行政院所屬各機關因公出國人員出國報告書

（出國類別：考 察 ）

考察「美國空氣品質監測站網運轉管理制度及新舊系統汰換銜接、最新監測技術應用」出國報告書

服務機關：行政院環境保護署

出國人 職 稱：科 長 設計師

姓 名：張順欽 林錫旗

出國地點：美國

出國期間：九十一年十月九日至十月十七日

報告日期：九十二年一月九日

行政院及所屬各機關出國報告提要

出國報告名稱：考察美國空氣品質監測站網運轉管理制度及新舊系統汰換銜接、最新監測技術應用

頁數：186 頁(含附件)

出國計畫主辦機關：行政院環境保護署

出國人員：

張順欽　行政院環境保護署　環境監測及資訊處　科長

林錫旗　行政院環境保護署　環境監測及資訊處　設計師

出國類別：考察

出國期間：民國 91 年 10 月 9 日至 10 月 17 日

出國地區：美國

報告日期：民國 92 年 1 月 2 日

分類號/目：I5/化學與環境科學

關鍵詞：

內容摘要：

本次考察第一站到達位於南加州的加州南灣空氣品質管理局(South Coast Air Quality Management District，簡稱 SCAQMD)，拜會了該局多位資深官員及參觀二個空氣品質監測站。考察第二站到達美國環保署位於北卡州三角研究園區，考察美國環保署對於 $PM_{2.5}$ 監測之最新發展與規劃，以及未來推動方向。

SCAQMD 現有空氣品質監測站共有 32 個;空氣品質監測站由 12 人負責操作(平均每人約負責 3 個測站)，維護工作由 10 個人負責，另有 6 個人負責人工採樣，內部品質保證工作由 3 個人負責，進行儀器定期內部品保。另外委託外包執行外部品保查核。各測站監測項目包括 SO_2(7 站)、O_3(32 站)、PM_{10}(32 站)、$PM_{2.5}$(19 站)、NOx(25 站)等。各個測項站數並不相同，其中以 SO_2 測項站數最少，而探其原因主要為 SO_2 環境中濃度已遠低於空氣品質標準，因此站數減少，僅保留 7 個設置於該類污染附近。空氣品質監測站減站原則，在檢討空氣品質監測站數時，凡監測結果符合空氣品質標準(環境中濃度遠低於空氣品質標準)，則可減少該測項之監測，如 SO_2、Pb 等。測站減少時，則以鄰近區域各該測站測值相關性進行檢討，當有數個測站相關性高，且符合測站減少原則，此時保留測值高之測站繼續監測，測值低而與高測值測站相關性高者，可進行減站。

加州 $PM_{2.5}$ 24hr 質量監測網已於 1999 年建立，共有 82 個測站，目前正加速擴增 $PM_{2.5}$ 連續質量監測及 $PM_{2.5}$ 連續化學成份監測網。以提供 $PM_{2.5}$ 質量及化學成份資料，支持空氣品質保護計畫，$PM_{2.5}$ 監測結果將用於界定不合格區域、發展及追蹤空氣品質改善計畫，評估區域煙霧(regional haze)，協助健康效應研究，以及支援其他大氣氣膠研究計畫等。由於空氣品質標準之判定須用到連續三年數據，因此，目前僅有二年資料尚不足以用來判定是否符合空氣品質標準，但可用來比較各測站間之監測結果。

$PM_{2.5}$ 監測網之設置在執行國家新的 $PM_{2.5}$ 空氣品質標準時，為重要之工作。1997 年 7 月公佈新的空氣品質標準以來，美國聯邦除了有關微粒研究經費，已投入超過 1 億 2800 萬美元，來建立 $PM_{2.5}$ 監測網。$PM_{2.5}$ 監測網相關規定係依美國聯邦法規 Title 40,Code of Federal Regulations(40 CFR)，Parts 50, 53, 58。美國環保署細懸浮微粒($PM_{2.5}$)監測網大致上分成三大類：質量監測、例行化學成分分析、及特殊研究目的之超級測站。監測網主要目的：空氣品質標準符合度評估、發展空氣品質維護計畫(State Implementation Plan, SIP)及追蹤污染減量趨勢及進度。

細懸浮微粒($PM_{2.5}$)質量監測(FRM)約有 1050 個站，例行性化學成分監測約有 300 站，每六天或十二天採集一次樣品。其中 54 個為建立趨勢之測站每三天採樣一次，40 個測站支援超級測站每三天採樣，10 個站配合健康效應研究每天採樣，約 200 個測站支援空氣品質維護計畫(SIP)及其他計畫每六天採樣一次。根據 40 CFR 58, Appendix D, § 2.8.2.3 規定，在全美 52 個大的都會區域須設置 $PM_{2.5}$ 連續監測儀器，目前全美各州約走 115 個連續式監測站，未來可能擴增到 200 站。連續式 $PM_{2.5}$ 監測結果將用作公佈即時短期間測數據，提供細微粒日夜變化及污染特徵，作為科學健康評估瞭解暴露型態(exposure pattern)使用。美國環保署空氣品質監測之規劃與發展方向，可以作為國內業務推動之參考。

