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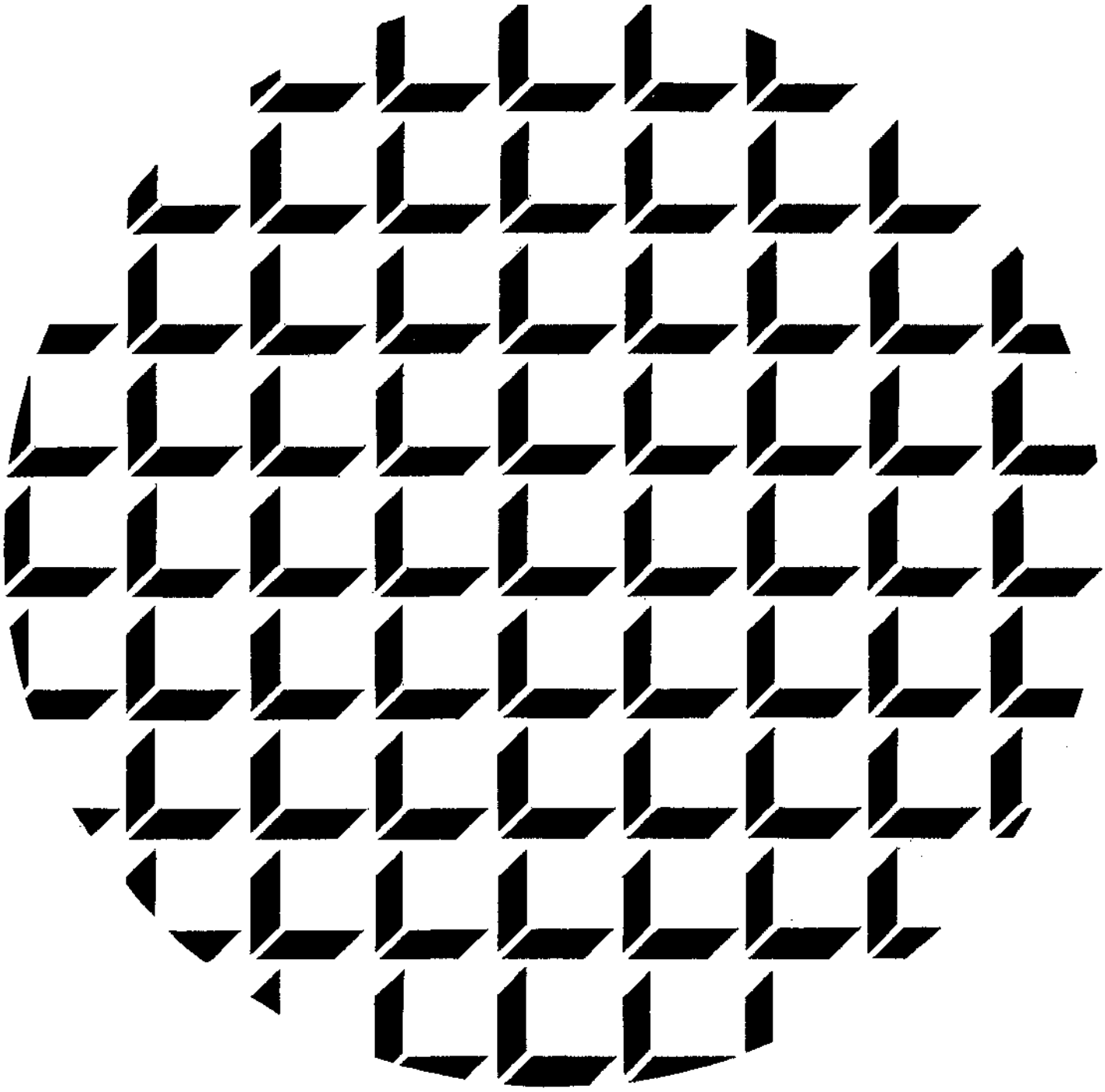

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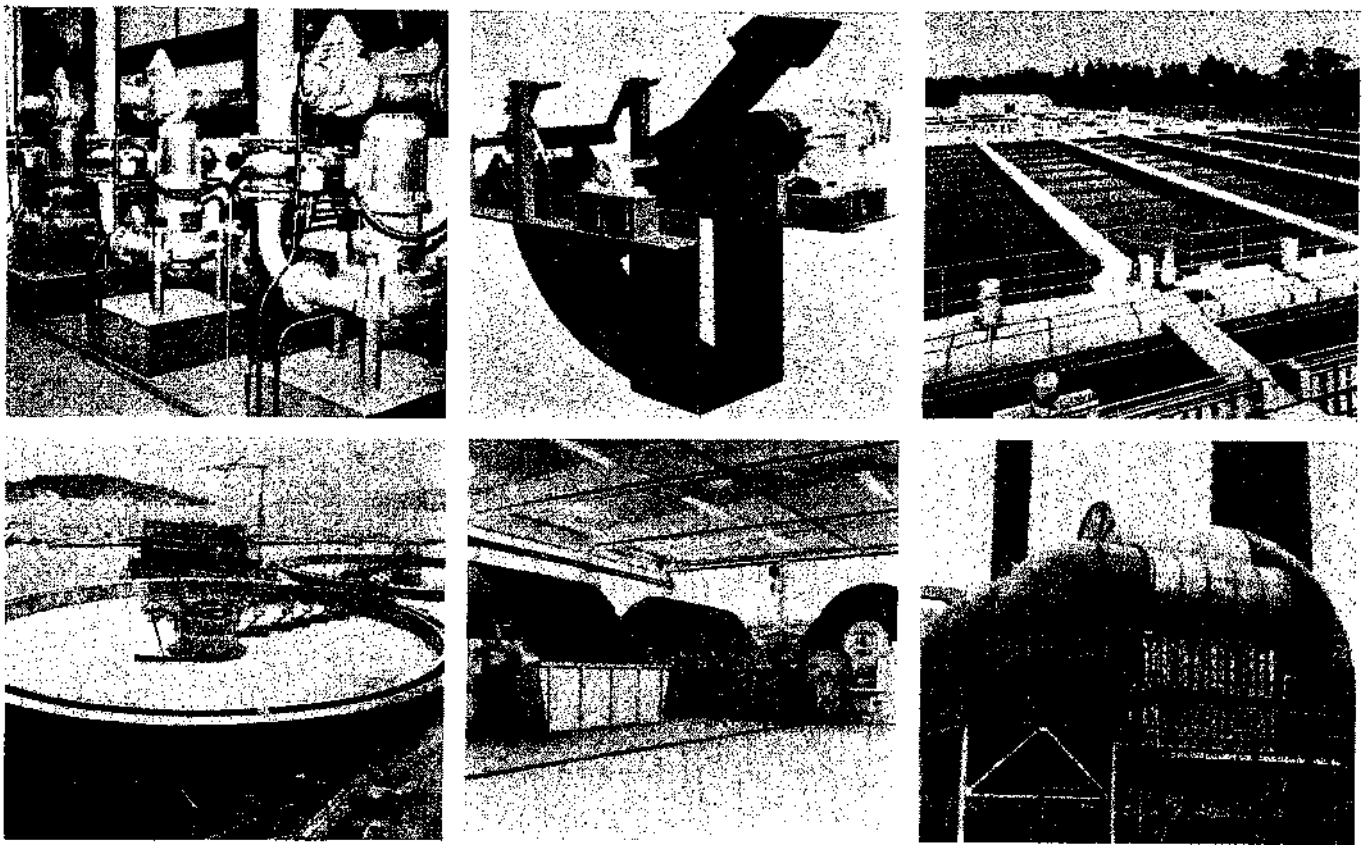

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Vol. 7 / No. 4 November, 1973

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Federal Secretary: Dr. J. Harry, P.O. Box 163 Lidcombe, N.S.W. 2141

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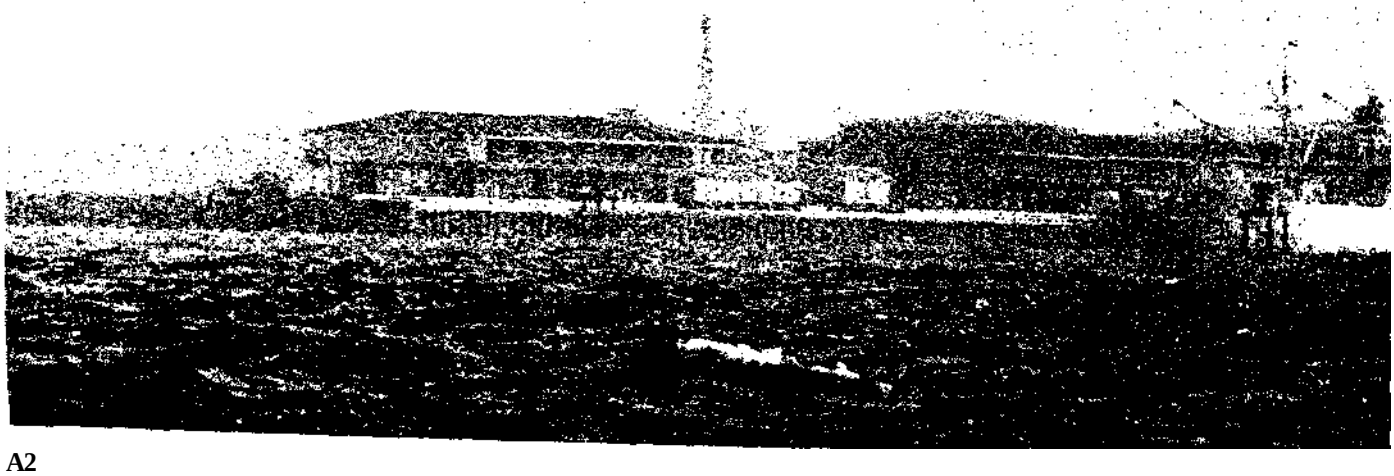
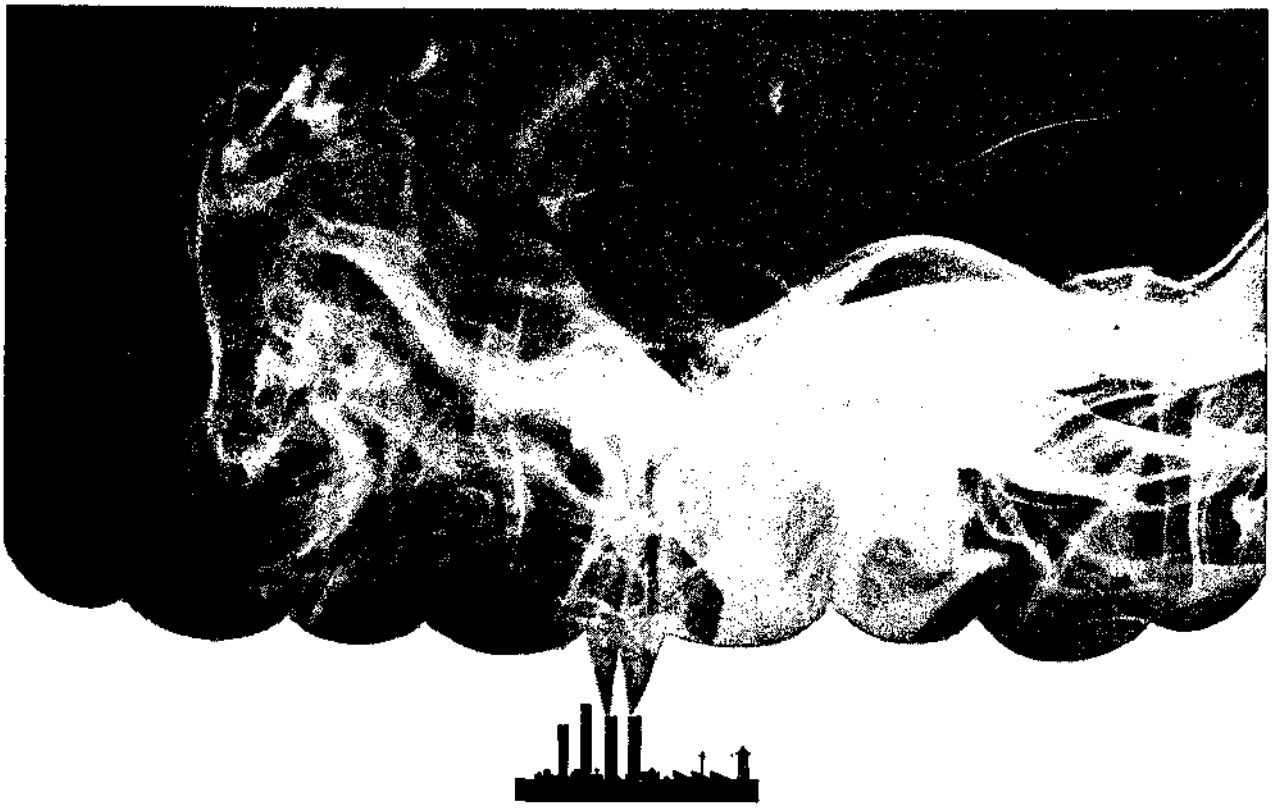


The clean air crisis:

LET'S CLEAR THE AIR...



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EDITORIAL

The I.U.A.P.P.A.!

Australia is a full member of the International Union of Air Pollution Prevention Associations (IUAPPA). This cumbersome title covers the association of non-governmental societies in the field of air pollution control. Full membership requires the national society (such as our own Clean Air Society of Australia and New Zealand) to have a regular membership, an acceptable constitution, a publication communicating information to members, and independence from the government of the country in which it exists. We fulfilled all these conditions, and so became a full member, the first such member accepted after the foundation members, namely, the United Kingdom, the United States (including Canada, through A.P.C.A.), Germany, France and Argentina, who together formed the International Union in 1965.

The societies in a number of countries, such as Norway (which does not publish a journal) or Yugoslavia, where the society cannot be independent of the Government, have "associate membership" status. Whether this division in membership will continue in the future will be decided by the next full executive council meeting, which will have the advice of an ad hoc committee made up of six European members, who will meet under the chairmanship of the current IUAPPA president, Prof. Schackmann.

At present the sole function of IUAPPA has the holding of regular international congresses, which bring together those working in air pollution. Forty-two countries sent a total of 1,500 delegates to Dusseldorf (of which five came from Australia and New Zealand). These congresses have now been held in 1966 (London), 1970 (Washington) and 1973 (Dusseldorf). The full executive decided to accept the offers which were made by the national bodies in Japan and Argentina to hold the next two meetings in Tokyo (1977) and Buenos Aires (1980). The president and secretariat of IUAPPA is the responsibility of the host country for two years before an international congress and a similar period after. The IUAPPA executive discussed the need for a permanent secretariat, with an executive officer, who would be concerned with facilitating communications between the executive and the different national bodies, and with other possible functions of the IUAPPA, for example in the field of air quality standards and liaison with appropriate United Nations bodies (W.H.O., U.N.E.C.O., I.L.O. etc.).

Communications between nations is a real problem, even in such a relatively small body as the IUAPPA executive. Four languages (German, French, Spanish and English) are used, and each statement is translated into the three other languages by two interpreters, as only a small fraction of the executive members (usually the Europeans) have adequate mastery of more than one language.

However, in such a body as the IUAPPA there is a common aim — a better environment — and so, much basic goodwill is present. The solution of problems in air pollution on an international basis will lead to a broadening and a strengthening of this organization.

W. STRAUSS

BRANCH NEWS

N.S.W. Branch

A one-day symposium was held on 18th September, 1973, in conjunction with the fourth International CETIA exhibition. The symposium entitled "Air Pollution Control and Instrumentation" was opened by Mr. Jago, N.S.W. Minister for Health. Six papers were presented: Professor J. S. Ratcliffe (University of N.S.W.), "Environmental Impact Policy;" Dr. D. Iverach (N.S.W. Health Commission), "Instrumentation for Motor Vehicles Exhaust Testing and Implications for Legislation in N.S.W."; Dr. R. W. Bilger (University of Sydney), "Control Techniques for Automotive Emissions"; Mr. J. Armstrong (Commonwealth Bureau of Meteorology), "Instrumentation of the Gore Hill TV. Tower with Results of Analysis of a Year's Temperature Data at Three Levels"; Mr. L. M. Ferrari (N.S.W. Health Commission), "A New Technique for Measuring Ozone"; Dr. O. J. Tassicker (Wollongong University College), "New Instruments for the Determination of Airborne Particle Parameters".

The speaker at the August N.S.W. Branch Meeting was Dr. J. Knetsch, a visiting Fulbright scholar at the University of Newcastle. Dr. Knetsch who had worked as a U.N. consultant and also with the U.S. E.P.A. in Washington gave a most thought-provoking lecture about the economic and practical repercussions of various types of legislation for effluent control.

A special meeting has been arranged for 7th November to enable N.S.W. members to hear a lecture by Prof. D. Ragone on the subject of "Automotive Emission Standards and Photochemical Smog.".

Prof. Ragone of the University of Michigan is Chairman of the U.S. Advisory Committee on Environmental Quality, and a member of the Advisory Panel on Automotive Air Pollution. He is in Australia at the invitation of the Society of Automotive Engineers and P.I.E.C.E.

The regular November meeting of the N.S.W. Branch will take the form of a visit to the new Waverley (Sydney) incinerator installation.

