GPSCI:PC

THE FAWLEY B PROJECT

CONSIDERATION OF ATMOSPHERIC EFFECTS AND METHODS OF POLLUTION CONTROL

By:

Dr. Paul Johnston,
Greenpeace Research Fellow,
Scool of Biological Sciences,
Queen Mary College,
London.

Date: 18 May 1988

INTRODUCTION

Widespread forest death in Europe and Scandinavia has led to a rapid appreciation of the problems caused by acid deposition. This has led to considerable political effort in attempts to effect reductions in aeolian sulphur dioxide and nitrogen oxides (UN 1987). Although the UK has not yet ratified the 1985 sulphur dioxide protocol to the Convention on Long-range Transboundary Air Pollution it has now become accepted that British forests show evidence of acid precipitation damage. Evidence is now being accumulated in order to ascertain the extent of any damage of freshwaters.

The choice of possibilities to effect reductions ranges widely in terms of applied policy. Johannson (1987) discusses the economics of various strategies. He cites analyses of the situation in the U.S and Sweden where energy efficient technology could result in a <u>per capita</u> decrease in demand for energy at the same time as increasing the Gross Domestic Product. He notes that this is probably true for other industrialised countries also. Further, he suggests that "the emission situation stimulates an interest in energy end use devices and conversion systems that make use of a minumum quantity of fuel per unit of energy service rendered". He acknowledges however that centralised power plants present a good pollution abatement prospect.

There is no doubt that the UK Central Electricity Board contribute significantly to the total burden of sulphur dioxide released into the atmosphere over the UK. This has been estimated (ENDS 1988) at some 2.4 Mt / annum. This represents some two thirds of the total emissions of the gas in the UK.

The CEGB approach to reduction of acid emissions is illustrated by the statement of Burdett et al. (1987) in relation to nitrogen oxides. "The potential importance of acid rain has been recognised by the CEGB and is reflected in the magnitude of the UK scientific research programme aimed at assessing the effects of atmospheric pollutants upon aquatic and terrestrial ecosystems". They note that "Attempts to comprehend the overall situation are however hampered by the variety and complexity of natural eco-systems and their inter-relationship with environmental systems". They however justify "a limited research programme" on nitrogen oxides. This is designed to investigate the reductions acheivable by retro fitting existing plant. The Mersey-side power plant at Fiddlers Ferry is to be retro fitted with NOx reducing burners.

At the same time a limited programme of fitting flue gas desulphurisation equipment is in progress at a number of UK power plants. The first is at Drax in Yorkshire to be completed in 1995. The whole programme is designed to reduce CEGB emissions by an overall 10% of total. According to UN figures stationary combustion sources contributed some 89% of total sulphur dioxide and some 49% of the total nitrogen oxides emitted to the atmosphere in the UK in 1984. By 1990 total emissions are projected to rise substantially. A fall to 1984 levels is forecast for the year 2000 (UN 1987). NOx emissions from these sources are about one quarter of SO2 emissions by weight. It is undeniable that the CEGB is responsible for a major part of such emissions.

Currently, the CEGB is being considered for privatisation (HMSO 1988). That environmental effects are omitted from discussion in this document is of potential significance given the environmental impact of the industry. Burdett et al. (1987) note that the CEGB aim is to "evaluate the applicability of commercially available technology with a view to establishing the extent of NOx reduction which can be achieved in existing boilers without punitive operational difficulties that might lead to unjustified cost to the electricity consumer."

This international aspect of the FAWLEY B proposal is acknowledged in the CEGB environmental impact statement (CEGB 1988 p.51 : 11.25) : "when considering acid rain or ozone it is the total national emissions which come under discussion". No data are given on the likely contribution to national emissions from Fawley B. It is stated that for ozone and sulphur dioxide "the contribution of even a substantial source on its local environment is small compared with the combined effect of regional and distant sources." This statement may be misleading in local terms. Certainly no supporting data is given in the document to this effect.

THE CEGB IMPACT STATEMENT

Fawley B station is intended to occupy a site adjacent to Fawley A station. This latter facility is oil fired and has been generating since the late 1960's. In common with many of the CEGB oil fired stations it is operated intermittently to satisfy peak demand. The Fawley B station is designed to have a phased lifetime generating electricity to satisfy the base load in the first phase. As the plant ages it is intended to shift operation towards peak demand functions. In accordance with current CEGB policy it is to be fitted with a limestone / gypsum flue gas desulphurisation system and NOx efficient burners. The following is an indication of areas concerned with environmental impact of atmospheric emissions from the Fawley B plant which require further evaluation and availability of data.

