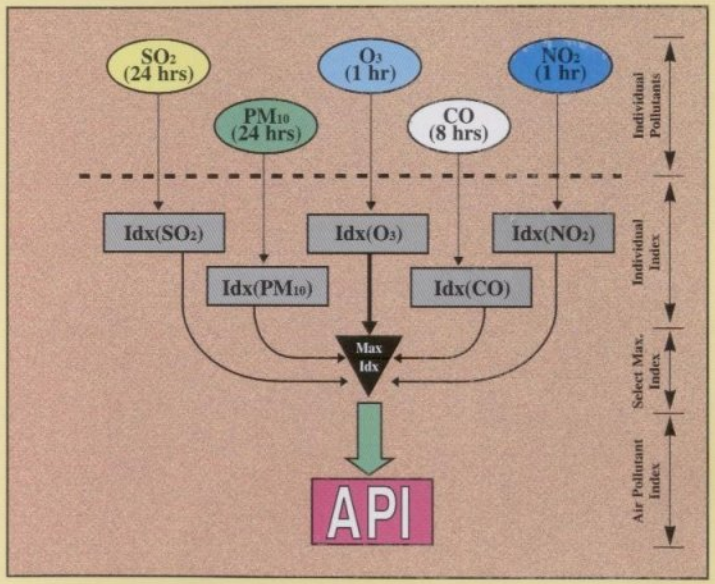
A GUIDE TO AIR POLLUTANT INDEX IN MALAYSIA
(API)



DEPARTMENT OF ENVIRONMENT

1997

A GUIDE TO AIR POLLUTANT INDEX IN MALAYSIA
(API)

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Ministry of Science, Technology and the Environment
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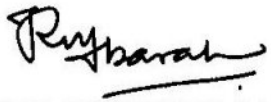
FOREWORD

The Air Pollutant Index (API) is established to provide easily understandable information about air pollution to the public. Its predecessor was the Malaysian Air Quality Index (MAQI) which was developed after a study done by the University Pertanian Malaysia in 1993. In line with the need for regional harmonisation and for easy comparison with the countries in ASEAN, the API was adopted in 1996. The API follows closely the Pollutant Standard Index (PSI) developed by the United States Environmental Protection Agency (US-EPA).

Air pollution levels are determined using internationally recognised ambient air quality measuring techniques. The pollutants measured which include sulphur dioxide, nitrogen dioxide, carbon monoxide, ozone and suspended particulate matters of less than ten microns in size are considered health related pollutants. API is then computed using the technique developed by US-EPA.

With the publication of this information booklet, I hope the public will have a better understanding of the API. Last but not least, I would like to acknowledge with thanks the contributions by University Putra Malaysia, ASMA Sdn Bhd and all those who have contributed towards the publication of this booklet.



HAJAH ROSNANI IBARAHIM
Director-General of Environmental Quality
Malaysia.

A GUIDE TO AIR POLLUTANT INDEX IN MALAYSIA

Introduction

In 1989, the Department of Environment (DOE) formulated a set of air quality guidelines, termed Recommended Malaysian Air Quality Guidelines (RMG) for air pollutants, defining the concentration limits of selected air pollutants which might adversely affect the health and welfare of the general public. Based on the RMG, the Department subsequently developed its first air quality index system, known as the Malaysian Air Quality Index (MAQI) in 1993. An index system plays an important role in conveying to both decision-makers and the general public the status of ambient air quality, ranging from good to hazardous. Application of the index system, particularly in industrialised countries, has demonstrated its useful role in providing a sound basis for both the effective management of air quality, as well as the effective protection of public health.

In line with the need for regional harmonisation and for easy comparison with countries in the region, the Department revised its index system in 1996, and the Air Pollutant Index (API) was adopted. The API system of Malaysia closely follows the Pollutant Standard Index (PSI) system of the United States.

Air Pollutant Index (API)

Recommended Malaysian Air Quality Guidelines

An air pollution index system normally includes the major air pollutants which could cause potential harm to human health should they reach unsafe levels. The air pollutants included in Malaysia's API are ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and suspended particulate matter of less than 10 microns in size (PM10).