目　　錄

圖 目 錄

赴美考察心得

壹、摘要

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-貳、行政院環保署因公派員出國計畫書

一、計畫內容

(一) 計畫項目：中美環保技術合作計畫--考察美國空氣品質監測站網運轉管理制度及新舊系統汰換銜接、最新監測技術應用

(二) 項目名稱：考察

(三) 前往國家：美國

(四) 行程安排：美國環保署

(五) 出國期間及人數：九十一年十月九日至十七日，共九日，二人。

(六) 出國行程：

日期	地點	活動名稱
九十一年十月九日(三)	台北至美國洛杉磯	台北出發，抵達美國洛杉磯
九十一年十月十日(四)	洛杉磯	考察美國南加州空氣品質監測汰換及未來規劃
九十一年十月十一日(五)	洛杉磯	考察美國南加州空氣品質監測站網運轉管理
九十一年十月十二日(六)	洛杉磯	考察資料整理
九十一年十月十三日(日)	洛杉磯至北卡州 RTP*	考察資料整理及行程
九十一年十月十四日(一)	北卡州 RTP	考察美國環保署空氣品質監測最新發展
九十一年十月十五日(二)	北卡州 RTP	考察美國環保署監測資訊管理與模式運用
九十一年十月十六、十七日(星期三、四)	北卡州 RTP 至台北	回程

註：RTP：美國環保署位於北卡州之三角研究園區

(七) 預期目標及達成計畫之方法

透過美國環保署安排，考察美國空氣品質監測站網運轉管理制度及新舊系統汰換銜接、最新監測技術應用等，可瞭解國外空氣品質先進監測技術發展，作為國內空氣品質監測汰換業務參考。

(八) 經費概算及來源

1. 交通費(機票及美國境內交通費)：三九、四００元×二人=七八、八００元。

2. 生活費：

〔(一八六美元×Ｏ．四×一日＋一八六美元×三日+一０八美元×三日＋一０八美元×Ｏ．四×二日)×三五．二七〕×二人=七三、五五九元。

3. 護照簽證、保險及機場服務費等：三、八五Ｏ元＋七九九×二人=五、四四八元。

4. 雜支：六ＯＯ元／天×九天×二人=一０、八ＯＯ元

5. 合計：一六八、六０七元

6. 經費來源：由本署環境監測及資訊處(91-L1-01-02)辦理中美環保技術合作計畫項下支付。

二、出國理由與業務發展之關係

本署自九十一年開始進行空氣品質監測網汰換，並新增監測項目等，以提升空氣品質監測系統功能，為順利推動業務亟須汲取國外相關作業技術經驗。由於美國環保署空氣品質監測相關作業規範相當完善，各項監測技術之發展也領先國際，因此藉由考察美國空氣品質監測站網運轉管理制度及新舊系統汰換銜接、最新監測技術應用等，可瞭解國外空氣品質先進監測技術發展，作為國內空氣品質監測站網汰換業務參考。

參、考察心得

本次考察到達位於南加州的加州南灣空氣品質管理局(South Coast Air Quality Management District，簡稱 SCAQMD)，承該局公共事務部 Ms.Rainbow Y. Yeang 安排，拜會了該局多位資深官員及參觀二個空氣品質監測站。考察第二站到達美國環保署位於北卡州三角研究園區，考察美國環保署對於 $PM_{2.5}$ 監測之最新發展與規劃，以及未來推動方向。

圖 1、考察期間在加州南灣空氣品質管理局合影

以下為本次考察心得介紹：

一、 加州南灣空氣品質管理局(SCAQMD)空氣品質監測現況

(一)SCAQMD 現有空氣品質監測站共有 32 個(早期建置 34 個監測站，後減少為 32 個)；空氣品質監測站由 12 人負責操作(平均每人約負責 3 個測站)，維護工作由 10 個人負責，另有 6 個人負責人工採樣，內部品質保證工作由 3 個人負責，進行儀器定期內部品保。另外委託外包執行外部品保查核。

(二)各測站監測項目包括 SO_2(7 站)、O_3(32 站)、PM_{10}(32 站)、$PM_{2.5}$(19 站)、NOx(25 站)等(詳如表一)。這裡我們發現各個

測項站數並不相同，其中以 SO_2 測項站數最少，而探其原因主要為 SO_2 環境中濃度已遠低於空氣品質標準，因此站數減少，僅保留 7 個設置於該類污染附近。

表一、South Coast Air Quality Management District
空氣品質監測儀器數量

Ozone	32		PM_{10}/BAM	6
NOx	25		PM_{10}/Dichot	4
CO	21		$PM_{2.5}$/RM	21
SO2	7		$PM_{2.5}$/BAM	2
Met	31		$PM_{2.5}$/Dichot	4
TSP	16		PAMS	7
PM_{10}/SSI	23		PAMS/GC	2
PM_{10}/TEOM	10		TEP2000	9

Autocalibration systems	29		Audit Transfer Standards	36
Telemetry Remotes	31		Primary Reference Standards	8
Paperless Chart Recorders	22		Special Purpose Vehicles	12
Calibration Transfer Standards	36			

(三)表一為 South Coast Air Quality Management District 空氣品質監測儀器數量，由於南加州地區臭氧污染仍不符美國聯邦標準，因此臭氧監測站數量較多。臭氧監測網測站共有 28 個監測站，其中 5 個測站為國家級測站(NAMS)，其餘為地方級監測站。針對臭氧前驅物設有 7 個光化學評估監測站(PAMS)，在臭氧季節(Ozone Season，約每年 5 月至 9 月)以採樣器採集空氣樣本送回實驗室分析，其中 2 個監測站設有連續式氣相層析儀，用以連續分析臭氧前驅物濃度變化，探

