CHAPTER 5

空氣污染法規 - 美國之CAA(A)

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- 網路資源：

1. PLAIN ENGLISH GUIDE TO THE CAA:

HTTPS://WWW.EPA.GOV/CLEAN-AIR-ACT-OVERVIEW/PLAIN-ENGLISH-GUIDE-CLEAN-AIR-ACT

2. FULL TEXT OF CAA:

- **HTTP://WWW.EPA.GOV/AIR/CAA/**

目錄

5-1.名詞定義

Criteria Pollutant. One of six air pollutants for which a National Ambient Air Quality Standard (NAAQS) has been established by EPA: sulfur dioxide, nitrogen oxides, carbon monoxide, ozone, particulate matter (PM_{10} and $PM_{2.5}$) and lead. NAAQS has been established based on specific health criteria.

Air Toxic. A toxic air pollutant is defined as any potentially hazardous non-criteria air pollutant. Criteria pollutants are SO_2, NO_x, CO, O_3, suspended particulates, and lead.

5-1.名詞定義

AAL. ***Acceptable Ambient Levels*** are ambient air quality standards or guidelines for air toxics established by various state agencies intended to protect public health.

Air Quality Standards. The maximum limits or concentrations of pollutants permitted in air. United States standards are based on estimates of maximum concentrations, which with an allowance for safety, present no hazard to human health or the environment.

AAQS. ***Ambient Air Quality Standards*** are ***emission limitations*** that protect the air quality of the surrounding air.

Ambient Air Guidelines. Air quality criteria incorporated in some state air toxics programs used to evaluate the acceptability of a source's impact. Guidelines differ from standards in that other factors can also be incorporated into the evaluation.

5-1.名詞定義

Fugitive Emissions. Emissions to the atmosphere from pumps, valves, flanges, seals, and other process points not vented through a stack. Also includes emissions from area sources such as ponds, lagoons, landfills, and piles of stored material. The emissions often are not regulated.

GEP. ***Good Engineering Practice*** Stack Height is the height at which emissions from point sources are not influenced by **aerodynamic downwash** as established by EPA regulations.

IDLH. ***Immediate Danger to Life and Health*** is the level that represents a maximum concentration from which one could escape within 30 minutes without any escape-impairing symptoms or any irreversible health effects. These include substances that should be treated as potential human carcinogens.

5-1.名詞定義

BACT. ***Best Available Control Technology*** is required for **major new or modified major** sources located in PSD areas. BACT is determined on a case-by-case basis taking into account energy, economic and environmental impacts.

BART. ***Best Available Retrofit Technology*** is required for existing sources that contribute to visibility impairment in **Class I areas**. BART is determined on a case-by-case basis.

Emission Standard. The maximum amount of a specified pollutant permitted in airborne discharges.

LAER. ***Lowest Achievable Emission Rate*** is required for **new or modified** major sources located in **nonattainment areas**. LAER is based on the most stringent emission rate contained in any SIP or achieved in practice by the same or similar sources.

RACT. ***Reasonably Available Control Technology*** is the recommended level of emission controls applicable to some sources located in **nonattainment areas requiring revisions of SIPs**.

5-1.名詞定義

NSPS. ***New Source Performance Standards*** are a set of national emission standards for both **criteria and designated pollutants** from specific classes or categories of new, modified, or reconstructed sources. For the last ten years, NSPS have been the bedrock of air pollution control strategy.

NESHAP. ***National Emission Standards for Hazardous Air Pollutants*** are a set of national emission standards for listed **hazardous pollutants** (carcinogens, mutagens, toxicants, etc.) emitted from specific classes or categories of new and existing sources. These include and were introduced in the Clean Air Act Amendments of 1977.

5-1.名詞定義

MACT. ***Maximum Achievable Control Technology*** — standards based on emissions levels that are already being achieved by the better-controlled and lower-emitting sources in an industry.

In setting MACT standards, **EPA does not generally prescribe a specific control technology**. Instead, whenever feasible, **the Agency sets a performance level** based on technology or other practices already used by the industry. Facilities are free to achieve these performance levels in whatever way is most cost-effective for them.

5-1.名詞定義

- **MACT floor**

When developing a MACT standard for a particular source category, EPA looks at the **level of emissions** currently being achieved by the **best-performing similar sources** through clean processes, control devices, work practices, or other methods. These **emissions levels set a baseline** (often referred to as the "**MACT floor**") for the new standard.

At a minimum, a MACT standard must achieve, throughout the industry, a level of emissions control that is at least equivalent to the MACT floor.

EPA can establish a more stringent standard when this makes economic, environmental, and public health sense.

5-1.名詞定義

- **MACT for existing and new sources.**

The MACT floor is established differently for existing sources and new sources :

•**For existing sources**, the MACT floor must equal the average emissions limitations currently achieved by **the best-performing 12 percent** of sources in that source category, if there are 30 or more existing sources. If there are fewer than 30 existing sources, then the MACT floor must equal the average emissions limitation achieved by the **best-performing five** sources in the category.

•**For new sources**, the MACT floor must equal the level of emissions control currently achieved by the **best-controlled** similar source.

Wherever feasible, EPA writes the final MACT standard as an emissions limit (i.e., as a percent reduction in emissions or a concentration limit that regulated sources must achieve). Emissions limits provide flexibility for industry to determine the most effective way to comply with the standard.

5-1.名詞定義

NA. ***Nonattainment Area*** is an air quality control region (or portion thereof) in which the EPA has determined that ambient air concentrations exceed NAAQS for one or more criteria pollutants.

PSD. ***Prevention of Significant Deterioration*** regulations were established by the 1977 Clean Air Act Amendments to limit increases in criteria air pollutant concentrations above baseline.

SIP. ***State Implementation Plans*** are requirement set forth by the Clean Air Act for states to develop plans and programs to achieve and maintain NAAQS.

5-1.名詞定義

OEL. ***Occupational Exposure Levels*** are a **general description** for permissible occupational exposure levels set by occupational health agencies. OEL are often used as a basis for developing ambient air guidelines for air toxics programs. (不同單位會訂定其建議的OEL值(職業暴露標準))

PEL. ***Permissible Exposure Limits*** are **workplace exposure limits** established by the Occupational Safety and Health Administration (OSHA, 美國職業安全衛生署). PEL有法源依據。

TLV. ***Threshold Limit Values*** are the recommended concentrations of airborne contaminants to which workers may be exposed according to the American Council of Governmental Industrial Hygienists (ACGIH, 美國政府工業衛生師協會).

5.2 CAA之歷史

- 5-2.1 CAA簡介
- 5-2.2 CAA之版本演進

5-2.1 CAA簡介

- The Clean Air Act is the comprehensive **Federal law** that regulates air emissions from area, stationary, and mobile sources. **This law authorizies the U.S. Environmental Protection Agency to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment.**

- **The goal of the Act was to set and achieve NAAQS in every state by 1975.** The setting of maximum pollutant standards was coupled with directing the states to develop **state implementation plans (SIP's)** applicable to appropriate industrial sources in the state.

5-2.1 CAA簡介

- The Act was amended in 1977 primarily to set new goals (dates) for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines.
- The 1990 amendments to the Clean Air Act in large part were intended to meet unaddressed or insufficiently addressed problems such as acid rain, ground-level ozone, stratospheric ozone depletion, and air toxics.
- The Clean Air Act in1970 was **the first** major environmental law in the United States to include a provision for **citizen suits**.

