.R.-MAC value, in contrast to that of the Federal Republic of Germany, the discomfort factor is left out, but on the other hand they have the stricter formulation that in no case should biological or functional changes be ascertained. This strict formulation of the U.S.S.R. concept is[3]:

"Maximum allowable concentrations of harmful substances in the air of the working area are those concentrations that, in the case of daily exposure at work for eight hours throughout the entire working life, will not cause any diseases or deviations from a normal state of health detectable by current methods of investigations, either during the work itself or in the long term." The MAC value for new substances is fixed in a gradual process: provisional toxicological evaluation, assessment from experiments with animals and statistical epidemiological interpretations. To date this procedure has been applied for more than 800 substances[4].

Spain has a TLV list of its own, mainly derived from the TLV-ACGIH; however, these values have to be respected as ceiling values[5].

b.) TLV Values

These are based on the lists which are published yearly by the ACGIH*. As can be seen from the foreword, the limit values are fixed in such a way that practically all jobs which are exposed to such concentrations repeatedly over a longer period of time, do not result in any injury to health or in discomfort. A certain discomfort and reversible injury to health in connection with special prerequisites cannot be excluded, however, in exceptional cases.

The following kinds of threshold limit values are defined by the ACGIH:

"Threshold Limit Value-Time Weighted Average (TLV-TWA) - the time-weighted average concentration for a normal 8-hour workday or 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect."

"Threshold Limit Value-Short Term Exposure Limit (TLV-STEL) - the maximal concentration to which workers can be exposed for a period up to 15 minutes continuously without suffering from 1) irritation, 2) chronic or irreversible tissue change, or 3) narcosis of sufficient degree to increase accident proneness, impair self-rescue, or materially reduce work efficiency, provided that no more than four excursions per day are permitted, with at least 60 minutes between exposure periods, and provided that the daily TLV-TWA also is not exceeded.

* American Conference of Governmental Industrial Hygienists[6]

"Threshold Limit Value-Ceiling (TLV-C)- the concentration that should not be exceeded even instanttaneously."

These values are marked with a C in the tables where the substances are named.

Apart from a very few substances, e.g. acetone (listed in the appendix to the TLV), the limit values of other substances may be exceeded for short periods as follows:

TLV > 0-1 (ppm or mg/m^3)	Excursion factor	= 3
" > 1-10 "	" "	= 2
" > 10-100 "	" "	= 1.5
" > 100-1000 "	" "	= 1.25

The number of transgressions is limited by adherence to the 8 hour value.

ACGIH also publishes a documentation of the threshold limit values which is adapted to the latest results, continuously revised and added to[7].

c.) Other Values

Some countries[3] have in addition to the time-weighted averages, a value for short periods of exposure, for example a reaction time of 10 minutes (Czechosolovakia) or 45 minutes (German Democratic Republic). Similar short time values are also already being discussed in the Federal Republic of Germany. Rumania has, besides a mean concentration comparable with TWA, also a maximum concentration which must not be exceeded at any time. It is probable that defined short time exposure limits as also proposed by ACGIH, will gain in importance in future.

d.) Limits for Carcinogens

In the case of substances which have to be classified as carcinogens, according to today's knowledge, no harmless quantities can be indicated with any certainty. In order to make an assessment nevertheless, some substances have been listed in the ACGIH-TLV values on basis of eipidemiological studies with simultaneous reference to their cancerogenic character. In the Federal Republic of Germany, TRC's* (technical reference concentrations) have been introduced for a few substances known to be cancerogenic. These values have no preventive medical substantiation, but can be used as reference for measurements in connection with technical and personal protection.

In most of the TLV and MAC value lists, the carcinogens are listed divided into groups.

e.) Limits for Mixtures and Substances of Variable Composition

The West German MAC value committee rejects a calculation of the MAC value from mixtures, as special toxicological know-how for the substances in question is necessary for evaluation. In most countries, above all those which base their lists on the TLV values, a calculation of mixtures is possible; however, the character of the mixtures e.g. two different acids or as an example to the contrary, a solid and an acid (not chemically related), has to be taken into consideration.

A typical example for a variable composition is the welding fume for which the TLV of ACGIH gives a value of 5 mg NOC/m^3**. However, it should be noted that when welding aluminium, the most important pollutant is ozone, and for that reason above all this MAC value is of significance.

*German: Technische Richtkonzentrationen = TRK

**NOC = Not otherwise classified

reason no limit values of their own are issued but the latest TWA values of ACGIH and in the meantime the Russian MAC values are published.