The environmental impact statement contains few quantitative data concerning the environmental impact of atmospheric emissions from Fawley B. These may be broadly classified into three major areas which are discussed below.

1) Gaseous emissions

2) Stack Particulate emissions

3) Fugitive dust emissions

GASEOUS EMISSIONS

As noted above the gaseous emissions of interest are sulphur dioxide and the nitrogen oxides. These will be discharged as reheated flue gases from the FGD plant. The impact statement (Page 49: Section 11.11) notes that downward displacement of the plume caused by high buildings close to the stack might occur but that the magnitude of any effect is uncertain. This immediately raises the possibility that calculations of ground concentrations of these gases may be modified from the scenario presented in Figure 11.1. This in turn may involve modification to the stack design such as increasing the height. This doubt should be resolved since it could be necessary to double the stack height to some 500m and would necessarily be a factor in the granting of planning permission. Assuming the distributional correctness of FIGURE 11.1, a maximum ground impact zone for sulphur dioxide is shown in the region of Fareham, Hampshire. Variously lower impacts are forecast for the Medina area of the Isle of Wight although the report does not cover the southern part of the island. The area impacted constitutes a geologically sensitive area to the effects of acid deposition.

The dispersion characteristics correspond closely with prevailing wind direction. Examination of Figure 1, a January wind rose for the adjacent sea area (after Lee & Ramster 1981) shows that winds blow predominantly from the south / south west. However, there is a strong northerly component to wind direction which will occur throughout the year. This may be further modified by local breeze changes particularly in summer. Hence although local mean levels of sulphur dioxide appear to remain within EEC levels there is likely to be a wide daily variation according to weather and power demand fluctuations. The precise effect on the Isle of Wight remains uncertain although the statement indicates that appreciable impact will occur.

It is of interest to examine some of the available data. The statement notes that total deposition is estimated as 70% lower than in 1970. It is not stated precisely how this relates to the operation of Fawley A. For example, the increased use of low sulphur North Sea oil may be a contributory factor. Similarly the use of the power station for peak demand supply means that change of usage forced by oil prices may also be a contributory factor (Burdett et al. 1987).It would be of interest to know how the Fawley A facility has been utilised and to relate this back to records of sulphur dioxide levels held by the CEGB for the Fawley monitoring network. This project however was only run from 1966-1980. The network formed part of the National Survey of Smoke and Sulphur Dioxide which ended in 1982 and was resolved into the much smaller UK Smoke and Sulphur Dioxide Basic Urban Network (DTI 1985). Since the CEGB state that monitoring takes place round all new power stations before and after commissioning, (Page 47: 11.2) it is presumed that at least the original local network will be brought back into operation. Detection of medium field effects will also have to be provided for since rationalistion of the Survey resulted in the loss of all but three of the Hampshire based monitoring points and all nine in Dorset which may have contributed data to the Fawley A study. A report of this study should be published and the raw data made available.

An indication of the uses to which such data may be put is illustrated by Figure 2 (A-F). This shows the mean monthly and maximum monthly levels of SO2 in air at air sampling stations at various localities for 1985-1986 (DTI 1987). Portsmouth is projected to lie in a moderate impact zone for Fawley B. It is presently subject to moderate impact from Fawley A. Certainly the mean levels of SO2 are consistently higher than for Southampton as revealed by Figure 3.

It is possible that the high SO2 value recorded in June 1986 reflects some aspect of plant operation whilst the consistent elevation of mean levels and maximum recorded values suggests considerable impact of the plant on these. The relatively lower values recorded at Dibden Purlieu are consistent with the maximum effect from combustion plant at Fawley being exerted at 10km (Page 47: 11.2) since this site lies only 3km from the stack. It is noticeable that at all three sites SO2 maxima rise sharply in September 1986 which may be related to the increased use of Fawley A in the winter months. It is not possible to differentiate between this source and other local sources although the lesser relative weighting of other sources is suggested by the figures from Plymouth.

The points used on the Isle of Wight were lost when Fawley A monitoring was discontinued. An idependent analysis of the available data would probably prove useful as noted above. The relevance of the Fawley A study to Fawley B is likely to be limited since the two power stations will operate in entirely different ways. Nonetheless the data should be made available since it is desirable to know not only the mean SO2 levels but also the maxima.

Unfortunately, nowhere in the document is the total tonnage of sulphur dioxide emissions detailed. Page 48: 11.6 suggests that 90% of the sulphur dioxide would be removed prior to discharge from a 230m stack. If it is assumed that the plant will burn 5,000,000 tonnes per year of coal (Page 19: Table 6.1) and that this contains 1.7% by weight of sulphur with a load factor of 76%, then the expected emission of SO2 will be in the order of 17,000 tonnes per annum. Since this plant is described as a base load plant this may be expected to be emitted on a steady basis over the year, ie at 327 tonnes per week. This load factor is consistent with those of other coal fired power stations which range from 18-100%. It is concievable that Fawley B may operate at a higher load factor in which case emissions would increase concomitantly.