討臭氧生成原因。

(四)二氧化氮監測網共有 22 個監測站，其中 4 個為國家級監測站，7 個為光化學評估監測站。一氧化碳監測網共有 23 個監測站，其中 4 個為國家級監測站，2 個污染調查監測站，其餘為地方測站。二氧化硫監測網共有 7 個監測站，其中 4 個為國家級監測站，3 個為地方測站。由於二氧化硫排放管制得宜，空氣中濃度已遠低於國家空氣品質標準，因此監測站數量也隨之減少，僅維持 7 個監測站設置於主要污染排放源附近。

(五)$PM_{2.5}$ 監測站共有 19 個，其中 5 個監測站每日採樣，11 個測站每三日採樣一次，另 1 個測站每 6 日採樣一次。監測站中有 4 個站進行成分分析。光化學評估監測站共有 7 個，結合 4 個高空氣象觀測以利進行臭氧生成原因分析。

(六)各個監測站與 SCAQMD 採專線(PHONE RELAY)資料傳輸，並於必要時以測站內一般電話線路備援傳輸資料，每個測站每分鐘數據均傳回中心再行處理，計算小時平均後進行資料發布及數據確認。

(七)空氣品質監測站端設有無紙之紀錄器(paperless recorder, Euro therm)，經由撥接式電話線路可直接下載監測儀器數值。即時測值(分鐘值)，凡數據有效性確認過程認為數據有疑義，則可立即連線查詢儀器輸出狀況，驗證數據有效性。

(八)數據有效值確認工作共有 3 個人負責，有效性確認分成三級，第一級(level 1)為去除無效數據，第二級則針對可疑數據進行測站端紀錄器驗證，第三級則為後續統計分析確認。

(九)如同 SO_2 一般，鉛監測站由 43 站減為 7 站，由於鉛在環境

中測定濃度低，因此減少測定站數。

(十)空氣品質監測站減站原則，在檢討空氣品質監測站數時，凡監測結果符合空氣品質標準(環境中濃度遠低於空氣品質標準)，則可減少該測項之監測，如 SO_2、Pb 等。測站減少時，則以鄰近區域各該測站測值相關性進行檢討，當有數個測站相關性高，且符合測站減少原則，此時保留測值高之測站繼續監測，測值低而與高測值測站相關性高者，可進行減站。

(十一) 空氣品質監測結果之發布除每小時公布於網站供作民眾查詢外，並送到美國環保署(USEPA)(AIRs)供即時查詢。為確保空氣品質監測數據之正確性，該局委託外包廠商進行測值即時性檢核。而數據有效性確認則由該局每個月進行，因此即時性數據傳輸僅供即時查詢使用。至於提供美國聯邦政府進行空氣品質趨勢分析之數據，則係經該局確認後之數據，因此時間上約有 1~2 個月的延遲。

(十二) 對 PM_{10} 監測而言，該局採用 FRM 人工採樣及自動監測二種方式。大體上人工採樣係用以量測質量濃度成份分析(部分測站)，同時提供聯邦空氣品質數據分析使用。至於自動測站監測採用貝他射線衰減法(BAM)共 5 站，而 TEOM 則有 5 站，自動監測結果通常用於紀錄 PM_{10} 日後變化情形成(特殊事件影響，如森林火災，並作為空氣品質預報。因此，人工採樣與自動監測結果之差異性，基於用途之差異性，並未深入探討，所有監測結果之後續分析，包括送美國環保署之數據，均以人工監測為主，如自動監測結果與人工採樣結果差異性過大，則儀器須送原廠調校。