In most countries the state or official organizations publish their own limit values based on the TLV or MAC values. These limit values are indications and recommendations which are generally recognized and applied. They are used by official supervisory authorities and insurance companies as a criterion. The values can also be declared binding for granting operating permits to plants or in a wage agreement between employers and trade unions.

It must be pointed out once again that apart from the Russian MAC values, the limit values are not to be regarded as a sharp limit between safe and dangerous, but as a guide for monitoring health.

An open problem when comparing the different TLV and MAC values is their determination, which is very often different. Considerable differences can result during sampling already.

B. Status of the Limit Values

The status of the limit values varies considerably in the different countries. In the following countries the official lists of the maximum admissible concentrations are legally binding[8]: Bulgaria, Czechoslovakia, Finland, Hungary, Poland, Rumania, U.S.S.R. and Yugoslavia.

In the U.S.A. there is an official list of TLV's which are published in the Federal Register (FR)[9] and which have to be respected by all the holders of government contracts. They are based mainly on the latest lists issued by ACGIH. In the lists published by the Occupational Safety and Health Administration (OSHA)[10] based on the FR, no excursion factor is defined, but for 20 substances an "acceptable maximum peak above the acceptable ceiling concentration for an 8-hour shift". The time of exposure is indicated additionally.

The TLV values of ACGIH are a recommendation and have, like those of the American National Standards Institute or other organizations, no legal status. However, these values can be declared to be legal by the Federal Government or by individual states. In general they largely correspond to somewhat older issues of the two above-mentioned organizations.

In some countries[8] e.g. Argentina and Italy, limit values are laid down by the state for selected substances, above all mineral and silica dust, by decree. In France too the limit value for asbestos for example has been laid down by decree. The limit value for CO was fixed in an official circular letter. In general France is against laying down limit values, the reasons given for this point of view being above all individual reaction, differing external circumstances such as for example heavy manual work, the doubtful transfer of experiments with animals to human beings and the different analysis methods. For that

C. Short Discussion of the TLV and MAC Values of Primary Importance for the Aluminium Industry

As an extract from the various MAC and TLV lists, the most important substances are briefly discussed in the following and attention is drawn to trends towards possibly stricter limits. The figures in brackets correspond to the numbers in the table in the appendix The Limit of Exposure in Different Countries: Summary of Airborne Contaminants in the Aluminium Primary Industry.

Fluoride (I 6)

Up until a few years ago, most of the limit values (with the exception of the U.S.S.R.) corresponded to the presently valid TWA of 2.5 mg/m^3 for gaseous and particulate fluorides and 3 ppm or 2 mg/m^3 for hydrogen fluoride. To an increasing extent, however, the values in various countries have become stricter. For example, Switzerland has fixed a limit of 1.5 mg/m^3 for fluoride, for both gaseous and particulate, Italy and Holland 1.0 mg/m^3 for HF. To declare a short-term value in the same order of magnitude as suggested for a time by ACGIH or to fix this value as a ceiling value (for example as done in Sweden), is hardly appropriate, above all for particulate fluoride as its influence on human beings is primarily a long-term one.

In addition to these technical limit values, a biological limit proposed by NIOSH [11] is used in many countries as a guide for health surveillance. This biological limit is 4 mg fluoride/liter as preshift value and 7 mg/liter as postshift value.

Carbon Monoxide (I 7)

The limit value of 50 ppm or 55 mg/m^3, which is generally valid, has recently been replaced by 35 ppm or 40 mg/m^3 in the Scandinavian countries. An identical change is now also being discussed in the Federal Republic of Germany. In the U.S.A., NIOSH is also propagating a reduction of the presently valid value.

Sulfur Dioxide (I 8)

Besides the presently valid TWA value of 5 ppm or 13 mg/m^3, a limit value of 2 ppm or 5 mg/m^3 has been included in the TLV list since 1978 as an intended change. These values are already valid in Scandinavia and are being taken into consideration as a possible amendment in the Federal Republic of Germany.

Coal Tar Pitch Volatiles (I 3)

Formerly when fixing the limit value, only a limited number of aromatic hydrocarbons soluble in benzene (anthracene, BaP, phenomtrene, acridine, chrysene, pyrene) was included. Today this term, when fixing the TLV value of 0.2 mg/m^3, extends to all existing components of a mixture, which are soluble in benzene, this in view of the fact that a "safe" limit for cancerogenic substances cannot be given. In Norway and Iceland in addition to this value, a limit value for the identified polycyclic aromatic hydrocarbons (PAH) of 40 µg/m^3 is applied. Sweden for its part has fixed its limit value at 10 µg BaP/m^3. In Switzerland a provisional limit value of 0.2 mg/m^3 has been proposed for the fraction which is soluble in cyclohexane.