The nitrogen oxide emissions from Fawley B are to be controlled using new burner technology. This system provides NOx reduction of some 30-40% over equivalently sized power stations. This method of control although cheap is also inefficient when compared to Specific Catalytic Reduction (SCR) techniques which remove 70-80% of NOx emissions (Bosselman 1987). The reasons for not using such a system are not apparently discussed in the statement. This is potentially of great importance. Although power stations are not significant generators of hydrocarbon emissions (Page 52 : 11.26) the proposed site adjoins the ESSO oil refinery whose fugitive emissions of hydrocarbons appear not to have been considered. This should be studied since it may influence lower atmosphere ozone levels.

There appear, therefore, to be a number of aspects of the gaseous discharge from this stack which have been insufficiently studied. The environmental impact statement must not therefore attain the status of a complete environmental impact assessment until these points are addressed.

STACK PARTICULATE EMISSIONS

Page 20: 6.18 states that the electrostatic precipitators will have a 99.7% dust removal efficiency.

This will generate some 85mg/ cubic metre of flue gas at 15C, 1 bar pressure, 6% oxygen and dry conditions. This limit applies whether FGD is in operation or not. This is an indication that the FGD may be taken off stream from time to time. Although no flue gas flux figures are given, the annual particulate discharge from the plant may be estimated from PFA production estimates at approximately 2500 tonnes per annum. With FGD in operation this figure could be lowered slightly.

Particulates from power stations are known to contain appreciable quantities of heavy metals. No indication of the total terrestrial deposition in local areas is given. It may be expected on the basis of other studies that the fallout of particulates will be governed by their individual mass, with smaller particles travelling relatively further than large ones and obeying a general Gaussian plume dispersion model in the case of continuous discharges.

An aspect of power station emissions which is not considered in the CEGB impact statement is the fate of radioactivity originally contained in the coal which will be burned. The release of radioactivity to atmosphere from a coal fired power station occurs through the stack gases and particulates. The environmental fate of released isotopes as air concentration downwind will be considerably related to the buoyancy of the plume and to the stack release height. This is of potential significance in an operation incorporating FGD where the stack gases must be reheated after passage through the FGD apparatus. It is of interest that the FGD system will entrap some radioactive material. The effluent from this plant will result in the discharge of some 30 kg per year of thorium. Page 55: Table 12.1 (CEGB 1988).

Other natural radionuclides which will be discharged probably include those of uranium, radon, potassium and carbon. The precise implications of this are unclear. The CEGB has conducted some work on the problem eg Corbett (1980). The radiological significance of both the atmospheric and aquatic discharge of these materials remains unclear. In the case of the atmospheric discharges they are likely to be deposited in a manner analagous to the deposition of similar non radioactive materials. Discharge of the FGD effluent may pose a threat to the oyster fishery in Stanswood Bay. The handling of the ash wastes component and use as feedstock for manufacture of building materials needs to be examined closely as do disposal sites for sludges and ash wastes in terms of the radioactive component and a critical group study carried out which takes account of the prevailing wind pattern.

Generally it might be expected that deposition of particulates would follow the same pattern as ground level sulphur dioxide levels emanating from the power station but over a shorter distance.

FUGITIVE DUST EMISSIONS

The use of limestone/gypsum FGD equipment means that not only will there be a considerable handling of the raw materials in addition to volumes of ash waste. It is expected that much of this material would arrive by sea (Page 104 17.58). Nonetheless it would appear that provision is being made for excess coal import capacity over the requirements of the station which could lead to substantial movement by rail.

The statement is generally vague about the control of dust emissions, seeking to control these by containment during handling and transfer operations (Page 50: 11.18-11.21). No quantitative data are supplied and this makes correct evaluation impossible from the statement. It is inevitable that considerable fugitive emissions of coal and PFA would occur. In this connection it is desirable to subject the choice of FGD system to further scrutiny. That proposed neccessitates the handling of large quantities of limestone and gypsum. There is some doubt concerning the ability of the market to absorb the waste gypsum. Indeed in Germany, power utilities pay plasterboard manufacturers to take this material. An alternative FGD system does exist in the form of the Wellman-Lord process. The impact statement certainly considers this process (Page 21: 6.21). It is rejected on the grounds that it would involve road and rail transport of considerable quantities of the sulphuric acid produced by this process. The other possible bulk product from the Wellman-Lord equipment is elemental sulphur which is widely imported in the UK and has few associated transport hazards. The process uses regenerable reagents.
This aspect of the FGD plant should be carefully re-examined. Whichever process is used, there would still be need to discharge an effluent and dispose of sludges (CEGB 1987).