Generally, an air pollution index system is developed in easily understood ranges of values, instead of using the actual concentrations of air pollutants, as a means for reporting the quality of air or level of air pollution. To reflect the status of the air quality and its effects on human health, the ranges of index values could then be categorised as follows: good, moderate, unhealthy, very unhealthy and

hazardous. The index values may also be categorised according to episode or action criteria, such as air pollutant levels within stipulated standards, or levels signifying conditions for alert, warning, emergency and significant harm. The key reference point in these air pollution index systems is the index value of 100 (the "safe" limit), which is based on the National Air Quality Standards or Guidelines for the specific air pollutants concerned.

The Recommended Malaysian Air Quality Guidelines (RMG) which form the basis for calculating the API are presented in **Table 1**. These guidelines have been derived from available scientific and human health data, and basically represent "safe levels" below which no adverse health effects have been observed. The RMG are generally comparable to the corresponding air quality standards recommended by the World Health Organisation and other countries.

The averaging time, which varies from 1 to 24 hours for the different air pollutants in the RMG, represents the period of time over which measurements is monitored and reported for the assessment of human health impacts of specific air pollutants. As such, the air pollution indices are normally monitored and reported for the same averaging times as those employed for the air quality standards/guidelines.

API

As mentioned earlier, the API system closely follows the PSI system of the United States. As such, the API breakpoints at 100 for the various air pollutants correspond to the respective RMG concentrations regarded as being "safe levels". In other words, air quality with API values exceeding 100 are considered likely to cause health effects to the general public. Further, a linear correlation is assumed from API 0 to API 100, with the breakpoint at API 50 corresponding to 50% of the RMG concentration standards for the various air pollutants.

Breakpoints at API 200, 300, 400 and 500 directly mirror those of the PSI system of the United States. Figures 1 to 5 depict the sub-index functions of the five API pollutants involved, which are used as the basis for calculating the API. The respective breakpoints and their corresponding episode category descriptors are also indicated. The relevant equations for the calculation of API values for the various concentration segments are also presented in Figures 1 to 5. The corresponding API values calculated as a function of the air pollutant

concentrations are listed in Table 3. Further, air quality in terms of human health impacts and implications are categorised as follows under the API system adopted in Malaysia:

API	DESCRIPTOR
0 - 50	good
51 - 100	moderate
101 - 200	unhealthy
201 - 300	very unhealthy
>300	hazardous

Table 4 summarises additional information on general human health effects and cautionary statements within each of the API categories.

Following the requirements of the RMG from the standpoint of human health implications, the API values are reported for varying averaging time as follows: PM10 and SO_2 on 24-hour running averages, CO on 8-hour running averages and O_3 and NO_2 on 1-hour running averages. The API for PM10 (based on a 24-hour period running average), reflects specifically levels of suspended particulate matter pollution and it may not be linked directly to visibility factors, as visibility is often determined by results of semi-quantitative observations over relatively shorter time periods.

How Is the Air Pollutant Index Calculated?

To determine the API for a given time period, the sub-index values (sub-API) for all five air pollutants included in the API system are first calculated using the above mentioned sub-index functions for the air quality data collected from the Continuous Air Quality Monitoring Stations. The corresponding air quality data are subjected to the necessary quality control processes and quality assurance procedures, prior to the sub-index calculations.

The API value reported for a given time period represents the highest API value among all the sub-APIs calculated during that particular time period. The predominant parameter contributing towards a particular API value is normally indicated alongside the API value. For example, during the 1997 haze episode, the predominant air pollutant parameter was PM10 and hence the API values reported were primarily based on the PM10 sub-index.

This approach is also adopted by the PSI system of the United States, and is also commonly followed by other countries in an effort to promote a uniform and comparable API system. Ideally, all sub-API values exceeding the API 100 threshold limit should also be reported in addition to the predominant API value *per se*.

The following is an outline of the procedures involved in calculating the API values (process flow chart is shown in Figure 6):-

(i) Collect continuous air quality data for the five air pollutants in the API system for sufficient averaging time periods;

(ii) Conduct the necessary calibration, validation, quality control and quality assurance in the process of data collection;

(iii) Calculate average concentration of the specific air pollutants for the specified averaging time periods;

(iv) Calculate sub-index value for each of the five air pollutants based on the average concentrations calculated and with the use of the sub-index functions (Figures 1-5);

(v) Report the API at a given time for the preceding averaging period (taking the common end point of 1-hour, 8-hour or 24-hour for all five pollutants) in terms of the highest sub-index value obtained; i.e.