As analytical points of view also have to be observed when fixing the limit value for tar and pitch vapours, it can be assumed that there will be a further development of today's way of thinking.

Coal Dust (I 4)

A special value for coal dust is only found in the ACGIH-TLV lists and in such countries which adopt these lists more or less in their entirety. It amounts to 2 mg/m^3 respirable fraction* <5 % quartz. In the Scandinavian countries the general limit for organic dust amounts to 5 mg/m^3. In Switzerland due to the differentiation between substances with a density larger or smaller than 1.5, a value of 5 mg/m^3 also results for the total particulate and 2 mg/m^3 for fine particulate*.

Aluminium ~~Metal and~~ Oxide, ~~Welding Fumes (I 1)~~

A special value for aluminium metal and oxide is found in the ACGIH-TLV lists. In some countries, for example Switzerland, Al_2O_3 is allocated to the nuisance particulate. A value of 5 mg/m^3 for aluminium welding was included. These values were listed in the adopted values 1979 for the first time.

Asbestos (I 2)

The limit values for asbestos are being reduced worldwide. In the last edition of the TLV-ACGIH list, the value of 5 fiber/cm^3 is still shown in brackets. This value is indicated in the list of cancerogenes, and it is also pointed out that cigarette smoking can enhance the incidence of bronchogenic carcinoma. In the definition of the fiber, a length of more than 5 µm is given. The limits published in the US Federal Register Vol. 39 (1974) valid as from July 1, 1976, are 2 fiber/cm^3, longer than 5 µm. Furthermore, a ceiling concentration of 10 fiber/cm^3 is declared to be binding. The method of determination is also specified. These values refer to all kinds of asbestos.

* Definition, cf. paragraph on Nuisance Particulate (I 7)

In the TLV-ACGIH the following breakdown is made for the intended changes in the mineral dusts:

Asbestos		
Amosite	0.5	fiber/cm^3
Chrysotile	2	" "
Crocidolite	0.2	" "
Tremolite	0.5	" "
Other forms	2	" "

In Germany, a reduction of the technical reference concentration (TRC) has been made both for asbestos and asbestos-containing particulate. The value valid today of 2 fiber*/cm^3 for all kinds of asbestos is still applicable only for existing plants. For new plants and with effect 1.7.1982 for existing plants, a TRC value of 1 fiber/cm^3 will apply. Parallel to this change, a reduction of the value for asbestos-containing particulate from 4 to 2 mg/m^3 will take place.

A number of countries have followed the value indicated in the US Federal Register. For example, in France, Norway and Switzerland a limit value of 2 mg/cm^3 has been fixed for all kinds of asbestos. Sweden and Iceland limit the value to 1 fiber/cm^3, the use of crocidolite being more or less forbidden in Sweden. Iceland limits crocidolite to 0.1 fiber/cm^3.

Nuisance Particulate (I 7)

In the case of airborne particulate, the size of the particle among other things is important. That is why very often differentiation is made between respirable and total dust. The respirable fraction is generally meant to be the particulate with an aerodynamic diameter of less than 5 µm.

* Definition fiber: length > 5 µ, diameter < 3 µ,
  length: diameter > 3 : 1

The sampling of this particulate takes place with an instrument that has a size separation according to the ACGIH criteria.[12] A similar definition is also used in the Federal Republic of Germany for fine dust based on the Johannesburg Convention 1959 (50 % separation of the particles with an aerodynamic diameter of 5 µm).

In the assessment of whether the limit values for nuisance particulate can be applied, attention must be paid to the quartz content. If it is >1 %, for example according to the TLV-ACGIH or German MAC values, the limit value for quartz-containing dust must be applied (cf. Table II 12).

For inert dust, a value of 10 mg/m^3 total dust and 5 mg/m^3 respirable dust is indicated in the TWA-ACGIH lists. In Switzerland the limit value is adjusted to the specific weight of the substance as follows:

density $\geq$ 1.5:	20 mg/m^3	for total dust
	8 mg/m^3	for fine dust
$<$1.5:	5 mg/m^3	for total dust
	2 mg/m^3	for fine dust.

