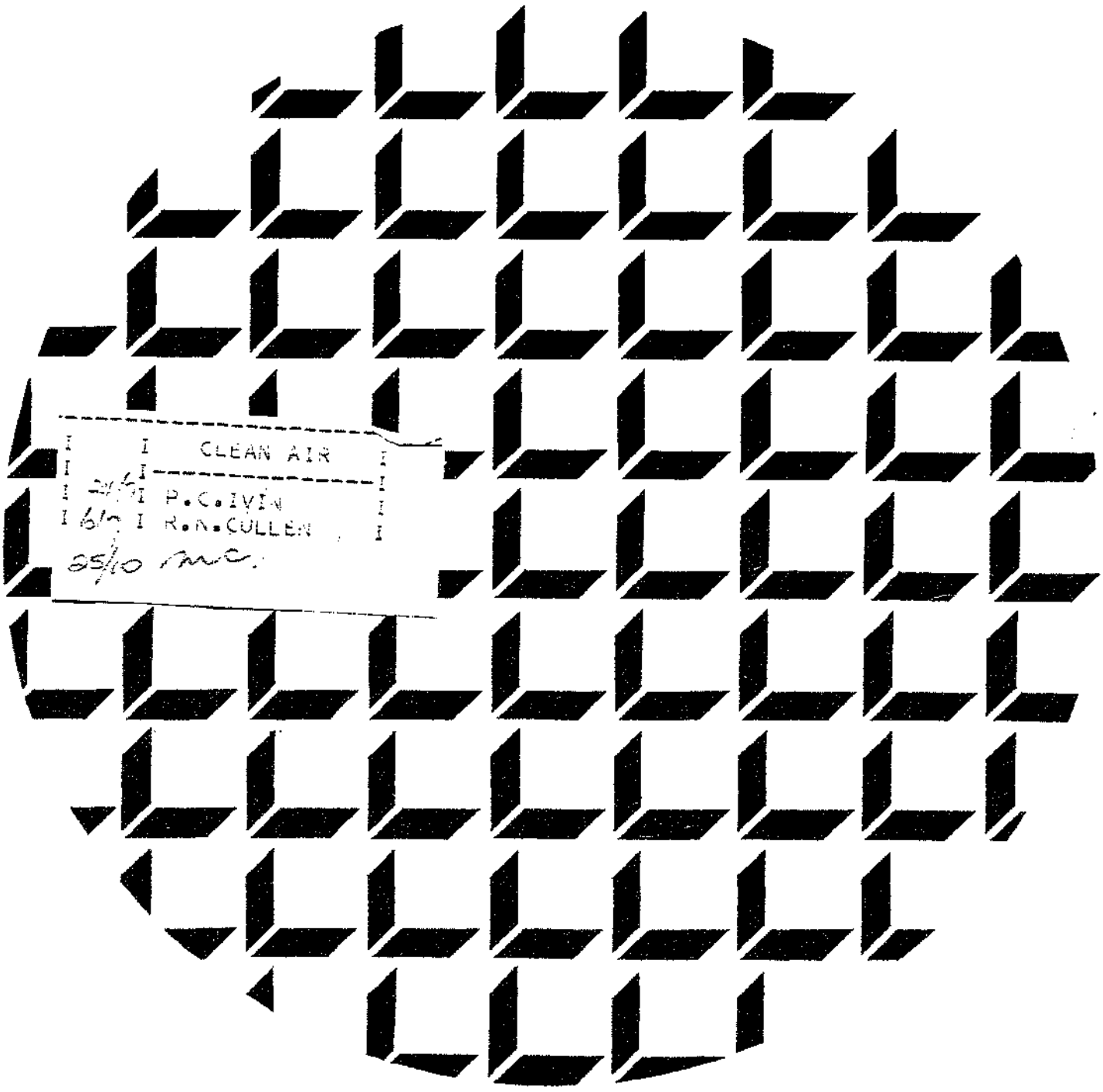
VOLUME 12 No. 2 MAY, 1978 PRICE $2.00
G.P.O. Melbourne for posting as a publication (Category B)



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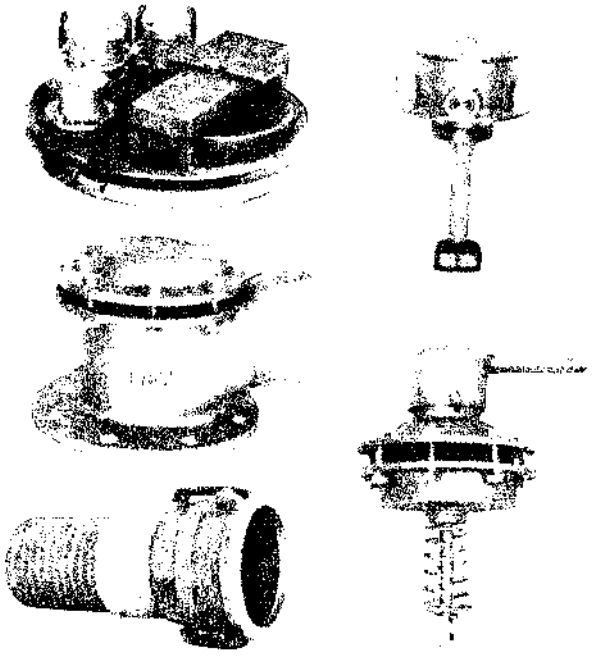

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CLEAN AIR Vol. 12 No. 2 May, 1978

JOURNAL OF THE CLEAN AIR SOCIETY OF AUSTRALIA AND NEW ZEALAND
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Advocate Press Pty. Ltd. 329 6588

Publication is quarterly in February, May, August and November.
Annual Subscription rates (inc. postage) for non-members and libraries:

Australia $A6.75
U.S.A. $US12.00
U.K. Six Pounds
Germany DM30.00
Elsewhere $A8.50
Single Copies $A2.00

Subscriptions and subscription enquiries should be directed to the Circulation Manager,
Mr. A. Crapp, Box 191 Eastwood.
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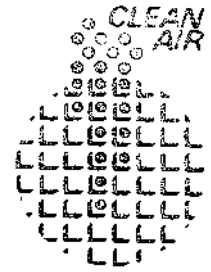
'Clean Air' is listed in Current Contents and Environmental Periodicals.



EDITORIAL
Clean Air Medal Award to John L. Sullivan.

The Society is delighted to honour its foundation president, John L. Sullivan with its highest award, the Clean Air Medal. It is just twelve years since the Foundation Meeting took place in Sydney. John Sullivan was also primarily responsible for two International Clean Air Conferences in Sydney held under the joint sponsorship of the University of New South Wales and the N.S.W. Department of Public Health.

At the inaugural meeting, 19 of those present were elected to the interim Council; and of these, four are still on the Council, while a number of others are active in their branches.

The original suggestions for a name were along the lines of our sister organization in the United States, but as another Society Medallist, Louis Layton pointed out, Clean Air was our aim, while air pollution control was the means to this end.

The society had a slow beginning; after four years there were branches in Sydney, Melbourne and New Zealand, with 274 members. At this time however, the world at large became interested and concerned with the environment and environmental management. During the next decade, under the leadership of the former president, John S. Schroder, the membership grew to 800, with branches in all states of Australia, the Capital Territory, and in New Zealand. If this is compared with the Air Pollution Control Association in North America, we have 48 members per million of population, compared with about 30 per million for our sister organization.

Members of the Society, in reading the annual report will realize that'this is now a well established body with an important voice in promoting a rational approach to pollution control. This voice is being heard through our major International Conferences — now the sixth — our special symposia, such as "Smog 76", which are now held almost annually, and our journal'.

John Sullivan, to our regret, left Australia just a year after founding the Society, to take up a senior position with the Federal Government in Canada. Subsequently he took up academic work; first at Syracuse University, and more recently at the University of Western Ontario, still specializing in air pollution. He was the driving force for clean air in New South Wales, which for a number of years led the other states in Australia in the development of effective air pollution control. John started this work as early as 1954, pioneering the systematic assessment of air pollution.

So, we welcome the return of our foundation president, to show him the results of his early efforts; a strong and successful Society, and widespread legislative and technical control of air pollution throughout Australia and New Zealand.

W. STRAUSS.

BRANCH NEWS

Victorian Branch News

On March 7, Mr. G. Rusden, managing-director of Birrus Engineering Co., spoke to the Victorian Branch on *Vacuum and Pressure Conveying of Solids.* His company makes equipment for solids handling ranging from the minute — the removal of dental debris in a surgery — to the very large; systems for handling 150 tonnes/hour of granular materials.

A large range of the different industrial applications were discussed; some is portable for cleaning up materials spills, while other equipment is permanently installed for solids handling on a continuous basis.

Essentially the units have a suction entry nozzle, a conveying pipe system, cyclone separator (with hopper and slide valves) and a fine dust bag filter. A multi-stage fan is used to provide the high flow-high pressure drop suction system. The equipment has been largely developed by Mr. Rusden and his firm, and has overcome the difficult design problems involved in the high speed handling of abrasive solids.

The units are now widely used in mining, ore beneficiation, minerals transport, coal processing, cement plants and other dusty industries. It was noted that vacuum removal is effective and relatively inexpensive in comparison with manual removal of spillatc. Furthermore, hazards are reduced, and the technique can be applied to enclosed spaces. Over thrity people were present, and a lively discussion followed the meeting.

W. R. HICKS

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Present and future sulphur emissions from Australian oil refineries and their products have been estimated. It is suggested that while the sulphur content in the fuels be limited, and stack heights be strictly controlled in the capital city areas, the permissible sulphur levels should be raised elsewhere provided strict stack height controls are maintained.