API = Max {sub-indices of all five air pollutants}

State the specific air pollutant responsible for the API value as the predominant parameter along with the index;

State the relevant health effect category of the API reported;

Report also other sub-indices, if any, which exceed 100 (thereby indicating violation of an RMG).

(vi) An example of graphically presenting the air quality in terms of the API, that can be used for reporting in the TV media, is shown in Figure 7. The shaded segments may be represented by successive colours of the spectrum: "good" (blue); "moderate" (green); "unhealthy" (yellow); "very unhealthy" (orange); "hazardous" (red). This would give a subjective impression of a gradual worsening of the air pollution problem with each descriptor category.

Table 1: Recommended Malaysia Air Quality Guidelines (at 25°C and 101.13 kPa) adopted in Air Pollutant Index calculation

POLLUTANT	AVERAGING TIME	MALAYSIA GUIDELINES	
		(ppm)	($\mu g/m^3$)
OZONE	1 Hour	0.10	200
CARBON MONOXIDE #	8 Hour	9	10
NITROGEN DIOXIDE	1 Hour	0.17	320
SULFUR DIOXIDE	24 Hour	0.04	105
PM10	24 Hour		150

mg/m^3

Table 2: Significant Harm Level to API value of 500

Pollutant and Averaging Time	Concentration	
	($\mu g/m^3$)	(ppm)
Carbon Monoxide (CO) 8 hr	57,500	50
Nitrogen Dioxide (NO_2) 1 hr	3,700	2.0
Ozone (O_3) 1 hr	1,200	0.60
Particulate Matter (PM10) 24 hr	600	-
Sulfur Dioxide (SO_2) 24 hr	2,620	1.0

Table 3: API values, in steps of 5, from 5 to 500

API	Gravimetric Units					Volumetric Units			
	CO mg/m3	O3 µg/m3	SO2 µg/m3	NO2 µg/m3	PM10 µg/m3	CO ppm	O3 ppm	SO2 ppm	NO2 ppm
5	0.50	10	5.25	16.00	5.00	0.45	0.005	0.002	0.009
10	1.00	20	10.50	32.00	10.00	0.90	0.010	0.004	0.017
15	1.50	30	15.75	48.00	15.00	1.35	0.015	0.006	0.026
20	2.00	40	21.00	64.00	20.00	1.80	0.020	0.008	0.034
25	2.50	50	26.25	80.00	25.00	2.25	0.025	0.010	0.043
30	3.00	60	31.50	96.00	30.00	2.70	0.030	0.012	0.051
35	3.50	70	36.75	112.00	35.00	3.15	0.035	0.014	0.060
40	4.00	80	42.00	128.00	40.00	3.60	0.040	0.016	0.068
45	4.50	90	47.25	144.00	45.00	4.05	0.045	0.018	0.077
50	5.00	100	52.50	160.00	50.00	4.50	0.050	0.020	0.085
55	5.50	110	57.75	176.00	60.00	4.95	0.055	0.022	0.094
60	6.00	120	63.00	192.00	70.00	5.40	0.060	0.024	0.102
65	6.50	130	68.25	208.00	80.00	5.85	0.065	0.026	0.111
70	7.00	140	73.50	224.00	90.00	6.30	0.070	0.028	0.119
7.	7.50	150	78.75	240.00	100.00	6.75	0.075	0.030	0.128
80	8.00	160	84.00	256.00	110.00	7.20	0.080	0.032	0.136
85	8.50	170	89.25	272.00	120.00	7.65	0.085	0.034	0.145
90	9.00	180	94.50	288.00	130.00	8.10	0.090	0.036	0.153
95	9.50	190	99.75	304.00	140.00	8.55	0.095	0.038	0.162
100	10.00	200	105.00	320.00	150.00	9.00	0.100	0.040	0.170
105	10.35	210	139.75	360.50	160.00	9.30	0.105	0.053	0.192
110	10.70	220	174.50	401.00	170.00	9.60	0.110	0.066	0.213
115	11.05	230	209.25	441.50	180.00	9.90	0.115	0.079	0.235
120	11.40	240	244.00	482.00	190.00	10.20	0.120	0.092	0.256
125	11.75	250	278.75	522.50	200.00	10.50	0.125	0.105	0.278
130	12.10	260	313.50	563.00	210.00	10.80	0.130	0.118	0.299
135	12.45	270	348.25	603.50	220.00	11.10	0.135	0.131	0.321
140	12.80	280	383.00	644.00	230.00	11.40	0.140	0.144	0.342
145	13.15	290	417.75	684.50	240.00	11.70	0.145	0.157	0.364
150	13.50	300	452.50	725.00	250.00	12.00	0.150	0.170	0.385
155	13.85	310	487.25	765.50	260.00	12.30	0.155	0.183	0.407
160	14.20	320	522.00	806.00	270.00	12.60	0.160	0.196	0.428
165	14.55	330	556.75	846.50	280.00	12.90	0.165	0.209	0.450
170	14.90	340	591.50	887.00	290.00	13.20	0.170	0.222	0.471
175	15.25	350	626.25	927.50	300.00	13.50	0.175	0.235	0.493
180	15.60	360	661.00	968.00	310.00	13.80	0.180	0.248	0.514
185	15.95	370	695.75	1008.50	320.00	14.10	0.185	0.261	0.536
190	16.30	380	730.50	1049.00	330.00	14.40	0.190	0.274	0.557
195	16.65	390	765.25	1089.50	340.00	14.70	0.195	0.287	0.579
200	17.00	400	800.00	1130.00	350.00	15.00	0.200	0.300	0.600