5-2.2 CAA之版本演進

第一版：1955年　Clean Air Act (Air Pollution Control Act)

第二版：1960年　加入對移動源之污染管制

第三版：1963年　加入與fuel desulfurization及air quality criteria相關法規

第四版：1965年　對新污染源進行調查

第五版：1967年　CAA→**Air Quality Act of 1967**. 其對空污管制區局限於空污問題嚴重者

5-2.2 CAA之版本演進

第六版：1970年　**EPA成立**，AQA→**Clean Air Amendments(CAA)**

第七版：1977年　最大修正規模之版本，目標在保護人民之健康及環境保護。

許多法規均在此次CAA中明確訂定

第八版：1990年　CAA**A**(Clean Air Act **Amendments**)，CAA(USC版)共分為6個subchapters (titles), CAA**A**則共計有11個titles，其中包括7個主要之titles。較大之變革為增加air toxic, acid rain,針對平流層與對流層之臭氧相關規範

最後一次修訂版: 2008年(但只有小修正，主要修正版還是1990年的版本)

5-2.2 CAA之版本演進

- 以下將分別敘述1977年之舊版CAA之內容（這些舊版內容在1990年之CAAA中絕大多數都被保留），以及1990版之變革。

5-3 Clean Air Act之主要條款（1977年版）

- 在1977年版之Clean Air Act主要條款包括了：

1) **NAAQS**
2) **PSD program**
3) **NA area regulations**
4) **NESHAP**
5) **NSPS**
6) **Stack Height Regulation**

5-3 Clean Air Act之主要條款（1977年版）

以下則分別就下列章節進行說明:

- 5-3.1 NAAQS
- 5-3.2 PSD program
- 5-3.3 NA area
- 5-3.4 NESHAP
- 5-3.5 NSPS
- 5-3.6 Stack Height Regulations
- 5-3.7 SIP & FIP

5-3.1 NAAQS（National Ambient Air Quality Standards）

- NAAQS乃依污染物對公眾之健康或福祉之可判定影響而訂定之大氣中各污染物濃度之上限值。
- 在美國NAAQS分為一級及二級標準。一級標準主要即在於考量對人體健康之影響，二級標準則主旨在維護環境。
- 1977年版之CAAA為各法規污染物訂定了期程，探討其標準之適用性。在1979年時，O_3標準訂定，以了解光化學氧化物之影響；
- 而在1983年時，則廢除了HCs之標準；
- 1987年時，增加了PM_{10}標準，並廢除了TSP標準，但在各州準備其PM_{10}之SIP期間，TSP標準仍可並用。
- 1997年則再增加$PM_{2.5}$之標準(65μg/m^3, 24hr-ave.; 15μg/m^3, annual)，並修訂O_3標準(0.08ppm, 8-hr ave.)。
- 2008年起，NAAQS持續下修，如2008年O_3改為0.075ppm之8-hr平均標準值; 2015年再下降為0.07ppm。PM2.5於2006年將24hr平均下降為35μg/m^3; 2013年則再將年平均分為一級(12μg/m^3)與二級標準(15μg/m^3))

5-3.1 NAAQS（National Ambient Air Quality Standards）

表5-1說明了美國現行之NAAQS，基本上其訂定即是依上述原則（**健康、環境保護**）所訂，然亦有經濟學家對此持不同看法，如Downing[1](1984)即認為依上述原則所訂定之標準將導致在執行上缺乏效率，因此標準之訂定應至少再包含**技術可行性**及**經濟效率**兩個原則。

5-3.1 NAAQS（National Ambient Air Quality Standards）

表5-1 Summary of National Ambient Air Quality Standards (NAAQS).

Pollutant [links to historical tables of NAAQS reviews]		**Primary/ Secondary**	**Averaging Time**	**Level**	**Form**
Carbon Monoxide (CO)		primary	8 hours	9 ppm	Not to be exceeded more than once per year
			1 hour	35 ppm	
Lead (Pb)		primary and secondary	Rolling 3 month average	0.15 $\mu g/m^3$ (1)	Not to be exceeded
Nitrogen Dioxide (NO_2)		primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		primary and secondary	1 year	53 ppb (2)	Annual Mean
Ozone (O_3)		primary and secondary	8 hours	0.070 ppm (3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 $\mu g/m^3$	annual mean, averaged over 3 years
		secondary	1 year	15.0 $\mu g/m^3$	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb (4)	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

5-3.1 NAAQS（National Ambient Air Quality Standards）

表5-1 Summary of National Ambient Air Quality Standards (NAAQS).

(1) In areas designated nonattainment for the **Pb** standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, **the previous standards (before 2008 it was 1.5 μg/m^3 as a calendar quarter average) also remain in effect**.

(2) The level of the annual NO2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

(3) Final rule signed October 1, 2015, and effective December 28, 2015. **The previous (2008) O3 standards additionally remain in effect in some areas.** Revocation of the previous (2008) O3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

(4) The previous SO2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (i) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (ii)any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO2 standards or is not meeting the requirements of a SIP call under the previous SO2 standards (40 CFR 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its State Implementation Plan to demonstrate attainment of the required NAAQS.

5-3.1 NAAQS（National Ambient Air Quality Standards）

- NAAQS有一個很特別的地方是，其**O_3舊標準**之決定為由**期望值(expected value)**所決定，其O_3每天之1-hr average之最大值超過該小時標準值次數之期望值每年不得超過1次，PM10年平均值亦有類似之採期望值情況。
- 而在後續持續更新之NAAQS標準中， O_3(8 hr ave)及$PM_{2.5}$（年平均; 24 hr）則由過去3年所得之監測值記錄平均值決定之（98%值或第四高值等），我國目前對criteria pollutants也採用過去三年之監測記錄來決定（詳見新版之我國空污法）。
- 此外較有趣的現象是，O_3 8hr 標準在大多數地區於2004年6月15日適用一年後，O_3 1 hr標準值即被取消，美國目前O_3只剩下8-hr NAAQS。

➢ 各防制區（**attainment與non-attainment areas**）之劃分，即**依NAAQS來劃分**，某個區域可能是PM10之non-attainment area，卻為SO_2之attainment area。

註: 期望值就是統計學上平均數的意思

5-3.2 PSD program

What is PSD (preventing significant deterioration)?

In 1977, the Clean Air Act (CAA) was amended by Congress to include specific provisions aimed at **preventing significant deterioration (PSD) of air quality in areas meeting the National Ambient Air Quality Standards (NAAQS).**

- PSD是針對可以符合空氣品質標準的區域 (attainment area) 所訂定的法規

5-3.2 PSD program

- Under the CAA, new major stationary sources of certain air pollutants, defined as "**regulated NSR pollutants**," and major modifications to existing **major sources** are required to, among other things, obtain a **PSD permit** prior to construction or major modification.
- Once major sources become subject to PSD, these sources must, in order to obtain a **PSD permit**, meet the various PSD requirements.
- For example, they must apply **BACT**, demonstrate compliance with air quality related values and **PSD increments**, address impacts on special Class I areas (e.g., some national parks and wilderness areas), and assess impacts on soils, vegetation, and visibility.

5-3.2 PSD program

What is NSR (New Source Review)?

- New Source Review (NSR) is a Clean Air Act program that requires industrial facilities to install modern pollution control equipment when they are built or when making a change that increases emissions significantly.
- The program accomplishes this when owners or operators obtain permits limiting air emissions before they begin construction. For that reason, NSR is commonly referred to as the "preconstruction air permitting program."
- Specifically, its purpose is to ensure that air quality:
  - does not worsen where the air is currently unhealthy to breathe (i.e. **nonattainment areas**)
  - is not significantly degraded where the air is currently clean (i.e. **attainment areas**)

5-3.2 PSD program

What is a Major Source (主要污染源)?