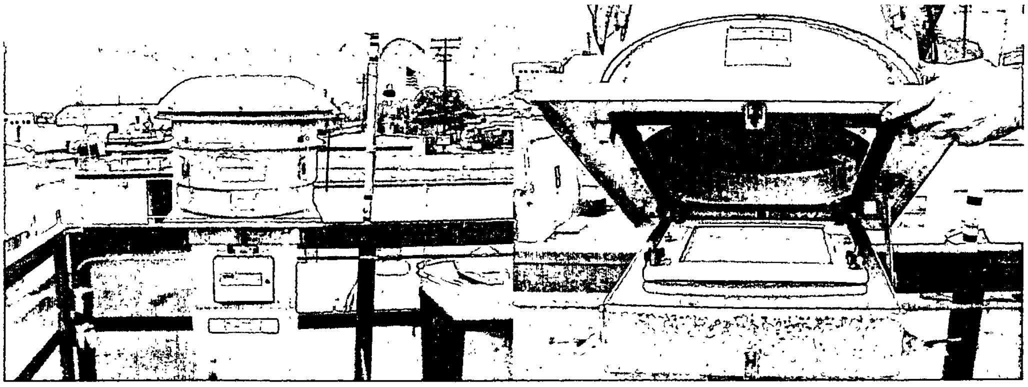

圖 2、加州南灣空氣品質管理局 PM_{10} 人工採樣器

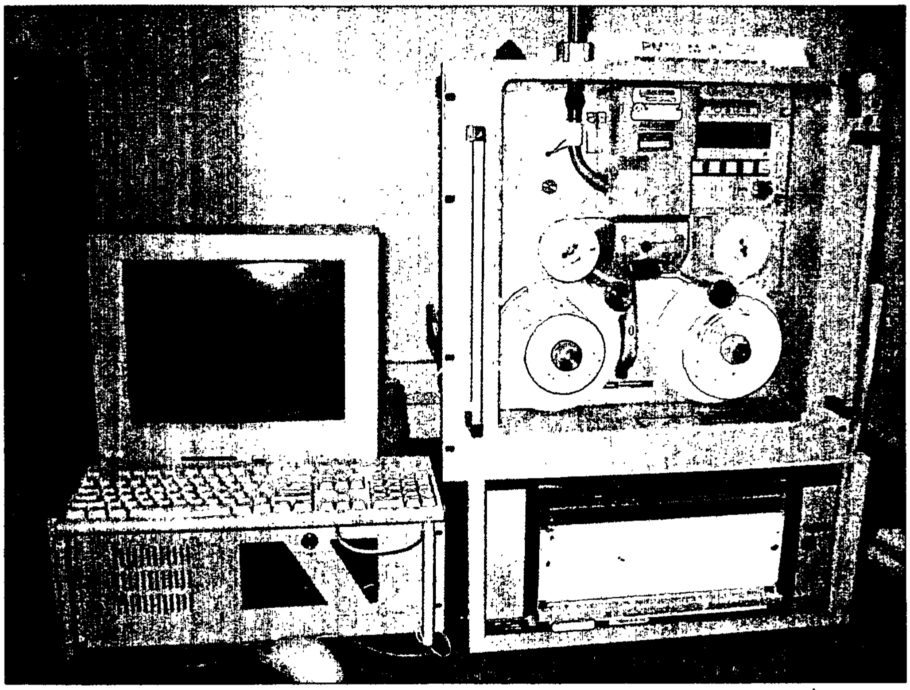

圖 3、加州南灣空氣品質管理局 PM_{10} 連續式監測儀器

(十三) 類似 PM_{10} 之情形，$PM_{2.5}$ 亦以人工採樣監測為主，該局也嘗試進行 BAM $PM_{2.5}$ 自動監測。$PM_{2.5}$ 自動監測結果之應用與 PM_{10} 自動監測相同，其目的在於即時發布監測結果，瞭解濃度日夜變化及探討特殊污染事件等。

(十四) 根據美國環保署人員表示，在聯邦政府同時也接受 PM_{10} 連續自動監測結果，但僅要求提報日平均值(據 USEPA RPT 人員表示)。

(十五) 根據聯邦法規要求，該局設置 17 個 $PM_{2.5}$ 採樣站，$PM_{2.5}$ 採樣後送回實驗室分析，包括秤重或者成份分析等。而為確保數據精準性，根據美國環保署規定，在 17 站中設計同址採樣，同步採樣分析，用來進行採樣結果之精密度評估。

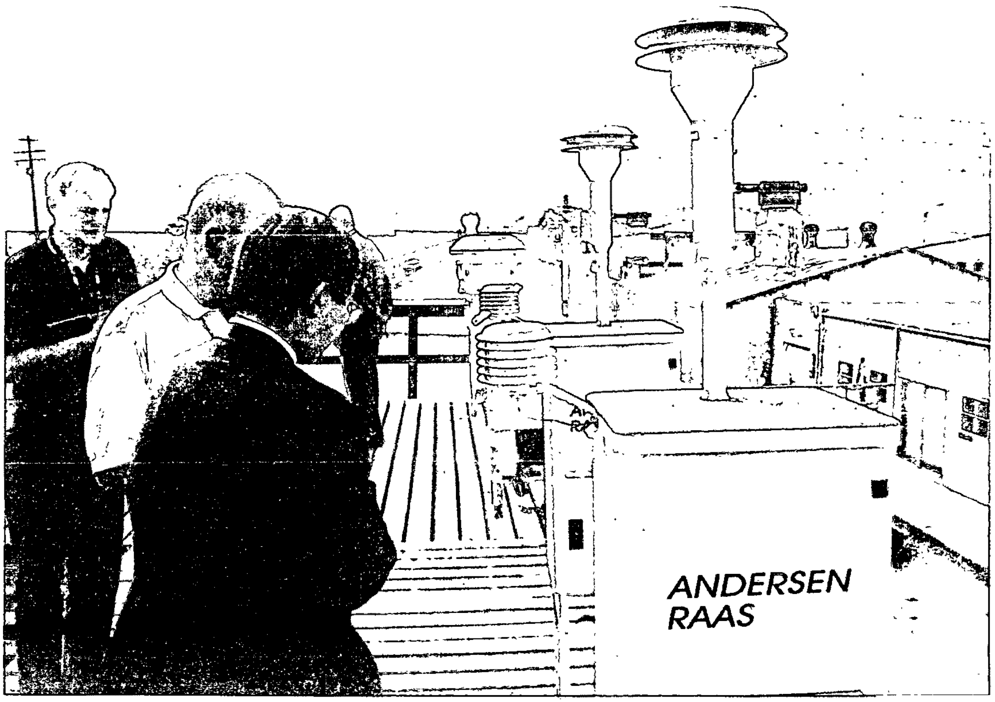

圖 4、$PM_{2.5}$ sequential filter sampler system (collocated sampler)