This paper was presented at a Workshop entitled 'Sulphur Cycling in Australian Ecosystems' held in Canberra in April this year by the Australian National Committee for SCOPE, the Scientific Committee on Problems of the Environment.

Mr. Manuel! is the Chief Environment Officer with Esso, Australia Ltd.

!NTRODUGT!OM: Sulphur contained in crude oils or natural gases rarely occurs as elemental sulphur. In crudes it may be present as dissolved hydrogen sulphide, mercaptans of varying molecular weight, or various organic sulphides. Hydrogen sulphide is the most common sulphur compound in sour natural gases, followed by mercaptans.

The discovery of substantial quantities of indigenous crude and natural gas in Australia in the '60s was welcome not only for economic and strategic reasons, but also because they were "sweet", i.e. crude petroleums, petroleum distillates, or natural gases which contain such small amounts of mercaptan sulphur compounds that most refining processes can be undertaken without the need for prior removal of those compounds. Crudes and natural gases containing significant amounts of mercaptan sulphur are described as "sour". The composition of major crudes processed in Australia are given in Table 1 and of indigenous natural gases in Table 2.

Hydrogen sulphide must be removed from crude and natural gas because it presents a potential health hazard, has a repugnant smell, and causes severe corrosion in petroleum equipment. Mercaptans may give rise to corrosive sulphur compounds during refining processes, so they too must be removed. Although they have repugnant odours, they constitute a lesser health hazard than hydrogen sulphide. They have particularly low odour thresholds with most low molecular weight mercaptans about 1 ppb) and for this reason are used to odorize finished LPG (Liquified Petroleum Gas) and natural gas for consumer sales. The actual concentration used is about 12 mgm/m^3, this being a mandatory addition. Indigenous crude accounted for 71% of total input to Australian refineries in 1976/77, the remaining 29% coming principally from the Middle East, as indicated in Table 3 (2).

Estimates of Sulphur Contained in Crude and Natural Gas: About 6.4 billion cubic metres of "dry" or sales quality natural gas were used in Australia in 1976/77, Victoria accounting for about half of the total consumption. The average total sulphur content of the "wet" or raw gas was about 8 mgm/m^3, and after the addition of odorants in the preparation of dry gas, 12 to 13 mgm/m^3. The total quantity of sulphur entering the environment from this source was negligible, being some 800 tonnes.

For the same period sulphur contained in all crude oil entering Australian refineries estimated to be 174,000 tonnes for an average sulphur content of 0.6% wt.

Estimates of Sulphur in Finished Products: The distribution of sulphur compounds in finished products varies markedly for two reasons. Firstly, the nature of most sulphur compounds in crude oils causes them to occur primarily in the heavier fractions, particularly fuel oils, as shown in Table 1. Secondly, the end use of some products is sensitive to sulphur induced corrosion and therefore their

Table 1 Typical Composition Major Crude Oils Processed in Australia, 1977

Fraction	Gippsland		Middle East Light		Middle East Heavy	
	% Vol	Sulphur % wt	% Vol	Sulphur %wt	% Vol	Sulphur % wt
upto C_4	3	0	2	0	3	0
naphthas C_5 to 150=C	29	0.006	17	0.03	15	0.01
gas oils 150-343°C	40	0.08	36	0.64	29	0.95
residuals	28	0.2	45	3.1	53	4.35
Total	100	0.09	100	1.8	100	2.8

Table 2 Typical Composition of Australian Natural Gases
(Wellhead or raw gas, 1977)

Raw Gas Composition Vol.%	Victoria Bass St.	QLD. Roma	S.A. Gidgealpa
CH_4	86	87	75
C_2H_6	6	5	4
C_3H_8	3	2	1
C_4H_{10}	2	1	1
C_5+	1	1	1
CO^2	0.6	0.4	18.0
N_2+0_2	1.8	3.6	0.4
S(mgm/m³)	12	0	6

sulphur content must be reduced to an acceptable level. This applies mainly to aviation, automotive and diesel fuels.

The total amount of sulphur in major petroleum fuels as marketed has been estimated in Table 4. It was calculated by assuming products derived from imported crude and imported products were consumed in Australia and that all other locally consumed products were derived from indigenous crude. Typical sulphur concentrations (Table 5) (3), weighted according to the distribution of sales between States (Table 6) (4), were then used to estimate total contained sulphur.

Estimate of Sulphur Emitted to Air: Assuming that 100% of the sulphur present in fuel oils leaves the combustion chamber in flue gas as sulphur dioxide, and that combustion of other fuels, including refinery flares, releases all the contained sulphur as sulphur dioxide then the total amount of sulphur emitted to the Australian environment from petroleum sources in 1976/77 was in the order of 164,000 tonnes. The major portion of this sulphur dioxide was emitted in or near cities.

Extraction of Sulphur From Crude Oils: Table 7 shows the sulphur recovery plants in Australian refineries as at December 1976, and the quantity of sulphur produced annually (5). Refineries built before Bass Strait crude oil was available were usually designed to operate on higher sulphur content crudes. Thus current actual sulphur recovery is well below design capacity for most refineries. Sulphur recovery plants are somewhat sensitive to operating conditions and frequently display poor service factors when operated well below design throughputs. Furthermore, the need to run successive blocked operations on crudes of significantly different sulphur contents also reduces operating efficiency.

Some refineries built about the time Bass Strait oil started flowing were designed for 100% operation on indigenous crude and therefore made no provision for sulphur recovery.

The industry is presently planning for the "post indigenous crude" era and an increase in sulphur recovery plants may be expected in the next decade. This expansion can not be quantified with any certainty until specific sources of crude supply for the 1980s are known.

Four groups of products were omitted from Table 4 for the following reasons. Solvents, sales of which were about 120,000 tonnes in 1976/77, were excluded because their sulphur content was insignificant. Lubricants (400,000 tonnes) were excluded because although many contain sulphur compounds, only a trivial portion of them ever reaches the environment. The catch all "other products" (806,000 tonnes) although of indeterminate composition, is believed to include substantial amounts of naphthas, ethane and similar products used as fuels. This group was also considered to contain no sulphur.

The fourth group, bitumen (540,000 tonnes) does contain a substantial amount of sulphur, probably ranging from about 3% for bitumens made from light Middle East crudes to 5.5% for those made from heavy Middle East crudes. Australian crudes yield neither bitumen nor lubricants. The sulphur in bitumen is retained tightly for such a long time it can be regarded as being removed from the crude as effectively as in a sulphur recovery plant. The amount of sulphur involved may be 23,000 ± 6,000 tonnes for 1976/77.

Subtracting sulphur recovered directly in refineries (11,800 tonnes) and that bound in bitumen from the estimated total input sulphur gives a total of about 140,000 tonnes entering the environment in 1976/77. This may be compared with the total of 163,000 tonnes derived from fuel consumption data in Table 4.

FUTURE EMISSIONS

By 1990 the proportion of local crude entering refineries will be approximately 10% of total input unless further discoveries are made, at least as large as those in Bass Strait[6] Fig. 1 shows that indigenous crude has already passed its maximum contribution to meeting local petroleum demand. Although production will remain steady for a few years it will decline absolutely and rapidly after 1983. The deficit, which will cost some $2.5 billion annually[7] may be supplied from the Middle East and perhaps South East Asia. Petroleum production off the eastern coast of Malaysia in South China Sea is rising and does not yet appear to be committed to the same extent as North Sea crude.

The Malaysian government recently announced the immediate production target to be 400,000 bpd and the new Tapis and Pulai fields are expected to

Table 3 Crude Input to Australian Refineries 1976/77: Estimate of Contained Sulphur

	Crude Input			Sulphur	
Origin	Volume ,000 bbls	bbl/t	Mass ,000 tonne	% wt.	Mass tonne
Victoria	142,433	7.92	17,986	.09	16,188
Western Australia	11,591	7.92	1,464	.05	732
Queensland	409	7.92	52	.02	10
Indigenous Sub Total	154,443	7.92	19,502	.09	16,930
Saudi Arabia	25,722	7.18	3,584	1.7	60,921
Kuwait	13,680	7.18	1,906	2.5	47,652
Iraq	6,914	7.18	963	1.9	18,303
Iran	6,507	7.18	907	1.4	12,693
Qatar	2,627	7.18	366	1.1	4,026
Bahrein	1,536	7.18	214	1.7	3,638
Trucial States	957	7.18	133	0.8	1,067
Other Middle East	1,426	7.18	199	1.4	2,782
Middle East Sub Total	59,369	7.18	8,272	1.8	151,088
Singapore	3,212	7.18	448	1.0	4,475
Indonesia	724	7.18	101	.06	61
China	325	7.18	45	1.0	453
Other Imported Sub Total	4,261	7.18	594		4,989
Imported Sub Total	63,630	7.18	8,866	1.76	156,074
From Stock	1,625	7.69	211	.61	1,287
TOTAL	219,698	7.69	28,579	.61	174,291

Consumption by Apparent Crude Source and Estimated Contained Sulphur 1976/77

Product	Imports Quantity 000 t.	Imports Contained Sulphur t	Local Quantity 000 t.	Local Contained Sulphur t	Total Consumption 000 t.	Total Contained Sulphur t
LPG	0	0	447	0	447	0
Aviation gasoline	68	7	12	1	80	8
Motor Spirit	678	203	9,560	1,361	10,238	1,564
Power kerosene	0	0	24	3	24	3
Aviation turbo fuel	102	102	1,405	491	1,507	593
Lighting kerosene	22	3	202	20	224	23
Heating Oil	0	0	805	490	805	490
Automotive diesel oil	410	1,640	4,509	8,608	4,969	10,248
Industrial diesel oil	179	1,432	1,413	5,631	1,592	2,063
Fuel oil	2,076	62280	4,124	57,736	6,200	126,202
Refinery fuel and flares	0	0	2,403	22,866	2,403	24,219
TOTAL	3,535	65,667	24,954	97,207	28,489	164,227

commence production during April at 30,000 bpd.[8] It seems reasonable to assume crude will be imported in the proportion 2:1 Middle East to South East Asia. If it is further assumed that the market mix will not change markedly, that present refining techniques will continue and that existing regulations will be relaxed rather than made more stringent, then the total amount of sulphur emitted to the atmosphere from petroleum sources will rise for three reasons; firstly, higher average sulphur content of crude, secondly market growth and thirdly increases in sulphur content allowable limits.