CO is measured as an 1 hr average, O3 and NO2 are 1-hr averages, SO2 and PM10 are 24-hr averages

(continued)

API	Gravimetric Units					Volumetric Units			
	CO mg/m3	O3 µg/m3	SO2 µg/m3	NO2 µg/m3	PM10 µg/m3	CO ppm	O3 ppm	SO2 ppm	NO2 ppm
205	17.85	420	840	1187	353.50	15.75	0.210	0.315	0.630
210	18.70	440	880	1243	357.00	16.50	0.220	0.330	0.660
215	19.55	460	920	1300	360.50	17.25	0.230	0.345	0.690
220	20.40	480	960	1356	364.00	18.00	0.240	0.360	0.720
225	21.25	500	1000	1413	367.50	18.75	0.250	0.375	0.750
230	26.25	505	1005	1469	372.5	23.75	5.25	5.375	5.75
235	22.95	540	1080	1526	374.50	20.25	0.270	0.405	0.810
240	23.80	560	1120	1582	378.00	21.00	0.280	0.420	0.840
245	24.65	580	1160	1639	381.50	21.75	0.290	0.435	0.870
250	25.50	600	1200	1695	385.00	22.50	0.300	0.450	0.900
255	26.35	620	1240	1752	388.50	23.25	0.310	0.465	0.930
260	27.20	640	1280	1808	392.00	24.00	0.320	0.480	0.960
265	28.05	660	1320	1865	395.50	24.75	0.330	0.495	0.990
270	28.90	680	1360	1921	399.00	25.50	0.340	0.510	1.020
275	29.75	700	1400	1978	402.50	26.25	0.350	0.525	1.050
280	30.60	720	1440	2034	406.00	27.00	0.360	0.540	1.080
285	31.45	740	1480	2091	409.50	27.75	0.370	0.555	1.110
290	32.30	760	1520	2147	413.00	28.50	0.380	0.570	1.140
295	33.15	780	1560	2204	416.50	29.25	0.390	0.585	1.170
300	34.00	800	1600	2260	420.00	30.00	0.400	0.600	1.200
305	34.80	810	1625	2297	424.00	30.50	0.405	0.610	1.220
310	35.20	820	1650	2334	428.00	31.00	0.410	0.620	1.240
315	35.80	830	1675	2371	432.00	31.50	0.415	0.630	1.260
320	36.40	840	1700	2408	436.00	32.00	0.420	0.640	1.280
325	37.00	850	1725	2445	440.00	32.50	0.425	0.650	1.300
330	37.60	860	1750	2482	444.00	33.00	0.430	0.660	1.320
335	38.20	870	1775	2519	448.00	33.50	0.435	0.670	1.340
340	38.80	880	1800	2556	452.00	34.00	0.440	0.680	1.360
345	39.40	890	1825	2593	456.00	34.50	0.445	0.690	1.380
350	40.00	900	1850	2630	460.00	35.00	0.450	0.700	1.400
355	40.60	910	1875	2667	464.00	35.50	0.455	0.710	1.420
360	41.20	920	1900	2704	468.00	36.00	0.460	0.720	1.440
365	41.80	930	1925	2741	472.00	36.50	0.465	0.730	1.460
370	42.40	940	1950	2778	476.00	37.00	0.470	0.740	1.480
375	43.00	950	1975	2815	480.00	37.50	0.475	0.750	1.500
380	43.60	960	2000	2852	484.00	38.00	0.480	0.760	1.520
385	44.20	970	2025	2889	488.00	38.50	0.485	0.770	1.540
390	44.80	980	2050	2926	492.00	39.00	0.490	0.780	1.560
395	45.40	990	2075	2963	496.00	39.50	0.495	0.790	1.580
400	46.00	1000	2100	3000	500.00	40.00	0.500	0.800	1.600