二、 空氣品質監測站

(一)此行參觀二個空氣監測站，其中 AZUSA 測站係長久性水泥建築，空間頗大，除了例行性監測儀器外，該站亦為光化測站，餘裕空間則提供學校研究使用；另一站為 ANAHEIM 測站，係屬於移動式測站，長 20 呎、寬 8 呎。測站參觀結果，有幾點值得作為國內借鏡。

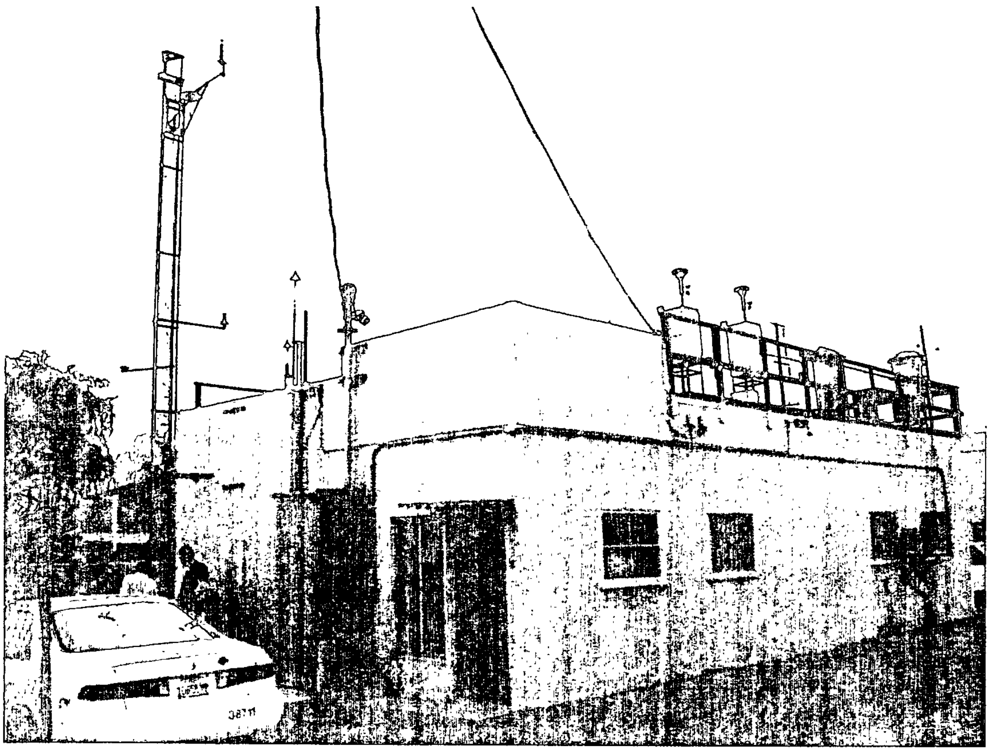

圖 5、加州南灣 AZUSA 空氣品質測站

圖 6、加州南灣 AZUSA 空氣品質測站採樣口

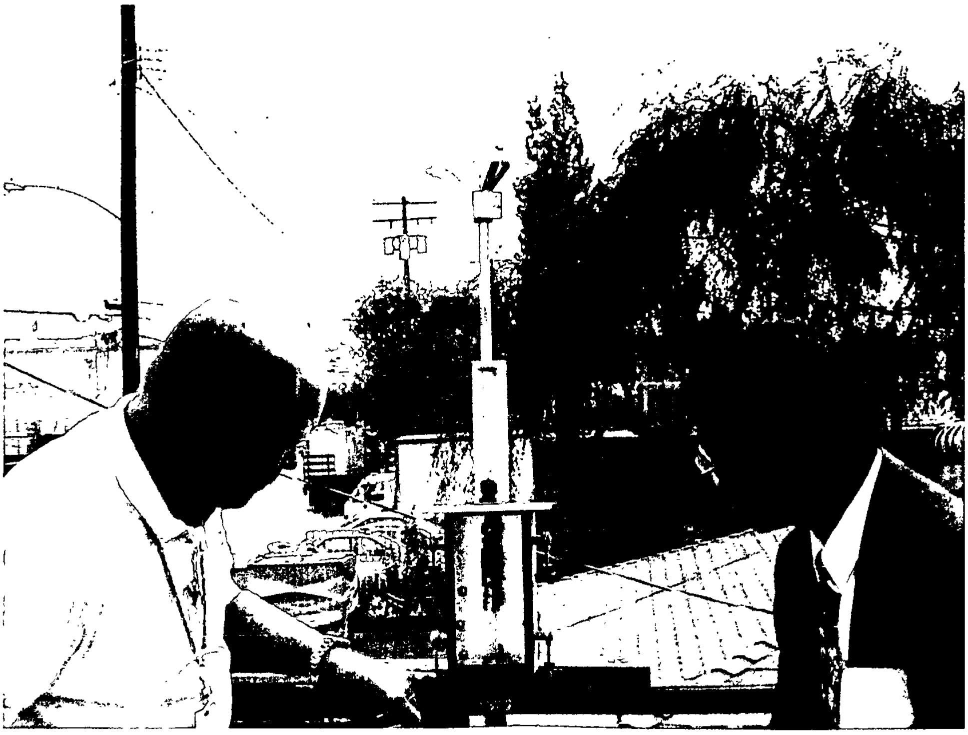

圖 7、加州南灣 AZUSA 空氣品質測站採樣口及查核氣體入口

圖 8、加州南灣 AZUSA 空氣品質測站採樣系統外觀

(二)空氣品質監測站之採樣系統係以流量計控制，採定流量 3 公升/分鐘，自外界採氣體進入站房內供儀器分析使用，此舉有助於瞭解採樣系統是否正常，避免採樣系統故障時採集到不具代表性數據，影響監測數據品質。這種採樣系統設計與國內之設計方式截然不同，值得國內參考。