In this connection it is noticeable that there is very little discussion in the statement concerning the fate of wastes from the site. It is possible that a sea dumping operation is planned, since it is unlikely that sufficient landfill capacity exists in the area.

CONCLUSION

A large number of questions remain to be resolved concerning the contribution of the planned Fawley B plant to atmospheric loadings and subsequent deposition characteristics of gaseous, particulate and dust emissions. The issue of discharge of radionuclides not addressed in the statement is of potential radiological significance given the gradation of impacted areas and should involve an extensive critical group study. The CEGB statement cannot be regarded as a correct Environmental Impact Assessment under the terms of the European directive since the details supplied for the greater part provide insufficient quantitative data. It thus must be regarded as having the status of a discussion document. Until many aspects of the potential effects on the atmosphere and other systems are known, the ecological and health impacts become impossible to determine adequately.

REFERENCES

Burdett, N., Lawn, C. & Clapp, R. (1987)
NOx control in the United Kingdom- constraints and options in the power generating industry.
Economic Bulletin for Europe 39 (1): 135-142

Bosselman, W. (1987)
Flue gas desulphurization by lime/ limestone processe in the Federal Republic of Germany.
Economic Bulletin for Europe 39 (1): 62-68

Central Electricity Board (1988)
Proposed Fawley B coal fired power station: Environmental Statement: CEGB London, 139pp.

Central Electricity Board (1987)
Evaluation and treatment of liquid discharges from flue gas desulphurisation processes. I: The limestone Gypsum process. CEGB.

Corbett, J.O. (1980)
The enhancement of natural radiation dosage by coal fired power generation in the United Kingdom.
CEGB, Berkely, Glos. RD/B/N4760.

Department of Trade and Industry (1985)
The Investigation of Air Pollution: I: Daily observations of smoke and sulphur dioxide. Sites used frm the beginning of the Co-operative investigation.
Warren Spring Laboratory Special Publication W85030. 51pp

Department of Trade and Industry (1987)
UK smoke and sulphur dioxide montoring networks: Summary tables for April 1985-March 1986.
Warren Spring Laboratory Special Publication W87023 97pp

ENDS (1988).
CEGB poised for go-ahead with FGD project bu faces inquiry on new coal station.
Environmental Data Services Report 159 (April 1988). pp8-9

HMSO (1988)
Privatising Electricity
Government White Paper Cm 322 (HMSO)

Johannson, T.B. (1987)
Strategies for reducing sulphur and nitrogen emissions in relation to energy production structure and energy use.
Economic Bulletin for Europe 39 (1): 17-22

Lee, A.J. & Ramster, J.W. (1981)
Atlas of the seas around the British Isles.
MAFF (Lowestoft)

GPSCI:PC

United Nations (1987)
Convention on Long-range transboundary air pollution: National Strategies and policies for air pollution abatement. ECE/EB. AIR/14., UN (New York) 56pp.

LEGENDS TO FIGURES

FIGURE 1:

Open sea January wind rose for the Channel area. The arrows represent directional vectors while the scale indicates the percentage of measurements falling at each compass point at speeds of 1 knot and over. The marks on each vector represent a division of wind speeds into 1-16 knots (closest to centre) and 16+ knots. As may be seen from this figure the prevailing winds are from the south and west although there is a significant northerly component. Extensive local modification of this in coastal areas is likely.

FIGURE 2:

A: Mean and maximum levels of sulphur dioxide recorded at Portsmouth 1985-1986

B:Mean and maximum levels of sulphur dioxide recorded at Southampton 1985-1986

C:Mean and maximum levels of sulphur dioxide recorded at Dibden Purlieu 1985-1986