- 定義如表5-2所示之28項污染源，排放量在100 ton/yr（任一項污染物）者，
- 如果該廠非表5-2所屬之污染源，但排放量超過250 ton/yr者亦為主要污染源。
- 若**主要既存**污染源在擴廠時，排放量顯著增加（如表5-3）則需**PSD review**。該排放量為估計之“**最大操作容量下，考量污染防治效率**”之排放量。

5-3.2 PSD program

表5-2 Major Stationary Sources（Threshold－100TPY）(1/2)

1. Fossil-fuel fired steam electric plants of more than 250,000,000 Btu per hour heat input
2. Cool cleaning plants (with thermal dryers)
3. Kraft pulp mills
4. Portland cement plants
5. Primary steel mills
6. Iron and steel mills
7. Primary aluminum ore reduction plants
8. Primary copper smelters
9. Municipal incinerators capable of discharging more than 250 tons of refuse per day
10. Hydrofluoric acid plants
11. Sulfuric acid plants
12. Nitric acid plants
13. Petroleum refineries
14. Lime plants

5-3.2 PSD program

表5-2 Major Stationary Sources（Threshold－100TPY）(2/2)

15.Phosphate rock processing plants
16.Coke oven batteries
17.Sulfur recovery plants
18.Carbon black plants (furnace process)
19.Primary lead smelters
20.Fuel conversion plants
21.Sintering plants
22.Secondary metal production facilities
23.Chemical process plants
24.Fossil-fuel boilers of more than 250,000,000 Btu per hour heat input
25.Petroleum storage and transfer facilities with a capacity exceeding 300,000 barrels
26.Taconite ore processing facilities
27.Glass fiber processing plants
28.Charcoal production facilities

5-3.2 PSD program

表5-3 Significant Pollutant Emission Rates (for 既存廠)

Pollutants	Emission Rate (TPY)
Carbon monoxide	100.0
Nitrogen oxides	40.0
PM (TSP)	25.0
PM10	15.0
PM2.5	10.0
Sulfur dioxide	40.0
Ozone	40.0[1]
Lead	0.6
Mercury	0.1
Carbon monoxide	100.0
Nitrogen oxides	40.0

[1]As volatile organic compounds (VOC) or NOx (如德州就如此定義其VOCs SER); 尚有其他物種，此處略，詳參閱課文

5-3.2 PSD program

PSD的精神: PSD does not prevent sources from increasing emissions. Instead, PSD is designed to:

1. **protect public health and welfare**;
2. preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special **national or regional natural, recreational, scenic, or historic value**;
3. **insure** that **economic growth** will occur in a manner consistent with the preservation of existing clean air resources; and
4. assure that **any decision to permit increased air pollution** in any area to which this section applies **is made only after careful evaluation** of all the consequences of such a decision and after adequate procedural opportunities for informed public participation in the decision making process.

Source: https://www.epa.gov/nsr/prevention-significant-deterioration-basic-information

5-3.2 PSD program

PSD program所需進行項目如下：

1. installation of the "Best Available Control Technology" (BACT);
2. an air quality analysis;
3. an additional impacts analysis; (Visibility Impairment Analysis、Impacts on Vegetation and Soils、Growth In Commercial, Residential and Industrial Activity)
4. public involvement.

PSD permit案例詳: http://www.kdheks.gov/bar/westar/1770030_permit_summary_sheet.pdf

5-3.2 PSD program

茲分別敘述PSD program主要內容如下：

(1)評估該污染源所適用之BACT：

BACT之決定為case by case，其可隨污染源之種類，以及之前是否有類似之污染源已設置BACT，另外亦可考量能源、經濟之衝擊等因素。

5-3.2 PSD program

(2)污染源附近之背景濃度分析：

此可藉由實地監測，或借助於既有之資料。借助於既有之資料時，必須能證明其可以代表該地區之空氣品質，且需為兩年內之資料，仍可代表現在之狀況（亦即境內無新增之其他大污染源下之監測結果），如此方能證明其與實際監測結果具有相同之品質。

但在下列之情況下，則可以不必準備空氣品質資料：

1. 當地之背景濃度值小於“de minimis”值。
2. 經由模式預測所得之影響小於“de minimis”值。

表5-4即為各污染物種之de minimis值。

5-3.2 PSD program

表5-4 *De Minimis* Monitoring Concentrations

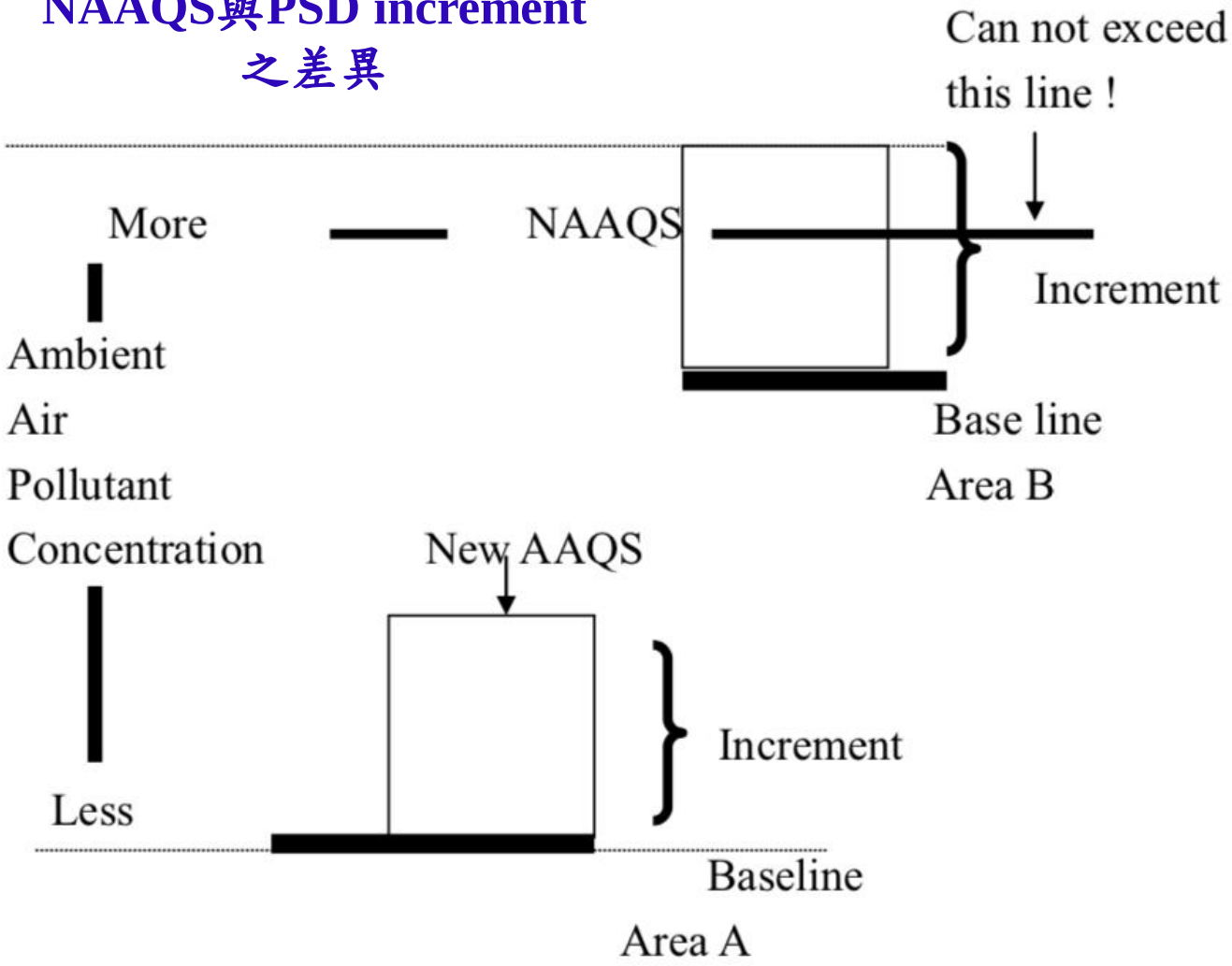
Pollutant	Air Quality Concentration ($\mu g/m^3$)	Averaging Time
Carbon monoxide	575	8-hour
Nitrogen dioxide	14	Annual
Sulfur dioxide	13	24-hour
Particulate matter	10	24-hour for TSP
Particulate matter	10	24-hour for PM-10
Ozone	0.1	3-month
Lead	0.1	3-month
Fluorides	0.25	24-hour
Total reduced sulfur	10	1-hour
H_2S	0.2	1-hour
Reduced sulfur compounds	10	1-hour