Queensland Branch

The Queensland Branch held a one day Symposium on the afternoon and evening of September 13. The opening address, following a welcome by Mr. M. Smith, the Branch President, was given by Prof. Zelman Cowen, Vice-Chancellor of the University of Queensland.

Nine technical papers were presented: Prof. D. J. Nicklin (Chemical Engineering), "Air Pollution and its Problems"; Prof. D. Gordon (Preventative and Social Medicine), "Health Aspects of Air Pollution"; Dr. E. T. White (Chemical Engineering), "What Air Pollution Regulations Mean to You"; Mr. B. R. Thiele (Division of Air Pollution Control), "Measurement of Air Pollution"; Mr. P. C. Kendall (Division of Air Pollution Control), "Air Pollution Control of Furnaces"; Dr. L. S. Leung (Chemical Engineering), "Emission Control Principles"; Mr. J. C. Read (Western Precipitation Division, Joy Manufacturing Co.), "Mechanical Collectors and Electrostatic Precipitators"; Mr. S. Stanley (Malleys Ltd.), "Practical Aspects of Fabric Collectors and Wet Scrubbers," and Mr. D. N. Perkins (Ampol Refineries Ltd.), "Gaseous Emission Control on Refineries and Chemical Works". Extensive discussions were held on all papers, and the B.P. film, "The Shadow of Progress" was shown.

This was the first major function of the Queensland branch and proved most successful in arousing wide interest in the work of the Society.

Queensland Director of Air Pollution Control

It was announced in August that Dr. G. J. Cleary has been appointed Director of Air Pollution Control for Queensland. He will control a staff of eleven: two control engineers, a senior chemist, a scientific officer, two inspectors and five other support staff. He replaces Mr. A. Gilpin, who took up the post of Chairman of Victoria's Environment Protection Authority last December.

Dr. Cleary, who has spent the past three years with the World Health Organization in Geneva, is well known to members of the Society. He was its first Federal Secretary, Treasurer and Editor of this journal. We welcome him back to Australia and to the active participation in the Society which he did so much for in its formative years.

N. R. Haye

A NEW HIGH VOLUME AIR SAMPLER

A high volume air sampler is described, which operates from normal power supplies, and gives a volume flow rate of about 50m³/hr. when using a high grade polyester filter material capable of retaining particles larger than about 0.2 microns. The unit is suitable for continuous operation, requires little maintenance, and is easy to use. A network of ihese samplers has completed its first /ear of operation.

Mr. Haye is an officer with the C.S.I.R.O. Division of Atmospheric Physics, P.O. Box 77, Mordialloc, Vic. 3195

Introduction: Near surface air sampling has been conducted at Aspendale for several years, using high volume air samplers consisting essentially of a blower and filter (1). The samples obtained have been used to measure particulate concentrations(2) and detect the presence of naturally-occurring and fission-produced radioactive isotopes, using a multi channel gamma spectrometer. Measurements of concentrations of Be-7, which is mainly of polar stratospheric origin, and the measurement of fission products Cs-137, Ce-144, and Nb-Zr-95, (mainly of equatorial origin) afford a means of studying global atmospheric circulation.

The same samples are used to measure total particulate matter in the atmosphere, so that comparisons between observed meteorological conditions and total dust concentration may be made. Filters are brought into equilibrium with standard conditions of temperature and humidity and weighed both before and after exposure. Dust concentrations are calculated from particulate mass and airflow rate.

For scientific reasons as was discussed in an earlier paper by Goodman and Hicks (2) it was decided to extend the work by establishing a network of sampling stations disposed along a north-south line from Port Moresby (9°S: University of Papua and New Guinea), through Townsville (19°S: James Cook University), Brisbane (27°S: University of Queensland), Sydney (34°S: C.S.I.R.O. Division of Cloud Physics), to Hobart (43°S: University of Tasmania). This led to a need for a high volume air sampler suitable for use in temperate or tropical conditions, capable of operating on existing electrical supplies and requiring a minimum of maintenance. In addition, ease of operation in the field when making routine filter changes during poor weather and work conditions, and a low level of operational air noise so that the unit could be used in residential areas on a 24 hour basis, were considered desirable. A unit to meet the above requirements was designed and built at C.S.I.R.O, Division of Atmospheric Physics,

Description

Figure 1 is an overall view of the air sampler, shown at the Aspendale site, near Melbourne. The entire unit stands about 2 m high, and features a low-profile motor and blower assembly to minimise interference with the natural air flow.

The sampler is designed around a Sturtevant GL10 $^{1}/_{2}$ Rootes-type blower. A feature of this unit is that there is no contact between the two rotors, or the rotors and the chamber walls. In consequence there is neither wear nor need for lubrication and continuous operation is possible.

To avoid the need for a special electrical supply a 1/2 h.p. 1425 R.P.M. 240 V. single-phase, capacitor-start motor* is used, this being suitable for connection to the normal power outlet socket. To ensure trouble free operation in tropical conditions, the motor is tropic proofed, has "B" class insulation and is fitted with a ther-

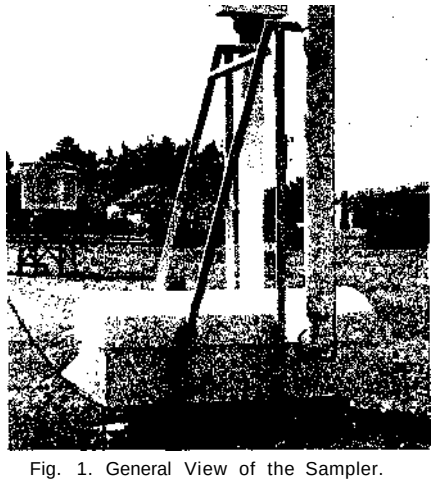

Fig. 1. General View of the Sampler.

•The motor used Is shell size 56K dimensionally to Australian Standard C350 Part 1; 1963. It is interchangeable with British and American Standard Motors to BS2048, Fart 1: 1962 and NEMA standard MC1-1959 respectively.

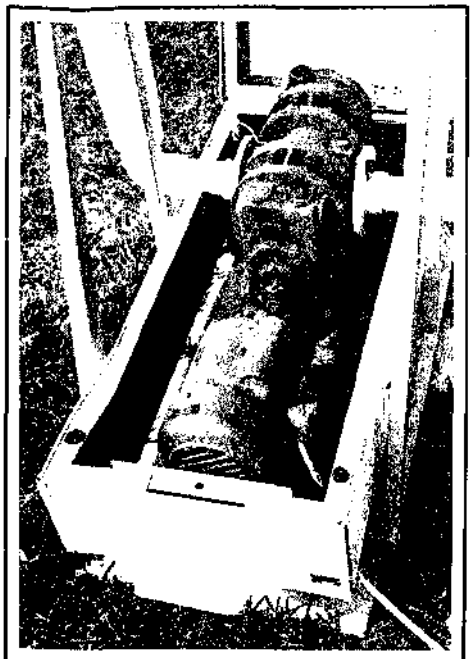

Fig. 2. Blower and motor, joined by flexible coupling and mounted on anti-vibration mountings in P.V.C. covered sheet metal case.

mal cutout with an automatic reset. Wired into the motor supply is an electric hour meter which automatically records actual running time.

The blower is directly driven and is coupled to the motor by a flexible coupling (Fig. 2). Both units are mounted on a stout fabricated base, galvanised after manufacture and fitted with three anti-vibration mountings which absorb vibration, reduce noise and overcome any tendency for the sampler to move during operation. The whole assembly is contained in a P.V.C. covered galvanised sheet metal case with hinged lid. To avoid maintenance no paint is used on this sampler, and timber is avoided to ensure that it is termite proof.

The inlet and outlet ports of the blower are connected to vertical P.V.C. pipes designed as "straight through" silencers. These are aimed at reducing the operational air noise due to the trapping of air and its compression by the pump rotors. The inlet pipe terminates at about 1.5 m. above the surface and the exhaust pipe at about 2.0 m. Both are adequately supported.

In order to overcome the difficulties experienced in the field when changing filters, the polyester filter (approximately 165 mm. (6 1/2 in.) x 216 mm. (8 1/2 in.) ,) is clamped into a holder (Fig. 3) in the shelter of the laboratory. The holder consists of an anodised aluminium alloy recessed frame, fitted with a wire mesh to support the filter material, together with a second frame which fits into the recess and is locked in position by cam action clamps. The holder is provided with a handle and is machined to close

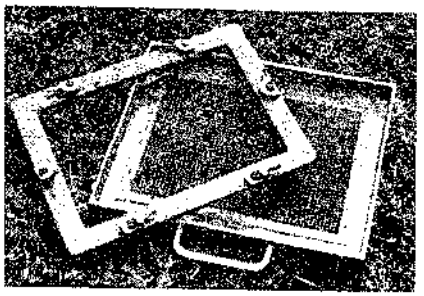

Fig. 3. Holder for polyester filters.

tolerances. It fits snugly into slides fitted inside a protective hood mounted on top of the inlet pipe (Fig. 4). The filter holder is keyed so that it cannot be inserted backwards. It is retained by a spring loaded catch, but may be withdrawn when required by pressing a button which disengages the catch. Each sampler is provided with two filter holders (Fig. 5).

Near the open end of the exhaust pipe an orifice plate provides the differential pressure for a manometer, set at eye level. This may be calibrated by measuring the air flow with a hot wire anemometer while using a graded series of filters. The filter used in the present network is a high

Fig. 4. Protective hood for mounting filters.

grade polyester material (sealed at the edges) which retains all particles larger than about 0.2 μm. An air flow rate of about 50m.^{3}/hr. is obtained using this material. The manometer is normally read each day. The hour meter previously mentioned is also displayed at eye level. The pre-weighed filters are changed weekly and are supplied in pre-stamped, pre-addressed boxes for return through the post to Melbourne.

Conclusions

The samplers at Townsville, Brisbane, Sydney, Melbourne and Hobart, were

(Continued on page 88)

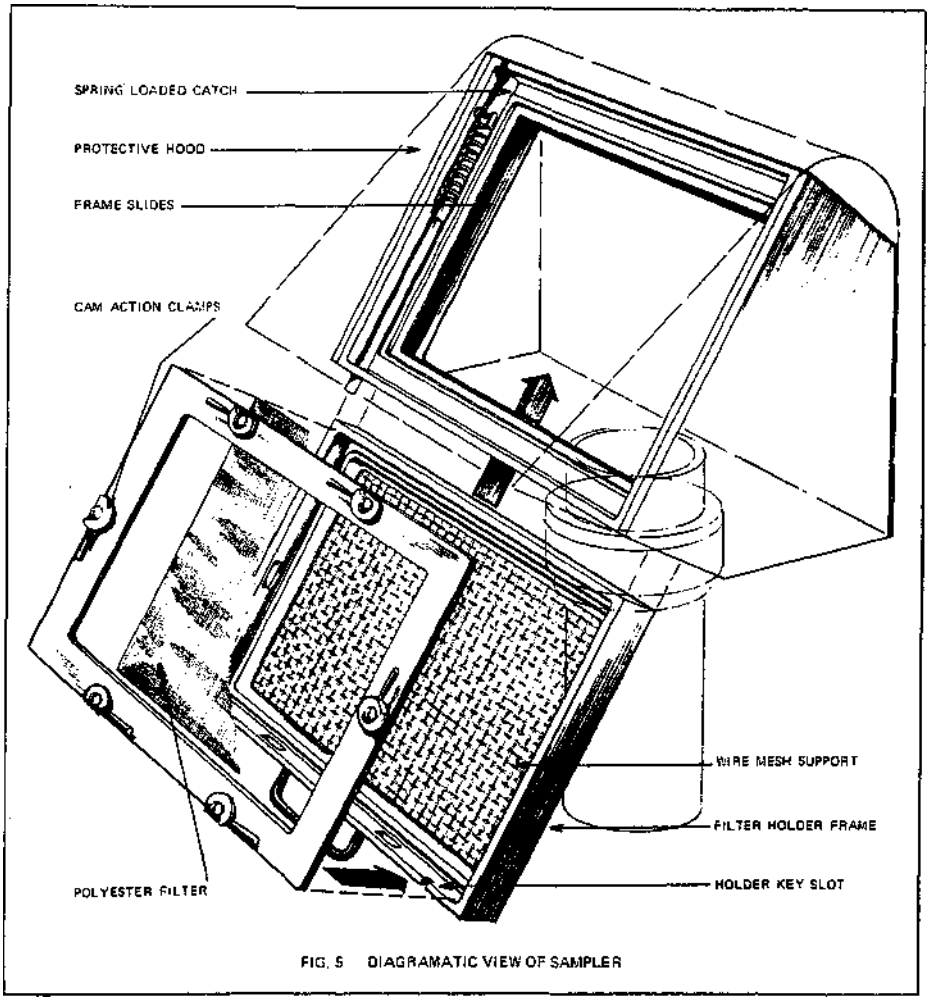

FIG. 5 DIAGRAMATIC VIEW OF SAMPLER

L. M. Ferrari

OZONE OBSERVATIONS IN THE SYDNEY REGION

Continuous chemiluminescenf ozone monitors have been developed and constructed in the N.S.W. Air Pollution Control Branch to provide measurements of ozone in the Sydney region (1). The ozone concentrations measured in the Sydney basin, with the use of conventional oxidant monitors and two cherriliuminescenf ozone monitors, ever a period of more than twelve months, has given evidence of a photochemical pollution problem existing in Sydney under certain climatic conditions

Mr. Ferrari is a chemist in the N.S.W. Air Pollution Control Branch of the Department of Public Health.

Introduction: Ozone in the atmosphere can be generated by several processes. In the upper atmosphere ozone is formed naturally either by the action of ultra violet rays from the sun or electrical storms on oxygen. This ozone layer forms the ozonisphere which reaches down to about 60,000 ft. above sea level. The ozonisphere, by absorbing more UV light helps prevent radiation damage on earth.

In the lower atmosphere, ozone is produced by the interaction of ultraviolet light on oxygen, nitrogen oxides and gaseous hydrocarbons. The latter two commonly result from fuel burning and especially the emission products of the internal combustion engine of the motor car. Photochemical oxidants is a term given to a group of air pollutants consisting mainly of ozone and smaller amounts of nitrogen oxides, peroxy acetyl nitrate (PAN), and other oxygenated hydrocarbons. The reactions involved were first postulated by Haagen-Smit(2) in 1951. The reactions resulting in ozone formation are —

$NO_2 + h\nu = NO + O$ … (a)

$O_2 + O = O_2$ . . . (b)

$O_2 + NO = O_2 + NO_3$… (c)

Reaction (c) would prevent a large concentration of ozone building up, however under conditions leading to photochemical smog the concentration of NO is too low for this reaction to be significant.

The relative contributions of these and other ingredients for ozone formation, and the meteorological influence, all of which vary from place to place are examined here, but more data will have to be collected to fully explain the photochemical pollution situation in Sydney.

Photochemical Smog in Sydney

Photochemical pollution was first noted in Los Angeles in the early 1940's and since that time has increased and spread to other cities. Ten years ago Sullivan (3) described the geographical similarity of Sydney and Los Angeles and suggested that Sydney had a photochemical pollution potential. Sydney is on the 34° South latitude and Los Angeles on the 34° North latitude. Both cities are on the seaboard of the Pacific Ocean, in a natural basin with high hills or mountains surrounding. Sydney with over 1,000,000 motor vehicles and over 2,800,000 people has considerably less photochemical pollution potential than Los Angeles today, but approaches that of Los Angeles in 1940. Both cities suffer from frequent stable temperature inversions, though those in Sydney do not last throughout the day as they can do in Los Angeles.

Sullivan (3) mentioned Sydney oxidant values in 1959 and 1960 averaging up to 8.1 parts per hundred million (pphm) for a month and a maximum daily average of 18.8 pphm. He, at the time, expressed doubts as to the reliability of the analytical techniques and they are seriously questioned here. The highest nitrogen dioxide figure measured at that time was 3 pphm. The error in the oxidant was probably due to instability of the iodide method of analysis.

Cleary(4) reviewed the situation in 1967 and quoted the car population in the County of Cumberland as 714,000(5) compared with the car population of Los Angeles County in 1942(6) (when photochemical pollution was first noted) as 1,100,000 and adding a factor for growth rate, comparative engine sizes and gasoline usages came up with the year 1998 before Sydney would experience photochemical smog.

In Sydney, stable inversions occur overnight during calm or slight winds and last until late morning, when a breeze builds up. Vertical mixing is prevented by this inversion and horizontal mixing is slowed by the surrounding mountains. The layer of smoke haze accompanying this inversion can be very dense and reduce visibility to one or two miles. The visibility increases as the morning progresses although sometimes a less dense haze persists. High ozone readings are often associated with these low visibility days.