D:Mean and maximum levels of sulphur dioxide recorded at Alton 1985-1986

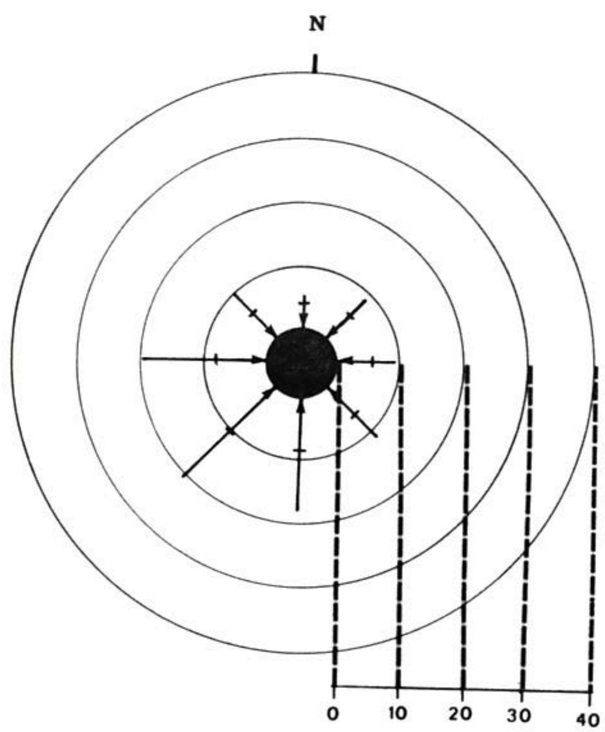
E:Mean and maximum levels of sulphur dioxide recorded at Plymouth 1985-1986

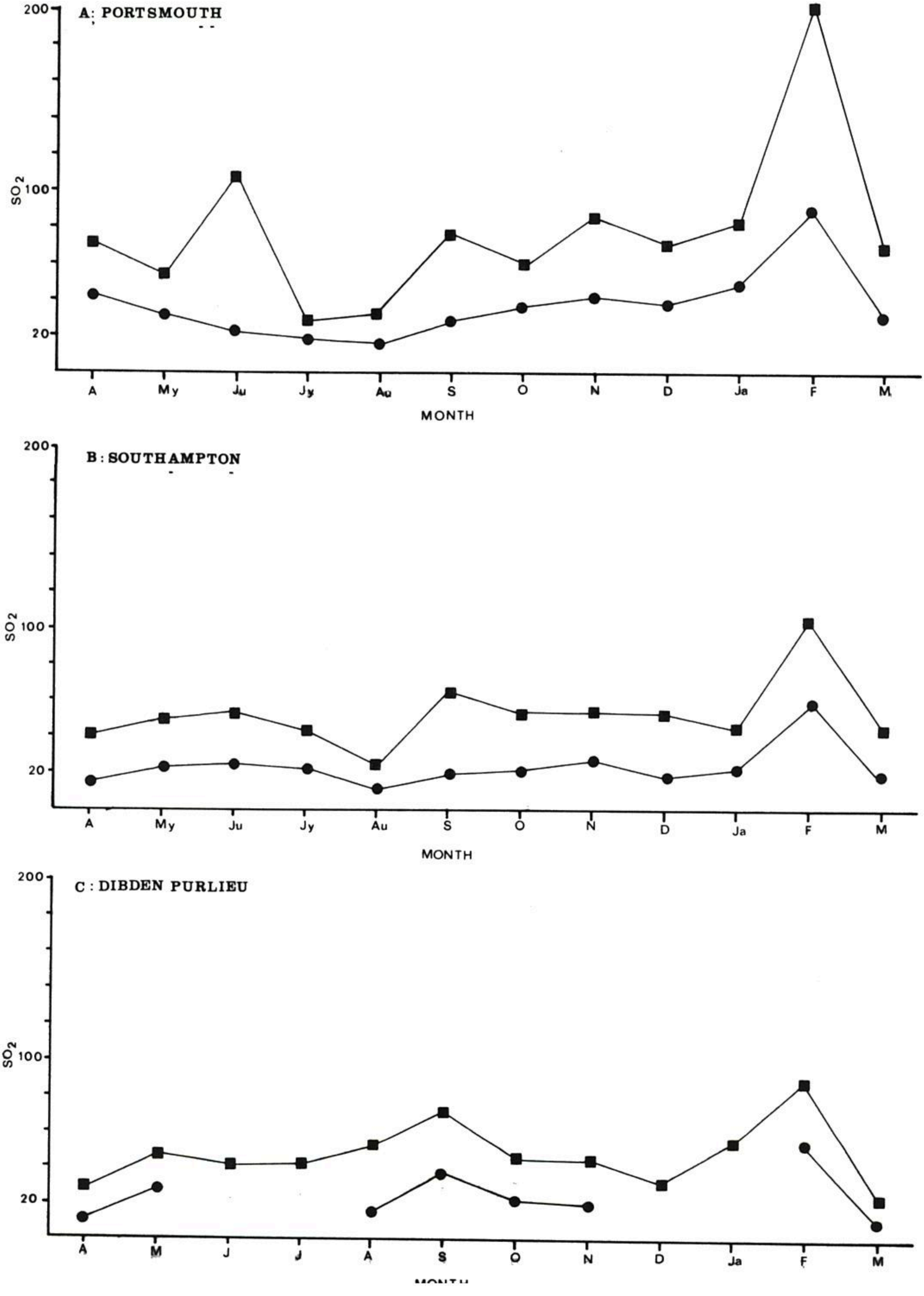
F:Mean and maximum levels of sulphur dioxide recorded at Swindon 1985-1986