尚有其他物種，詳參閱課文

5-3.2 PSD program

(3)証明因該污染源之設置所造成之空氣品質，將不會超過NAAQS或“PSD increment”。

NAAQS與PSD increment之差異



5-3.2 PSD program

PSD Increments[1] ($\mu g/m^3$)

Sulfur Dioxide	Class I	Class II	Class III
Annual	2	20	40
24-hr	5	91	182
3-hr	25	512	700
PM10			
Annual	4	17	34
24-hr	8	30	60
PM2.5			
Annual	1	4	8
24-hr	2	9	18
Nitrogen Dioxide			
Annual	2.5	25	50

[1] Ref.: San Joaquin Valley APCD, District Rule 2410, General Modeling Requirements
http://www.valleyair.org/busind/pto/tox_resources/general-psd-modeling-requirements-jan-2014-rev3.pdf

5-3.2 PSD program

在PSD area中之土地分類為三區，說明如下：

- **Class I** In National Parks and Wilderness Areas, almost no increment is available, and stringent permitting requirements will be applied if your facility is in or near a Class I area.
- **Class II** Most of the country attaining NAAQS is designated as Class II with larger available increments than for Class I areas.
- **Class III** Although the Act allows for Class III areas wherever larger increases in air quality pollutant levels would be allowed, the procedures required to redesignate an area from Class II to Class III are so complex that few Class III areas are likely to be designated under the present law. Currently there are no designated Class III areas.

(註: 美國將PSD分三區，而不符合NAAQS的區域則稱為Nonattainment (NA) area。我國則是直接將防制區分成三區，前兩區定義基本上和美國相似，而三級防制區即為美國的NA area。)

5-3.2 PSD program

(4)對土壤及農作物之影響評估

需針對影響範圍內所有具商業或休閒娛樂值之作物進行影響評估調查工作。通常此種影響可直接由文獻中取得各種植物在不同濃度下所受之影響。

(5)評估因該開發案所造成之人口、設施、中下游工廠及交通等增加所產生之衝擊。例如一個輕油裂解廠設立後，將可能在附近增設中下游廠，故需進行該項評估方案。而一個發電廠之建造，則不致產生其他之人口、工廠增加。

5-3.2 PSD program

(6) 能見度之影響評估

工廠若在**Class I area**中擬新建，則需能見度評估，另外有些州亦會要求能見度評估。

一般能見度影響評估多利用現成之模式進行模擬工作，能見度評估模式分為兩種，第一種為較簡易之模式，其評估結果較為保守，通常此種模式為最普遍使用者；而另外兩種模式則較為複雜。

因能見度分析主要針對國家公園等之Class I area，因此通常會要求進行**第一種之保守模式**，只有在工廠無法通過第一類模式預測結果時，才會再進行第二類，乃至更複雜之第三類模式分析。

5-3.2 PSD program

所謂之能見度分析，意指工廠排放Particulates、SOx或NOx三種污染物，而造成之不可回復能見度，其可分三大類：

(i)"Plume blight"，亦即因工廠排煙，造成附近區域之能見度受損。

(ii)因氣體排出所造成者。如secondary aerosols或NO_2本身會吸收藍綠色範圍之光，而使天空呈現黃褐色，造成能見度受損。

(iii)較大範圍之能見度問題，如煙、霧（smog and haze）等可能同時由該固定源、附近之移動源，以及自然因素所造成者。

5-3.3 NA area

- Non-attainment (NA) area中之新污染源，需要取得相當嚴格之**NSR（New Source Review）許可**[1]。
- NSR之目的，即需該污染源能證明其在新增或擴建後，其所造成之空氣品質影響，要小於其他污染源所減少之空氣污染量，
- 亦即該廠必須向他廠“購買”其排放量，使NA中之空氣品質不致因新污染源而更加惡化。
- 此即為NSR之精髓所在－ “**Reduction must exceed new installation**”。

註1:NSR在舊版之CAA中由各州執行，而新版(CAAA, 1990)則規定整個permit system由聯邦EPA訂定之。

5-3.3 NA area

- 如果能取得其他方式之排放抵換（**emission offsets**），則該工廠即不需符合上述NSR要求。
- 如美國EPA即曾讓一家煉油廠設立於碳氫化合物（O_3）之NA中，其排放抵換為要求所在地之州政府高速公路部門降低某種柏油之使用量，而非減低新污染源附近工廠之VOCs排放量。
- 若無此種例外情形，則通常排放抵換需為一磅換一磅，case-by-case處理之。

5-3.3 NA area

- NSR要求新廠須採用LAER技術，亦即不能考慮任何經濟或能源利用問題。
- 因此新污染源在NA中設立相當不容易，除非有既存廠即將關閉，或本身在該區內設有舊廠可進行調整，否則不易增設，
- 況且有些州對“主要污染源”之定義更嚴格，因此在舊法僅有emission offsets，尚無排放交易制度時，新廠之設立幾乎不可能。

5-3.3 NA area

另外即使在attainment area中，若設立某新廠，發現其對附近之NA區域會造成嚴重之衝擊，如表5-6，則該廠仍須取得NSR許可。

表5-6 Significant Air Quality Impacts *Concentration by Averaging Time* ($\mu g/m^3$)[1]

Pollutant	*Annual*	*24-hour*	*8-hour*	*3-hour*	*1-hour*
SO_2	1	5	—	25	—
TSP/PM-10	1	5	—	—	—
NO_2	1	—	—	—	—
CO	—	—	500	—	2000

[1] 這些數值目前已有部分更新，詳參閱 San Joaquin Valley APCD, District Rule 2410, General Modeling Requirements http://www.valleyair.org/busind/pto/tox_resources/general-psd-modeling-requirements-jan-2014-rev3.pdf

5-3.4 NESHAP

- NESHAP（National Emission Standards for Hazardous Air Pollutants）為針對致癌性、致突變性及具毒性（carcinogens, mutagens and toxicants）之空氣污染物所訂定之排放標準。
- 表5-7中即列出NESHAP中最早開始管制之HAPs物種[1]。

5-3.5 NSPS

表 5-7 Hazardous Chemicals Regulated Under NESHAP

Designed as Hazardous Air Pollutants	*Date of Notice*
Asbestos	3/71
Benzene	6/77
Beryllium	3/71
Coke oven emissions	9/84
Inorganic arsenic	6/80
Mercury	3/71
Radionuclides	12/79
Vinyl chloride	12/75
Acrylonitrile	6/85
1,3 Butadiene	10/85
Cadmium	10/85
Carbon tetrachloride	8/85
Chlorinated benzenes	8/85
Chlorofluorocarbon	6/85
Chloroform	9/85
Chloroprene	9/85
Chromium	6/85
Epichlorohydrin	6/85
Ethylene dichloride	10/85
Ethylene oxide	10/85
Hyxachlorocyclopentadiene	10/85
Manganese	8/85
Methyl chloroform	6/85
Methylene chloride	10/85
Perchloroethylene	12/85
Polycyclic organic matter	8/84
Toluene	5/84
Trichloroethylene	12/85
Vinylidene chloride	8/85

- 新版之CAAA(1990)所管制之HAPs更多，至1990年之新法規止其所列之原始HAPs物種共有189種，且其依法規要求需使用MACT。
- 隨著不定期之更新，至2010/11/03經USEPA公告之HAPs共有190種（汞(mercury)原本被刪除，現又加入：http://www.epa.gov/ttn/atw/orig189.html)。