In the survey on Motor Vehicle Pollution in Sydney by Murphy and Ferrari in 1969(7), the average oxidant values were given as less than 1 pphm with readings rarely exceeding 3 pphm. Just a few years later, in 1971, readings more than eight times

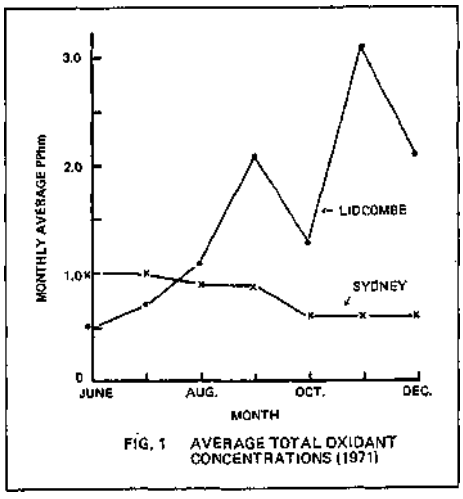

FIG. 1 AVERAGE TOTAL OXIDANT CONCENTRATIONS (1971)

this maximum are found. It is possible that the primary reactants for ozone formation may build up to certain critical levels before they trigger off the chemical reactions that produce photochemical pollution.

Oxidant Measurements

All measurements of oxidants in Sydney up until December 1971, were based on the oxidation of potassium iodide by ozone. Analysis was by titration, or by colour development in the Beckman Acralyzer. Inherent errors in expressing this as the ozone concentration are chiefly the interference of sulphur, dioxide, nitrogen dioxide and peroxy-acetyl nitrate (PAN).

In 1971 the Acralyzer began to record significant values. For a period of seven months oxidant measurements were made simultaneously on Acralyzers at Lidcombe in the Parramatta River Valley about 16 miles inland and at Sydney on Sydney Harbour 4 miles inland. The monthly average oxidant values for Sydney and Lidcombe are plotted in Fig. 1. The values at Lidcombe were considerably higher than those at Sydney. The maximum hourly average at Lidcombe was 17 pphm and at Sydney was 5 pphm, whereas the daily maxima were 5.7 pphm and 2.2 pphm respectively.

Due to continuing problems in keeping the Acralyzers In service and the much more satisfactory performance of the new chemiluminescent monitors ([1]), the Acralyzers were taken out of service in mid-1972.

The two chemiluminescent ozone monitors used in the investigation gave specific measurement of ozone. One monitor is based on the reaction of ozone with a plate impregnated with Rhodamine B, while the other monitor relies on the reaction of ozone with ethylene. Both these are fully described by Ferrari and Brown(1). These instruments are virtually solid state instruments, with none of the problems of old conventional monitors, and give accurate instantaneous readings of ozone without interference from other gases. The instruments give almost identical results when sited side by side and are very satisfactory for giving comparative ozone profiles from different sites.

Survey Results

Since December 1971, continuous measurements of ozone have been monitored at Lidcombe as well as several other sites. Fig. 2 shows the 1972 diurnal variation • at Lidcombe throughout the year. The average minimum of 0.4 pphm occurred at 6.30 a.m. and the average maximum of 3.6 pphm occurred at 1.30 p.m. Ozone concentration during the day is lowest just before sunrise and as the day progresses the concentration builds up to a maximum about midday and then gradually deteriorates throughout the afternoon. At night, the ozone falls to a low value often reaching zero.

Fig. 3 shows the diurnal variation on a typical high ozone day. The sudden changes in concentration of ozone can be linked with wind velocity and direction changes. It is probable that the ozone peak during the day is a result of the reaction of the emission products from the morning peak traffic periods. These exhaust gases will produce ozone in the presence of UV light, given sufficient time to react. The higher the concentration of the reactants, the longer they are in contact and the greater the intensity of UV radiation, the more ozone will be formed. Meteorology appears to have a major influence, since high ozone values usually only occur on days of relative calm when reactants are in contact longer. On these days, which occur often during summer in Sydney, the day begins with a gentle westerly drift towards the coast and later during the morn-

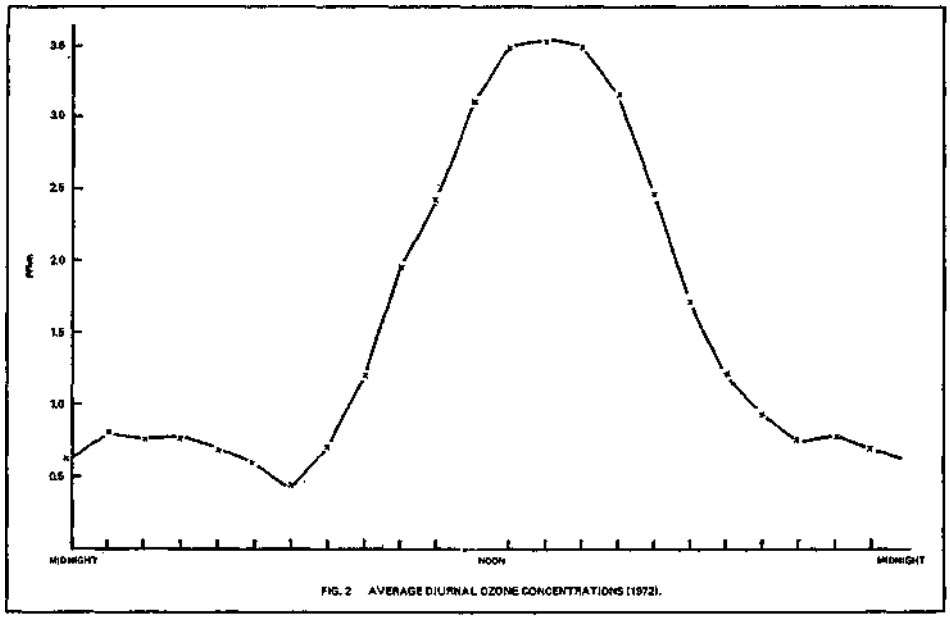

FIG. 2 AVERAGE DIURNAL OZONE CONCENTRATIONS (1972).

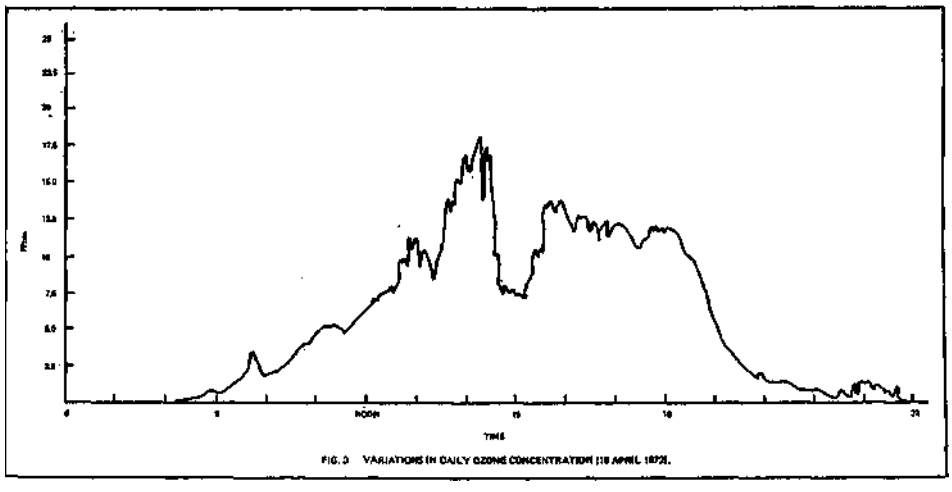

FIG. 3 VARIATIONS IN DAILY OZONE CONCENTRATION (18 APRIL 1972).

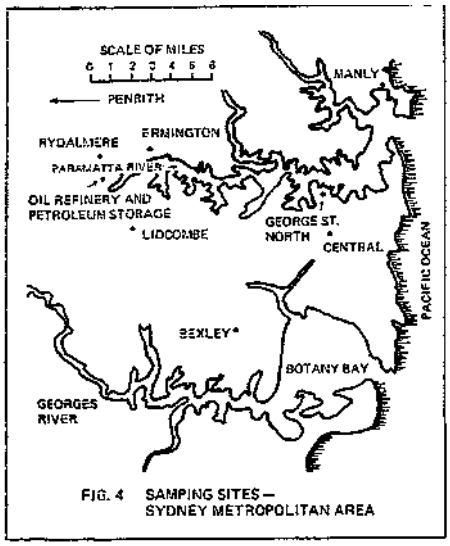

FIG. 4 SAMPING SITES — SYDNEY METROPOLITAN AREA

ing a sea breeze develops as the temperature of the land mass rises. This sea breeze develops at first on the coast and gradually works its way inland. Some time later, the sea breeze builds up in intensity, the components for ozone production disperse and the ozone concentration decreases. A map of Sydney, with the sites marked, is shown in Fig. 4.

The yearly average for ozone in 1972 was 1.5 pphm with maximum hourly average greater than 25 pphm. Fig. 5 shows a plot of the monthly averages and maximum monthly hourly values through the year. These values show that the maximum hourly values are significant during every month of the year and not only during the summer months. This indicates that the calm conditions and more frequent temperature inversions during the winter give high ozone concentrations comparable with those in the summer months.

Obviously, more monitoring is required before the situation in Sydney can be explained. Continuous monitoring for total hydrocarbons and nitrogen oxides was not carried out for the whole of 1972, however total hydrocarbons were continuously measured for several months late in 1972 at Lidcombe and the average was 1.4 ppm, with maximum daily average 3.2 ppm, and maximum hourly average 3.8 ppm. Only a few 3 hourly samples (6 a.m.-9 a.m.) for total nitrogen oxides were taken during the year. These samples were near peak traffic and the average 3 hourly value was 20 pphm and maximum 3 hourly value 35 pphm.

A limited amount of data has been collected for comparison of ozone concentrations in different areas. Measurements were made to examine the ozone distribution around Sydney. For these measurements the Rhodamine B (ozone) monitor was stationed at Lidcombe, while the Ethylene (ozone) monitor was sited for periods at Rydalmere, Penrith and Bexley. Ozone was monitored for 9 days at Rydalmere, 14 days at Penrith and 13 days at Bexley. Unfortunately, from the point of view of comparison, the ozone levels were low for the period of the tests.

Rydalmere, about 4 miles N.N.W. of Lidcombe, is 18 miles inland and here the hourly average over the period showed a maximum of 1.4 pphm at 4 p.m. The Lidcombe average was 1.2 pphm at 12.30 p.m., see Fig. 6.

Penrith, about 24 miles west of Lidcombe is 40 miles from the coast and here the maximum hourly average over the test period was 2.9 pphm at 4.30 p.m. compared with a Lidcombe value of 2.1 pphm at 12.30 p.m., Fig. 6.

Bexley, 7 miles S.E. of Lidcombe, is 3 miles from Botany Bay and 8 miles in from the projected coastline. Here the maximum hourly average over the period was 1.9 pphm at 12.30 p.m. compared with a Lidcombe value of 1.4 pphm at the same time, Fig. 6.

The data shows that the ozone reaches a maximum at a time related to the distance from the coast. At Penrith which is distant from the seaboard, the ozone peak occurs late in the afternoon, compared with Bexley where ozone reaches a peak near noon. It is expected that when monitoring on the coast the maximum ozone level would be reached before noon.

At night during calm conditions, the ozone often falls to zero or near zero, but during conditions of turbulence ozone concentrations are found at night. Fig. 7 shows the reading stable near zero for several hours till just before midnight when a strong southerly change occurred accompanied by high winds. The ozone instantaneously increased to almost 6 pphm and slowly decreased throughout the early morning to a low at 5 a.m. Similar sharp increases during daytime occur with the onset of strong southerly winds. Sudden strong winds during daytime could, for a short time, increase the ozone concentration by some type of concertina effect concentrating the pollution, or perhaps cause the chemical reactions for ozone production to occur at a rapid rate, due to the frequent collision of the molecules during the turbulence.

This explanation cannot be made for night-time occurrences and possibly the explanation is that large parcels of the upper atmosphere are suddenly brought down to ground level. In the atmosphere at 80,000 ft. ozone occurs at lethal concentrations of 10 to 12 ppm. Although turbulence would cause considerable decomposition and dilution, relatively high concentrations of ozone could reach ground level.

Another incident took place after two releases of hydrocarbons, probably from an oil refinery or petroleum storage tanks, 4 miles up wind of the monitor. At 8.35 a.m. a flame ionization detector total hydrocarbon monitor adjacent to the ozone monitor recorded an increase from approximately 0.5 ppm to over 3 ppm for several minutes, and simultaneously the ozone increased from 0.5 pphm to over 24 pphm. Fig. 8 shows the ozone and hydrocarbon concentration. This sudden increase in ozone concentrations early in the day is extraordinary as the ozone level seldom exceeds 2 or 3 pphm at this time. The ozone level later in the day reached a peak just before 1 p.m. and was decreasing rapidly until 1.20 p.m. when a hydrocarbon level was reached of over 6 ppm. This time the ozone reached a peak about 20 minutes later and remained high for over an hour. These readings demonstrate that ozone formation can be accelerated by the release of excessive amounts of hydrocarbons alone, without a simultaneous

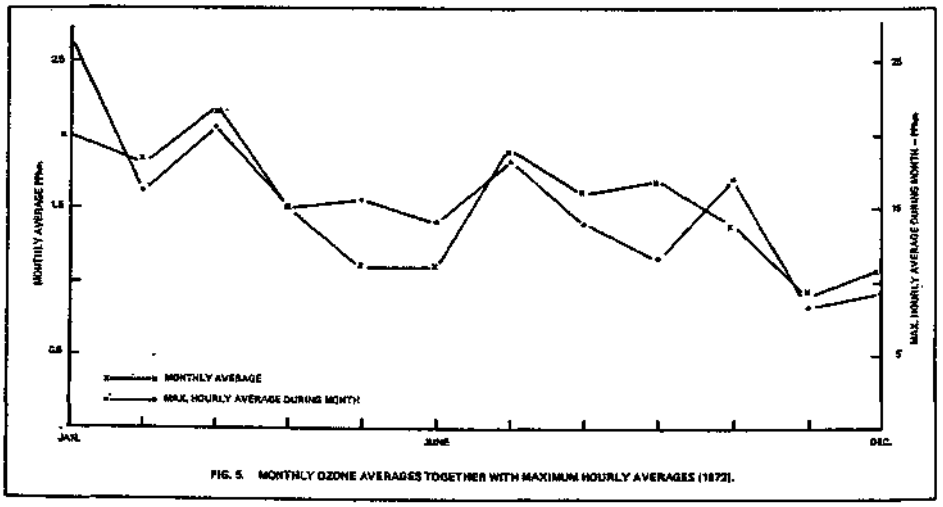

FIG. 5. MONTHLY OZONE AVERAGES TOGETHER WITH MAXIMUM HOURLY AVERAGES (1972).

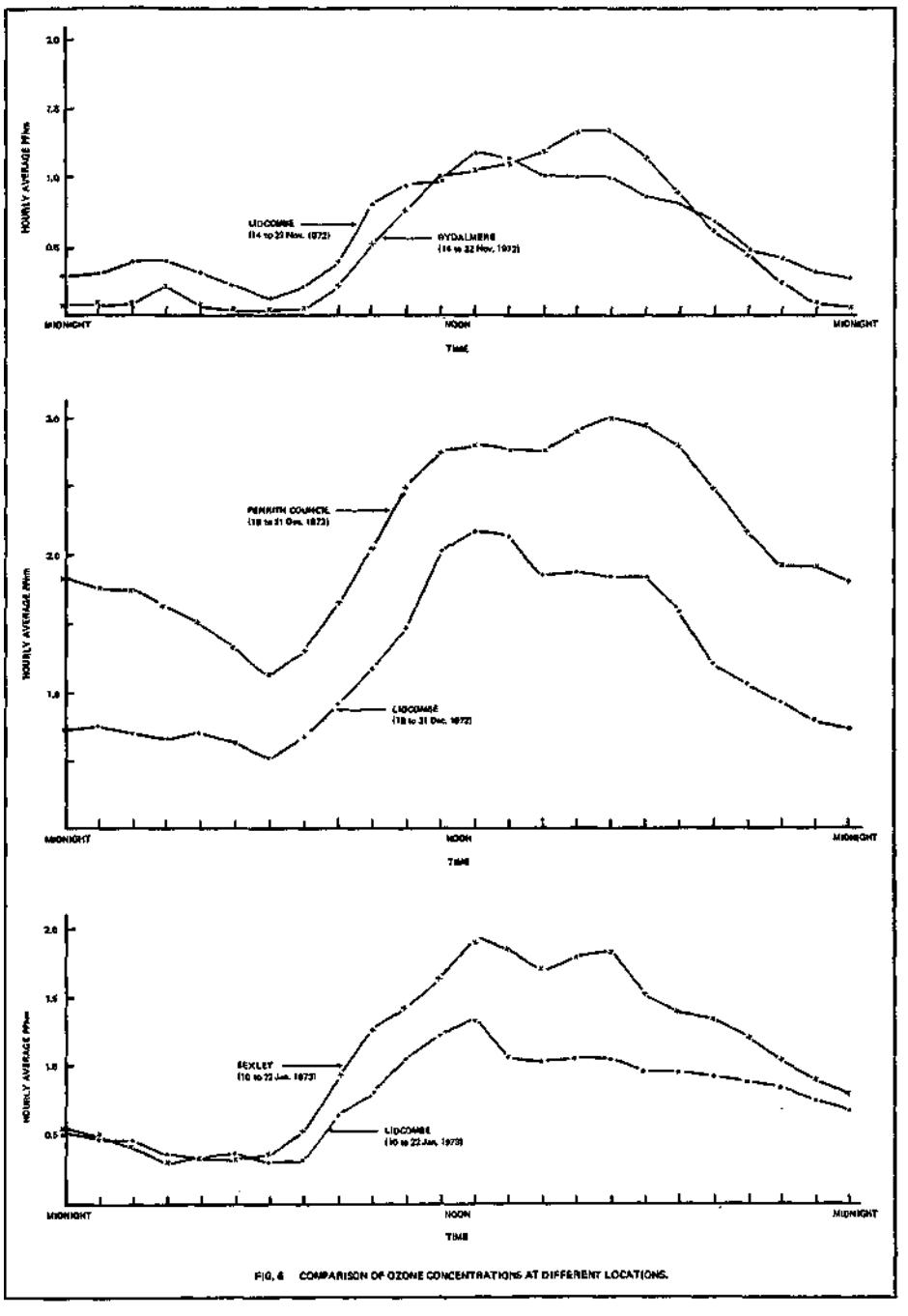

FIG. 6 COMPARISON OF OZONE CONCENTRATIONS AT DIFFERENT LOCATIONS.