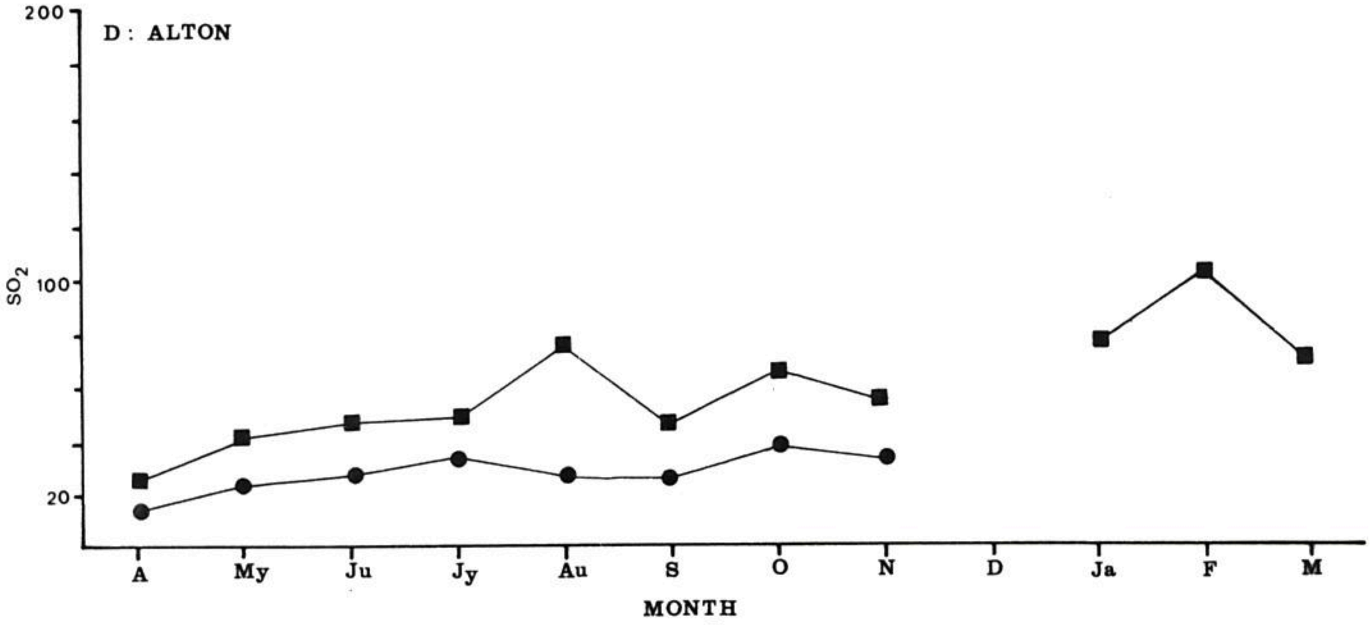
Data taken from DTI (1987). SO2 concentratins measured as microgrammes / cubic metre of air