Careful predictions made in the industry suggest daily demand for crude oil will exceed 1 million bpd. by 1990 (Fig. 2)[9]. If one assumes the allowable sulphur contents of industrial diesel oil and fuel oil will be about 0.8 and 3.0% respectively by 1990, the increase in sulphur emissions will be in the order of 212,000 tonnes annually. The industry's unquantified but well founded plans to install additional sulphur recovery plants will possibly reduce this additional sulphur burden by as much as 25,000 tonnes. Continuous operation on higher sulphur crudes will lift their service factor considerably. Regretably, the market for elemental sulphur lags behind that for petroleum energy, so the added efficiency will be dampened by inability to dispose of the byproduct.

Two variations on this forecast are worth noting. Firstly, it has been suggested that there is an 80% chance of finding 1.8 billion barrels more crude oil in or around Australia[10] (Fig. 3). If this came to pass, the sulphur content of fuels would fall below the base case, and sulphur emissions in 1990 could be about 122,000 tonnes p.a. The other variation is based on North-West Shelf gas or other gas finds. If natural gas does displace fuel oil it will at least eliminate fuel oil imports which presently supply one third of the demand and could displace local fuel oils too. This could lower 1990 sulphur emissions to 200,000 tonnes.

One other possible variation, that of replacement of motor spirit by LPG would have minimal effect, as LPG supply limitations prevent it from displacing more than about 17% of motor spirit, and motor spirit contributed less than 10% of 1976/77 sulphur emissions in any case.

TABLE 5 TYPICAL SULPHUR CONTENTS MAJOR PRODUCTS 1977

Sulphur % wt.

PRODUCT	N.S.W.	VIC. & TAS.	QLD.	S. AUST.	W.A. & N.T.
Aviation gasoline	0.02	0.02	0.02	0.02	0.015
Motor Spirit	0.02	0.01	0.015	0.001	0.03
Power kerosene	—	—	0.015	0.001	—
Aviation Turbine fuel	0.04	0.01	0.03	0.01	0.1
Lighting kerosene	0.03	0.001	0.03	0.005	0.001
Heating oil	0.06	0.07	0.06	0.01	0.04
Auto. diesel oil	0.25	0.2	0.15	0.15	0.4
Industrial diesel oil	0.45	0.45	0.18	0.25	0.85
Fuel oil high S	2.5	3.0	2.6	2.8	3.3
Fuel oil low S	0.9	0.3	0.3	—	—

— Indicates not manufactured in that State.

TABLE 6 FUEL CONSUMPTION BY STATES 1976/77

% by mass

PRODUCT	N.S.W.	VIC. & TAS.	QLD.	S. AUST.	W.A. & N.T.	AUST.
Aviation gasoline	26.4	20.3	21.7	9.6	22.0	0.3
Motor Spirit	33.3	31.5	15.2	9.7	10.3	36.5
Power Kerosene	15.6	25.3	38.7	11.8	8.6	0.1
Aviation Turbo fuel	42.2	21.4	15.8	5.5	15.1	5.4
Lighting Kerosene	26.5	26.2	9.9	8.5	28.9	0.8
Heating Oil	29.4	57.6	2.0	9.4	1.6	2.9
Automotive diesel oil	26.6	21.8	20.9	8.2	22.5	17.7
Industrial diesel oil	28.4	24.4	5.9	17.6	23.7	5.7
Fuel oil	28.6	15.7	16.8	4.4	34.5	22.1
Refinery fuel (f.o.e.)	41.8	28.8	13.5	4.3	11.6	8.6
TOTAL %	31.6	25.6	15.5	8.0	19.3	100.0
000 tonnes	8861	7179	4346	2243	5412	28041

AMBIENT AIR QUALITY GOALS AND NEEDS

The accuracy of the 1990 estimates cannot be improved until specific supply sources are determined. The base case represents a little more than a doubling of current emissions which for one or two capital cities would mean a return to sulphur dioxide levels prevalent in the 1960s. Either of the other possibilities (more indigenous crude or natural gas) could result in quite modest increases. This suggests there has been undue caution in the setting of some State regulations regarding sulphur emission control. Although this holds for the national case, the situation in large urban areas which are prone to experience low level inversions does warrant continued close monitoring.

Three forms of control are used by regulatory bodies; stack emission limits, stack height specification and limits on the sulphur content of fuels. Only the second of these, stack height control, appears to be closely related to desirable air quality goals. The values commonly used, 16-20 pphm or 40-50 $\mu g/m^3$ for a three minute average maximum[11] do not correlate easily to annual average figures. Guthrie and Lamb discussed the assessment of ground level concentrations of sulphur dioxide under Australian conditions, and proposed that longer sampling times than those currently used would improve the correlation[12]. This would permit some relaxation in stack heights in most cases. The WHO long term goal itself ($60\mu g/m^3$ annual mean) has been criticized for failure to take adequate account of particulate concentrations and temperature effects occuring at the same time[13].

Even the limits set on sulphur in fuel have been recognized as stringent by those setting them[14]. However, authorities around the world are still using these challenged conservative goals, as indicated in Figs. 4 and 5 ([15, 16, 17, 18]).

There is no doubt that controls are needed in highly urbanized areas subject to meteorological conditions favouring the generation of low level inversions such as the Parramatta valley in Sydney. In such areas a combination of stack height control and sulphur content limitation will continue to be needed. But in "non capital city" areas where ambient concentrations of sulphur dioxide will not become unhealthy, the permitted sulphur levels could be raised substantially, provided stack height control is retained.

The oil industry is responsive to the health objectives of the community and co-operates with government in the establishment and maintenance of

TABLE 7 SULPHUR RECOVERY PLANTS

December 1976

COMPANY	LOCATION	CAPACITY tonnes annual	PRODUCTION tonnes 1976/77
Amoco Aust. Pty. Ltd.	Brisbane Qld.	4,300	430
Australian Oil Refining Pty. Ltd.	Kurnell N.S.W.	9,125	2,340
Petroleum Refineries (Aust.) Pty. Ltd.	Altona Vic.	9,000	1,400
	Adelaide S.A.	6,000	2,500
Shell Chemical (Australia) Pty. Ltd.	Geelong Vic.	8,000	3,057
	Clyde N.S.W.	16,000	2,050
		52,425	11,800

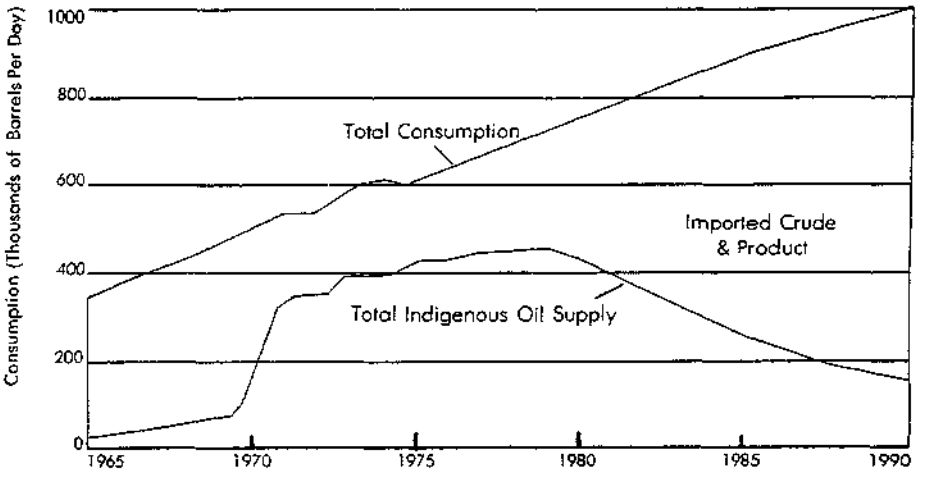

Figure 1. Australia's Oil Supply (No new discoveries)