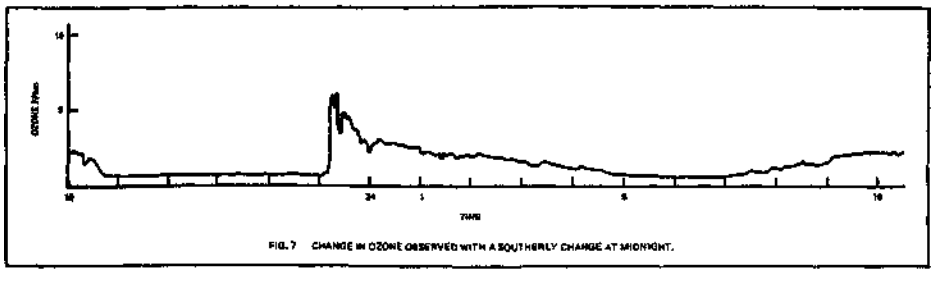

FIG. 7 CHANGE IN OZONE OBSERVED WITH A SOUTHERLY CHANGE AT MIDNIGHT.

increase in the concentration of nitrogen oxides.

This incident shows that uncontrolled emissions of hydrocarbons to the atmosphere from stationary sources are not blameless in the formation of photochemical pollution. It is suggested that reductions in hydrocarbons from both stationary and mobile sources, even without severe reductions in nitrogen oxides, may be sufficient to decrease the ozone concentration significantly.

Adverse Effects of High Ozone Concentrations

In the U.S.A. ozone is probably the cause of more vegetation damage than any other air pollutant (8). It was suggested by Hartigan (9) that the gradual demise of Norfolk Island pine trees along Sydney's beachfront since the the early 1960's could be due to ozone. For a period of several months in 1969-70 an Acralyzer was situated on the beach at Manly but the readings were not high enough to suggest ozone was the cause. The maximum hourly average measured at Manly was 5 pphm and monthly average up to 1.5 pphm. Tests carried out by Scheltemad(10) on the fumigation of Norfolk Island pines with much higher concentrations of ozone indicate that levels of ozone in Sydney are not a primary factor in the damage to these trees.

On 5th November 1971, at a large nursery near Ermington, about 16 miles inland, in the Parramatta River Valley, a large number of white petunia seedlings were reported to have suffered leaf damage. The oxidant values on that day measured at Lidcombe 4 miles away, were the highest recorded to that date. The maximum hourly average was 17 pphm and the 4 hourly average 14 pphm. The petunia damage was microscopically examined and shown to be ozone damage. Petunia damage was also reported in six other sites in early November. Controlled glasshouse fumigation tests on white petunia seedlings by Scheltema (10) confirm these levels being injurious. In 1972 leaf damage on a much smaller scale was noted on white petunia seedlings and it also appeared to be the result of ozone damage.

Ozone in high concentrations has been accepted for a long time as a highly irritating and toxic substance, it is only recently that scientific studies on the long term exposure of animals to lower concentrations of ozone have been carried out.

In 1970, Jones, Jenkins, Coon & Siegel(11) showed that repeated exposures of rats, guinea pigs, monkeys, dogs and mice to concentrations just over 100 pphm caused mortality in most species, while exposures to half this value caused non specific in-

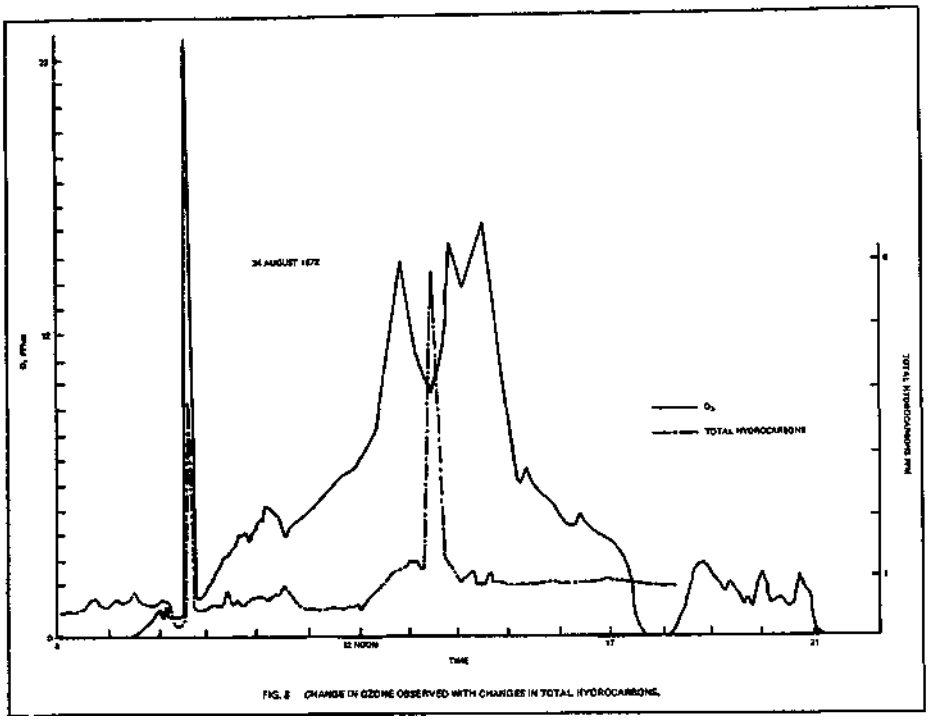

FIG. 8 CHANGE IN OZONE OBSERVED WITH CHANGES IN TOTAL HYDROCARBONS.

flamatory changes, primarily in the lungs of all species.

Also in 1970, Wethamer, Schwarz, Carr & Soskind (12) carried out tests exposing mice to 4.5 ppm for 2 hours every third day for 75 days. Results indicated increases in pulmonary adenomas, organising pneumonia, septal fibrosis and epithelial hyperplasia.

In 1972, P'an, Beiand and Jegier(13) exposed rabbits to 40 pphm of ozone for 6 hours a day, five days a week for 10 months. During the test the rabbits developed both emphysematous and vascular lesions.

The U.S. National standard in ambient air for photochemical oxidants, corrected for interference from nitrogen oxides and sulphur dioxide is 8 pphm for one hour, not to be exceeded more than once per year. This value was set as a result of evidence of increased frequency of asthma attacks on susceptible subjects when the estimated hourly average concentration reached 10 pphm. Data available on the impairment of athletic performance at levels below 10 pphm has been debated. The value of 8 pphm as a primary standard is expected to allow a safety margin to protect the community from known and anticipated effects from this pollutant.

In Sydney 1972, this U.S. National standard of 8 pphm for one hour was exceeded no less than 137 times.

Conclusion

There is a **real need for more monitors to** be sited **in the Sydney region, together** with **wind velocity and direction** recorders to more fully explain the relationship between meteorology and ozone. The UV radiation, nitrogen oxides and hydrocarbons, which are the primary ingredients for ozone, should also be measured. It would be necessary to measure the ozone gradient above ground level at night and day during varying wind conditions to explain some of the phenomena described. If the concentration of ozone off the coastline was monitored, together with a network of land based monitors, considerably more information on the ozone buildup would be obtained. The credibility of ozone, and ingredients for its future production, moving off the coast in the early morning to be returned to Sydney with the onset of the seabreeze, could be examined.

It should be possible in the future after considering meteorological conditions, and hydrocarbon emissions in the morning, to forecast days of high ozone concentrations with some degree of accuracy.

Many phenomena remain unexplained and only the collection and collation of much more data will resolve them. The results of ozone monitoring so far have indicated that controls on motor vehicles are necessary to reduce hydrocarbon emissions. It has also demonstrated hydrocarbon emissions from stationary sources must be controlled. Controls on nitrogen oxides for motor cars are also necessary but it is suggested that the degree of reduction required may be less if comprehensive control of hydrocarbons from stationary sources is achieved. There are fewer stationary sources than cars, and efforts in this direction could achieve reductions in ozone levels much more rapidly than controls applied only to new cars.

Acknowledgements

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W. L Bourke

AIR POLLUTION FROM AIRCRAFT OPERATIONS AT SYDNEY (KINGSFORD-SMITH) AIRPORT

Aircraft landing and takeoff movements at Sydney's Kingsford-Smith Airport have been analysed to determine the average daily pollutants emitted. It has been estimated that the atmosphere within the airport boundary is less polluted than adjacent residential and industrial areas and that this situation will not change significantly in the future.

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Introduction: The recent world-wide concern for the environment has focused attention on atmospheric pollution due to energy consumption, particularly related to modes of transport. The advent of turbo-jet engined aircraft stimulated a phenomenal growth in air traffic in the 1960's, and therefore airport activity. This has evoked many community complaints due to aesthetically displeasing smoke plumes resulting from high fuel consumption rates and fuel rich combustion during take-off and approach.

A programme of fitting modified fuel spray nozzles and combustion chambers to reduce smoke to Pratt & Whitney Aircraft JT8D engines which power Douglas DC9 and Boeing 727 aircraft, has been voluntarily undertaken by the Australian domestic airlines and will be completed in the near future. This particular engine, which powers the major proportion of non-communist domestic jet fleets produced the most smoke. The more recent large advanced technology engines, Pratt and Whitney Aircraft JT9D (Boeing 747), General Electric CP6 (McDonnel-Douglas DC10), the Rolls Royce RB211 (Lockheed L1011) and the Olympus 593 engine for the production Concorde aircraft have already demonstrated virtually smoke-free operation.

However concern is now being expressed in regard to the gaseous pollutants emitted during aircraft operations on and around the airport. Pollutants such as carbon monoxide, unburnt hydrocarbons, nitric oxides, sulphur dioxide, if present in sufficient concentration, may constitute a biological hazard to humans and to plant life, while NO_x and unburnt hydrocarbons contribute significantly to the formation of photochemical smog.

A recent U.S. Environmental Protection Agency (U.S. E.P.A.) study of major U.S. airports concluded that aircraft operations do contribute significantly to the regional pollution burden at some of these airports. (1) However, in a study undertaken at London Heathrow Airport, it was shown that the airport was not contributing unduly to local pollution. (2) While taking cognisance of the successful engine conversion (JT8D) programme and advanced engine technology, the U.S. E.P.A. is recommending further reduction in jet engine CO, HC, NO_x and smoke emissions, particularly as the automobile industry is committed to a control programme. The U.S. E.P.A. recommendations have been published in the U.S. in the form of a Notice of Proposed Rule Making (NPRM).(3) They will regulate standards for new jet engines manufactured after January 1, 1976, and initiate technology for further reduction to emission goals by January 1, 1979. Public hearings involving all interested parties on this NPRM, have indicated that the 1976 standards could be substantially met but that the 1979 goals would be extremely difficult to meet with present or even projected technology; in fact the environmental relevance of these goals has been questioned. The undeveloped state of present emission measurement technology for aircraft engines must be of major concern in relation to any proposed standards.

It has been established that the aviation industry contributes to about 1% of total world pollution from energy consumption.(4) Although this may not seem significant on a global scale, its impact on the local environment should be assessed and compared to other sources.

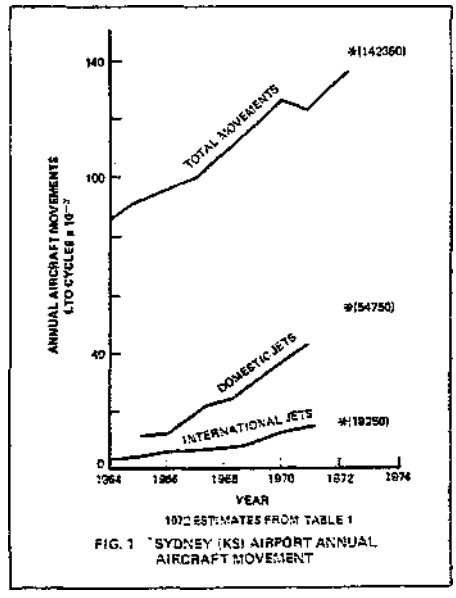


FIG. 1 SYDNEY (KS) AIRPORT ANNUAL AIRCRAFT MOVEMENT

It was therefore considered timely to carry out an estimate of aircraft engine emissions on and around Sydney's Kingsford-Smith Airport.

The Airport and its Environs

Kingsford-Smith Airport is Australia's leading airport in terms of both domestic and international air traffic. In addition there are significant movements associated with General Aviation.

The Airport has a dual runway configuration, situated on approximately 1800 acres of the northern shores of Botany Bay. Areas of parkland fringe the eastern and western boundaries. Dense residential areas are located underneath runway flight paths in the northern, eastern and western sectors. The airport is bounded by main roads carrying heavy automobile traffic at all hours of the day, particularly during morning and evening peak hours.

Airport Movements

Pig. 1 illustrates the growth of aircraft movements in terms of take-offs plus landings from 1964 to the present day. (5) Jet aircraft movements have now reached significant proportions; 1972 annual statistics indicate that these are 53.5% (40% domestic and 13.5% international) of total movements.

Recent installation of a noise monitoring system at Sydney Airport, which requires correlation of noise events with each aircraft movement, enables daily statistics of runway utilization and movements by aircraft to be obtained. The average number of aircraft landing and take-off cycles (LTO) per day by aircraft type that have been used in this study are shown in Table 1. These have been based on statistics for the November/ December 1972 period and airline time-tables, together with assumptions of a 70/30 mix for DC9 and Boeing 727 domestic operations — each airline operated 12 DC9's and six B727's at that time — and a 50/50 mix between single and twin-engined light aircraft (General Aviation). The

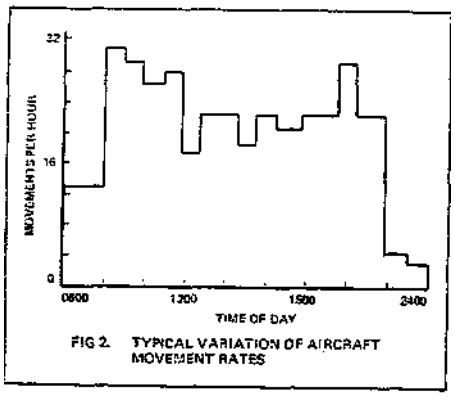


FIG 2. TYPICAL VARIATION OF AIRCRAFT MOVEMENT RATES

Table 1

	Average No. of LTO Cycles/Day Estimated	% Total
Domestic Jets		
B727	22	11.3
DC9	53	27.2
International Jets		
B707/DC8/VC10	22	11.3
B747	3	1.5
Turbo Prop.		
F27	45	23.1
Piston Engined Transport		
DC4/Carvair	3	1.5
General Aviation		
Single Engined	23	11.8
Twin Engined	24	12.3
Total:	195	100.0

piston transport LTO's allow for DC4 operations to Norfolk Island and DC4/Carvair cargo operations.

LTO activity at Sydney is quite low compared with major international airports overseas; e.g. Los Angeles 281,000 (1971),(6) J. F. Kennedy (New York 219,200 (1970), O'Hare (Chicago) 339,300 (1970(D and Heathrow (London 133,500 (1970(2).

A typical variation of aircraft movement rates throughout the day is illustrated in Fig. 2. Concentration of pollutants emitted would correlate with this variation. Maximum concentrations would occur at the peak periods of 0800-0900 hours in the morning and 1800-2000 hours in the evening. A noise curfew operates between 2300-0600 hours which prevents scheduled and now unscheduled jet aircraft operations. Activity of other aircraft types is also very low within these hours.

The Landing and Take-Qff Cycle (LTO)

For this study, the mixing height for the Sydney basin has been assumed to be 3000 ft. All engine emissions below 3000 ft. have been included in the pollution inventory as contributing towards a possible environmental impact. An area of 10 nautical mile (NM) radius can be considered as the most likely area in which operations will be conducted below 3000 ft. Distances to 3000 ft. during departures will depend upon aircraft types, weights, operating procedures and meteorological conditions of wind and temperature. Arrival procedures require international jets to align with the runway at or above 3000 ft; e.g. a northern approach to the north-south runway would commence at the West Pymble locator about 10 NM from touchdown. Domestic jets may frequently join closer in to the airport at 2000 ft.

The LTO cycle considered for the emission inventory is as follows: start-up and idle at the terminal (5 minutes), taxi-out to runway (5 minutes), take-off to 1500 ft. (at take-off power), climb to 3000 ft. (at climb power), approach from 3000 ft. to touchdown, land and taxi-in to the terminal (5 minutes).