5-3.5 NSPS

- **New Source Performance Standards**為針對不同污染源所排放出之法規污染物（criteria pollutants）及其他之主要污染物種所訂定之排放標準。
- 其訂定主要依據為考慮可行之各種方式（如製程改善）及控制技術，希望能不造成空氣品質之太大衝擊，且具經濟可行性。
- 除了聯邦所訂定之NSPS外，各州亦可訂定自己之NSPS，目前已有許多州訂定自己之較為嚴格之NSPS。

5-3.6 Stack Height Regulations

在1985年時，美國EPA針對應用擴散模式，以符合各種review process（如PSD review、NSR等）時，其所使用之煙囪高度值，不得超過GEP（good engineering practice）高度。所謂之GEP高度限制如下：

GEP stack height = (H + 1.5L) where：

H = height of nearby structure(s)

L = lesser dimension of the height or width of nearby structure(s)

5-3.6 Stack Height Regulations

- 但實際上固定源之煙囪高度並沒有限制，亦即實際建廠時，工廠之煙囪可以有任意高度，但是為了預防擴散模式中所用到之一些dispersion enhancement技巧，因而規定如果實際煙囪高度超過GEP高度時，則在空氣品質影響預估時，只能用GEP高度。
- 舉例而言，如某廠之實際煙囪高度為150m，而其GEP高度為100m，則在擴散模式中只能用100m作為煙囪高度，也就是說預測結果將較為保守。
- 其主要用意在於確保如果發生下沖（down wash）現象時，該污染排放亦不會影響大眾健康，因為工廠可能因此需加裝APCD。

5-3.6 Stack Height Regulations

- 然而也有例外時，如果風洞實驗或野外實驗證明了需使用較GEP高度為高之煙囪高度時，則可利用此實驗值，以免發生超估情形，此乃因風洞實驗或野外實驗結果可評估高山之影響，而GEP只能評估建築物下沖之影響，因高山所造成之下沖效應往往大於建築物，故可採用之。
- 例如GEP高為75m，實際煙囪高為100m，而風洞實驗發現在煙囪高為85m時，即會造成(i)超過背景濃度值40%，且(ii)超過NAQQS或PSD increment，如此則應用於擴散模式中之煙囪高度即可用85m，但前提為該風洞模擬係符合NSPS下之排放法規。
- 然而污染源之GEP高度如低於65m時，其可將GEP值更改為65（亦即65m為模式模擬之最小值）。

5-3.6 Stack Height Regulations

- In summary, **GEP stack height** is defined to be **the tallest of the following**:
  - 65 meters (213 feet), as measured from the ground-level elevation at the base of the stack
  - 2.5H (for stacks in existence in January 12, 1979), or H + 1.5L (for all other stacks), where H is the height of the building itself or any significant nearby structure or structures and L is the lesser of the projected height or width of the building in question
  - The height demonstrated by a an approved fluid model or a field study that ensures that the emissions from a stack do not result in excessive concentrations of any air pollutant as a result of atmospheric downwash, wakes, or eddy effects created by the source itself, nearby structures or nearby terrain features.

5-3.7 SIP &FIP

CAA要求在NAAQS公告後，各州即須提出SIP (State Implementation Plan)，以確保其能維護空氣品質於NAAQS下。**SIP之基本定義即為“在空氣品質管制區域（Air quality control region）內，所執行之空氣品質改善或維護之計畫，以符合NAAQS”** 。

除了每個AQCR（亦即每一州）需有一份SIP外，對於NA區域，更需**定期修正**其SIP，以反應空氣品質之進展。而一份SIP之內容包括了：

(1). 建立管制策略。

(2). 建立排放限制值。

(3). 管制時程表。

(4). 其他為達空氣品質目標之相關事宜。

5-3.7 SIP & FIP

Elements of a SIP

- Emission limits for specified pollutants
- Compliance schedules for attaining the NAAQS
- Control strategies
- Ambient monitoring program to measure attainment progress and compliance with the NAAQS
- Permit/enforcement program for sources
- Emergency air pollution episode plan
- Plan to avoid interstate air pollution impacts
- Resource and legal authority to prepare、implement and revise the SIP as needed

5-3.7 SIP & FIP

- FIP:

  - A Federal Implementation Plan (FIP) is an air quality plan developed by EPA under certain circumstances to help **states or tribes** attain and/or maintain the National Ambient Air Quality Standards (NAAQS) for common air pollutants.
  - EPA is required to develop a FIP if a state fails to submit an implementation plan, or if the plan does not fully comply with the NAAQS. EPA may also develop a FIP for tribal lands if a tribe elects not to develop their own implementation plan, as appropriate.
  - EPA has developed and implemented the following FIPs **(Total 11**):

Arkansas (Subpart E) ; Fort Berthold Indian Reservation Oil and Natural Gas Well Production Facilities (ND) ; Hawaii Regional Haze ; Louisiana (Subpart T) ; Montana Regional Haze; Navajo Generating Station (AZ) ; New Mexico (Subpart GG) ; North Dakota Regional Haze; Oklahoma (Subpart LL); Texas (Subpart SS); Wyoming Regional Haze

•See also: Approved SIPs

5-4 1990年版之CAAA主要條款說明

- 在此之前之CAA不到50頁，而新版之CAA(A)卻將近800頁(光是USC版的CAA就有近300頁,見附錄說明)，此乃國會不相信聯邦EPA，因此要求白紙黑字詳細說明之結果。
- 因此CAAA有個別名“Employment security bill for lawyers”，因為其增加了律師之工作機會。

5-4 1990年版之CAAA主要條款說明

- 幾個較大之改變包括了：

(1)**許可制度**：之前係由各州自行負責，現在則改由聯邦負責建立[1]，因該制度之未落實執行，被認為是各地無法符合NAAQS之原因。

(2)**排放交易制度**：其允許工廠自由買賣其多餘之排放量，或將其存下來，留待日後法規加嚴時使用。目前已有許多電廠實施排放交易制度。

(3)**嚴格之執行期限**：其要求在兩年內完成30條施行細則，而這通常需10年之工作期。

註: [1]我國許可制度亦由環保署建立，而審查核發則是由各縣市環保局或由工業區管理局負責審查核發。

5-4 1990年版之CAAA主要條款說明

- 許可制度執行後，對許多廠衝擊相當大，因為在該制度下，如果違反CAA，可能面臨坐牢之可能，因此許多工廠甚至會選擇關閉。
- 各州亦面臨經費不足問題，因為在CAAA後，將有10,000～150,000件許可案件[2]，美國會建議收費標準為每噸污染物收＄25美金作為經費來源，但各州EPA仍認為不夠支付。
- 此外在CAAA中，針對許可審查也提供了工廠於許可申請時之彈性[3]。

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[2] USEPA於1998年1月之統計顯示，全美國總計有14,000件之空污許可申請案件，約占美國符合許可申請(subject to permit)工廠數(22,000件)之 60% (http://www.epa.gov/air/oaqps/permits/permitupdate/brochure.html)。

[3] USEPA在其許可(permit)制度下，導入了**污染預防**的概念，只要工廠能提出其排放在總量限值內，並提供其污染預防技術說明，則可省卻後續在製程改變時，要重提取可申請審查等之法規要求，此項制度稱為**P4 (pollution prevention permitting pilot (P4)) program**，第一個P4 program 在某個電子零組件廠 (computer chips)施行。

5-4 1990年版之CAAA主要條款說明

- 5-4.1 Title Ⅰ - Attainment of AAQS
- 5-4.2Title II - Mobile Sources
- 5-4.3 Title III - Air Toxics
- 5-4.4 Title IV - Acid Deposition
- 5-4.5 Title V - Permit
- 5-4.6 Title VI - Ozone Depleting Chemicals
- 5-4.7 Title VII - Enforcement

5-4.1 Title I—Attainment of AAQS

- 其要求針對:

✓ **CO**

✓ **O_3**

✓ **PM_{10}**

三種污染物之**NA（non-attainment areas）**訂定更嚴格之排放法規，並將其分區變得更細。

5-4.1 Title I—Attainment of AAQS

(i) O_3 NA分區(note 1)：

- Extreme：此主要針對洛杉磯(Los Angeles)地區，只要排放超過10 TPY之VOCs及NOx就被列為major sources(note 2).
  - LA (隸屬於南加州AQMD) 經過多年努力後，O_3問題確實已有顯著改善, 詳見下面註解圖(note 3)。但8hr O_3還是持續偏高。
- Severe or serious：50 TPY以上為major sources
- Moderate or marginal：100 TPY以上為 major sources

5-4.1 Title I – Attainment of AAQS

Nonattainment Areas Subject to PAMS	Classification
Atlanta, GA	Serious
Baltimore, MD	Severe
Baton Rouge, LA	Serious
Boston-Lawrence-Worcester, MA-NH	Serious
Chicago-Gary-Lake County (IL), IL-IN-WI[1]	Severe
Dallas-Fort Worth, TX	Serious
El Paso, TX	Serious
Greater Connecticut, CT	Serious
Houston-Galveston-Brazoria, TX	Severe
Los Angeles-South Coast Air Basin, CA[2]	Extreme
Milwaukee-Racine, WI[1]	Severe
New York-New Jersey-Long Island, NY-NJ-CT	Severe
Phoenix, AZ	Serious
Philadelphia-Wilmington-Trenton, PA-NJ-DE-MD	Severe
Portsmouth-Dover-Rochester, NH-ME	Serious
Providence-Pawtucket-Fall River, RI-MA	Serious
Sacramento, CA	Severe
San Diego, CA	Serious
San Joaquin Valley, CA	Serious
Santa Barbara-Santa Maria-Lompac, CA	Serious
SE Desert Modified AQMA, CA[2]	Severe
Springfield, MA	Serious
Ventura County, CA	Severe
Washington, DC-MD-VA	Serious

Note1 ***This table identifies the 24 1-hour ozone nonattainment areas currently subject to PAMS(Photochemical Assessment Monitoring Stations).***

(Source: http://www.epa.gov/ttnamti1/pamssites.html)

1) Chicago and Milwaukee are combined into one PAMS area referred to as Lake Michigan.
2) 2) Los Angeles-South Coast and SE Desert Modified AQMA are combined into one PAMS area referred to as South Coast-SEDAB

5-4.1 Title I—Attainment of AAQS

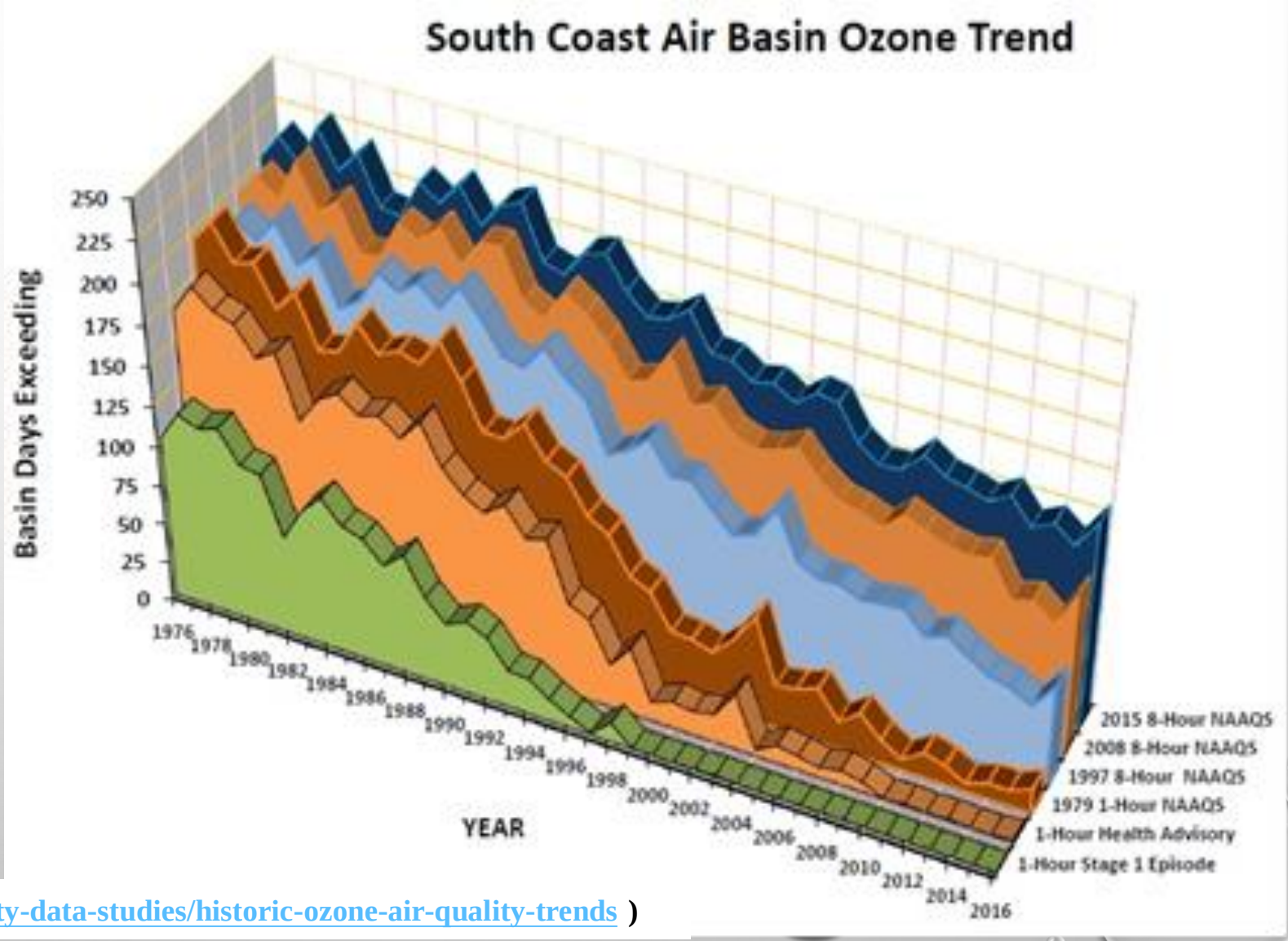
Note 2

- 我國無特別針對”主要污染源”進行定義，但對需申請許可之工廠，在最早第一批公告時，是以任一固定污染源操作許可證記載之空氣污染物年許可排放量達下列規模之一者，應申報前一年空氣污染物年排放量：**NOx>40公噸; SO2>60公噸; VOCs>30公噸; PM>15公噸**。
- 但後續針對第一至八批應申請許可之工廠則直接依其製程規模大小決定。
- 而針對[開發行為空氣污染物排放量增量抵換處理原則]，則要求空氣汙染物排放量在**1000公噸/年**以上才須進行增量抵換。

5-4.1 Title I—Attainment of AAQS

Note 3

South Coast Air Quality Management Distric (SCAQMD) 之O_3 變化趨勢



(https://www.aqmd.gov/home/air-quality/air-quality-data-studies/historic-ozone-air-quality-trends)

5-4.1 Title I—Attainment of AAQS

(ii)CO及PM_{10}分區：

- 分為serious及moderate兩區，排放量限制同O_3，分為50及100 TPY
- 對NA區中工廠所進行之排放抵換範圍為1比1至2比1間，亦即前面所提之“reduction must exceed new emission”將嚴格執行，不再有例外。
- 針對NOx排放之工廠加裝**RACT**，此外EPA需針對11個HCs之主要分類源找出其RACT。
- 各州之SIP中，需說明如何在前6年內，每年要降低15%之總排放量。
- 若無法完成其SIP，聯邦EPA需於18個月內以下列兩種方式之一處罰各州：(1)削減聯邦所給之高速公路補助費(2)對新增污染源增加其排放抵減量。
- 如果處罰無效，則Federal Implementation Plan將取代SIP，由聯邦EPA代為執行。