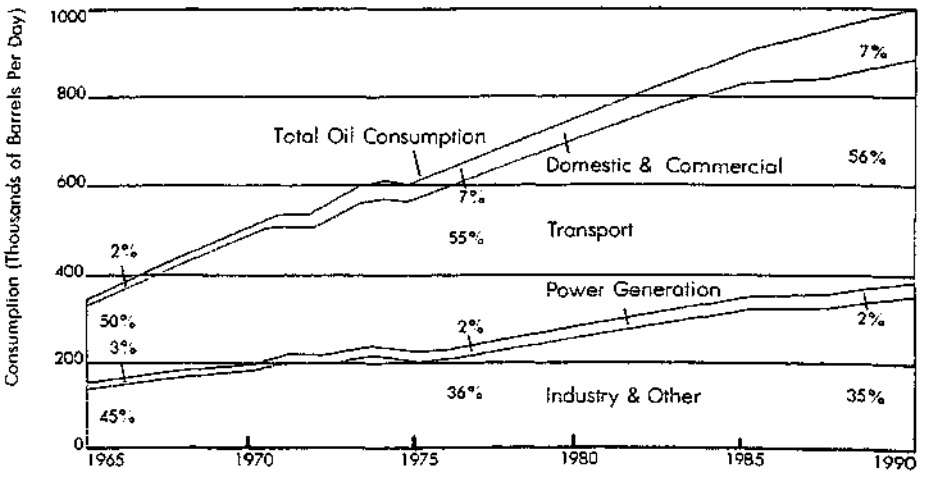

Figure 2. Australia's oil consumption by end use

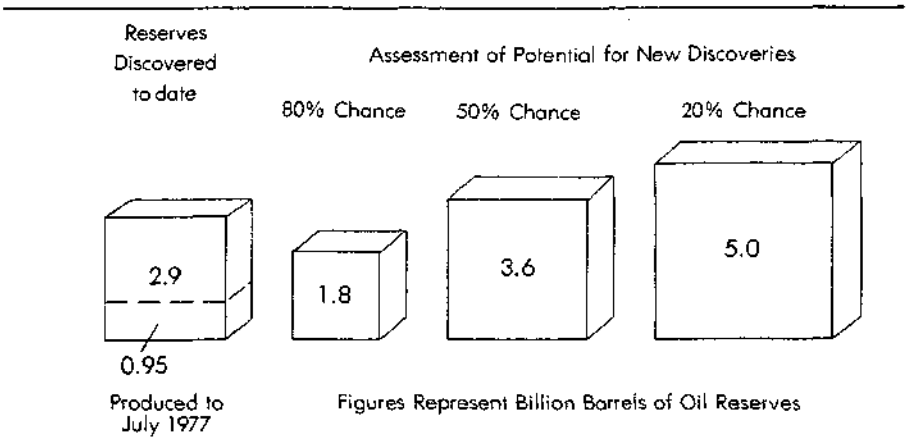

Figure 3. Australia's oil reserves

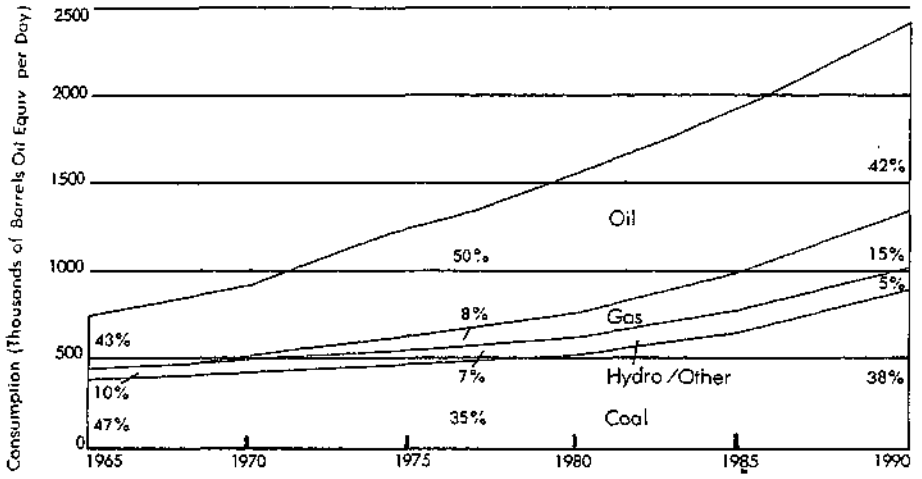

Figure 3a. Australian energy supply

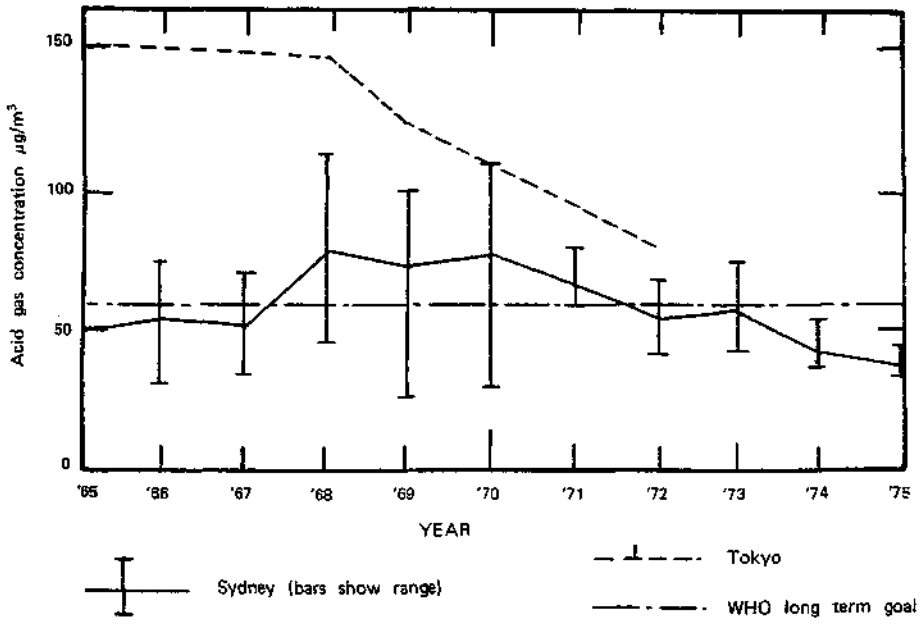

Figure 4. Acid gas concentrations (as SO_2) in Sydney and Tokyo (From SPCC Report 1976). (Composite annual averages, µg/m³; 24 hr samples)

sound sulphur emission controls. But it must also be responsive to the economic objectives of the community, and should ensure that those controls are always cost effective. The quality of Australian urban air is good. There is a need to monitor it at all times, but is there a need to take strong pre-emptive action when the future may hold options not requiring stringent controls?

The question must be put. Is it reasonable to add to the impending economic pressure associated with the approaching petroleum shortage by preserving unduly cautious regulations based on unnecessarily conservative WHO goals.

It is suggested that stack height controls could be based on as much as double the existing ground level concentrations used by authorities, or longer sampling periods, and that fuel sulphur limits imposed for environmental reasons could be eased out to 3% for fuel oil and 1% for industrial diesel oil provided users have stack heights consistent with the conditions present in their local environment.

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CONTROL OF ODOUR BY EMISSION LIMITATIONS

M. Feldstein, T. E. Story and T. S. Mangat.

The enforcement of limits, on odorous emissions requires additional regulations based on odour perception by a panel. Field samples, appropriately diluted, are presented via a dynamic olfactometer to three pre-selected panelists. If two of the three perceive the odour, at the dilution, the regulation has been violated.

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INTRODUCTION: In 1972 the San Francisco Bay Area Air Pollution Control District of California enacted a regulation designed to limit the emission of specific chemically identifiable odorous substances.[1] These were dimethylsulfide, ammonia, mercaptans, phenolic compounds, and triethylamine. They were chosen because information was available on their odour threshold values and they represented compounds which had been the cause of odour complaints at one time or another in the District. The regulation was a departure from the usual enforcement procedures associated with complaints about odour. California State statutes prohibit the emission of odorous substances which would cause annoyance to a considerable number of persons or to the public. It was because of difficulties associated with prosecuting odour nuisances under the State statute that the District developed and enacted the regulation on the maximum allowable emission of chemically identifiable odorous substances.

The emission limits which were chosen for the five compounds were conservatively based on one hundred times the odour threshold concentration. While it was recognized that concentrations which are attained at ground level are dependent upon concentration in the stack, flow volume and effective stack height, this initial attempt to limit the emission of odorous substances did not make any allowances for dilution which generally occurs beyond the emission point. It did provide, however, for a hundredfold dilution at the emission point. Because this approach limited odour enforcement to the five compounds previously mentioned, it was not adequate for enforcement action concerned with odorous substances which could not be identified chemically. Other approaches to odour regulations have been developed and were the subject of a review paper published in 1974.[2]

During the past two years, the district has been involved in developing further regulatory controls on the emission of odorous substances which result in complaints. This action culminated in the passage by the District Board of additional odour regulations in 1976.[3] These consisted of three additional odour regulations. The first involved limitation on the emission of odorous substances from emission points at a facility. The second involved limitations on odorous substances beyond the property line associated with a facility, and the third involved limitation on the emission of total reduced sulphur compounds at kraft pulp mills. This paper will discuss the requirements for collecting and evaluating odorous samples for odorous substances emitted from emission points or collected beyond the property line of the facility involved.

ODOUR COMPLAINTS

A novel feature introduced into the regulation makes the regulation effective only after ten verified complaints from ten different complaintants are received by the District within a ninety day period. The significance of this requirement will become apparent during the discussion to follow. It should be mentioned that this feature is referred to as "opening the gate" for the odour regulations.

In order to avoid biased reporting of complaints due to odours, the District utilizes a standard procedure for the investigation and verification of complaints received. For each complaint received, an inspector is assigned to investigate the circumstances surrounding the complaint. During the course of the investigation, the inspector will document time of complaint, wind direction at the time of complaint (ascertained from District meteorological stations or local airport data), character and nature of the perceived odour and possible sources in the vicinity of the complainant.

In some cases, complaints are received by the District designating a particular source in the neighbourhood. If the results of the investigation indicate, for example, that the wind direction at the time of the complaint was from the opposite

direction of the suspected source, _ and there is no other source in that direction, the complaint is not logged among the 10 necessary to "open the gate." While the 90 day requirement for 10 verified complaints from 10 different complainants is required to "open the gate", experience has shown that the time required to accumulate this number varies markedly on a case by case basis. For example, in the case of odour complaints associated with a kraft mill operation some 27 complaints were investigated over a five month period. The required 10 verified complaints were logged after the fifth month, and the "gate was opened" at that time. At the other extreme, in the case of an odour episode which affected a large area, the 10 verified complaints were logged within a forty eight hour period.