Ground operating times are based upon a daily average. However, during the peak periods (Fig. 2) of both departure and arrival activity, additional idling in departure queues will occur: arriving aircraft have priority, typically with a minimum of two minutes air traffic control requirement between consecutive departure and arrival movements.

Emission Inventory

LTO Activity: Table 2 sets out the emission indices for each aircraft engine type at various power settings,(7) (8) The majority of the 4 engined international jets, e.g. B707 and DC8, are powered by Pratt and Whitney Aircraft JT3D turbo-fan engines. The same emissions were also assumed for the BAC VC10 as no data was available for the Rolls Royce Conway engine. The domestic Fokker F27 aircraft indices have been based upon the Allison 501 turboprop engine, as again indices for the actual engine, the Rolls Royce Dart, were not available. Indices for the Pratt and Whitney Aircraft JT9D engine were obtained from Ref. 8. The Continental 10-502 engine is considered to be representative for the majority of general aviation aircraft engines.

A review of reports (9) on engine emissions indicates wide variations in measurements for a particular engine type from engine to engine, test to test

and between different test methodologies. The indices assumed in this study are therefore considered conservative, particularly for the JT3D engine.

It is evident from Table 2 that the turbine engine cycle exhibits very clean combustion relative to the piston engine, particularly for CO and HC emissions. Combustion efficiency improves with engine power, with resultable significant reduction in CO and HC emissions. However, high combustion cycle pressures and temperatures at take-off power increase NO_x emissions.

Combining fuel consumption for each LTO flight segment (Table 3) with the appropriate emission indices, the pollutant per cycle has been estimated and is presented in Table 4 for each aircraft type.

It is significant to note that the piston engined transport aircraft emit more (the maximum) air pollutants per LTO cycle than turbojets. Because, with the exception of the F27 turboprop, major domestic activity is now conducted by the DC9 and B727 aircraft, the increase in possible pollutants is minimised.

A further combination of pollutants per LTO cycle with the number of LTO cycles per day and summation by aircraft type leads to a daily pollutant level estimate of 8 tons. Figure 3 allows an overall analysis. CO is the predominant pollutant type (68%) with ground operations the major source (69%). Due to the high CO index assumed for low powers of the JT3D engine, international operations are shown to contribute 57.5% to the total pollutant level.

Other Aircraft Activities: This emission inventory would would not be complete without consideration being given to other aircraft activities. Located in the north-eastern area of the airport is the Qantas Jet Base where engineering activities require engine in-frame and test cell running to ensure the reliable operation of the Qantas 707/747B fleet. Test cell running after engine overhaul or rectification averages one JT3D engine per day (3 hours duration) and one JT9D engine per week (3 hours duration). Based upon a test schedule of 50% of runs at idle, 40% at medium power and 10% at high power, the total pollutants emitted are approximately 700 lbs. In-frame ground running for normal maintenance and pre-departure requirements average 3 runs of 70 minutes total duration per day. This activity contributes about 500 lbs. of pollutants. Ground running by the domestic operators is less frequent; there are some pre-departure runs in the early morning hours but the majority of maintenance work is undertaken at Melbourne Airport.

Dispersion of Emissions

Ground operations result in 1.64 tons of pollutants being emitted at passenger terminals and 3.88 tons during taxiing. This leaves 2.48 tons emitted during airbone operations, in areas outside the airport boundary. In addition, engine test running contributes a further 0.55 tons within the airport boundary.

To alleviate the serious community noise problem at Sydney Airport, a noise abatement preferential runway system operates, providing wind and/or air traffic control requirements are not overriding. Runway utilization statistics actually verify the feasibility of this system, at the same time allowing an estimate of the distribution of pollutants emitted during airport operations over the various areas adjacent to the airport. Figures 4 and 5 illustrate runway utilization for take-offs (all hours) and landings (daylight hours).(10) Departures are predominantly over Botany Bay with arrivals mostly from the northern and western sectors. During evening (1900-2100 hours) and late evening hours, arrivals are restricted to the eastern and southern sectors depending upon wind conditions. A combination of the pollutant levels in Table 5 gives the following sector distribution: south 1.07 tons, west 0.55 tons, north 0.5 tons, east 0.36 tons.

Table 2 **Emission Indices**

Aircraft and Engine Type	Operating Mode	Pollutants Produced lbs./1000 lbs. Fuel				
		CO	Hydro Carbons	NOi-	SO_2	Partic-ulates
B707/DC8/VC10	Idle/Taxi	174	**75**	**2.0**	1.0	**0.3**
P & WA JT3D	Approach	8.7	**16**	**2.7**	1.0	1.1
	Take-Off/Climb-Out	0.7	0.1	**4.3**	1.0	**0.6**
B747	Idle/Taxi	60	**15**	**1.3**	1.0	**0.3**
P & WA JT9D	Approach	5.0	**5**	**2.4**	1.0	1.1
	Take-Off/Climb-Out	0.7	**.05**	**6.8**	1.0	**0.6**
B727	Idle/Taxi	50	**9.6**	**2.0**	1.0	**0.6**
DC9	Approach	6.6	**1.4**	**2.7**	1.0	**2.7**
P & WA JT8D	Take-Off/Climb-Out	1.2	**0.6**	**4.3**	1.0	**2.5**
F27	Idle/Taxi	24.8	8.1	**3.7**	1.0	**0.6**
Allison	Approach	1.6	**0**	**2.9**	1.0	1.0
501-D13	Take-Off/Climb-Out	2.3	**3.2**	**3.1**	1.0	0.8
Piston	Idle	600	160	**0**	**0.2**	**2**
Transport	Taxi	900	**90**	**3**	**0.2**	**2**
P&WA R-2800	Approach	800	**60**	**5**	**0.2**	**2**
	Take-Off/Climb-Out	1250	190	**0**	**0.2**	**2**
General	Idle	600	160	**0**	**0.2**	**2**
Aviation	Taxi	900	**90**	**3**	**0.2**	**2**
Continental	Approach	800	**60**	**5**	**0.2**	**2**
10-520-A	Take-Off/Climb-Out	1050	110	**1**	**0.2**	**2**

Table 3 — Fuel Consumed (lbs.) Per LTO Cycle

Operating Mode	4 Eng. Jet B707/DC8	4 Eng. Jet B747	3 Eng. Jei B727	2 Eng. Jet DC9	T/Prop F27	Piston Engine Transport	General Aviation Single Engine	General Aviation Twin Engine
Start-Up & Idle (5 min.)	500	1000	150	100	**30**	**30**	**.5**	**1**
Taxi-Out (5 min.)	500	1000	250	150	50	**50**	5.0	**10**
Take-Off to 1500 ft.	1500	3000	1000	600	200	**70**	1.0	**2**
Climb to 3000 ft.	500	1000	300	200	140	280	**5.0**	**10**
Approach from 3000 ft.	1500	3000	700	450	200	200	**3.0**	**6**
Land & Taxi-In (5 min.)	500	1000	250	150	50	50	5.0	**10**
Total Per LTO Cycle	5000	10000	2650	1650	670	**680**	**19.5**	**39**

Winds above 10 knots are considered to influence lateral dispersion of these emissions and temperature variation with altitude will determine vertical mixing. Analysis of wind statistics for the Sydney area(11) indicates that on about 35% of occasions, winds would not be sufficiently strong to produce dispersion. For the remaining occasions, stronger winds exhibit southerly or north-easterly patterns which would disperse emissions from ground operations either to the north in heavy industrial areas or to south and southwest in the Botany Bay area.

Comparison with Other Major Airports: Comparison with estimated 1970 daily pollutant levels (Table 6) associated with LTO cycles indicates that present emissions at Sydney Airport are about one-eighth to one-tenth of those at major U.S. airports and one-third of those at Heathrow. This comparatively low level is due to:

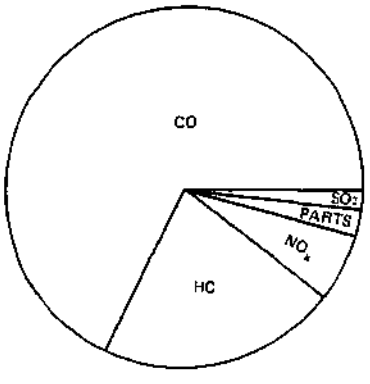
1. Significantly fewer LTO cycles; at least one-quarter of U.S. airport activity.
2. A different mix of aircraft type activity, e.g. 24% and 23% of movements are general aviation and F27 turboprop respectively, which contribute to only 10% of total emissions.
3. High movement rates at U.S. airports which cause significant departure delays with increased CO and HC emissions at idle powers.

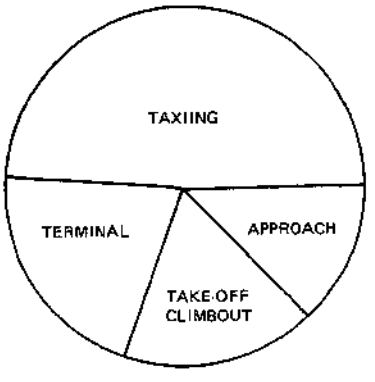
Future Emission Levels

Any projection of future emissions involves consideration of growth in activity and future aircraft type.

Examination of Fig. 2 indicates that except for a 1.5% fall in 1971, total movements have been increasing at a rate of approximately 7% per annum in the past few years. There has been a simultaneous growth of 22% in domestic jets and 18% in international jets. Peak movement rates are now in excess of 30 per hour (Fig. 2). With the present airport, LTO growth can be accepted until capacity of the runway system is limited by the demand that occurs in peak periods and the resulting departure delays.

It has been predicted that (costly) delays will begin to limit the airport's commercial life by the mid to late 1970's. A key factor in extending this life would be the restriction of general





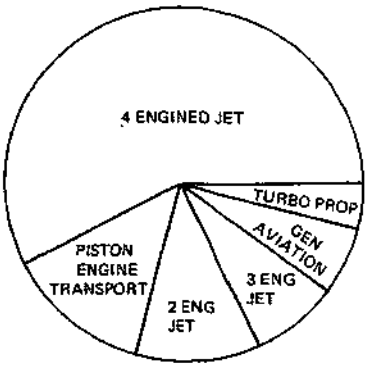


FIG. 3 TOTAL DAILY EMISSIONS FROM LTO ACTIVITIES

Composition by weight

CO	5.44 tons
HC	1.76 tons
NOx	0.48 tons
Particulates	0.20 tons
SO2	0.12 tons

Contribution of Operating Mode

Taxiing	3.88 tons
Terminal	1.64 tons
Approach	1.08 tons
Take-off/climb out	1.40 tons

Contribution of Aircraft type

4 Eng. Jet	4.60 tons
Piston transport	1.04 tons
2 Eng. Jet	0.92 tons
3 Eng. Jet	0.64 tons
General Aviation	0.60 tons
Turbo Prop	0.20 tons

Table 4 — Pollutant Per LTO Cycle (Lbs)

Aircraft Type	Total	CO	HC	NO_x	SO_2	Particulates
B727	64.5	39	8	9.5	5.5	2.5
DC9	40	24	5	5.5	3.5	2
B707/DC8/VC10	435	275	137	15	3	5
B747	275	168	53	38	7	9
F27	10	4.5	2.2	2.2	.5	.6
DC4/Carvair	780	710	64.4	3	2.3	.3
Single Engine General Aviation	20	18	2	Negligible	Negligible	Negligible
Twin Engine General Aviation	40	36	4	Negligible	Negligible	Negligible

aviation during peak periods. This would eliminate lengthy delays. At present, general aviation aircraft which contribute to 24% of LTO activity have equal operating priorities with regular public transport aircraft.

There is already evidence overseas that aircraft movements are tending to plateau off, as the use of new wide-bodied jets, e.g. B747, L1011, DC10 is increasing. Their increased capacity is absorbing passenger growth with fewer movements than the small aircraft they are replacing. A similar situation will develop at Sydney Airport—Qantas, BOAC. Air New Zealand, Pan American, and KLM are already operating wide-bodied aircraft. The domestic operators will most likely introduce similar aircraft by the mid 1970's.

Analysis of Table 4 indicates that although movements will increase and possibly level off, total daily pollutant levels will also be reduced with the introduction of "cleaner" wide-bodied jets, e.g. the pollutant per cycle of the B747 is 63% of that for the B707/DC8 aircraft. In addition DC4/Carvair cargo domestic operations have now been replaced by the turboprop Electra, while DC4 operation to Norfolk Island will, in time, be replaced by jet operation. This would mean elimination of about 13% (1.04 tons) of the present pollutants.

The contribution of ground operations (69%) requires further consideration, particularly as this mode may become more predominant as peak rates increase with resulting delays. In this regard the U.S. E.P.A. has issued an advanced NPRM([12]) proposing modification to ground operating procedures use of fewer engines at higher, more efficient power settings during taxiing and idle modes. Fuel cost savings would also be appreciable: the U.S. E.P.A. estimated a possible $10 million in the U.S. However, there are many safety and operational aspects that need to be considered. These can be categorized broadly into potential effects of:

1. Increased jet blast required for aircraft break-away and taxi due to fewer engines operating at higher thrust settings, e.g. damage to structures, ground personnel and passenger injury, hazards to light aircraft and occupants, and erosion of taxiway and runway surface.

2. Engine startup after gate departure, e.g. wind orientation starting problems, hot starts and fire hazards.

The foregoing indicates that there will be a small increase in the present

Table 5 — Average Daily Airborne Emissions LTO

Sector	Emissions (lbs) Departure	Arrival
South	2350	1065
East	470	965
West	255	340
North	65	50
Total:	3140	2420

Table 6 — Comparison of Average Daily Pollutant Levels (Due to Aircraft LTO Cycles)

Airport	Tons
Sydney 1972	8.0
Los Angeles 1970	80.0
J. F. Kennedy International 1970	63.0
Chicago (O'Hare) 1970	75.5
Heathrow 1970	27.0

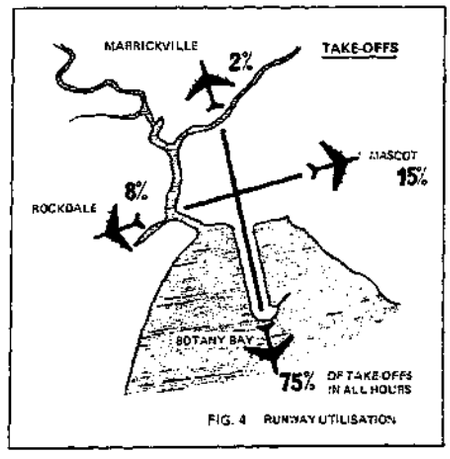


FIG. 4 RUNWAY UTILISATION

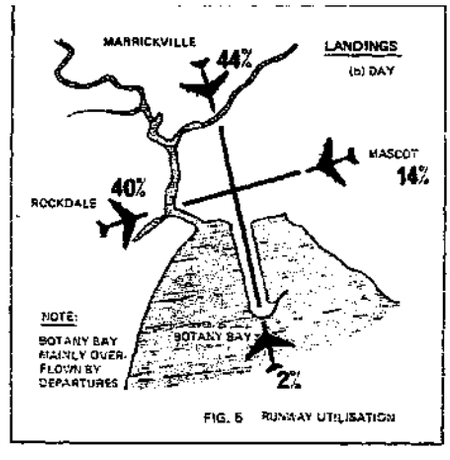


FIG. 5 RUNWAY UTILISATION

pollutant level as aircraft activities increase (less than 10% per year), but this trend will be reversed by the influence of wide-bodied jets as their contribution to aircraft activity at Sydney becomes predominant.

Comparison with Automobile Emissions: Automobile emissions are considered to be a major contribution to the total pollutant level in the Sydney area; a phenomenon which is typical world wide in major cities. To put aircraft emissions into perspective, a comparison with automobiles has been assessed. Strauss(13) has estimated for the Sydney area (approximately 1600 sq. miles) the 1970 population of just under 1 million automobiles consumed on average 1.28 million gallons daily. Assuming an average mpg of 25, automobile mileage was therefore 32 million miles daily. Assuming emission indices of 125 gms CO/mile, 18 gms HC/mile, and 6 gms NO_x/mile,(14) the total pollutant emitted per day on average is 4700 tons. By comparison, aircraft operations contribute only one five-hundredth of this level. Examination of variations of automobile movement density throughout the metropolitan area,(14) shows that in the areas adjacent to the airport the movement varies between 35-50 thousand miles/sq. mile/day. This results in a pollutant level of 5-7 tons/sq. mile daily. Aircraft pollution (from ground operation and engine ground test running) has been estimated at 6.0 tons/day. The airport area is approximately 2.8 sq. miles; therefore, average pollution at the airport is approximately 2.1 tons/sq. mile/day, which is of the order of one-third to one-half the automobile emissions concentration. This suggests that on the whole the airport is in fact relatively less polluted than the adjacent residential and industrial areas.

Conclusion

The average daily pollutants at Sydney Airport have been estimated to be 8 tons a day (below 3000 ft. altitude). This level is considered to have minimal impact on Sydney's regional air quality; it is only one five-hundredth of daily automobile pollutants emitted in the Sydney basin. United States Environmental Protection Agency studies have indicated pollutant levels at major U.S. airports to be eight to ten times the Sydney level. Projection of airport activities shows that the present pollutant level may increase slightly over the next few years (less than 10% per year) but that this trend will be reversed as the proportion of wide-bodied and advanced technology commercial transports,, e.g. B747, DC10. L1011 increases.