CO is measured as an 1 hr average, O3 and NO2 are 1-hr averages; SO2 and PM10 are 24-hr averages

(continued)

API	Gravimetric Units					Volumetric Units			
	CO mg/m3	O3 µg/m3	SO2 µg/m3	NO2 µg/m3	PM10 µg/m3	CO ppm	O3 ppm	SO2 ppm	NO2 ppm
405	46.58	1010	2126	3038	505.00	40.50	0.505	0.810	1.620
410	47.15	1020	2152	3075	510.00	41.00	0.510	0.820	1.640
415	47.73	1030	2178	3113	515.00	41.50	0.515	0.830	1.660
420	48.30	1040	2204	3150	520.00	42.00	0.520	0.840	1.680
425	48.88	1050	2230	3188	525.00	42.50	0.525	0.850	1.700
430	49.45	1060	2256	3225	530.00	43.00	0.530	0.860	1.720
435	50.03	1070	2282	3263	535.00	43.50	0.535	0.870	1.740
440	50.60	1080	2308	3300	540.00	44.00	0.540	0.880	1.760
445	51.18	1090	2334	3338	545.00	44.50	0.545	0.890	1.780
450	51.75	1100	2360	3375	550.00	45.00	0.550	0.900	1.800
455	52.33	1110	2386	3413	555.00	45.50	0.555	0.910	1.820
460	52.90	1120	2412	3450	560.00	46.00	0.560	0.920	1.840
465	53.48	1130	2438	3488	565.00	46.50	0.565	0.930	1.860
470	54.05	1140	2464	3525	570.00	47.00	0.570	0.940	1.880
475	54.63	1150	2490	3563	575.00	47.50	0.575	0.950	1.900
480	55.20	1160	2516	3600	580.00	48.00	0.580	0.960	1.920
485	55.78	1170	2542	3638	585.00	48.50	0.585	0.970	1.940
490	56.35	1180	2568	3675	590.00	49.00	0.590	0.980	1.960
495	56.93	1190	2594	3713	595.00	49.50	0.595	0.990	1.980
500	57.50	1200	2620	3750	600.00	50.00	0.600	1.000	2.000

CO is measured as an 1 hr average, O3 and NO2 are 1-hr averages; SO2 and PM10 are 24-hr averages

Table 4: Comparison of API values with level of pollution and health measures.