The regulation on source limitation for any odorous substance states that "no person shall cause, let, permit, suffer, or allow a source to emit any odorous substance which remains odorous after dilution with odour-free air as specified in Table 1." As can be seen from the Table, samples collected from point sources are diluted, depending upon the elevation of the emission point above grade, before evaluation of odour is made. The dilution ratios were conservatively chosen because of the requirement that at least ten complaints from ten complainants must be received and validated prior to the regulation becoming effective. As indicated in the Table, allowance is made for dilution of odorous substances prior to evaluation dependent upon stack height. This is a departure from the previous regulation on the limitation of allowable emission concentrations of the five chemically identifiable odorous substances.

ODOUR DISPERSION

In developing Table 1, application of standard Gaussian diffusion equations earlier reported[1] were utilized. This treatment resulted in the establishment of maximum allowable emissions of methyl mercaptan, dimethylsulphide, etc. at concentrations one hundred times the odour threshold for these specific substances. As has been indicated earlier, no allowance was made for stack height and effective dilution afforded by varying stack heights. This treatment was justified by the availability of measurement methods for these substances at the point of emission.

The acceptable concentration of odorous material at ground level is a matter of choice for local society. It cannot, therefore, be determined scientifically, but must be found politically. That process resulted in the Bay Area setting a ground level limit such that any odour requiring more than four dilutions with clean air was deemed unacceptable.

Based on the ambient limit of four dilutions, Turner's dispersion equation (with Holland's equation for plume rise) yielded for a thirty foot stack with exit velocity, temperature and wind speed commonly found in practice,* a stack concentration of one thousand dilutions. Limits for taller stacks were allowed to vary with the squares of their heights. Neglecting the fact that mass emission rates are normally higher for higher stacks may be considered a weak point in the setting of those higher limits so simply. The method is valid to some extent, however, as a guide for someone with a low stack in violation, who wants to meet the regulations by extending his stack.

Admittedly, the resulting dilution ratios are somewhat arbitrary. Experience in the enforcement of the regulation will provide the necessary data to correct any inequities which may result from application of the Table. The ratios may be too high or too low, relative to complaints received.

The regulation on off-property limitations for any odorous substances states that "no person shall cause, let, permit, suffer or allow the emission of any odorous substance which causes ambient air at or beyond said person's property line to be odorous and to remain odorous subsequent to its dilution with four parts of odour-free air." The literature is replete with references on the recommended dilution of ambient air samples prior to measurement of odour.[2] These range from a one to one dilution in residential areas to a ten to one dilution in industrial areas. The Board of Directors chose to adopt a four to one dilution to cover all areas on the theory that all persons, regardless of their location, should be protected from odour annoyance.

Both of these regulations require a specific procedure for the collection and analysis of odorous substances. This procedure becomes the heart of the regulatory process in addition to the ten complainant requirement for "opening the gate." There were two problems which had to be resolved prior to application of the regulation. The first involved the selection of a panel to make evaluations of odour on collected samples, and the second, of course, involved the manner in which samples are collected for exposure to the panel.

* Arbitrary values: Exit velocity: 50 ft/sec: Temperature: 150°F; Wind speed: 4.5 mi/hr; Stack flow rate: 25,000 cfm.

ODOUR PANEL

The selection of a panel to evaluate collected odorous samples represents a novel approach to panel evaluation of odorous materials. A dynamic olfactometer was used to prepare varying dilutions of methyl mercaptan at or around the odour threshold for this substance. District personnel were evaluated in terms of their ability to perceive the odour of methyl mercaptan at varying dilutions. After evaluation of a large number of District employees was made, an odour profile chart was prepared for each. The charts generally indicated the sensitivity of the individual relative to the concentrations of methyl mercaptan which were evaluated. After completion of the odour profile study on District employees, a cadre of panelists was chosen representing the median sensitivity to detection of methyl mercaptan. That is, the upper and lower twenty five percent of District employees were removed from the panel list and the median fifty percent were chosen as panelists for the evaluation of odorous samples collected in the field. By this technique, those individuals who were extremely sensitive to odorous compounds and those individuals who were insensitive to odorous compounds were removed from the cadre of panelists.

A question may be raised at this point that the use of a single odorous substance for evaluation of the "odour profile" of District employees may not consider variations of individual perception to different odorous materials. That is, it is probably true that an occasional panelist may be able to perceive the odour of methyl mercaptan at or around the odour threshold, but may be insensitive to the threshold concentration of other odorous substances. Hopefully, the round robbin testing of butanol, toluene and mineral spirits as proposed by Committee TT4 of the Air Pollution Control Association, along with other odourants, will provide additional information on this subject.

However, it is important to point out that we are not engaged in determining odours at the threshold level. The variations in ability to detect odours at the threshold level have been well documented.[2] Obviously, the techniques for exposure to panelists, the care necessary to dilute odours to the threshold level and the individual variations to odours at the threshold level must be rigorously controlled.

The regulation calls for the recognition of an odour in collected samples which have been properly diluted in accordance with stack height or field collection. In most cases, particularly when the "gate has been opened" we will be concerned with odours which

are well above the threshold concentrations. Appraisal of collected samples requires a "go or no go" response. The appropriately diluted sample will be presented to the selected panel for a "yes" or "no" response. Field investigation of odours over the past twenty years indicates that most odour episodes are associated with odour concentrations well above the odour threshold. If an appropriately diluted sample is presented to the panel, and if that sample represents an odour concentration fifty or one hundred times the odour threshold, we are assured that there will be a positive response from at least two of the three panelists. If the odour is at or around the threshold concentration, results may be equivocal, and obviously enforcement action would not proceed.

This point cannot be stressed too strongly. None of the arguments which apply to measurement of odour threshold levels can be applied there, except in a relatively few borderline cases. Experience has indicated that when ten or more complainants call the District to complain about an odour, we are not dealing with threshold concentrations.

To further amplify this consideration, District practice in the evaluation of collected samples will involve two procedures. First, the appropriately diluted sample will be evaluated by the panel for a "yes" or "no" response. Secondly, that sample will be presented to the panel via the dynamic oflactometer at successively greater dilutions than required by the regulation to determine the intensity of odour in the collected sample. This step will be used for possible Court presentation to indicate how much further dilution was required to reverse the initial panel's response. For example, a collected sample may be presented to the panel at the required dilution of one thousand to one and a positive response elicited from the panel indicating that a violation of the regulation has occurred. Successive dilutions of the sample presented to the same panel then may elicit a positive response at a dilution ratio of thirty thousand to one or more. We feel confident that this added data will strengthen the finding of the original violation for the source being investigated and which received a "yes" response on the required one thousand to one dilution.

The regulation requires that three panel members selected in accordance with the procedure described above shall be seated out of sight of the evaluation apparatus and fitted with an inhalation mask. A signal lamp and a signal switch are in front of each subject. The subjects are given twenty presentations, each of five seconds' duration and ten seconds apart, for appraisal. Half the presentations are diluted field samples and half consist only of dry odour-free air. The presentations of sample and odour-free air are given in random order. At the time each presentation is made, each subject's response is solicited by lighting of the subject's signal lamp. If a subject can detect any odour, he responds by pressing his signal switch. The operator records each subject's affirmative or negative response. If the presentation of a sample elicits an affirmative response in less than five seconds, odour-free air is substituted for the remainder of the five seconds of presentation period. During the ten second relaxation peiod between presentations, odour-free air is supplied to the mask.

For purposes of enforcement requirements, a diluted sample is deemed to be odorous if during evaluation as described above, two of the three subjects gave negative responses to at least eight of the ten odour-free or blank presentations, and affirmative responses to at least eight of the ten sample presentations. Samples deemed to be odorous in accordance with this evaluation analysis are deemed to be a violation of the limits established in the regulations. Again, it should be emphasized that we are not dealing with odours at or around the threshold concentration, as has been discussed earlier.

It should be mentioned that prior to the selection of the three panelists for the evaluation of collected field samples, the panelists repeat an odour profile study with methyl mercaptan. The purpose of this pre-evaluation test is to determine whether or not specific panelists have undergone marked changes in their odour profile. Those panelists who, because of a variety of reasons, have departed from their original profile are not selected for panel evaluation of field samples.

ODOUR SAMPLING AND EVALUATION

The collection of samples for presentation to the selected three subjects required by the regulation is done with the aid of tedlar bags. The regulation states that samples shall be collected in clean tedlar bags in a manner which minimizes alteration of the sample, either by contamination or by loss of odorous materials. If dilution air is introduced at the time the sample is collected, it is passed through a bed of drying agent followed by two successive beds of activated charcoal prior to mixing with the source gases. The regulation does not specify whether or not samples should be diluted in the field prior to presentation to the evaluation panel, or whether dilution shall take place at the time of the panel presentation. Experience will indicated which Procedure is most effective; that is, dilution in the field, or dilution prior to presentation to the panel. However, it is required that all samples collected pursuant to the requirements of the regulation be presented to the panel as soon after collection as is possible.

The evaluation apparatus consists of a dynamic olfactometer (variable dilution device) accepting sample from the tedlar bag and diluting it with treated air from the room. The train for treating room air prior to its combination with the field sample consists of a bed of drierite or other drying agent followed by a bed of activated charcoal. The dynamic olfactometer expels treated room air, or field sample diluted with treated room air, to an inhalation mask at a flow rate of approximately 0.5 cfm.

TABLE 1: Dilution **Rates for Collected** Odour Samples

Elevation (a) (metres)	Dilution Rate (b)
Less than 10	1,000
10 to 20	3,000
20 to 30	9,000
30 to 60	30,000
Greater than 60	50,000

(a) Elevation of emission above grade.
(b) Volumes of odour-free air per volume of source sample.