8 mg/m^3 is the German limit value for fine dust, while Norway and Sweden apply a limit value of 10 mg/m^3 for the total dust.

In Norway, a special value for potrooms is applied, namely 5 mg/m^3 total dust.

APPENDIX

The Limit of Exposure in Different Countries: Summary of Airborne Contaminants in the Aluminium Primary Industry

A table of the different TLV and MAC values was published in 1977 in the Occupational Safety and Health Series No. 37: Occupational Exposure Limits for Airborne Toxic Substances by the International Labour Office (ILO) Geneva[3]. For a better general view, the limit values in different countries are listed in Tables A - C in order of their importance for the aluminium industry.

The number allocated to the individual substances is indicated in Table D. The workplaces or jobs where the airborne contaminants mentioned mainly arise are indicated in this table.

As a basis the TWA values in the TLV list 1979 of ACGIH were taken.

In the colum "Different", those countries with deviating values are listed, while those with no fixed limit value are listed under "None".

The lists of TLV and MAC values have been reviewed for the following countries:

Australia	(AUS)	1975	
Federal Republic of Germany	(FRG)	1979	
Holland	(HOLL)	1979	
Japan		1975*	
Italy**		1975*	(by
Norway	(NORW)	1979	
Iceland	(ICEL)	1979	(only mentioned when different from Norway)
Sweden		1979	
Switzerland	(SWITZ)	1979	with changes fc 1980

** Italian Association of Industrial Hygienists and the Italian Society of Industrial Medicine

The following abbreviations were used:

CA for carcinogenic
resp. for respirable
prov. for provisional

* value taken from 3)

Summary of Airborne Contaminants, Table I: Of Primary Importance

Airborne Contaminant	No.	TWA-ACGIH	CA	Different	None	Footnote/Remarks
Aluminium oxide metal and oxide welding fume	I/1	10 mg/m^3 5 mg/m^3		SWITZ only for Al_2O_3 20 mg/m^3 total, 8 mg/m^3 resp.	AUS[1] FRG[1] JAPAN HOLL[1] SWEDEN[1]	[1] Can be considered as nuisance particulate (cf. I/7)
Asbestos, all sorts	I/2	(5 fiber/cm^3) [1]	+	ITALY[2)6)], NORW, SWITZ: 2 fiber/cm^3 AUS[2)]: 4 fiber/cm^3 SWEDEN[3)]: 1 fiber/cm^3 HOLL: corresponding intended changes FRG: TRC all sorts 2 fiber/cm^3 (1 fiber/cm^3) [5)] asbestos-containing dust: 2 mg/cm^3 (1 mg/cm^3) [5)]	JAPAN	[1] Federal Register: 2 fiber/cm^3, ceiling limit: 10 fiber/cm^3 [2] excl. crocidolite [3] crocidolite not to be used [4] intended changes [5] for new installations and from 1.7.82 [6] asbestos-containing total dust: $\frac{30}{q+3}$ mg/m^3 (q = % asbestos)
Amosite		0.5 fiber/cm^3 [4)]	+			
Chrysotile		2 fiber/cm^3 [4)]				
Crocidolite		0.2 fiber/cm^3 [4)]				
Tremolite		0.5 fiber/cm^3 [4)]				
Other form		2 fiber/cm^3 [4)]				

Airborne Contaminant	No.	TWA-ACGIH	CA	Different	None	Footnote/Remarks
Coal tar pitch volatiles = particulate polycyclic aromatic hydrocarbons (PPAH) as benzene solubles	I/3	0.2 mg/m^3	+	SWITZ: cyclohexane soluble, provisional value	JAPAN	
PAH		-		NORW: 40 µg/m^3	all other countries	
Benzo(a)pyrene		-	+	SWEDEN: 10 µg/m^3		
Coal dust	I/4	2 mg/m^3 resp. fraction < 5 % quartz		NORW, SWEDEN: 5 mg/m^3 total dust (general limit for organic dust) SWITZ: 20 mg/m^3 total dust, 8 mg/m^3 resp. fraction	AUS ITALY	
Carbon monoxide	I/5	ppm: 50 mg/m^3: 55		SWITZ, NORW: 35 40	-	