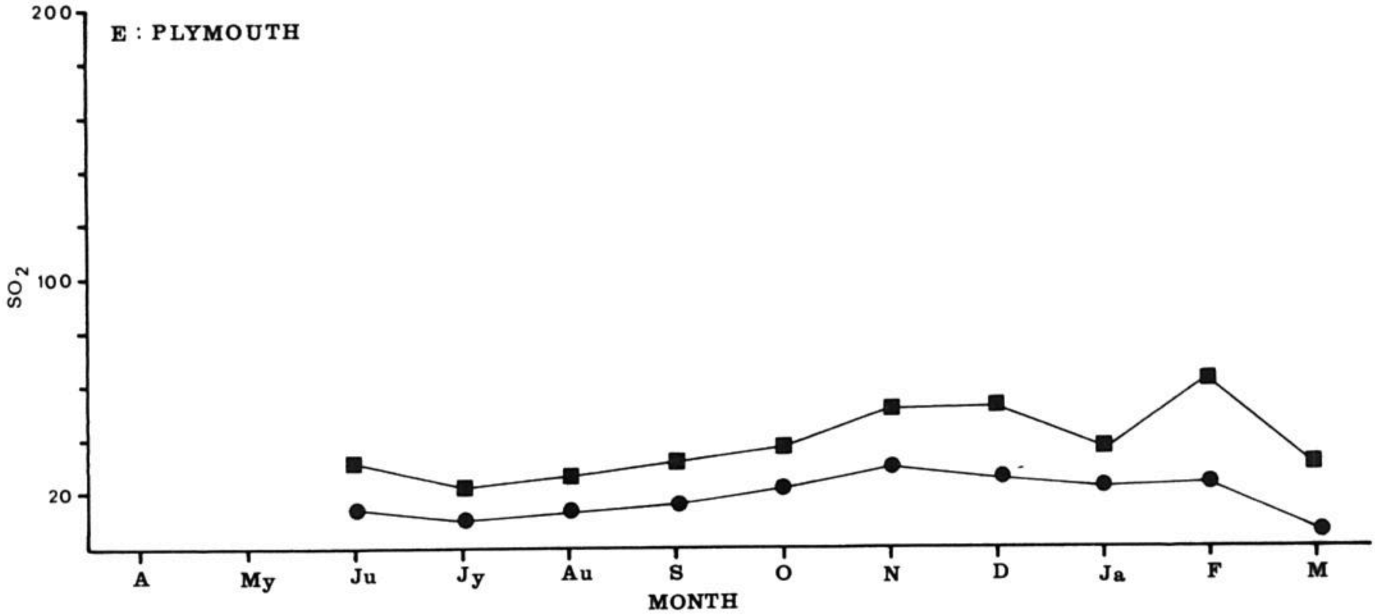
FIGURE 3:

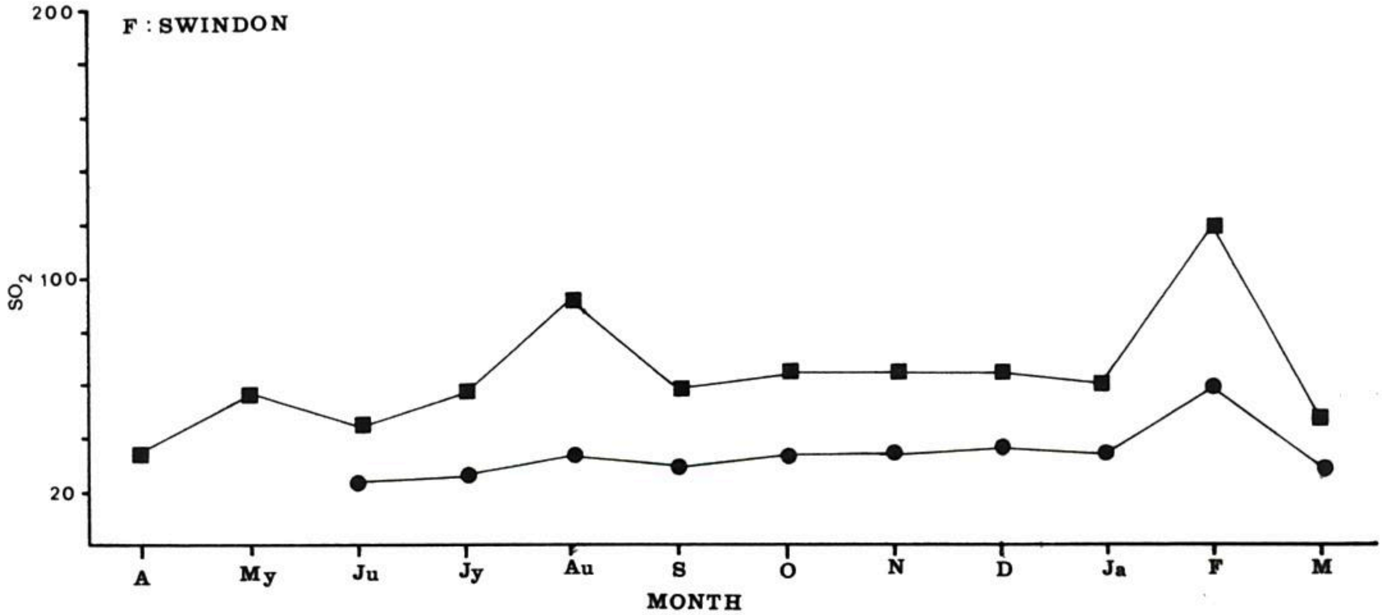
The percentile distribution of sulphur dioxide measurements from Suthampton and Portsmouth 1985-1986 (DTI 1987). This clearly shows that Prtsmuth S2 levels were cnsistently higher than those recorded in Southampton.