Experience has indicated that samples collected in Tedlar bags generally decay in odour concentration with time. Therefore, the procedure for the collection and exposure to panel members with samples of collected odorous materials generally would be favourable to the suspected source in that odour concentrations would gradually decrease with time prior to exposure to evaluation panels. This again represents a conservative approach in terms of potential violations to the regulations.

It should be pointed out that under requirements of the District regulations, a violation occurs when the appropriate sample, diluted in accordance with either the stack height requirement or the field sample requirement, still remains odorous to two of the three selected panelists. The regulation requires that no further evaluation of the sample be undertaken. However, in order to determine the intensity of the odour sample for possible use in litigation procedures, additional dilutions are made for presentation to the panel so that they can determine the intensity of the odour as collected in the field. This means that if a sample collected from a source requires a three thousandolfd dilution before presentation to the panel for odour evaluation, all that

must be determined is that two of the three panelists agree that the sample is odorous at that dilution.

However, additional dilutions are made to determine the level at which the panel no longer perceives odour. This may be of significance in terms of potential litigation procedures in that if the required dilution is three thousand to one, and the sample is still perceived to be odorous at nine thousand or thirty thousand to one, it indicates that the sample was well over the required odour perception level in terms of regulatory requirements.

CASE HISTORY

While experience thus far has been limited in the application of the new regulatory limitations of odorous substances, it would be of interest to describe a typical case utilizing the new procedures. On January 20, 1977, a sample was taken at a vegetable oil operation in the Bay Area. As a step in the refining process of vegetable oils, steam distillation is applied to remove undesired impurities. The overhead from the steam stripping operation goes to a direct contact water spray chamber to remove condensibles, with the non-condensibles being discharged to the atmosphere. Thus non-condensibles are odorous. A sample was taken from the exit vent of the tank which collects water from the spray chamber. A dilution probe was used to take the sample and the sample was prediluted twenty three to one at the source. The elevation of the source is approximately five feet above the ground. The regulation requires that the sample emitted at this elevation be diluted one thousand to one prior to presentation to the panel.

Prior to evaluation of the sample, a series of screen tests was made in accordance with the regulation and five candidate subjects were chosen as having passed the screen test.

The dilution rate specified in the regulation for sources less than thirty feet in elevation is one thousand to one, and to be in violation, at least two of three qualified subjects must find it to remain odorous at this dilution. As the sample was already pre-diluted in the field by a ratio of twenty three to one, an additional forty three point four to one dilution ratio was set on the olfactometer to achieve the one thousand to one dilution of the sample for presentation to the panel as required by the regulation.

The regulation states that the sample (properly diluted) is considered to be odorous if two out of three qualified subjects respond "yes" eight or more times on the sample, and "no" eight or more times on the blanks. In the sample under question, three qualified subjects rated the diluted (one thousand to one) sample. All three subjects found the sample to be odorous. After determination that the sample was odorous, additional dilutions were made to determine the intensity of the odour and all three subjects found that the sample was not odorous at a two thousand to one dilution. Thus, had the source been at an elevation of thirty feet or more which requires dilution rates of three thousand to one prior to evaluation, the sample would not have been in violation of District regulations. However, as has been indicated, the actual source was less that thirty feet in height and the evaluated samples indicated a violation of District regulations.

In this case, even though the sample was rated as "odorous," no enforcement action was taken because the requisite ten complaints within a ninety day period had not yet been logged.

In another test, the effluent from two lime kilns at a kraft plant were collected and analyzed as noted above. In this case, both emission points were between one hundred and one hundred and eighty feet above grade, requiring a dilution of thirty thousand to one prior to evaluation. The samples were rated as "non-odorous" by the panel. Even though the "gate had been opened" by the logging of ten verified complaints in the ninety day period, no enforcement action was taken as a result of the tests performed on the day in question at the two lime kilns.

CONCLUSIONS

The obvious question to be asked is how successful will this approach to odour measurement be in reducing the frequency and duration of odour complaints. District enforcement procedures require that a notice of violation be issued when a properly diluted sample is rated as "odorous" by the panel, and the "gate has been opened." The person responsible for the emissions is required to respond to the notice within ten days, describing the cause of the odour emission and corrective action to be taken to prevent its recurrence. After evaluation of the response, the notice may be cancelled if it appears that the response was satisfactory. Where corrective action has not been taken, further legal action, including civil penalty and abatement action through the Hearing Board may be instituted.

It is still too early to assess the impact the regulation has had on the reduction of odour emissions. Most of the effort presently has been devoted to perfecting the sampling and evaluation procedures. These appear to be ready for full scale field enforcement trials in the immediate future.

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INTERNATIONAL NEWS

IUAPPA NEWSLETTER
Extracts from Vol. 3, No. 14, April 1978.

Switzerland: Switzerland has taken a further step in tightening up the acceptable levels of exhaust gases from road vehicles. The Federal Council recently approved modification of the European Community Regulation No. 15, which of course is applicable throughout most European countries, reducing the acceptable levels for carbon monoxide, hydrocarbons and the oxides of nitrogen as from 1st October 1979. This new regulation is in line with Switzerland's declared aim of reducing the levels of exhaust fumes from road vehicles by some 90% between 1970 and 1982.

Air Pollution in Japan: The Environment Agency in Japan recently published information about the monitoring of air pollution.

Sulphur dioxide concentrations in the ambient air have been declining annually since a peak was reached in 1967; however the pace of decline slowed down between 1975 and 1976. Data from 1,353 monitoring stations in some 504 cities indicated that in 1975 the required standard was reached in 88% of cases. Later in the year some other cities eventually reached the required standard but there was again a falling off in 1976.

Although the concentration of nitrogen oxides in the air has remained at virtually the same level as in 1976, there had been a distinct improvement over previous years and this improvement would seem to have been maintained. To a certain extent the same is true of carbon monoxide. In 1976 carbon monoxide concentrations in the ambient air levelled off from the previous year and no great change has been shown in the latest figures. On the other hand, the latest information indicates there has been a marked reduction in the amount of grit and dust in the atmosphere.

Italy: The International Association of Environmental Co-ordinators is organising a two day Symposium on May 22nd and 23 rd 1978 in Stresa, Italy on "The Environmental Dialogue between Industry and the Public". Invited speakers will present the points of view of industry and of conservationists and there will be ample time for discussion group sessions. Further information may be obtained from Miss C. Vander Borght, International Association of Environmental Co-ordinators, Avenue F. D Roosevelt, S 12 BTE 8, 1050 Brussels, Belgium.

France: The Association pour la Prevention de la Pollution Atmcspherique, France, will celebrate its 20th anniversary on September 21st 1978 in Paris. We congratulate our French member on their 20th birthday and hope that representatives of other member organisations will be present at the 'birthday party'. In this connection the APPA have very kindly offered to host meetings of the Executive Committee of IUAPPA on the two days, that is 22nd and 23rd September following the anniversary celebrations. All members of the Executive Committee have, of course, been informed of the kind invitation from APPA and the majority of the members of the Committee are looking forward to the meetings in Paris. What exact form the French celebrations will take are not yet known but we will publish details of these in later issues of this Newsletter.

Greece: The stringent measures taken to reduce air pollution in Athens are having a salutary effect. A statement from the Ministry of Social Welfare indicates that there has been a reduction of more than 70% in air pollution levels in a period of 12 months. This has been effected by the banning of the use of heavy fuel oil in industry and for central heating, and its replacement by light diesel oil. In 1976 the use of diesel oil became mandatory for central heating in buildings near the Acropolis. In late 1977 the ban was extended to manufacturing industries in that area as well. But although the reduction in pollution had been most marked, there is still some way to go; strict controls will still be necessary.

The Federal Republic of Germany: Experts from West Germany and neighbouring countries, from the USA and from Japan, will scrutinise the effect of oxidised sulphur compounds in the ambient air at an interdisciplinary Colloquium to be held in the Congress Hall at Augsburg on May 30th and June 1st next. Some 40 papers will be presented and will cover measurement techniques, air chemistry, the results of recent measurements, and new findings about effects on man, plants and materials. A new assessment of epidemiological studies will be a subject of particular interest. Proceedings will be conducted in German and English.

Further details may be otained from VDI — Kommission Reinhaltung der Luft, Postfach 1139 D 4000, Dusseldorf 1, West Germany.

NEW PRODUCTS

insertion Flowmeter

The Quadrina *Probefto* insertion flowmeter has been installed for portable and permanent monitoring of natural gas flows in several States in Australia. The unit consists of a small stainless steel turbine flowmeter mounted on the end of a stainless insertion tube. This passes through a pressure real system. The signal generated by the turbine is fed to an electronic pickup, which eliminates pickup drag; linearity of response better than ± 0.5% full scale and repeatability is better than ±0.2% full scale. The device can be used at pressures to 10 M Pa (1500 psig) and flow rates up to 60 m/s (200 ft/sec). Further information is available from their agents, Technical and Scientific Equipment, Co. Pty. Ltd, Box 24IE, GPO, Melbourne 3001. (Phone 602 1885).

!R Gas Analizer

An infra-red gas analizer (IRGA) for process measures, furnace and flue gases, and ambient concentrations is available from *G. P. Instrumentation.* (formerly the instrument division of Sir Howard Grubb Parsons & Co. Ltd.) for carbon monoxide (100 ppm) carbon dioxide (30 ppm), nitrous oxide (30 ppm) and methane (200 ppm). The values in brackets represent maximum sensitivities for full scale deflection. Sulphur dioxide, ammonia and water vapour can also be monitored.

The IRGA 40 uses a non-dispersive double beam optical system with a Luft pattern detector specific for a gas. The Luft pattern detector system involves passing sample and reference beams into two closed chambers containing the gases. The units are now wall mounting and are suitable for traffic monitoring (arth. alarm circuits) process flows and similar applications.