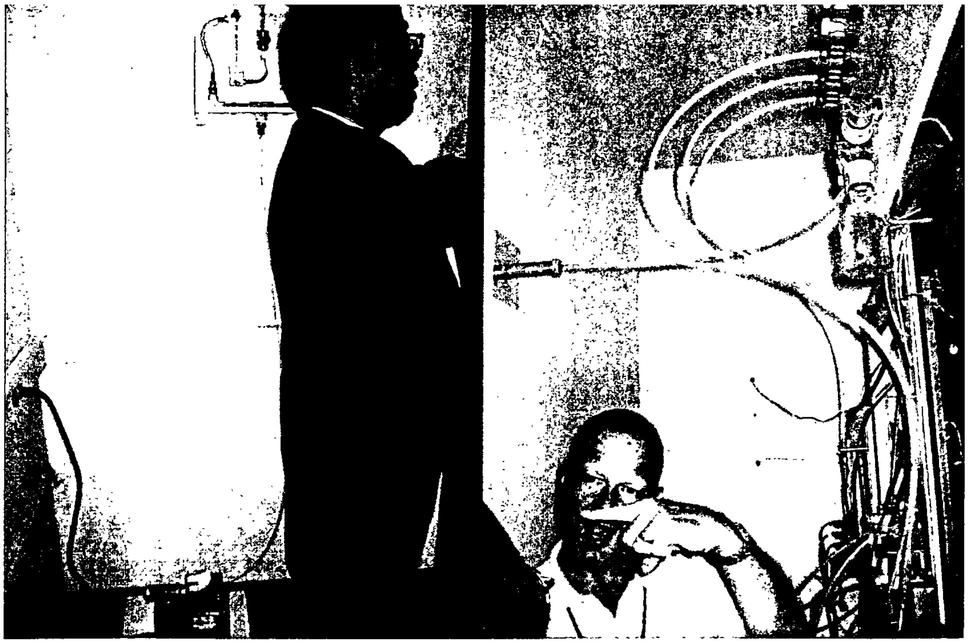

圖 9、加州南灣 AZUSA 空氣品質測站採樣系統

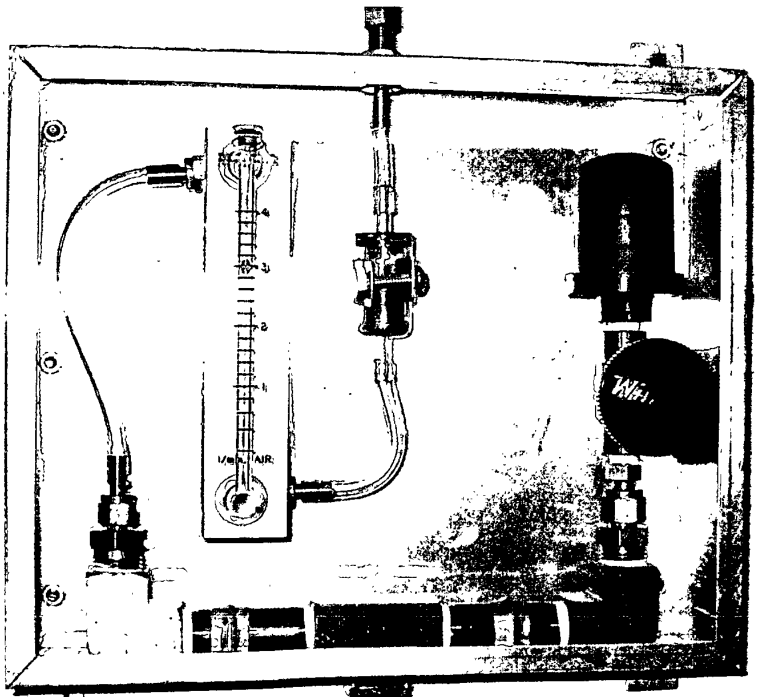

圖 10、加州南灣 AZUSA 空氣品質測站採樣流量計

(三)各儀器校正用鋼瓶均置於室內監測儀器旁，此舉除有助於縮短校正用傳輸管路長度，降低中途洩漏之可能性，鋼瓶置於站房內空調系統中，亦能有助於降低鋼瓶置於戶外，因溫度變化造成之危險。惟對於管路是否會有洩漏之虞應再日常操作過程特別留意。

(四)校正氣體送至採樣口再經採樣系統抽入監測儀器校正，由於採樣系統係 3 公升/分鐘，故校正氣體以 8 公升/分鐘注入採樣口，採樣口為開放式設計，如此過剩之校正氣體由採樣口排出，毋需加裝閥門控制。校正氣體經由採樣系統進入監測儀器分析，其優點在於可以在校正同時驗證採樣系統是否漏氣，污染物是否與採樣管路反應或濾紙是否過髒，當然包括儀器是否產生偏移等，有別於校正氣體直接進入儀器校正之作法。這種校正系統設計與國內之設計方式截然不同，值得國內參考。惟一缺點是校正氣體用量會較大。