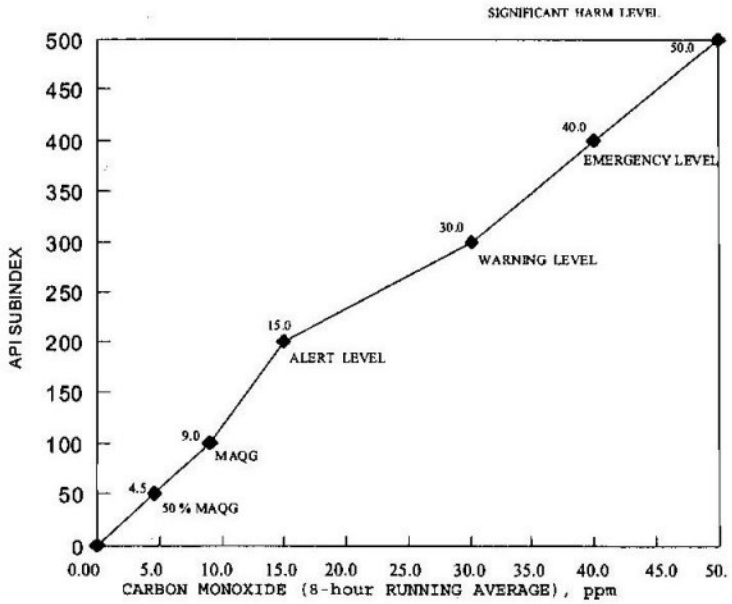
API	Status	Level of Pollution	Health Measures
0 - 50	Good	Pollution low and has no ill effects on health.	✡ No restriction of activities for all groups of people. ✡ To practice healthy lifestyle e.g. not to smoke, exercise regularly and to observe proper nutrition.
51 - 100	Moderate	Moderate pollution and has no ill effects on health	✡ No restriction of activities for all groups of people. ✡ To practice healthy lifestyle e.g. not to smoke, exercise regularly and to observe proper nutrition.
101-200	Unhealthy	Mild aggravation of symptoms among high risk persons, i.e. those with heart or lung disease.	✡ Restriction of outdoor activities for high risk persons. ✡ General population should reduce vigorous outdoor activity.

Table 4: continued

API	Status	Level of Pollution	Health Measures
201 - 300	Very Unhealthy	Significant aggravation of symptoms and decreased exercise tolerance in person with heart or lung disease.	✡ Elderly and persons with known heart or lung disease should stay indoors and reduce physical activity. ✡ General population should avoid vigorous outdoor activity ✡ Those with any health problems to consult doctor.
301 - 500	Hazardous	Severe aggravation of symptoms and endangers health.	✡ Elderly and persons with existing heart or lung disease should stay indoors and reduce physical activity. ✡ General population should avoid vigorous outdoor activity
Above 500	Emergency	Severe aggravation of symptoms and endangers health.	✡ General population advised to follow the orders of the National Security Council and always to follow the announcements through the mass media.

Source: Ministry of Health, Malaysia.

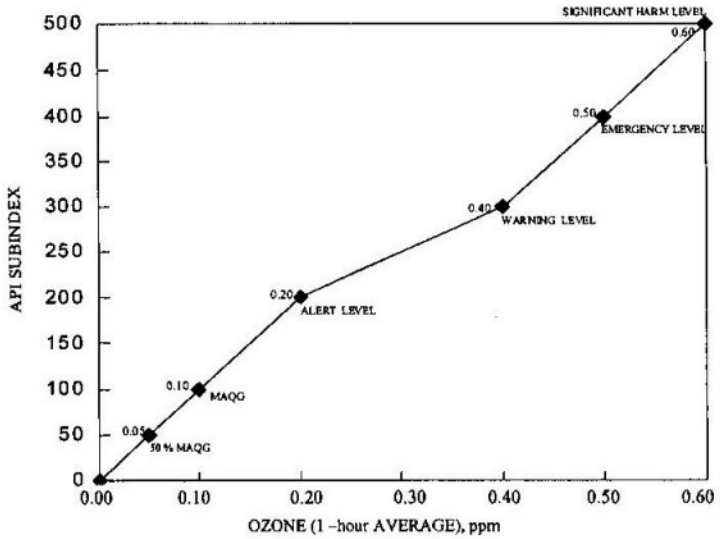
Figure 1 : API subindex function for carbon monoxide



Equation for the calculation of API based on 8– hour average concentration:

conc < 9 ppm	API = conc. x 11.11111
9 < conc. < 15	API = 100 + {[conc. – 9] x 16.66667}
15 < conc. < 30	API = 200 + {[conc. – 15] x 6.66667}
conc. > 30 ppm	API = 300 + {[conc. – 30] x 10}