It is noted that ground level operations contribute to about 70% of the total pollutant level. Safety and operational aspects of U.S. E.P.A. proposal to limit the pollution from this operating mode are at present being discussed in the United States. Irrespective of the outcome in the U.S., proposals to reduce the number of engines during taxiing operations will require detailed evaluation before being adopted at Sydney Airport.

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AIR POLLUTION RESEARCH IN AUSTRALIA & NEW ZEALAND

This report is a continuation of that published in the August issue of Clean Air, and includes a full report of air pollution research being carried out in C.S.I.R.O. Laboratories.

UNIVERSITY OF MELBOURNE

Department of Industrial Science

Total Atmospheric Emission in Australia

D. A. Thomson and W. Strauss

The total quantities of major atmospheric pollutants (particulates, sulphur dioxide, carbon monoxide, hydrocarbons and oxides of nitrogen) emitted into the atmosphere from all sources have been assessed. The total amount is 12.0 m. tons p.a., or 0.94 tons per capita, which is virtually the same as for the United States.

Mass and Energy Flows of a City

L. H. Pyke and W. Strauss

The input and output of materials in an Australian urban community are being measured. On the basis of the quantities of the constituents, optimum recycle and disposal systems will be assessed.

Recycling of Resources

I. Pausacker and W. Strauss

A detailed study of the domestic wastes of an urban unit is being carried out. The possibility of separation in the home and particle reclamation during collection is being studied, considering technological, sociological, psychological and economic aspects.

Dust Deposition around Point Sources

W. Strauss

Following the measurement of dust near a cement works and quarry over a two months period in 1971, an intensive two year project has been planned during 1972 in conjunction with the Gordon Institute of Technology, Geelong, and the Barrabool Shire Council. This project will also involve more detailed study of the micrometeorology. The results will be used by the Geelong planning authority in planning future housing in the Highton — Waurn Ponds area.

Airborne Lead Concentration near Roads

V. Farrington, S. J. Mainwaring and W. Strauss

Samples of airborne dust have been collected at a height of 1.5 m at a major highway, and analyzed for their lead content. This varies with traffic density and distance from the road.

Chemical Carcinogens in Urban Air

R. Cowdell, S. J. Mainwaring and W. Strauss

3-4 Benzpyrene has been determined in samples of urban air, using solvent extraction, thin layer chromatography and TJ-V fluorescent spectroscopy. Concentrations in Melbourne are of the order of 10 μg/1000 m^3 similar to urban concentrations elsewhere, but about 25 times as high as in country air.

Absorption of Nitrogen Dioxide by Water in a Packed Column Absorber

Y. Fukui, R. Arnold and W. Strauss

The possibility of using activated carbon as a packing, catalyzing and oxidizing action on nitrogen dioxide has been investigated. The effect appears to be marginal although if active carbon packings moulded into suitable shapes were used, it may prove more effective than conventional materials.

Modifications of Cyclone Designs to Reduce Pressure Losses

J. M. Browne and W. Strauss

Careful design of cyclone outlet vanes can reduce the pressure loss in cyclones by an appreciable amount. The effect of this on cyclone collection efficiency appears negligible. A provisional patent has been taken out covering the invention.

Utilization of Asphalt Plant Sludge

R. Yarwood and W. Strauss

The possibilities of using asphalt plant sludge as a filler in hot mixed asphalt has been investigated. The material has the correct properties, but the cost of sludge recovery, separation and drying are too high to make this feasible. If dry recovery systems are used, although they are greater in unit cost, the recovered product is immediately useable without further treatment.

Sulphur Dioxide on Australian Plants

J. O'Connor, D. G. Parbery and W. Strauss

A new exposure chamber was constructed and the susceptibility of 140 Australian species was investigated. It appears that, as a general rule, Australian species are more resistant to sulphur dioxide than their European or North American counterparts, in particular those species which also exhibit good drought resistance. The most susceptible species were Eucalyptus Regnans (Mountain Ash) and the hardiest were the Casuarina.

The Reduction of B.O.D. and Turbidity in Textile Mill Waste Liquors

H. Padama, S. J. Mainwaring and W. Strauss

A column of activated carbon was used to clean up the waste liquors from a textile works. While the degree of B.O.D. reduction proved satisfactory, the fixed bed tended to clog up with fibres. Suggestions for pretreatment, or cleaning of beds by fluidization will be investigated in the next stage of the project.

Department of Mechanical Engineering

Engine Exhaust Gas Composition

J. V. Deslandes and H. C. Watson

Predictions have been made of the exhaust composition of a hydrogen fuelled engine. Comparisons will be made with experimental measurements. Similar studies will be made for natural gas.

The Source of Vehicle Emissions in the Urban Environment

H. C. Watson

An extensive survey of worldwide vehicle emissions data has been made. Estimation procedures have been established for calculating the emissions source from trucks, buses and cars. The benefits from changing traffic flow patterns have been assessed for Edinburgh (Scotland). Correlation between prediction and measurement for selected roadways in London is proceeding.

Evaluation of the Adoption by Australia of U.S.A.'s Emissions Test Procedure

H. C. Watson and E. E. Milkins

The applicability of the 1973 U.S. Federal Test Procedure for representing the emissions source of Australian

cars is being investigated. Representative traffic patterns in Melbourne have been established. Comparisons between emissions rates for Melbourne roadways and the adopted Federal driving cycle are being made.

Cycle-by-Cycle Variability in Exhaust Emissions
E. E. Milkins

Investigations being made into the variation in exhaust emissions from one cycle to the next. A sampling system has been made which allows the extraction of exhaust gas from individual cycles or from fast burning or slow burning cycles as monitored by ionisation probes. The extracted exhaust samples are analysed by gas chromatography. Correlation between emissions levels and combustion phenomena will be sought.

Variations in Blow-by Emissions with Automotive Engine Age
H. C. Watson, E. E. Milkins et al.

Measurements of blow-by and exhaust emissions; HC, CO and NO_x have been made in new and old (80,000 miles) 4-cylinder petrol engines. The change in emissions and their source have been established.

Emissions from Dual Fuelled Diesel Engines

H. C. Watson, E. E. Milkins et al.

A V-6 truck diesel engine has been converted to partial LPG admission to operate in the 'tongue topping' mode as frequently employed by truck operators. It has been found that the emissions, smoke, HC and CO generally increase with increasing gas quantities at constant speed and load but NOx emissions decrease.

Department of Meteorology

Environmental Acoustic Research
T. Gething, D. Jones and U. Radok

Attention during the year was concentrated on the interpretation of acoustic backscatter signals and on comparisons of acoustic records obtained several miles apart. Estimates of the signal coherence were obtained from the degrees of freedom of the chi square distributions providing the best fit to the observed signal strength distributions. Comparison of acoustic records obtained at Mt. Derrimut and by the RAAF Physics Group at their Dunnings Road site showed that in the majority of occasions the backscatter structures were advected roughly with the mean wind over the height range investigated.

Wind Structure in an Urban Environment
R. Brook

A tower in a dock area near the mouth of the River Yarra has been instrumented to determine wind profiles, turbulent kinetic energy balances, statistical gust parameters and relationships between Eulerian and Sagrangian correlations and spectra. A 1 : 40 scale model of the installation has been used to determine the effects of the tower on the observations.

R.A.A.F. Physics

A High Tower Acoustic Sounding of Low Atmosphere
I. Bourne and T. Keenan

Pulsed 1KH« sound waves and a directive acoustic antenna are used to transmit signals vertically into the atmosphere. The sound waves which are very weakly backscattered by atmospheric irregularities are detected by a high gain receiving system, altitudes being determined by the time delay between transmitted and received pulses.

THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES, S.A.

Improvement of Water Sampling and Analysis Techniques
Project for the Australian Water Resources Council.

Desalination Studies
N. Blesing in conjunction with C.S.I.R.O. and I.C.I.

The application of the CSIRO Sirotherm ion-exchange method for desalination particularly of brackish waters is being studied.

Reclamation of Sewage Effluent

Renovation and reclamation of sewage effluent for agricultural purposes or by tertiary treatment for other uses is being examined.

Fluorine Emissions from Brick and Tile Works
R. J. Allen

An investigation into pollution by fluorine emission from Australian brick and tile manufacturers has been carried out. This reviewed the pollution damage, actual analysis of raw and fined products, relevant legislation and possible means of control.

Rehabilitation of the Nairne Pyrites Ltd. Quarry Area
A. Spry and N. Blesing
In collaboration with the South Australian Department of Mines

The determination of the degree of pollution of the Bremer River System by the abandoned pyrite quarry near Nairne, South Australia, together with the design and economic evaluation of a control system to reduce acidity and heavy metal content.

Rehabilitation of a Beach Sand Mining Area in Kerala, India
A. Spry

Evaluation of procedures for the reloocation of people and rehabilitation of a densely populated coastal area which is to be mined over many decades.

Treatment of Tailings Dams to Facilitate Plant Growth
W. McMahon

A study of various methods of stabilization and rehabilitation of tailings dams with emphasis on revegetation.

Fine Tailings Disposal
T. W. Leane
In co-operation with the S.A. Department of Mines, Quarrying and mining companies

An in-depth study of problems arising from the disposal of fine tailings from quarries in the Adelaide area. Includes processing of raw material, materials handling, dewatering, economic utilization of fines, stabilization and rehabilitation of dams.

Environmental Aspects of Uranium Extraction
J. Lackey
In conjunction with the Australian Atomic Energy Commission

A study of problems arising from past and future uranium mining in the Northern Territory. Disposal of toxic wastes (solid and liquid), damage to mines due to radiation and radon accumulation and the stabilization of tailings dams are being studied.

Incineration of Chlorinated Hydrocarbons
W. Walker

A study and comparison of the various methods of incineration and control of pollution.

Solid Waste Disposal
W. Leane In conjunction with S.A. Department of Conservation

A comparison (technical and economic) of problems of disposal of solid domestic and industrial wastes.

Environmental Impact Studies
A. Spry

Refinement of the various matrix methods used for E.I.S. with emphasis on quantification. Main interests are in mining and similar developmental projects.

ENVIRONMENT PROTECTION AUTHORITY, VICTORIA

Haze and Motor Vehicle Emission Study
P. Le Roy, W. Lau and G. Holden

The increasing incidence of haze which may be of a photochemical nature is being investigated and profile measurements of NO_2 and SO_2 are being carried out. The identification of reactive hydrocarbon in the ambient atmosphere and procedures for the control of oxides of nitrogen are being studied.

Petrochemical Works Study
P. Le Roy and W. Lau

Detailed methods of collecting hydrocarbon samples in the ambient atmosphere for subsequent analysis are being undertaken.

The Control of Lead Emissions to Atmosphere
P. Le Roy and W. Lau

Possible methods of controlling or limiting the emissions of lead to atmosphere are being examined, either by lowering the quantity of lead in petrol, or by controlling the emissions.

Albury, Wodonga
Micrometeorological Study
P. Le Roy, W. Lau and P. Makeham
It is intended to determine the height up to which 99.9% of all nocturnal or ground based inversions develop. The intensity of the inversions which develop in the area would also be found. All the foregoing information is essential prior to the orderly industrial development of the area.

DEPARTMENT OF PUBLIC HEALTH, W.A.

Use of the CERL Directional Dust Gauge
R. A. Powell
Work is in progress to ascertain the limits and practicability of the gauge.

Motor Vehicle Pollution
R. A. Powell
A programme is about to be initiated to co-relate motor vehicle pollution levels with the meteorological conditions that lead to photochemical smog.

DEPARTMENT OF PUBLIC HEALTH, S.A.

Carbon Monoxide Study of the Adelaide Metropolitan Area
It is intended to ascertain the present level of CO and to correlate concentrations with traffic flow and local conditions.

Port Pirie Survey
A survey will be carried out in the same two months of each year to determine the effect of controls on suspended particulates, the ground level concentrations of SO_2 in relation to the SO_2 sources and the conditions of heavy metals in the soil.

WOLLONGONG UNIVERSITY COLLEGE
Dept. of Electrical Engineering

Estimation of Precipitator Performance for the Collection of Fly Ash from Low Sulphur Coal
O. J. Tassicker
Electrical determinations on fly ash have been made to aid in the siting of a precipitator for the collection of ash from a new low sulphur coal field.

AUSTRALIAN COAL INDUSTRY RESEARCH LABORATORIES LTD., N.S.W.

The Laboratory Examination of Low Sulphur Coals
K. M. Sullivan
A laboratory micro furnace has been developed to produce fly ash for chemical, microscopic and electrical analysis in order to assess the likely behaviour of the fly ash in an electrostatic precipitator.

NEW ZEALAND METEOROLOGICAL SERVICE RESEARCH DIVISION, WELLINGTON, NEW ZEALAND

The service makes pollution evaluation studies of power station sites for the New Zealand Electricity Department and also of sites for large industrial projects. It has close liaison with the Chief Chemical Inspector of the Health Department.

Plume Rise from Thermal Power stations
J. T. Steiner
The vertical velocities, temperatures and plume rise from chimneys of thermal power stations with exit temperature excesses of up to 500°C are being investigated.

Time lapse photographs of plume behaviour have been compared with theory.

Acoustic sounding Studies
F. B. Knox of Department of Scientific and Industrial Research and D. C. Thompson of the Meteorological Service
A system has been developed for the study of the formation and break-up of temperature inversions in the Hutt Valley, a closely settled, industrialised area near Wellington.

A second mobile sounder will soon be constructed.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, NEW ZEALAND
Chemistry Division

Assessment of Filters for Removing H_2S and SO_2 from the Air
J. R. Sewell
Solid filters based on a form of manganese dioxide are produced by precipitation onto the surface of sawdust or pumice after the reduction of potassium permanganate. The use of these Alters in the treatment of geothermal atmospheres, sewage gases and other odours is under investigation.

AIR POLLUTION RESEARCH IN C.S.I.R.O.

Studies that bear directly or indirectly upon problems of air pollution are in progress in a number of C.S.I.R.O. Divisions. In general, the Organization is more concerned with obtaining an improved understanding of the factors responsible for air pollution and the processes involved in the dissemination of atmospheric pollutants than in controlling unwanted emissions from an isolated source. However, in the course of its practical investigations, new corrective measures may be developed by C.S.I.R.O. which are applicable to the abatement of atmospheric pollution from particular sources.

Brief descriptions follow of the Organization's current research activities in air pollution. Further information on particular projects can be obtained from the Chief of the Division concerned.

Division of Mineral Chemistry
(P.O. Box 124, Port Melbourne, Vic, 3207)
The Division of Mineral Chemistry is a component of the C.S.I.R.O. Minerals Research Laboratories and undertakes research on chemical topics of relevance to the Australian minerals industry. These activities are associated with problems of mining, beneficiation and extraction as well as the use of fossil fuels (coal, natural gas) for the production of energy, metallurgical reductants and special industrial carbons. The Division's involvement necessarily extends to the problems of air, water and land pollution that are encountered in the mining, mineral processing, metallurgical and power generation industries. The areas of current involvement on topics relevant to air pollution problems are as follows:

Abatement of Air Pollution arising from Fly Ash emission at Power Stations and other Industrial Plant
Air pollution problems due to fly ash emission from pulverized coal-fired power stations are experienced in Australia despite the use of electrostatic precipitators. Technical and bench scale studies, the former using a pulverised coal-fired furnace which simulates the combustion conditions under which fly ash is formed in full scale plant, seek to improve fly ash collection efficiences in electrostatic precipitators. A second technical-scale test facility is used to assess the behaviour of fly ashes from different coals during electrostatic-precipitations and hence provide advance information to assist in the design of of efficient electrostatic precipitators. Particular problems associated with dust emissions from mineral smelters are also being investigated.

Abatement of Air Pollution from the smelting of Sulphide Ores
Large quantities of oxides of sulphur are introduced into the atmosphere from smelting operations in Australia. Studies are in progress with the objective of removing these sulphur oxides from the smelter gases before they exhaust to atmosphere and to recover the sulphur in elemental form.

Control of Air Pollution from coal and mineral sulphide dumps
Very large tonnages of coal are wasted during its preparation prior to export or its use in the manufacture of metallurgical coke. A substantial proportion is rejected by the washing plant which is simply dumped at the present time. Apart from other pollution and conservation problems, the incidence of spontaneous combustion and the risk of ignition from external influences causes the dumps to be serious sources of local air pollution. The problem is being tackled at the source by pilot-scale studies of the

combustion of the reject material in fluidized beds. The object is to convert both the coarse rejects and slurries to an inert and potentially useful material incapable of polluting the atmosphere while at the same time yielding useful energy.

A similar problem arises in the storage and transport of sulphide mineral concentrates which are prone to evolve offensive sulphureous vapours as the result of spontaneous combustion. Practical techniques are being developed to prevent or control spontaneous combustion in these situations.

Production of Nitrogen Oxides during combustion

The incidence of photochemical smog in urban atmospheres is linked with the presence of nitrogen oxides. These are derived from industrial combustion — chiefly power stations burning fossil fuels — as well as from vehicular engines. The rates and mechanism by which nitrogen oxides are produced during combustion are being investigated with a view to the control of emissions from the former sources. Detailed studies of the chemistry of nitrogen in hydrocarbon flames are in progress involving photometric and spectroscopic measurements on both the flames and the combustion products.