5-4.2 Title II—Mobile Sources

- 針對移動污染源有了更嚴格之管末排放標準及使用較乾淨之燃料，分述如下：

1. 更嚴格之排放標準：

1) Tire I：

1994年起之新車排放標準，將需於2年內逐漸採用NOx：0.6 g/mile，HCs：0.4 g/mile之標準，而CO之10 g/mile標準則需於3年內逐漸採用。

上述之標準中NOx及HCs部份汽車需連續10年或100,000 miles之行程，卡車需7年或75,000 miles之行程內均需符合此標準而CO則為連續5年或50,000 miles。

2) Tire II：

1996年起：CO為9.5 g/mile，而NOx與HCs之標準則在2003年後需分別符合0.2及0.125 g/mile[1]。

5-4.2 Title II—Mobile Sources

討論: 我國與美國及歐洲現在的標準 相較?

Emissions standards for pollutants (g/km)	US	EU	Taiwan
Nitrogen oxides (NOx)	0.04	0.06/0.08*	0.18
Non-methane organic gases (NMOG)	0.06	0.07/na*	0.23 (THC+NOx)
Carbon monoxide (CO)	2.61	1.0/0.5*	0.5
Carbon Dioxide (CO2, in 2016)	155	130	=163+a ($M-M_0$) [1]
Carbon Dioxide (CO2, in 2020)	132	95	-
Form of vehicle emission testing	FTP	NEDC	NEDC
*Petrol / diesel standards	Federal Test Procedure (FTP)	New European Driving Cycle (NEDC)	台灣CO2為2015年標準

[1]M =歐盟測試程序下之標準重量 (空車重 +100 公斤)，並應採用 車廠宣告車 重值 (公斤)。 M0 =基準年之平 均車重，採 1,423 公斤。 a=0.1026 （ M＞ 1,423 公斤） a=0.0872 （ M≦1,423 公斤）

Source: Comparative study on the differences between the EU and US legislation on emissions in the automotive sector (2016)

5-4.2 Title II—Mobile Sources

2. 於污染較嚴重區域使用乾淨燃料

- 在部份smog問題嚴重之城市,要求其使用之燃料（汽油）中成份限制為：＜1% Benzene, 25% aromatics, 15% VOCs及其他之air toxics。
- 另外有CO問題者，要求其在2000年時使用oxygenated fuels，以幫助CO氧化。

討論：此項法規何時才會開始出現成效？
(其只針對“新車”)

5-4.3 Title III－Air Toxics

Air Toxics 法規分為兩個階段:

- 在第一個階段中，將189個 (2009改為187個，2010年又增為190個) air toxics列入法規管制，並在1年內公布**主要污染源**，其定義為**個別污染物超過10 TPY，總和超過25 TPY之污染源**。同時聯邦EPA須於兩年內建立40個污染源分類之**MACT**排放標準（技術），並執行之。
- 第二個階段則為在MACT標準執行8年後（亦即2000年後），新的**health risk-based standards**將針對造成**百萬分之一以上致癌率**之工廠生效。

註：[1]原本電廠所產生之汞（Hg）排放也將受到管制，但因缺乏相關之資訊而被取消。聯邦EPA被要求“study the problem before developing rules”，其後在2010年又再被加入。

[2] USEPA建立了一個暴露評估的模式，至2010/11/03已涵括了32+1(diesel PM)種air toxic，以了解其健康風險。

5-4.4 Title IV－Acid Deposition

- **酸沉降** 法規對電廠之衝擊最大，其針對造成酸沈降（乾、濕沈降）之污染物－**SOx及NOx**進行污染削減工作。
- 其目標為削減**SOx**之排放量達10×10^6 TPY，此相當於削減**1980年**時之SOx排放量（23×10^6 TPY）約**43%**；而**NOx**則削減2×10^6 TPY，此約削減1980年時NOx排放量之**10%**。
- 此項法案在1980年時曾被提出，但被國會否決，因將對美中西部衝擊太大。
- 本項法案在1990年之CAAA改以**市場經濟誘因（Market incentives）**方式著手，以取代從前之command-and-control regulations（行政管制）方式，讓各廠**自由交易**其多餘之允許排放量（allowances）。

討論：1. 此項法規之效果如何？如果有心解決酸沈降問題，為何又給allowances？

(參考數據：在1992年初時之排放交易價格為＄250~400/ton SO2，1998-2002年時則約在＄100~$220/ton SO2間。

5-4.4 Title IV－Acid Deposition

- 該項法案之推動分為兩個階段:
  - ✓ 第一個階段以2.5 lb-SO_2/10^6BTU之排放量為標準（1995年初－1999年底），若電廠能排放低於該限量，即可得到allowances，此可留待後用或轉賣之。
  - ✓ 第二個階段（2000年起）則將排放限量降至1.2 lb-SO_2/10^6BTU，若排放低於0.8 lb-SO_2/10^6BTU，則可得到allowances。
- 另外中西部地區特別給予第一階段100,000 TPY，第二階段50,000 TPY之allowances，此外若能達90%以上之去除率，更可再得到2：1（two for one）之allowances。
- 而針對NOx部份，則須於18個月內訂出新的排放限量。若無法達到SOx及NOx之新標準，又取不到allowance者將受罰款。

5.4.5 Title V—Permit

- 該項法規要EPA在12個月內建立類似於Clean Water Act中之National Pollutant Discharge Elimination System所規劃之許可制度。
- 各主要污染源在許可申請中，需提出5年期程之污染防制規劃，以符合各項法規要求。

5.4.6 Title VI－Ozone Depleting Chemicals

針對破壞臭氧層之CFCs及HCFCs等物質之管制。

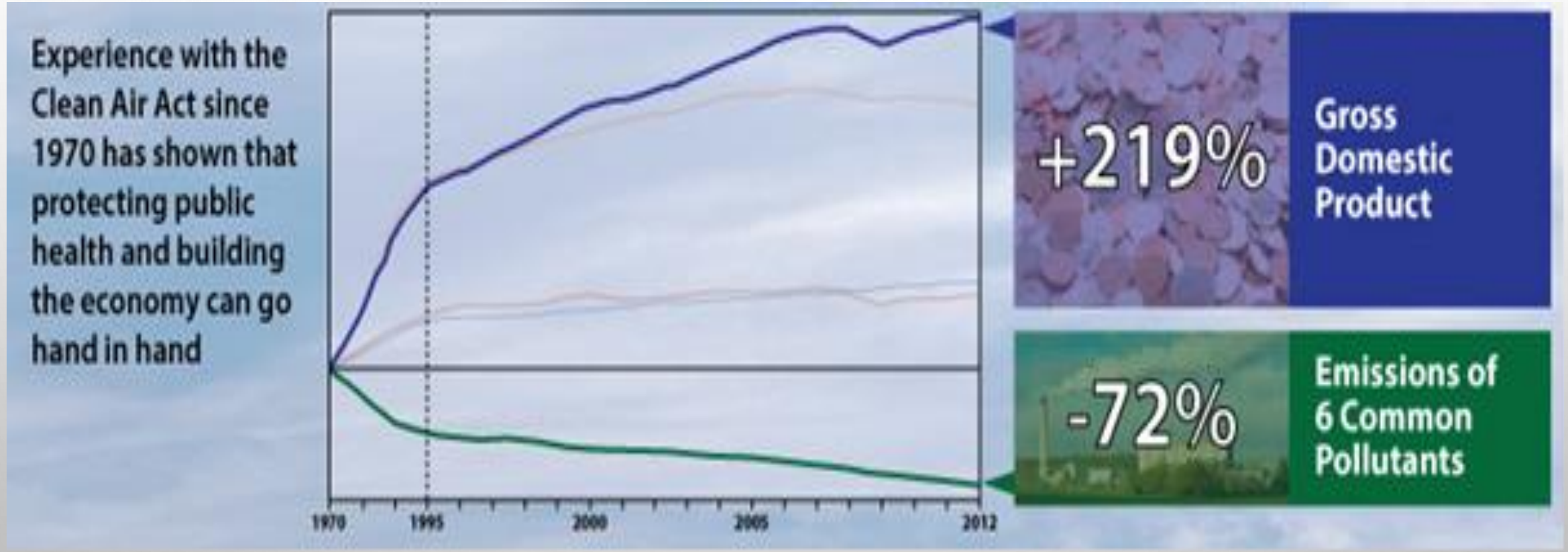
5.4.7 Title VII—Enforcement

- 最高罰款可達$200,000美元，稽查員可當場開最高$5,000美元之罰單。
- 個別市民亦可要求違規者之賠償。
- 所有罰款將成立基金，專款供EPA執行相關業務使用。