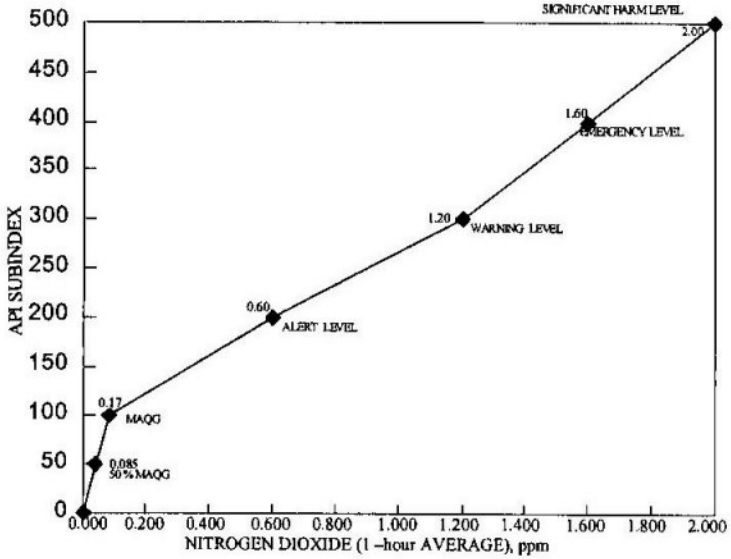
Figure 2 : API subindex function for ozone



Equation for the calculation of API based on 1– hour average concentration:

*conc < 0.2 ppm	API = conc. x 1000
0.2 < conc. < 0.4	API = 200 + {[conc. – 0.2] x 500}
conc. > 0.4 ppm	API = 300 + {[conc. – 0.4] x 1000}

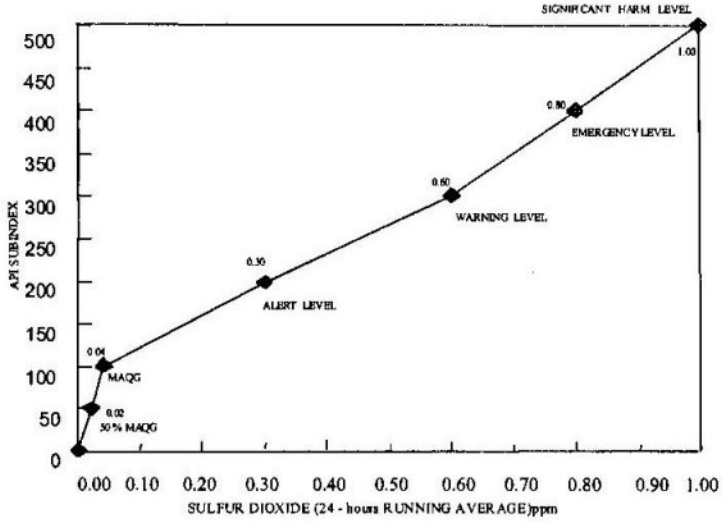
Figure 3 : API subindex function for nitrogen dioxide



Equation for the calculation of API based on 1– hour average concentration:

*conc < 0.17 ppm	API = conc. x 588.23529
*0.17 < conc. < 0.6	API = 100 + {[conc. – 0.17] x 232.56}
0.6 < conc. < 1.2	API = 200 + {[conc. – 0.6] x 166.667}
conc. > 1.2 ppm	API = 300 + {[conc. – 1.2] x 250}

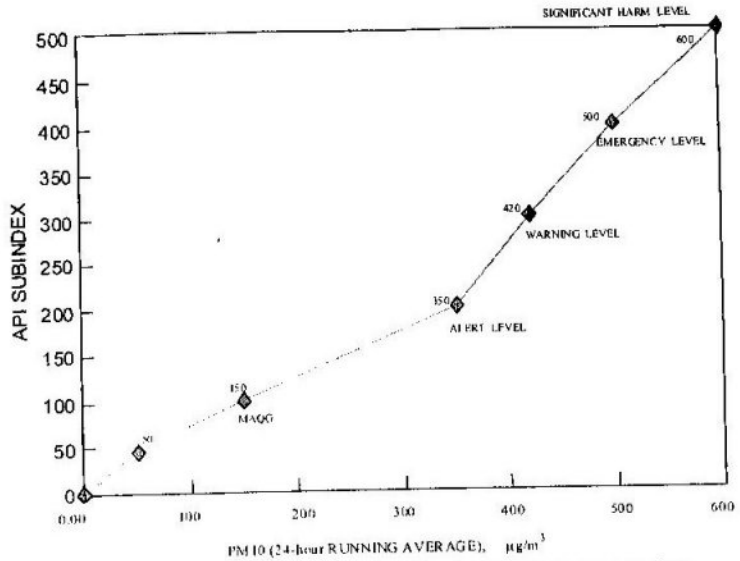
Figure 4 : API subindex function for sulfur dioxide