Airborne Contaminant	No.	TWA-ACGIH	CA	Different	None	Footnote/Remarks
Fluorides gaseous (HF) particulate	I/6	 ppm: 3 mg/m^3: 2 mg/m^3: 2.5		ITALY SWEDEN[1] SWITZ[2] - - 1.8 1 2 1.5 1.5 2 1.5		[1] Ceiling value [2] Total fluorides gaseous + particulate
Nuisance particulate	I/7	10 mg/m^3 [1] total dust 5 mg/m^3 [1] resp. dust		SWITZ: 20 mg/m^3 density > 1.5 8 mg/m^3 density < 1.5 FRG: 8 mg/m^3 SWITZ: 5 mg/m^3 density > 1.5 2 mg/m^3 density < 1.5	FRG JAPAN ITALY AUS JAPAN ITALY[2] SWEDEN NORW[3]	[1] < 1 % quartz [2] using formula for quartz: total 10 mg/m^3 resp. 3.3 mg/r [3] for potroom: 5 mg/m^3
Sulfur dioxide	I/8	ppm: (5) [1] mg/m^3: (13) [1]		ITALY SWEDEN NORW - 2 10 5		[1] intended changes: 2 ppm 5 mg/m^3

Summary of Airborne Contaminants, Table II: Of Secondary Importance

Airborne Contaminant	No.	TWA-ACGIH	CA	Different	None	Footnote/Remarks
Ammonia	II/1	ppm: 25 mg/m^3: 18		FRG JAPAN ITALY 50 - 35 20		Occup. standards 50 ppm, 35 mg/m^3 SWEDEN: 50 ppm and 35 mg/m^3 ceiling value
Carbon dioxide	II/2	ppm: 5000 mg/m^3: 9000				FRANCE: 1500 ppm
Chlorine Chlorides (HCL)	II/3	ppm: 1 mg/m^3 3 ppm: 5 [1] mg/m^3: 7 [1]		FRG SWITZ 0,5 1,5 2		[1] ceiling values, also in AUS, HOLL, SWEDEN, NORW, SWITZ [2] 2ppm in FRG in discussion [3] SWEDEN: 1 ppm and 3,0 mg/m^3 ceiling value
Fibrous glass	II/4	mg/m^3:10		ITALY 10 for total dust 3 for resp. dust	AUS FRG JAPAN NORW SWEDEN	US-Federal 10 mg/m^3 total dust 5 mg/m^3 resp. dust

Airborne Contaminant	No.	TWA-ACGIH	CA	Different	None	Footnote/Remarks
Hexachloroethane	II/5	ppm: 1 [1] mg/m^3: 10 [1]			ITALY JAPAN SWEDEN	Skin also in AUS, HOLL, NORW, SWITZ
Mineral wool fiber	II/6	mg/m^3: 10		ITALY: 10 mg/m^3 total dust 3,3 mg/m^3 resp. dust	[1]	[1] all other countries except ITALY and SWITZ
Oil mist particulate	II/7	mg/m^3: 5 [1]			FRG ITALY JAPAN	[1] in USA as sampled without vapor
Ozone	II/8	ppm: 0,1 mg/m^3: 0,2				
Perchloroethylene (=Tetrachloroethylene)	II/9	ppm: 100 [1] mg/m^3: 670 [1] [3]		NORW SWEDEN HOLL 20 [1] [2] 20 35 200 [1] [2] 135 240		[1] SKIN [2] ceiling value [3] ITALY 600 mg/m^3
Phosgene	II/10	ppm: 0,1 mg/m^3: 0,4		SWEDEN, NORW 0,05 [1] 2 [1]		[1] ceiling value
Phosphine	II/11	ppm : 0,3 mg/m^3: 0,4		FRG/SWITZ 0,1 0,15	JAPAN	

Airborne Contaminant	No.	TWA-ACGIH	CA	Different	None	Footnote/Remarks
Crystalline Silica — Quartz resp.	II/12	--		FRG,HOLL,SWITZ 0,15 mg/m3 fine dust NORW 0,2 mg/m3 SWEDEN 0,1 mg/m3	AUS JAPAN	1) NORW special regulations 2) RV = recommended value 3) RFS = resp. free silicon
Quartz-containing dust total		30 mg/m3 % quartz +3		1)		
resp.		10 mg/m3 % resp. quartz +2		AUS: RV2) = 25 mg/m3 / %RFS3) +5 Italy: 10 mg/m3 % resp. quartz +3 FRG,HOLL,SWITZ: 4 mg/m3 1)	JAPAN SWEDEN	
Welding fumes	II/13	mg/m3: 15 NOC1)		--	most countries	1) NOC = not otherwise classified