Australian agents are E. Coram. Aust. Pty. Ltd., 2 Cawarra Rd., Caringbah NSW 2229 (phone 544 0066) New Zealand agents are Selby-Wilton Scientific Ltd., P.O. Box 30-556, 410 Hutt Road, Lower Hutt (Phone 697-099).

Industrial Cylindrical Air Filters

DCE-Vokes Pty. Ltd. have introduced a modified range of industrial cylindrical air filters, under the *Microvee* trade name. They can be widely applied to stationary engines, compressors and displacement breathers, with capacities ranging from 0.5 to 95 1/s (l-2oo ft ^{3}/min). They feature a louvered outer case containing a pleated dry fabric element mounted on a wire gauge. The pleated construction lowers the actual velocity through the filter, increasing efficiency and life of the element, because of reduced particle penetration into the fabric. The *Microvee* filters fully comply with B S 1701 for grade A filters. Further information from DCE-Vokes Pty. Ltd., P.O. Box 105, 422 West Botany St, Rockdale, NSW 2216 (Phone 59 3367) and also in Victoria (Phone 877-2944) and W.A. (Phone 92-1592).

Cartridge Dust Collector.

A new, compact, cartridge dust filter, the TD 486 has been introduced by the Torit division of Donaldson Co. Inc., U.S. This unit requires 25% less head room than the conventional tube collectors with similar capacity. It uses a non-woven filter media, arranged in quick-change elements, and has no moving as the elements are cleaned by a reverse pulse-jet action. This enables the TD 486 (the 486 representing the square feet of filter area, which is arranged in nine 16 inch long cartridges) to have a large filtration area in a small space, reducing flow through the fabric, maximizing collection efficiency for fine particles.

The unit can have an integral fan or remove exhauster. It is compact and weighs 220 kg. Further information from D. Richardson and Sons Ltd, Ballarat Rd, Braybrook, Vic. 3019 (Phone 311 0541).

Business Personals

DCE-Vokes

Mr. D. W. Grosvenor has rejoined this company as managing director. *Mr. E. E. Finsten* is sales director. DCE-Vokes is a wholly owned subsidiary of the diversified U.K. Thomas Tilling Ltd. Group.

D. Richardson & Sons

Mr. Alan G. Day, the managing director is currently visiting the numerous principles for which Richardson's hold the Australian manufacturing licence. These include Buffalo Forge in the U.S., and a principal of Richardson's since 1935, the Torit division of Donaldson Inc, Dyson in the U.K. and Screenex Wire Weaving in South Africa.

Mr. R. E. Frey, a vice-president of the Torit division of Donaldson Co. Inc. Minnesota, will be visiting their Australian representatives in May-June. Torit dust collectors are manufactured under license by Richardsons, and large numbers have been installed throughout Australia.

Clean Air Society of Australia and New Zealand: Eleventh Annual Report.

(Year ending December 31, 1977)

Presented at the 12th Annual General Meeting held in Brisbane on May 18, 1978

Membership. With Branches in all States, the Australian Capital Territory and New Zealand, the next phase of consolidation of membership has begun. Branches are actively seeking new members and removing the names of those who had been unfinancial for extended periods. The year-end position is indicated on the following table.

Mr. John Schroder. After ten years of sterling service to the Society, John Schroder resigned from the position of President at the end of June.

John had always found and followed the quickest path for the achievement of the Society's objectives, and applied a strongly business oriented approach to its operations. As a result the Society achieved a great deal under his presidency and is in a sound financial position. In recognition of his contribution to the Society's progress, the Council voted unanimously to make him a Life Member of the Society.

Overseas Visitors. Dr. B. Commins of the Water Quality & Health Division of the U.K. Water Research Centre and formerly of the Air Pollution Unit of the British Medical Research Council and Mr. Milton Feldstein of the Bay Area Air Pollution Control District, California, U.S.A. were able to visit several Branches in conjunction with the Analytical Symposium conducted in May by the Victorian Branch. Although attendances in some cities were low, those who heard these experts learned much from their lectures.

Triennial Conference Brisbane 1978. The Queensland Branch continued to plan for a most effective Conference, having obtained the services of several notable scientists for Keynote speeches, including Dr. Brasser from TNO, Delft, Netherlands, Professor Loeffler, University of Karlsruhe, West Germany, Mr. J. Lagarias, Kaiser Engineering, California; and the general support of the Queensland Government.

The Journal "Clean Air". Under the guidance of Dr. Werner Strauss, the Editor, the journal continued to warrant its claim of being the authoritive air pollution control journal for the Southern Hemisphere. Changes in printer and format occurred in an effort to limit production costs. Members are encouraged to assist in the development of the journal by submitting papers for publication, introducing it to potential subscribers, and using it for advertising, not only for products and processes, but also for scientific staff appointment.

I. U.A.P.P.A. Ken Sullivan attended the 4th IUAPPA Congress and the IUAPPA Council Meeting held in Tokyo in May. The next Congress will be held in Argentina in September 1980 and the 6th Congress in Pans 1983. Australia has good prospects for the 7th Congress in 1986, but tre venue will not be decided until 1980 in Argentina. It was agreed that the National Society for Clean Air, U.K. would provide an International Secretariat for IUAPPA with Admiral Sharp, Secretary of NSCA, as the Executive Director. The cost to the Society of this move will be about SUS800 annually.

Four of the accepted six Australian and New Zealand papers were presented at the 4th Congress. Copies of the Proceedings may be obtained from the Japan Union of Air Pollution Prevention Associations.

Clean Air Medal. One medal was presented during the year to Mr. Terry Douglas. He first went to New Zealand in 1950 to work as a scientist engineer for DSIR on fuels research and became Chief Chemical Inspector for the Department of Health in 1959 with responsibility for the administration of air pollution control throughout New Zealand. He was one of the architects of the Clean Air Act of 1972 and always encouraged a co-operative approach with industry. In 1968 he was made a fellow of WHO and served on an expert committee in 1971. A founder member of the Society, his highly motivated and effective work in the field of Clean Air made his medal well earned.

Other Activities. Because of higher travel and accommodation costs and the larger size of the Council, it was decided to reduce Council meetings to an annual basis and to use Executive Committee meetings more. This arrangement appears to have worked well and subject to Council agreement will continue. The Executive Committee prepared a number of position papers on various pollutants, and these have been undergoing review at branch level. It is hoped they will eventually represent a clear consensus of the Society's position regarding each pollutant and be published in the Journal.

With energy costs rising rapidly conservation and efficient use of these resources have become increasingly necessary. In these circumstances it is essential to ensure that clean air is not sacrificed in the name of economy. The need for highly cost effective pollution controls has never been greater. It is, of course, a basic aim of the Society to encourage the practical control of air pollution and this should be pursued with consideration of other factors influencing the quality of life of our community.

Accounts. During 1977 our Treasurer, Dr. Ken Basden, with the assistance of the Auditor, Mr. Ron Lound, standardised some of the accounting reports as will be noted in the accounts. The fee rise introduced at the beginning of the year was timely and has assisted in maintaining the Society's finances on a sound basis.

Personal Message. Air pollution as we know it is nearly 700 years old, starting when coal was first used in

Clean Air Society Membership, December 1977

	NSW	VIC	Q	SA	TAS	WA	ACT	NZ	Other	Total
I.	153	148	49	49	22	45	13	106		586
0.	44	19	8	4	4	13	I	16		109
S.	13	3	1	3	1			1	—	22
Total	210	170	58	56	27	58	14	123	!	717
Change 76/77	-8	-15	-5	+6	+2	+41	+ 1	+ 13	-1	+34

Note I = Individual Member; O = Organization Member S = Sustaining Member.

Western Europe to replace the dwindling supplies of firewood.

However, it would be fair to say that world-wide consciousness of the problem probably followed the great London smog of December 1952 and, therefore, goes back a mere 25 years. In Australia the first interest was shown in 1957 and our Society was founded 10 years later. We have come a long way in the short time since then. The Society has been established on a firm basis both in human and financial terms.

Air pollution problems, however, have not all been solved. While our understanding of the technical aspects of air pollution has grown enormously, we are now facing new questions of appalling social and economic complexity due to the prospective shortage of energy and other mineral resources. The study of health effects of air pollutants has also become more difficult to assess the more we learn.

Thus, I see the role of the Society for the years to come as one of trying to bring some order into the enormous mass of often contradictory information and to help in placing air pollution control into a proper perspective relative to the general human environment.

I should like to thank all members and particularly those active on Branch Committees and the Federal Council for their untiring efforts and ask them for their continued support for the ensuing year.

Hans Hartmann,
PRESIDENT.

Financial Statement.

A consolidated statement of operations (for 1977), and a consolidated balance sheet (as at 31st December 1977) audited by Mr. R. H. Lound, the Society's auditor has been sent to all members of the Society, and further copies are available from the honorary treasurer, Dr. K. S. Basden.

The accounts show that, overall income from subscriptions and investments has exceeded expenditure ($11,895) but the major part of this is the grant from the Queensland Government ($10,000) towards the International Clean Air Conference, which is being held in Brisbane. The income was largely from subscriptions ($14,100) The Journal, Clean Air, operated at a loss of $1,261, due to increases in printing costs and falling off in advertising revenue.

SULPHER CONTENT OF PETROLEUM PRODUCTS

Continued from page 18.