Atmospheric Chemistry of sulphur and nitrogen

Much remains to be discovered about the chemical behaviour of potential pollutants in the atmosphere before the seriousness of the problems can be assessed both in general and in particular circumstances. The chemistry involves reactions of free atoms and radicals and perhaps other similarly active species but much more needs to be known about the relative importance of various reactions. Kinetic studies of possible key reactions are in progress using low pressure fast-flow techniques combined with measurements of the concentrations of the atoms and radicals by photometric, titration and electron spin resonance methods.

Division of Chemical Engineering

(P.O. Box 312, Clayton, Vic, 3168)

This Division also forms part of the C.S.I.R.O. Minerals Research Laboratories. As well as carrying out fundamental studies in chemical engineering aimed at meeting the present and future needs of the chemical and allied industries, the Division provides assistance to industry in the form of advice and may also make its facilities available for pilot-scale trials of novel processes. In the course of these activities, several in-depth studies have been carried out on processes aimed at eliminating or reducing the amounts of pollutants discharged by particular industries and advice has been given on the upgrading of waste materials to useful products.

Studies are proceeding on the use of active carbons produced from brown coal char to remove pollutant gases such as SO_2 and hydrocarbons from the air.

C.S.I.R.O. Environmental Physics Research Laboratories

A broad range of investigations with implications for air pollution are under way in the C.S.I.R.O. Environmental Physics Research Laboratories, comprising the Division of Atmospheric Physics, the Division of Cloud Physics and the Division of Environmental Mechanics. This complex has been formed with the object of unifying all C.S.I.R.O. research concerned with physical processes controlling weather, both global and local, with the experimental modification of weather such as rainmaking, and with the interaction of plants and their surroundings.

Division of Atmospheric Physics

(P.O. Box 77 Mordialloc, Vic, 3195)

The Division of Atmospheric Physics is involved in a variety of studies which are intimately linked, inter alia, with problems of air pollution. Whilst some of these investigations are explicitly connected with air pollution, much of the work is of a fundamental nature and includes such fields as atmospheric turbulence, convection, diffusion and wind circulation. On both a global and a local scale, these phenomena are responsible for the distribution of heat and momentum throughout the atmosphere as well as gaseous and particulate material. This work is long term and continuing in nature.

Theoretical studies in the laboratory are backed up by comprehensive expeditions in the field which in turn have the support of a Drawing Office and Machine Shop for the design and fabrication of the variety of specialised instruments that may be required. Where warranted, instruments are patented and then made under licence by a commercial manufacturer.

Free Atmosphere CO_2

Relatively small changes in the amount of CO_2 in the free atmosphere could significantly affect global climate. At Aspendale a long term high quality CO_2 measuring programme has been launched — the third in the world. With the assistance of the Department of Civil Aviation and Qantas Airways, CO_2 samples from various altitudes are obtained on a routine basis. Although currently confined to the air routes connecting Melbourne with Launceston, Sydney, Christchurch and Adelaide, it is hoped to extend the sampling programme in the near future.

The Stratosphere and above

Ozone: There has been some discussion recently as to the effect that high flying aircraft might have on the stratospheric ozone layer which filters out the biologically harmful ultra-violet radiation. The Division has a long and excellent record of quality ozone measurements and a network of stations currently extends from Darwin through Brisbane, Perth, Aspendale and Hobart to Macquarie Island. Total ozone content is measured daily using a ground based Dobson Spectrophotometer. A weekly profile is also obtained at Aspendale by the use of balloon borne sensors.

Water vapour: Although occurring in only very small quantities (some 5-10 ppm), water vapour plays an important part in the heat balance of the earth. As with CO_2, even a small disruption to the existing balance could markedly affect the world's climate. Water vapour measurements have been made successfully from balloons and aircraft using infra-red techniques and it is hoped shortly that a routine programme of such measurements will be introduced.

Diffusion and transfer at 100 km

Any man-made or naturally occurring material is dispersed around the globe very slowly at these levels. Ground-based air-glow techniques are used to learn something of the dynamics involved as well as the underlying physics and chemistry. On clear nights, observations of the radiation intensity, at a wavelength of 5577 A, are made at Deniliquin (N.S.W.), with an instrument which automatically scans the sky from horizon to horizon north to south and east to west, once every 30 mins., and records the results photographically.

Atmospheric Turbidity

Using a pyrheliometer, which measures the intensity of the direct solar beam, atmospheric turbidity co-efficients are determined at Aspendale on a routine basis. The method used is simple and direct and could be applied in other areas where appropriate personnel are available to make the observations.

In such work it is essential to have a long record of good observations. The Division's Radiation Observatory (also the Radiation Centre for the S.W. Pacific) operates a continuous and comprehensive monitoring programme, covering solar, atmospheric and terrestrial radiation.

Radioactivity

Air: Radioactive material (whether natural or artificial) attaches itself to particulates suspended in the air and this radioactivity can easily be determined by drawing the air through a filter paper and trapping the particles. To this end, the Division has established a network of stations at Port Moresby, Townsville, Brisbane, Epping (N.S.W.), Aspendale and Hobart. Sampling is regular and continuous:

analysis by gamma spectrometry covers Be_7 (naturally occurring) and fission products Cs-137, Ce-144 and Nb-Zr-95. The same techniques could be applied to measure other radioactive components.

Rainwater: The radioactivity of rain water can be used as an atmospheric tracer and has been monitored at Aspendale since 1958. The results are helpful in understanding vertical and lateral transfer processes operating in the atmosphere as well as the scavenging properties of rain.

Particulates in the surface air

The filter paper techniques described above are used to extract particles from the air with diameters greater than 0.2μ. Regular weekly figures of the dust loading are available for the six stations mentioned and it is intended to continue this programme.

Oxidants in the surface air

Some oxidants in the surface air are of natural origin e.g. ozone, whilst others are man-made e.g. exhaust gases from motor cars contain nitrogen oxides which can react in the presence of sunlight to form photochemical smog. Concentrations of ozone and nitrogen oxides near the surface are determined routinely: at Aspendale, Darwin, Macquarie Island and Robertson (N.S.W.). The last named is the only station where sampling is not continuous.

Evaporation

Although the physics of evaporation is studied principally in contexts other than air pollution, the knowledge gained is directly applicable to the dispersion of pollutants and other constituents of the atmosphere.

All the low level monitoring so far described has been carried out over the land. However, the oceans which cover some three quarters of the earth's surface can act as a source or sink for various atmospheric constituents depending on a variety of factors — including the weather. A large instrument tower standing in about 30 ft. of water is about to be installed in Port Phillip Bay, a mile or so off-shore from Aspendale, at which a variety of micro-meteorological measurements will be made using instruments specially designed for the purpose.

Plans are already advanced for releasing a series of free drifting buoys in the Southern Ocean to carry out a number of observations — e.g. sea and air temperature, which will be transmitted automatically via satellite to a computer in the U.S.A. for subsequent retransmission, in digested form, to Aspendale.

Division of Cloud Physics

(P.O. Box 134, Epping, N.S.W., 2121)

The Division is concerned with the general area of weather modification by human activity, either deliberate or inadvertent, and has carried out extensive investigations on the atmospheric particles on which cloud droplets first form ("cloud nuclei") and those on which ice crystals will form in supercooled clouds ("ice nuclei"). These particles are important because changes in their numbers or properties may be reflected in changed probabilities of precipitation with corresponding repercussions on our environment. Although many of the particles are of natural origin, they are nevertheless "pollutants" of the normal atmospheric gases. In order to have a standard of reference by which to gauge changes induced by man's activities, it is obviously necessary to obtain a good idea of the "background" numbers of such particles in clean environments away from populated regions. From the inception of the Cloud Physics work in Australia in 1947 until the present time, the group has actively initiated and improved the techniques for counting these nuclei and studying their origins. In recent years, attention has been directed towards the chemical nature of these particles because no deductions on their origin can be considered complete without this knowledge. Analyses of bulk samples are of little use in this connection, as the nuclei active in cloud or ice crystal formation may form a small or even almost negligible proportion of the total aerosol. Ways of studying the size distribution of particles containing given ions have recently been developed which involve the chemical identification of particles of mass 10^{-15} to 10^{-16} gm.

Division of Environmental Mechanics

(P.O. Box 821, Canberra City, A.C.T. 2601)

Although this Division is carrying out no work that bears directly upon air pollution, two areas of its research programme do contribute, however, to a basic understanding of the mechanics of the aerial transport of pollutants, namely: Studies of turbulent diffusion, and Studies of aerial transport processes within plant canopies.

The first area of research is relevant to such investigations as the statistical variation of pollutant concentrations in emissions from continuous stack sources; while the second is relevant to the penetration and deposition of pollutants on vegetation.

Division of Applied Chemistry

(P.O. Box 4331, Melbourne, Vic, 3001)

Air pollution research in this Division is centred on the contribution that bushfires make to atmospheric pollution. In this connection, work is continuing on bushfire prevention and control, in collaboration with the Division of Atmospheric Physics and the forest services. Arising out of the practice of "prescribed burning", the Fire Section of the Division is investigating the chemistry of bushfire smoke with the aim of establishing the concentrations of those species that are normally regarded as atmospheric pollutants.

Studies are continuing on the measurement of carbon dioxide, particulate concentration, nitrogen oxides, ozone, sulphur dioxide and hydrocarbons.

The experiments have been conducted from light aircraft which carry the following instrumentation as well as temperature and pressure transducers: infrared carbon dioxide analyser; integrating nephelometer; "Mast" ozone meter; electrostatic precipitator; high volume filter.

Another item which may be considered relevant is the development of a highly sensitive nephelometer for the detection of smoke particles. It has been used in aircraft to observe the behaviour of smoke from large-scale fires in forest areas.

Division of Mechanical Engineering

(P.O. Box 26, Highett, Vic, 3190)

Research into improved methods of aerial deposition of agricultural chemicals, viz. pesticides, weedicides and fertilizers, is contributing to the abatement of air pollution from this activity. In the case of aerial spreading of solids, the work has led to the development of an aerodynamic tetrahedron-shaped spreader which has given promising results in field trials. A patent application has been lodged for the device and licensing discussions are in progress.

Studies into the aerial spreading of liquids has proceeded along three complementary lines of research:

1. Simulation of the behaviour of droplets under the influence of air disturbances produced by the aircraft and by meteorological conditions.

2. Field experiments to measure the distribution and recovery of spray on the ground.

3. Laboratory studies to measure the flow and droplet size characteristics of particular types of nozzles.

Appropriate techniques and apparatus have had to be developed in order to carry out these investigations and a series of reports on the work is in preparation.

Division of Building Research

(P.O. Box 56, Highett, Vic, 3190)

Several industries concerned with the manufacture of building materials give rise to air pollution, and the Division is successfully contributing to the reduction of atmospheric pollutants from this source. Wood waste burners in the sawmilling industry have been particular offenders, and it is hoped that current research will enable these burners to be operated within the constraints of the various State clean air regulations. A pro-

(Continued on page 88)

BOOK REVIEWS

Power Generation and Environmental Change
Editors: David A. Berkowitz and Arthur M. Squires
The M.I.T. Press, Cambridge, Massachusetts and London
Price: US$16.95

This book contains the proceedings of the symposium on Power Generation and Environmental change, which was part of the 136th Annual Meeting of the American Association for the Advancement of Science; as well it contains a number of contributions which the editors invited to deal with questions raised in discussion periods, points of disagreement and areas not planned in the symposium.

The three opening chapters are of a general nature and centre around the predicament in which man finds himself through his increasing demands for electric power and his more recent awakening to large scale pollution and his desire for a cleaner environment. The development of various forms of environmental degradation into political issues has in many cases left experienced scientists shocked to find their expertise denigrated and their integrity questioned by conservationists who often see them as tools of the establishment. There is a need for open national debate between scientists, and need for a program to reduce the credibility gap existing between sections of the scientific community and society.

Technology is available to cope with the physico-chemical problems of pollution arising from power station operation if society is prepared to find it. The major problems which must be more vigorously tackled are alternate cycles for power generation, efficient means of sulphur removal, and means of utilizing power station by products.

A series of papers on Nuclear Power and Radionuclides follow the introductory articles. The first of these describes in simple terms Pressurized Water Reactors and Bailing Water Reactors, the radionuclides which can be expected from them and the regulatory standards to which nuclear emissions must conform in the United States. The following papers deal with the questions of public health and safety are linked with operation of nuclear power stations. A number of authors present a spectrum of views on this particularly controversial area.

Sections on hydroelectric and fossil fuel power generation follow, while the problem of waste heat disposal which is common to all power generating systems is treated in the closing chapters.

This informative book will be of particular interest to those working in the power industry but the contributions are well written in clear general styles which should make them enjoyable for anyone with an interest in the environment.

J. O'HEARE

The Environment Index
Published annually by the Environment Information Center, Inc.
124 East 39th Street,
New York, N.Y. 10016.
582 pp., $U.S. 75.00.

This index is a key to the environmental literature in the year before publication (i.e. the 1971 index appeared in March 1972) and covers general articles and specific papers, U.S. government documents, research reports, conference proceedings, books and films. The volume is introduced by a review of the different environment problems and issues for that year.

The coverage has a United States orientation, and tends to the popular. Thus the listing for Australia refers to the IUPPA paper on legislation by Cleary and Schroder, papers on Abalone fishing, crown of thorns, barrier reef conservation, fertility, dirty Sydney air (from the New York Times) and save the kangaroo, crocodile, etc., but no mention of the considerable amount of serious work published about the Australian environment in reputable journals.

The Index carried some useful lists, such as names and addresses of U.S. control officials (but this is also in the annual APCA listing), lists of relevant U.S. patents, lists of books, etc. However, this is likely to be of far greater interest to workers in the U.S. than in Australia. The price of $A50.00 for a paperback index produced by computer is also somewhat excessive. Nonetheless this type of information retrieval system should be available in our university libraries and environment protection authorities.

W. STRAUSS

Environmental Protection
E. T. Chanlett
McGraw-Hill, New York, 1973
569 pp. $US 10.50

This is a good, modern book, covering the whole range of activities of man in his environment, and ways of dealing with the effluents. Water resources, disposal of liquid and liquid borne effluents, air pollution control, solid waste disposal, radioactive wastes, food protection and related subjects are dealt with in an interesting but somewhat superficial manner. This book can certainly be recommended to engineers and technologists who wish to carry out some preliminary reading before entering a more formal course of study in environmental science.

W. STRAUSS

The Politics of Environment
S. P. Johnson
Tom Stacy, London, 1973.
Available from T. C. Lothair, Melbourne
240 pp. Recommended retail price $A9.35

Exploring New Ethics for Survival
Garrett Hardin
The Viking Press, New York, 1972.
273 pp. $US 7.95.

The Doomsday Syndrome
J. Maddox
McGraw-Hill, New York 1972
293 pp. $US 6.95

The current environment polemic appears to be carried out between opposing factions, one of which is usually referred to as the "Doomsday Men," and the others think of themselves as the "Optimists." Garrett Hardin speaks about the far-reaching changes that will have to be introduced for the ultimate survival of the human species, while John Maddox thinks that things are already moving in the right direction, i.e. the Thames is cleaner, there is more sunshine in London; while the survival of the western globe is not terribly important, and the Minimata tragedy was an accident we wouldn't have detected if we hadn't had better methods of determining mercury concentrations.

It is rather disappointing when reading these books that they tend to quote the same sources, Rachel Carson, Paul and Anne Erlich and Barry Commoner — rarely do they introduce new material, on a balanced basis. It is not really possible to join the pessimists and try and change society overnight, as the only way, as this is bound to be met with resistance; on the other hand it is not good enough to say "We're all right, Jack, don't worry;" people working on environmental problems have a tremendous task ahead, modifying current technology and creating new ones to meet the challenge of human survival.

The third book "The Politics of Environment" is subheaded "The British Experience." It deals with the United Kingdom developments in setting up the Department of the Environment. It discusses what has been done in the U.K., who the responsible ministers are, and other related governmental activities. In his preface the author states that he had hoped to become a Conservative M.P. This book may be of help in obtaining a minsterial post when he finally makes Westminister.

W. STRAUSS

New Energy Technology.
Some Facts and Assessments
H. C. Hottel and J. B. Howard
The M.I.T. Press, Cambridge,
Massachusetts and London
364 pages
Price: $10.00

This book is a "classic" by an author of world renown in his field and no fuel technologist can afford to be without it. Unfortunately, it is hard to come by in Australia, as this reviewer knows, having had it on order for months.

The book is the outgrowth of a study undertaken by the M.I.T. Environmental Laboratory sponsored ultimately by the U.S. National Science Foundation.

Chapter 1 gives a summary in 43 pages of the whole world energy scene dealing with energy resources and consumption as well as transportation and conversion. Exotic and experimental sources are also discussed. This represents a concise and masterly summing-up of the world situation as far as energy is concerned. While presenting a perfectly balanced account, taken alone it makes you want to read on.

Chapter 2 describes the background for the assessment while the rest of the book is devoted to dealing in detail with each major factor used in it.

There are ample illustrations in the form of tables and graphs. Also included is the available numerical evidence needed to corroborate the final assessments. The latter are presented unambiguously for use by economists and businessmen, political scientists and politicians as well as environmentalists. The more detailed technical sections are a bonus for the working engineer.