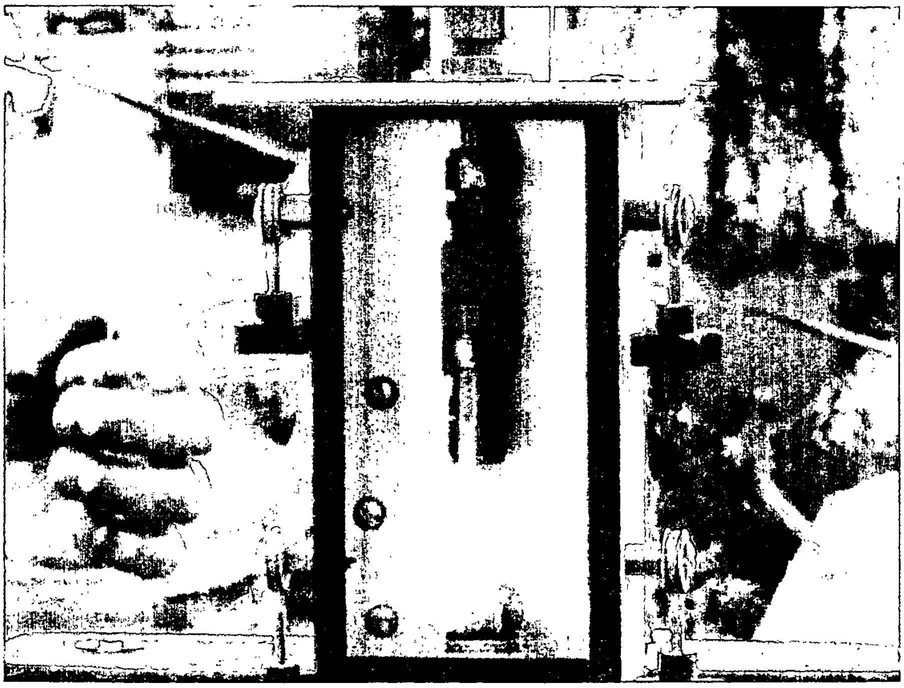

圖.11、加州南灣 AZUSA 空氣品質測站採樣系統校正氣體入口

(五)氣象塔之設計亦可供本署借鏡，該局氣象塔採固定式設計，氣象儀器則設置於氣象塔旁之平台，在需要校正或調修時，再將儀器平台降下。此舉可免除整個氣象塔調降操作人員可能危險，或氣象鐵塔升降過程時間一久造成氣象塔容易傾斜，致使風向、風速量測產生誤差。當儀器平台移動至定位後，搖桿收起，亦可避免未經許可人員亂動儀器。