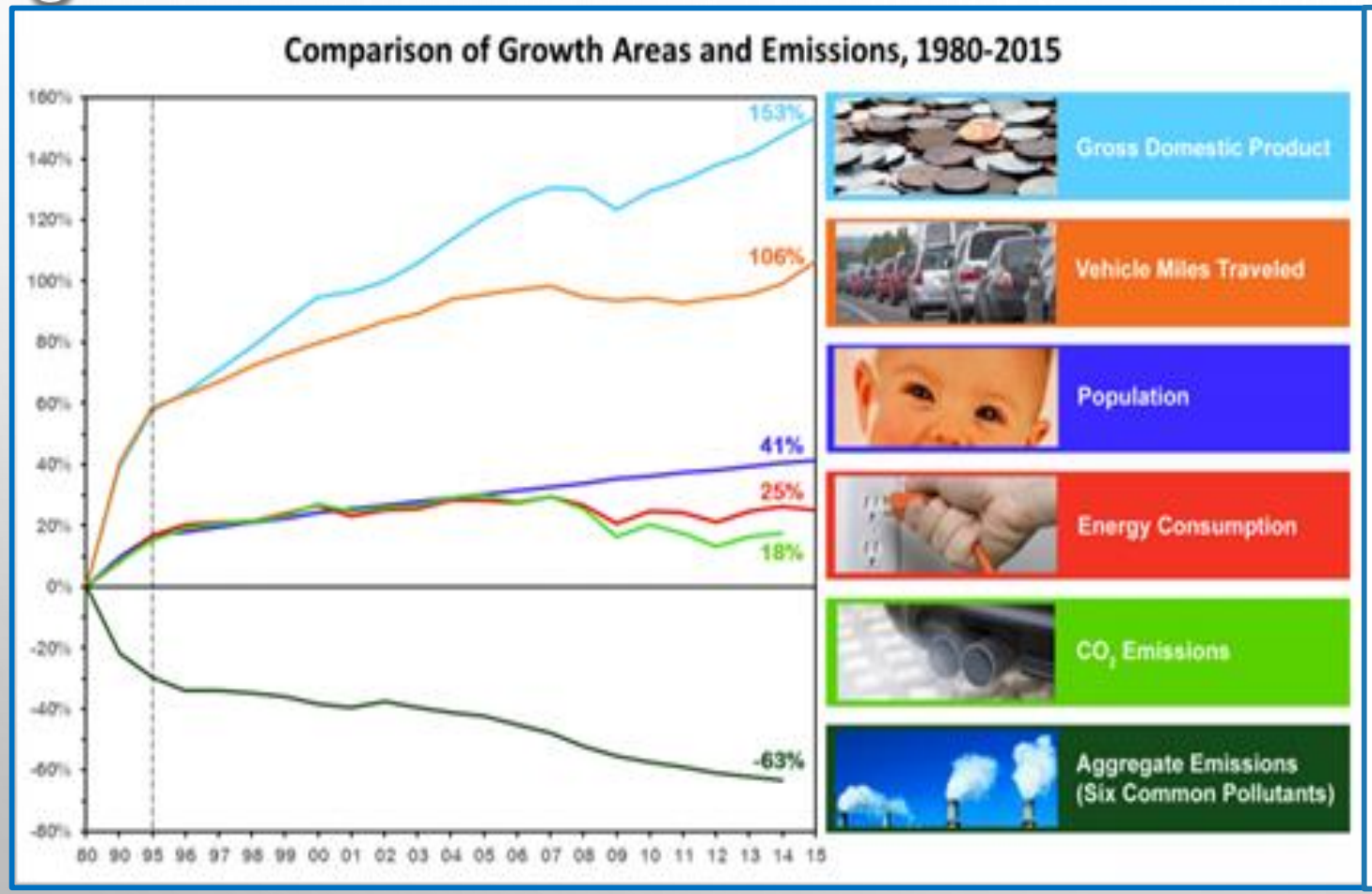
5.4.8 美國 CAAA 的精神

- 美國是**資本主義**國家，因此其在執行任何政策時，都會從經濟層面考量，即使在推動其CAAA空污法時也不例外。
- 從下面這兩張 USEPA CAA 曾放在 CAA 首頁(http://www.epa.gov/air/caa/)之兩張圖片(上圖為2014年之統計資料，下圖為2016)的圖片，就可以知道其如何將「**成本-效益**」放入空污法規執行策略中，且其認為**經濟與環保是可以並重的**。

5.4.8 CAAA的精神


Experience with the Clean Air Act since 1970 has shown that protecting public health and building the economy can go hand in hand
1970
1995
2000
2005
2012
+219%
Gross Domestic Product
-72%
Emissions of 6 Common Pollutants

5.4.8 美國 CAAA 的精神



- 左圖數據顯示，美國從1980年至2015年這35年間，GDP增加了153%，空氣污染則下降了63%。
- 美國Clean Air Act Overview網頁上寫著:
  - ***『40年經驗告訴我們，“空氣品質”是可以和“健康的經濟成長”攜手並進的』***

Over forty years of experience with the Clean Air Act shows that clean air and a healthy economy can go hand in hand.<Learn more about clean air the economy>

5.4.8 美國 CAAA 的精神

- 美國環保署於2011年進行一項研究，說明其因執行淨空法(1990CAAA)而在2010年所獲致的效應，該研究並預期在2020年將獲致的效益如下表。並簡要說明如下:

✓ **避免了超過16萬個早死案例、 13萬個急性心臟梗塞、數百萬個呼吸道疾病(如急性支氣管炎、氣喘)、以及8萬6千個入院案例。**

✓ **避免了1300萬人日的工時損失**，使工人能更有精神的創造更好的經濟發展。

✓ 使孩童更健康，避免因為呼吸道感染等空污所致疾病而**使學童減少無法上學的天數達320萬人日**。

✓ **預估在2020年，美國淨空法將可預防230,000個早死案例。**多數的健康效益(~85%)係來自於周界懸浮微粒濃度減量所致。

(From https://www.epa.gov/clean-air-act-overview/clean-air-act-and-economy)

5.4.8 CAAA的精神

The 1990 Clean Air Act Amendments prevent:		
	Year 2010 (in cases)	Year 2020 (in cases)
Adult Mortality - particles	160,000	230,000
Asthma Exacerbation	1,700,000	2,400,000
Chronic Bronchitis	54,000	75,000
Emergency Room Visits	86,000	120,000
Heart Disease - Acute Myocardial Infarction	130,000	200,000
Infant Mortality - particles	230	280
Lost Work Days	13,000,000	17,000,000
Mortality - ozone	4300	7100
School Loss Days	3,200,000	5,400,000

Thanks for your participation