It is both succinct and detailed. No aspect of fuel technology from house heating and air conditioning to fusion power, from pipe-lining to fuel cells, is neglected.

The book is cheaply produced by directly photographing the author's typescript and editing it to an acceptable level, but without trying to eliminate all typographical errors.

H. F. HARTMANN

Fundamentals of Air Pollution
S. J. Williamson
Addison-Wesley Publishing Company
P.O. Box 363
Crows Nest, N.S.W. 2065
pp. 472

The author, along with many others, considers that new lines of communication must be developed between disciplines if our growing pollution problems are to be contained.

Because of the complexities involved, exchange is required between scientific and technical disciplines as well as a flow from these areas to society. The book has been written as a contribution to this need in that it provides an introduction at a fairly elementary level to several technical areas which must be studied to obtain a thorough appreciation of air pollution and its possible environmental effects.

Material has been drawn from the fields of meteorology, chemistry, physics, medicine, psychology etc., and presented in a non-mathematical treatment which presupposes a knowledge of chemistry and physics equivalent to Higher School Certificate Standard.

Following an introductory chapter the author deals with physiological response to air pollution with particular reference to visibility, odour and respiratory effects. Meteorology is treated next and indeed approximately half the book's 453 pages are devoted to this topic. Chapters on smog, stationary emission sources, aerosols and the control of air pollution follow. Each chapter is well referenced and is followed by lists of questions and problems. In all the book produces a worthwhile introduction to theory and practice for those students and others seeking to enter the air pollution field.

J. O'HEARE

Air Pollution — Second Edition
W. L. Faith and A. A. Atkinson
393 pp. Wiley-Interscience,
New York, 1972
Recommended Australian
Price: $A 19.50

Air Pollution — An ACS Reprint Collection
ed. D. H. M. Bowen
138 pp. American Chemical Society,
Washington
Board covers $US 5.95,
paperback $US 3.50

The first of these volumes is a revised version of the excellent general book on air pollution first written by Faith in the late 1950's. At that time the treatment was as comprehensive as the literature permitted. Now, although all the chapters have been revised and updated, they have neither the depth of specialist books (such as Stern's "Air Pollution") nor the discussion of the technology in laymen's terms. The real strength of the book is in its newly added chapters on social and organization issues — Social Origins of Air Pollution; Urbanization and Metropolitization; Air Quality Management, etc. However, these chapters are very much concerned with the American picture. It was also noticed that all the references added since the first edition were from the United States. In spite of these criticisms, Faith remains the best general book on air pollution for interested laymen and semi-professionals, such as health surveyors, which is available.

The second volume is a collection of 38 articles reprinted from Environmental Science and Technology 1969-72. The articles are invariably well written, and deal with important problems — from sulphur dioxide removal from smelter gases to trends in controls. Directed at a more specialised group, nevertheless the papers should have a wide appeal to all working in the field, even if they have not had a science or engineering background. The low cost of the paperback version — $3.50 — also is a factor in the wide distribution that should be achieved by this collection.

W. STRAUSS

Biological Indicators of Environmental Quality
Compiled by W. A. Thomas, G. Goldstein and W. H. Wilcox
Ann Arbor Science Publishers, Inc.,
Ann Arbor, 254 pp. (1973)
Distributed in Australia by Ramsays,
182 Berkeley St., Carlton, 3053
Recommended Price: $16.50

The study of biological effects by air pollutants is scattered throughout the literature, and this is, in general, not readily available to many of the physical scientists working in this and related fields. This bibliography lists, with abstracts, many of the classical and also more recent papers. However, it is not comprehensive; such listings can be found in Soraver's "Handbuch der Pflanzenkrankheiten" (Berge and Jaag), Vol. 1, pt. 4 (reviewed in CLEAN AIR 6 37 (1972)). Nonetheless, it will be a useful quick reference on sources of biological pollution effects.

W. STRAUSS

Power, Pollution and Public Policy
ed. D. W. Ducsik
The M.I.T. Press
322 pp. (1972)
Recommended Price $12.50
Available in Australia from
John Wiley & Sons
Australasia Pty. Ltd.,
P.O. Box 271, Crows Nest,
N.S.W. 2065

While this book deals only in part with the air pollution problems arising from power generation, it is of tremendous value in showing the integration of problems resulting from urban development, power generation and waste disposal. It is the report of a study by students at three Boston universities, the Massachusetts Institute of Technology, Boston Univer-

sity and Wellesley College, who have as their background a range of disciplines from law and economics to a number of branches of engineering.

The study concentrates on the environmental issues involved in the use and misuse of the basic resources of land, water and air. In particular, it deals with the critical area of electric power production and its associated difficulties in environmental degradations and land use conflicts. The latter involves the use of shoreline for recreation, allocation of coastal land for private development and localized political decisions. The complexities of air pollution problems, with particular reference to the control of sulphur dioxide, are discussed in a separate chapter. So are the utilization of Boston harbour; and the possibilities for more effective regional government.

A book such as this does not present new material, and it asks more questions than it answers; but it does show us two things. First, how ambitious projects can be organized and guided for the education of senior and graduate students in multidisciplinary areas, and second, it may help us to ask some relevant questions about our own problems, which will help in the decision-making process required by the conflict between development and conservation.

W. STRAUSS

Understanding and Controlling Air Pollution

Howard H. Hesketh

Ann Arbor Science Publishers Inc.,
Ann Arbor, Michigan
Australian Distributors:
Ramsay Surgical Ltd.
Price: $17.50

This is a cheaply produced book which fulfills a need for a comprehensive text on air pollution and its control. The book is divided into two sections, the first dealing with definitions of pollution, sources and transport of pollutants, atmospheric reactions, resultant effects of air pollution and finally a separate chapter on automobile pollution. The reviewer found this first section of very uneven standard; the chemistry, for example, is at a very low level, the same is also true of the questions at the end of each chapter. Numerous errors in spelling, punctuation, decimal point position are also present; a figure is missing (Fig. 3.3), and the explanation of the "greenhouse effect" is incorrect.

The author seems much more at home in the second section on engineering control and this could be found to be particularly useful by students. Included in this section are chapters on pollutant classification, combustion, particulate collection and gaseous removal theories, together with chapters directly related to initiating control programmes, sampling, analysis methods and costing.

There are liberal references throughout and a useful appendix on possible U.S. sources for technical assistance.

S. J. MAINWARING

Occupational Health Practice

ed. R. S. F. Shilling

Butterworths, London, 1973.
466 pp. Recommended Price $13.00.

The effects of air pollutants on man are based, in most cases, on occupational and industrial hygiene practice. This has been the first area where the physican has worked with the engineer to make places of work safe from both visible hazards as well as invisible dangers. Although this is a well established field in Europe and the U.S.A., it has not been considered of importance in this country, where at present there are no university posts in industrial medicine.

This is an important book because it gives a fairly comprehensive treatment of the whole range of modern industrial medicine from hoods over vessels to executive health. The most important chapters for workers in air pollution are those dealing with airborne contaminants, the thermal environment and industrial ventilation.

The first deals in detail with threshold limit values, maximum allowable concentrations, maximum exposures for short periods, sampling and analyses, while the chapter on industrial ventilation is concerned with hooding, glove boxes, simple cleaning systems and related material at an introductory level. The book is competently written and adequately illustrated. The authors are nearly all associated with the T.U.C. Centenary Institute of Occupational Health of the London School of Hygiene and Tropical Medicine.

W. STRAUSS

An Introduction to Air Chemistry

Samuel S. Butcher and
Robert J. Charlson
Academic Press Inc.,
111 Fifth Avenue, N.Y.
Price: $12.50

This book is specifically designed for the reader with no appropriate scientific background in the field of air chemistry. The first six chapters, consequently provide the required background in meteorology and chemistry, together with discussions on the methods of collecting and analysing samples and of treating the data obtained. The authors are, I feel, trying to bridge too big a gap in such a few short chapters, much of the information given would be better suited to a volume on analytical methods in air chemistry.

The section of the book kept to atmospheric chemistry is relatively brief. There are chapters on sulphur compounds, nitrogen compounds and ozone, carbon compounds and aerosols, each dealing with sources and sinks, reactions and specific analytical techniques. The chapter on particulates is more detailed than the others and should prove very useful.

Referencing throughout is excellent and there are useful appendices on units and terminology. On the whole a readable book as an introduction to the topic, marred by an attempt to cover too broad a field too superficially.

S. J. MAINWARING

Source Book for Environmental Education

V. Eugene Vivian

C. V. Mosby Company, St. Louis, 1973
Australian Distributors:
Ramsay Surgical Co.
Price: $5.95, pp. 206

Although we cannot judge a book by its cover, the choice of colour and emphasis on children's activity on this book immediately directs attention to the idea of a green environment, from which children are gathering material for study. The book features a well laid out text and index.

Vivian has organized the text into five sections: objectives of environmental education; developing and using instructional materials; monitoring the environment; human communities — cases for environmental studies; and evaluation.

In the first section, the philosophies, aims and assumptions of the programme are clearly stated. Vivian then develops these, explains the goals to be attained and suggests various examples of the programmes at the primary and secondary levels.

In section 2, he clearly states objectives, generalizations, strategy, lesson outlines, materials evaluation, bibliography and inter-disciplinary aspects. Within this section there are five groups of lesson plans. Each group contains between 10 and 17 lessons. The grades are clearly stated from primary to senior secondary levels. There is much material for both individual and group work.

In section 3, reasons for monitoring the environment are stated. Vivian chooses what to monitor and later describes the ethics derived from knowledge. Again, the tasks he allocates to pupils are clearly graded. Unfortunately, some of the instruments he describes, although simple to construct, would lead to incorrect measurements and faulty conclusions, as, for example, in the case of the

water barometers. Calibration of the scales of instruments could only be done by those students who have mathematical skills of ratio and proportion. The section on water analysis, intended for higher secondary grades, would be generally difficult. Here much specific detail is given, but the explanation would only be understood by pupils with an adequate science background.

Section 4 contains environmental descriptions of 16 U.S. communities: their topology, climate, resources and population, followed by a discussion of wind and water currents (local and global) together with explanations and examples of the phenomena. Food chains and the web of life are mentioned and "man's changing evaluation of the natural setting."

Section 5 is an evaluation. A test in attitudes is prepared and it is stated that, "The ultimate goal of environmental education is to create a citizenry that is environmentally literate", its success to be measured by "the concern it engenders for whatever environment is being considered."

The lesson plans of sections 2 and 3 could prove very helpful in planning courses, although the obvious reference to U.S. communities makes sections of this book of limited use in Australia. However, provided the children undertaking the course are well motivated, reasonably intelligent and are organized in small groups, this book could be a useful teaching aid to "environmental literacy".

Because it attempts to cover a huge field of human knowledge the adhoc approach may offend some, cause purits to weep and intellectuals to complain of "mind pollution". But if you can agree with Vivian's basic philosophy and aims, it can be used for a great deal of carefully graded activity from the primary to the senior secondary level.

J. S. THOMAS

Air Pollution Research in Australia & New Zealand

(Continued from page 84)

visional application for a patent has been lodged for an improved type of wood residue burner and prototype equipment is under construction at the present time.

To replace "salt glazing" of burned clay products, a new glazing technique has been developed that does not have the disadvantage of releasing chlorine that combines with atmospheric water vapour to form dilute hydrochloric acid.

NOTE: Clean Air, Vol. 7, No. 3 1973 on page 61, under University of Auckland, Department of Physics, the name of R. J. Clegg should have been included.

A New High Volume Air Sampler

(Continued from page 68)

installed in August, 1971, and the one at Port Moresby in August, 1972. All have been in continuous operation since they were installed except for the unit at Townsville which was blown over and flooded by cyclone Althea (December 1971). After a period of three weeks this sampler was salvaged, the motor chamber of the blower was cleaned with solvent and the unit restarted. It has since been exposed to a grass fire and still continues to operate. The unit at Brisbane operated through cyclone Daisy (February, 1972), and provided a dry filter, even though near horizontal driving rain was experienced.

For measuring airborne particulates it is important that reliable air sampling equipment simple in operation under difficult conditions be available. The high sampling rate also allows direct measurement of such quantities as total dust content of the ambient air in much shorter time intervals than are feasible with many other techniques.

Acknowledgement

All of the samplers described were made at C.S.I.R.O. Division of Atmospheric Physics by Mr. Brian Turner who during development of the sampler, suggested many improvements which have been incorporated.

References

1. Hicks, B. B., Sulphur-35 and Beryllium-7 in Ground Level Air at Aspendale, Nature, 221, 172 (1969).
2. Goodman, H. S. and Hicks, B. B., Particulate Concentrations in Ground Level Air along Australia's East Coast, Clean Air, 7 (ii) 25-28 (1973).

Depreciation Allowances on Air Pollution Control Equipment?

Further clarification on the Australian Government's attitude to this important question was obtained from the answer to a question in the Senate by Senator C. L. Laucke (Liberal, South Australia), a member of the Senate Select Committee on Air Pollution.

Senator Laucke asked:

1. Is the cost to industry of plant and machinery installed to reduce air pollution, in most instances, a non-productive outlay, adding to the cost of goods and therefore to the inflationary spiral.

2. Does the Government intend to give effect to the recommendation of the Senate Select Committee on Air Pollution in respect to provision of greater investment and depreciation allowances on air pollution control equipment.

Senator Willesee (on behalf of the Treasurer) gave the following reply:

1. No. Unless one is prepared, as I am not, to assume that cleaner air is not a 'good', the prevention or reduction of air pollution is no more non-productive than the production of goods and services that can be bought and sold for cash over the counter.

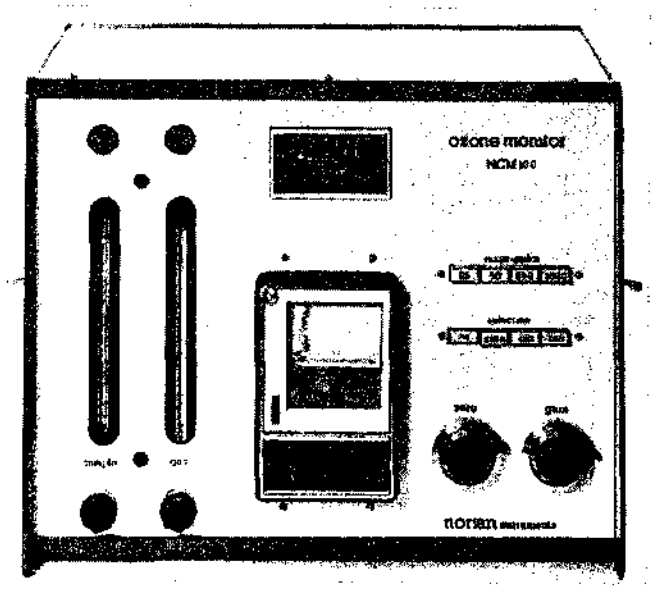
2. The Senate Select Committee on Air Pollution did not recommend certain tax concessions, as the honourable senator suggests, but only that consideration be given to such concessions. In fact, under the present law, the full cost to business enterprises of installing, operating and maintaining air pollution control equipment would normally be allowable either as business outgoings or by way of depreciation allowances. The proposition that extraordinary financial relief should be provided, at the general taxpayer's expense, to those incurring these expenditures is inconsistent with the 'polluter pays principle' which the Government endorses and which, briefly stated, holds that the real cost of pollution should be borne by the producers and users of those goods and services whose production or consumption brought about the pollution.

(From Hansard, 22nd August, 1973)

FORTHCOMING CONFERENCES

Marine Waste Disposal and Marine Pollution

A conference on marine waste disposal and pollution is being held in San Remo, Italy, between the seventeenth and twenty-first of December. This conference is being organized by the Institute of Sanitary Engineering, Polytechnic of Milan, in collaboration with the University of California at Berkeley and the International Association for Water Pollution Research.



NCM 100 Ozone Monitor

The Norian NCM 100 Ozone Monitor measures the concentration of ozone in ambient air by photometrically monitoring the chemiluminescence resulting from the reaction of ethylene gas with ozone. The NCM 100 has built-in calibration and thermo-electric stabilisation for wide range ambient operations. The Monitor is capable of measuring ozone in the presence of NO_2, SO_2, Cl_2, and other substances which have traditionally interferred with the Potassium Iodide reaction.

The instrument is capable of accurate measurements in quantities as low as 0.1 parts per hundred million (pphm).

The NCM 100 incorporates original engineering by Messrs. L. M. Ferrari and E. Brown of the New South Wales Department of Health, Division of Occupational Health and Pollution Control, Australia, and is manufactured under licence from that Department.

FEATURES:

- Chemiluminescent Reaction of Ozone and Ethylene.
- Ozone Response Instantaneous.
- No interferences from gases such as SO_2, NO_2, Cl_2, CO_2, etc.
- 4 Ranges covering 0-1,000 pphm.
- Ranges 0-250, 0-50 for Atmospheric Monitoring.
- Direct Digital Readout.
- BCD Output for Data Processing.
- Peripherals including external recorder, printer, computer and telemetry facilities.

We also invite your enquiry for

NCM 200 Chemiluminescent oxides of nitrogen analyser for measurement of stack and exhaust emissions, 0-20000 ppm.

NCM 300 Chemiluminescent oxides of nitrogen for atmospheric measurement, 0-100 ppm.

norian

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