Summary of Airborne Contaminants, Table III: Of Lesser Importance

Airborne Contaminant	No.	TWA-ACGIH	CA	Different	None	Footnote/Remarks
Beryllium	III/1	mg/m³: 0,002	+	--	--	
Cadmium oxide fume as Cd	III/2	mg/m³: 0,05	+	NORW[1] SWEDEN, ITALY 0,02 0,01 JAPAN[1]: 0,1	--	1) ceiling value, also in AUS, SWITZ
Copper fume as Cu	III/3	mg/m³: 1,0		NORW,FRG,SWITZ[1] 0,1 SWEDEN,HOLL,ITALY 0,2	AUS JAPAN	1) fine dust
Lead inorg. fume and dust as Pb	III/4	mg/m³: 0,15		FRG,NORW,SWEDEN, SWITZ 0,1	--	
Magnesium oxide fume	III/5	mg/m³: 10		FRG[1], SWITZ[1] 8	JAPAN,ITALY NORW,SWEDEN	1) fine dust
Manganese fume as Mn	III/6	mg/m³: 1,0		AUS,FRG,JAPAN,SWITZ 5,0 NORW,SWEDEN,ITALY 2,5	--	
Mercury (all forms except alkyl) as Hg	III/7	ppm: - mg/m³: 0,05		FRG 0,01 0,10 ITALY[1] SWEDEN[1][2] SWITZ[1][3]: 0,05	JAPAN	1) skin sensitive 2) ceiling value 3) provis.

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Airborne Contaminant	No.	TWA-ACGIH	CA	Different	None	Footnote/Remarks
Nitrogen dioxide	III/8	ppm: (5) [1)2)] mg/m^3: (9)		--	--	1) ceiling value 2) intended changes: 3 ppm, 6 mg/m^3
X Vanadium oxides (V_2O_5) as V fume	III/9	mg/m^3: 0,05 [1)2)]		FRG,JAPAN: 0,1 SWITZ: 0,09 [3)] ITALY: 0,015		1) ceiling value 2) intended changes: not ceiling value 3) Fine dust
X Zinc oxide fume	III/10	mg/m^3: 5,0		--	--	

Summary of Airborne Contaminants, Table IV: Principal Use or Source of Emission

Airborne Contaminant	No	Principal Use or Source of Emission
Aluminium metal,oxide and welding fume	I/1	Potrooms, cast house, material handling areas
Asbestos	I/2	Insulation, coverings, lagging materials
Coal tar pitch volatiles	I/3	Binder for electrodes, Soederberg potrooms, carbon and paste plants, pot relining
Coal dust	I/4	Carbon and paste plants, pot repairing
Carbon monoxide	I/5	By-product of incomplete combustion in: potrooms, fumes, internal combustion engines
Fluorides	I/6	Potrooms, pot repairing, solid fluxes, ALF_3 plants
Nuisance particulate	I/7	Material handling throughout plant
Sulfur dioxide	I/8	Potrooms, carbon plants
Ammonia	II/1	Spent potlinings, casthouse dross, pot repairing
Carbon dioxide	II/2	Potrooms, anode bake sections
Chlorine and chlorides (HCL)	II/3	Fluxing in casting operations
Fibrous glass	II/4	Casthouse, ingot casting, potrooms
Hexachloroethane	II/5	Fluxing in casting operations
Mineral wool fiber	II/6	Pot repairing and casthouse
Oil mist particulate	II/7	Sawing aluminium, hot rolling
Ozone	II/8	Welding fume (spec. of Aluminium, stainless steel)

Airborne Contaminant	No	Principal Use or Source of Emission
Perchlorethylene	III/9	Degreasing throughout plant
Phosgene	III/10	Remelting scrap with PVC, welding fume (when Cl-containing solvents are used)
Phosphine	III/11	Spent potlinings
Quartz	III/12	Pot, furnace and crucible repairing
Welding fumes	III/13	Throughout plant, spec. pot repairing
Beryllium	III/1	Metal alloying
Cadmium oxide fume	III/2	Metal alloying
Copper fume	III/3	Metal alloying, Al-refining
Lead	III/4	Metal alloying
Magnesium oxide fume	III/5	Metal alloying
Manganese fume	III/6	Metal alloying
Mercury	III/7	Rectifiers
Nitrogen dioxide	III/8	Welding fume, calcining
Vanadium (V2 O5) fume	III/9	Potroom, secondary aluminia
Zinc oxide fume	III/10	Metal alloying

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