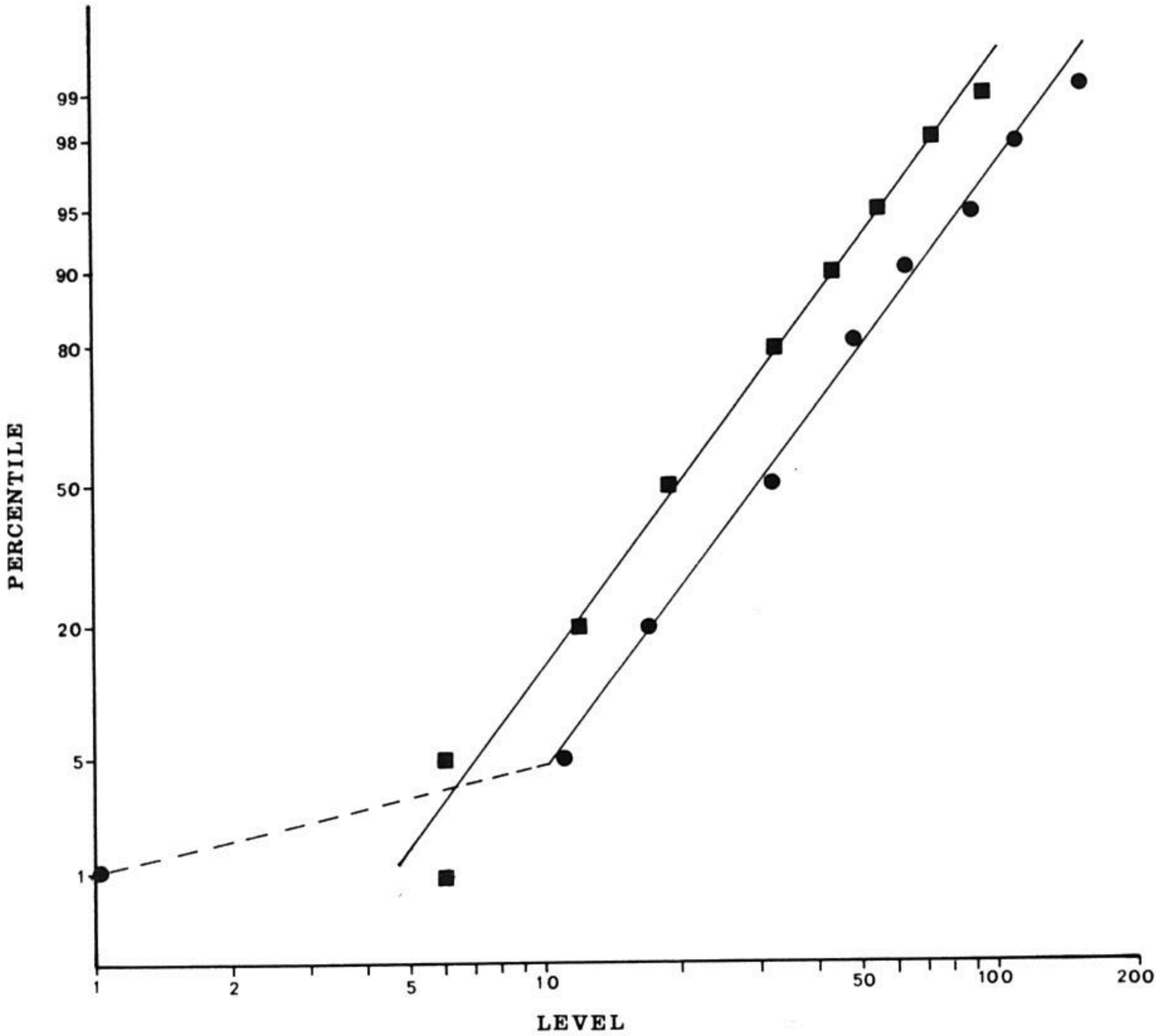

N
0
10
20
30
40


A: PORTSMOUTH
SO2
200
100
20
A
My
Ju
Jy
Au
S
O
N
D
Ja
F
M
MONTH
B: SOUTHAMPTON
SO2
200
100
20
A
My
Ju
Jy
Au
S
O
N
D
Ja
F
M
MONTH
C: DIBDEN PURLIEU
SO2
200
100
20
A
M
J
J
A
S
O
N
D
Ja
F
M


D : ALTON
200
100
20
SO2
A
My
Ju
Jy
Au
S
O
N
D
Ja
F
M
MONTH


E : PLYMOUTH
200
100
20
SO2
A
My
Ju
Jy
Au
S
O
N
D
Ja
F
M
MONTH


F : SWINDON
200
100
20
SO2
A
My
Ju
Jy
Au
S
O
N
D
Ja
F
M
MONTH



PERCENTILE
99
98
95
90
80
50
20
5
1
1
2
5
10
50
100
200
LEVEL