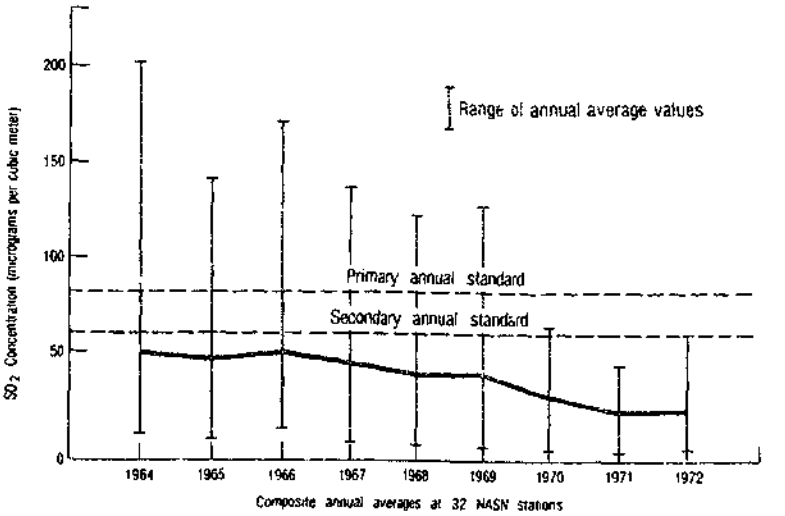

Figure 5. Trends in sulfur dioxide concentrations, 1964-72, National Air Sampling Network (NASN) Stations

APPENDIX A: MANDATED LIMITS ON FUEL SULPHUR

(Refer to appropriate State regulations for precise details)

1. N.S.W.

(a) General

Hourly Fuel Consumption Rate (Capacity)	Max. %S Permitted	Geographical Application
<200 kg.	0.5	Sydney Wollongong Newcastle
200-500 kg.	1.0	Sydney Wollongong Newcastle
>500 kg.	2.5	Whole State

(b) Premises with stacks 21 m. or less may use only 0.3% S fuel.

(c) Brick kilns or other uses involving large quantities of excess air are limited to 0.9% S by application of a maximum of 0.1 g/m³ of SO_2.

(d) Premises with S emission control equipment may use higher S fuel, provided emissions are no higher than those resulting from the use of fuels with existing S limits.

(e) All new scheduled premises must use 1% S fuel if they do not meet requirements of (d). Applies in Sydney, Wollongong and Newcastle.

(f) Stack heights. All occupiers of scheduled premises must obtain approval for stack heights before building them. Dispersion theories (Sutton — Bosanquet etc.) are used to determine heights adequate to keep glc's below about 16-20 pphm SO_2.

2. *VICTORIA*

(a) Permissible SO_2 levels are established for individual premises through a licensing system. Actual levels are based on predicted glc's using a dispersion model and a stack height determination derived from a UK memo. It differs from the latter by the method adopted to combine SO_2 and NO_2 emissions. Refer publication "Chimney Heights — a memorandum on chimney heights on industrial and trade premises", 504/74, issued by the EPA.

(b) In addition to setting stack heights, maximum levels may be stipulated for each stack.

(c) While no maximum level for sulphur in fuel has been set, in practice control is exercised through the licensing system when the fuel and its maximum S content are often written into the licence conditions.

3. S.A.
Unknown.

4. W.A.
Most stack heights require approval method of determination as specified in the UK memo on Chimney heights (25/63) 2nd Edition. Stacks emitting less than 3 lbs. SO_2 hourly are exempt.

5. QUEENSLAND
(a) General — A 3% S limit applies to all fuel oil throughout the State for those premises burning more than 0.5 tonne coal equivalent hourly.
(b) Stack heights — controlled as in W.A.

6. TASMANIA
General — If fuel containing more than 1% S is used the height of the stack must be approved by the EPA.

7. COMMONWEALTH
The NHMRC recommended emission standards (1972) do not have legal stature. The limit of 0.1 g/m³ of SO_2 (or equivalent) places similar practical limits on brick kiln operations to those applying in N.S.W.

The valuable assistance of the members of the *PIECE IE* Committee is gratefully acknowledged. All errors however, are the author's.

Odour Sampling and Evaluation

Continued from page 22

REFERENCES

(1) Feldstein, M., Levaggi, D.A., Thuillier, R., Odour Regulation by Emission Limitation at the Stack. *Annals of The New York Academy of Science*, 237, 309. (1974).
(2) Leonardos, G., A Critical Review of Regulations for the Control of Odours. — *Jour. Air Poll. Control. Assn.* **24** (5), 456 (1974).
(3) Bay Area Air Pollution Control District, *Regulation* 2, Division 15 (1976).

BOOK REVIEWS

Environmental Studies,
Editors J. Rose and E. W. Weidner, Paul Elek Ltd., Caledonia Road, London.

This is a new attractively produced and reasonably priced paperback series, priced at around £3 each in the U.K., which deals with areas of current interest that relate to the environment. The target group for these books would be students in secondary schools and under-graduate university students. The books do not fit directly into any discipline but could serve as a useful starting point for stimulating discussion in a tutorial programme on current issues, man and the environment or the future society. Because of the topical nature of the series they would also be of some interest to the general reader and it is only as a general reader that they would be of interest to scientists and engineers in the environmental area.

The basis of the books is not protection and planning of the environment but the reasons for that planning, the impact of technology on society and the appreciation of mans relationship to his environment. This is evident in the titles of the books at present in print.

Climate and the Environment — The Atmospheric Impact on Man by John F. Griffiths
Pesticides — Boon or Bane? by M. B. Green. (Ill pp.)
The Changing Information Environment by John McHale. (117 PP-)
Electromagnetism and the Environment by Joseph H. Battocletti. (84 PP-)
Transportation and the Environment by John G. B. Hutchins.
Cybernetics and the Environment by F. H. George.
Ecology and Ekistics* by C. A. Doxiadis edited by G. B. Dix.

* Ekistics is the study of human settlements.

Four sample volumes were received for review and these varied widely in their approach and attitude. "Climate and the Environment" is a well written factual account of climate as it relates to man with a very brief final chapter on the effects of human activities on climate in which pollution gets only a brief mention and the possible effects of carbon dioxide none at all. The bcok could be usefully used as an introduction to climate particularly by virtue of its clear exposition and excellent illustrations, the title however, is felt to be misleading.

"Pesticides — Boon or Bane?" although well argued, is obviously very partisan. If this were to be used as a class text it would need to be balanced by another point of view; perhaps one that argues against monoculture. "Electro-magnetism: Man and The Environment" is a plea for serious consideration of electrical pollution as a possible health hazard. As such, it provides a wealth of information on the beneficial and adverse effects of the whole range of electrical and magnetic fields on the human organism. The fourth volume, "The Changing Information Environment" is a masterpiece of gobbledegook but this may well be the result of a basic prejudice of sociological works, on the part of the reviewer.

S. J. MAINWARING

Marine Chemistry in the Coastal environment
ACS Symposium Series 18.
American Chemical Society, 1975, 710 pp.
Price US$37.75.

The coastal environment presents a challenging problem to the marine chemist since its character is controlled by fluctuations of the two very different systems, river and deep ocean, which form its boundaries. Unravelling chemical processes in the deep ocean has been simplified by the fact that the composition of seawater is almost independent of time or location. In the coastal waters complications arise because of the mixing of fresh and seawater; the introduction of suspended solids carried by river; immense biological productivity; and, in many cases the introduction of industrial and domestic effluents. Tidal action may lead to a system whose dynamic processes are never in a steady state. In a country like Australia whose major cities are sited on the coast the possibility of contamination of coastal waters by urban discharges always exists. It is, therefore, important to gain some understanding of the complexities of coastal and estuarine waters in order to assess the degree of contamination, the likely effects and the most efficient form of control.

This symposium is the first major attempt to collate some of the most recent advances in the field of marine chemistry in the coastal environment. Six major areas are covered: physical, organic and tracer marine chemistry; estuarine geochemistry; hydrocarbons and metals; ocean disposal of industrial and domestic wastes; applications and resources in marine chemistry; and organic and biological marine chemistry.

Among the forty-one chapters are many relating directly to matters concerning environmental pollution and control. For example, chemical and bacterial cycling of heavy metals in estuaries; release of heavy metals from sediments; chemical needs for the regulation of ocean disposal of wastes. One of the aims of this symposium was, in fact, to go beyond just description of effects and indicate the way in which chemistry and other disciplines can be employed to help solve pollution problems in this particular environment. This book is to be recommended for highlighting the importance and complexity of coastal waters and their chemistry and should stimulate further work in this area.

J. BAGG.

Air Pollution
R. Guderian
Springer Verlag, Berlin, New York, Heidelberg. (1977).
127 pp. $26.70 (Dutch-Australian Book Depot, Mitcham, Victoria).

Air *Pollution*
H. W. Parker.
Prentice Hall, New Jersey. (1977).
287 pp. $25.75 (Prentice Hall Australia, Brookvale, N.S.W.).

These two books, in spite of their identical name, are very different in character and contents. Guderian's book, sub-titled "Phyto toxicity of acid gases and its significance in air pollution control" is a translation from German, and deals, in four chapters, with the study of effects, of air pollutants on plants.

The first chapter discusses experimental methods of field experiments as well as experiments in growth chambers, while the second deals with methods of measurements. Chapter three is concerned with the effect of sulphur, fluorine and chlorine compounds on the plant metabolism, and how to detect injury. The last chapter discusses the use of plant response for setting air quality standards of cultivating resistant species, and taking other measures, such as suitable fertilizing to reduce air pollution effects. The book is well researched, adequately referenced and indexed.

Parker's book, on the other hand is a rather strange collection of information, mostly very dated, on air pollution control equipment. Perhaps the kindest comment is that the book is exceptionally well produced and profusely illustrated with catalogue photographs. But it is neither comprehensive in its theoretical approach or adequate in coverage. The reviewer doubts the statement in the preface that "the book contains sufficient application and tabular data to lead the resourceful engineer to one or more methods on how to solve over 98% of the common air pollution problems that do not require process modification".

W. STRAUSS.

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