Equation for the calculation of API based on 24 – hour average concentration:

*conc < 0.04 ppm	API = conc. x 2500
*0.04 < conc. < 0.3	API = 100 + {[conc. – 0.04] x 384.61}
0.3 < conc. < 0.6	API = 200 + {[conc. – 0.3] x 333.333}
conc. > 0.6 ppm	API = 300 + {[conc. – 0.6] x 500}

Figure 5 : API subindex function for PM10



Equation for the calculation of API based on 24 – hour average concentration:

conc < 50 µg/cu.m	API = conc.
50 < conc. < 350	API = 50 + {[conc. – 50] x 0.5}
350 < conc. < 420	API = 200 + {[conc. – 350] x 1.4286}
420 < conc. < 500	API = 300 + {[conc. – 420] x 1.25}
conc. > 500 µg/cu.m	API = 400 + [conc. – 500]

Figure 6: Air Pollutant Index Process Flowchart

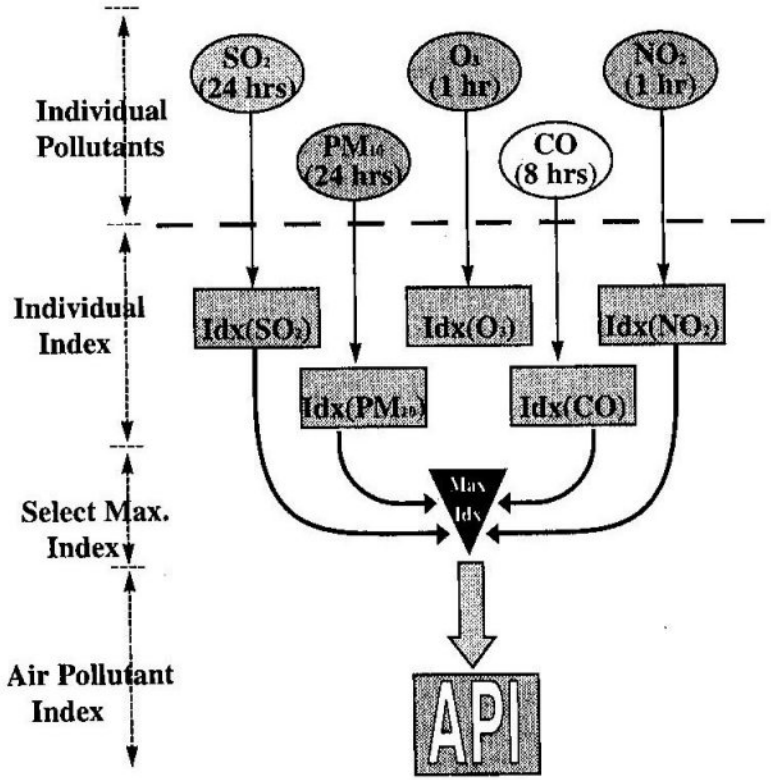
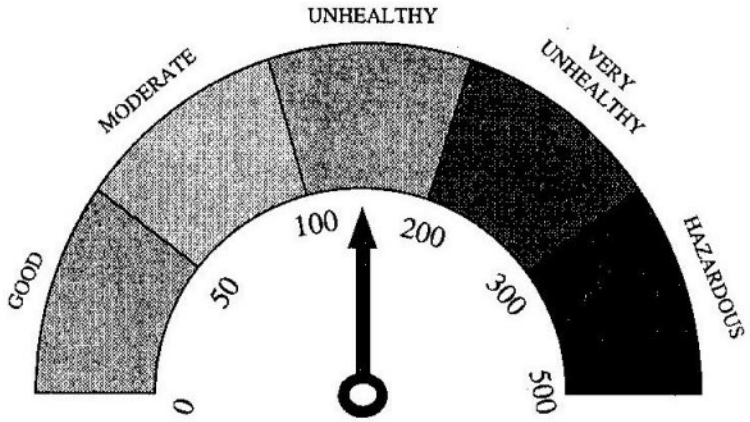


Figure 7: Example of possible API report for television.



POLLUTANT: Ozone

TODAY'S HEALTH IMPLICATION:
Mild aggravation of symptoms among high risk persons, i.e. those with heart or lung disease.