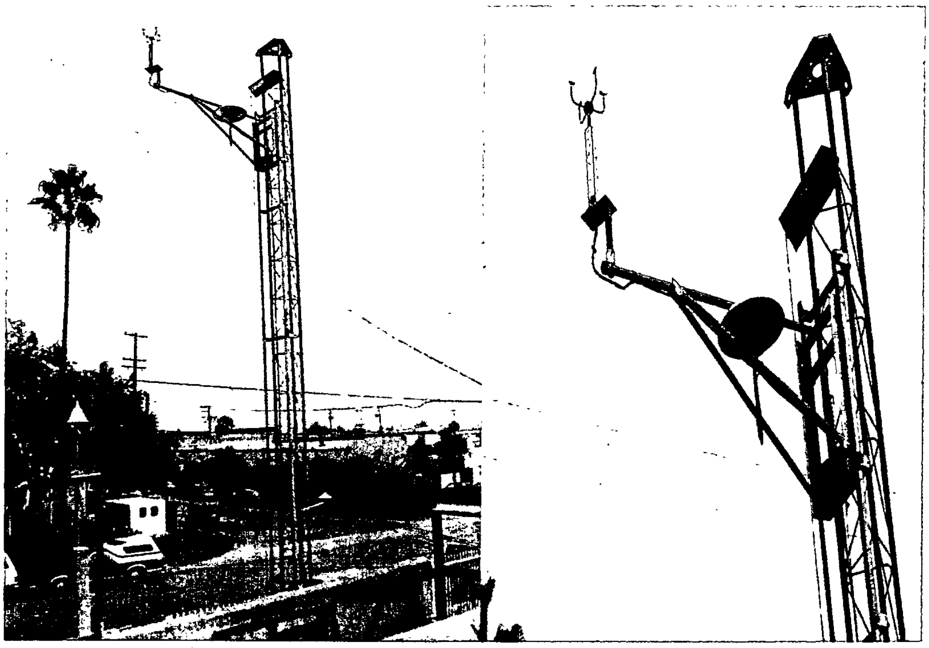

圖 12、加州南灣 AZUSA 空氣品質測站氣象監測鐵塔

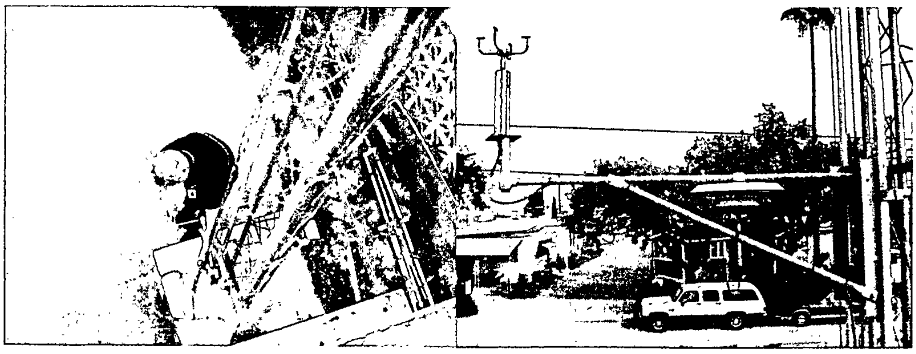

圖 13、加州南灣 AZUSA 空氣品質測站氣象監測鐵塔與儀器平台

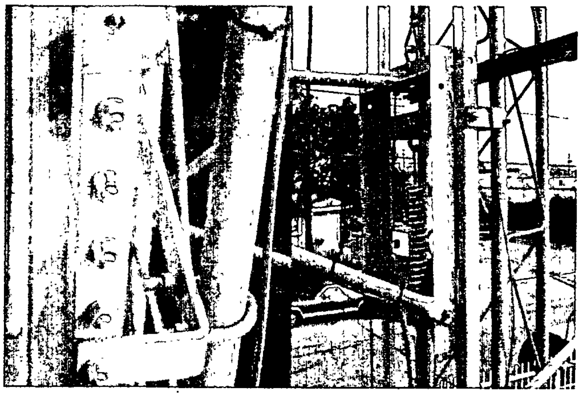

圖 14、氣象監測鐵塔儀器平台

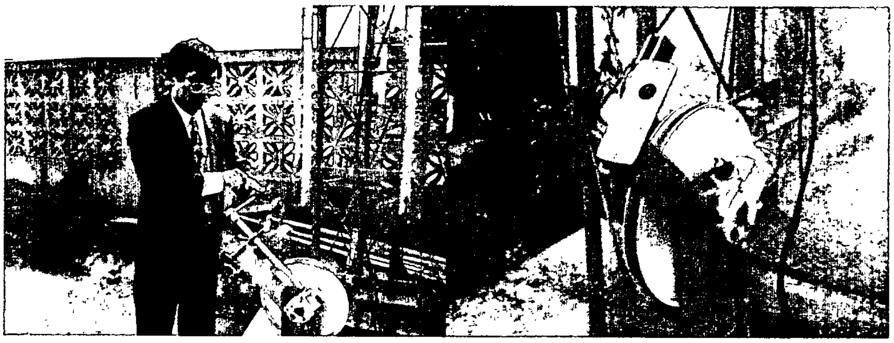

圖 15、加州南灣 AZUSA 空氣品質測站氣象監測鐵塔儀器平台升降設施

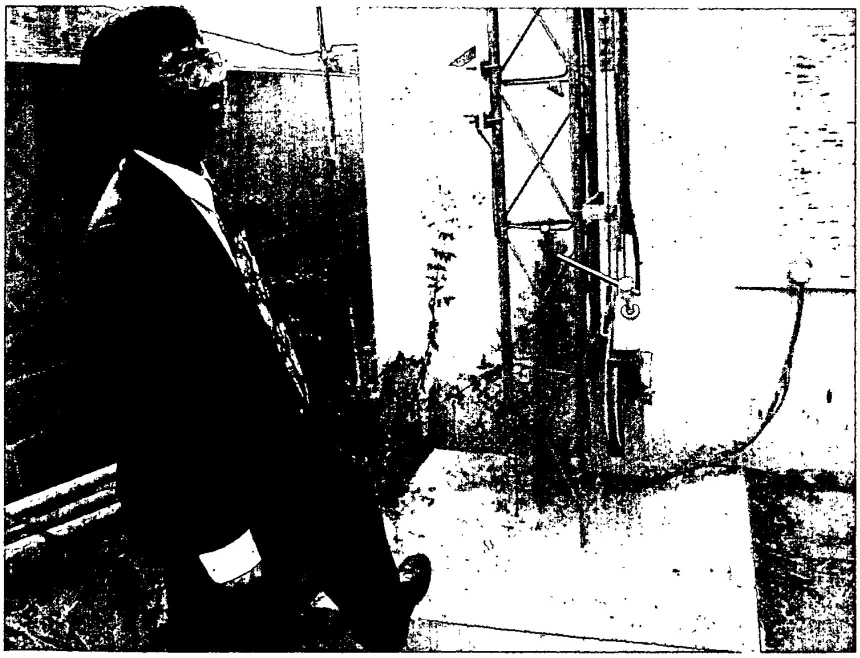

圖 16、加州南灣 AZUSA 空氣品質測站氣象監測鐵塔基座

(六)測站內部設置人員進出登記簿，供人員進出登記使用，登記簿為合訂本，不使用活頁方式。登記簿登記內容為進出測站重要記事，此外如有儀器增減、暫停運轉等則另以紀錄版貼於測站內明顯處。

(七)由於該地區屬於臭氧污染嚴重，不符合空氣品質標準，因此根據聯邦規定，設置光化學評估監測站(Photochemical Assessment Monitoring Stations, PAMS)，PAMS 測站部分該局使用 Canister 採樣儀器混合樣本，平時分析一天一個樣本，在高臭氧濃度季節(約每年 6~9 月)連續分析每三小時樣本，採樣亦為每三小時一個 Canister，分析使用儀器為連續式氣相層析儀。

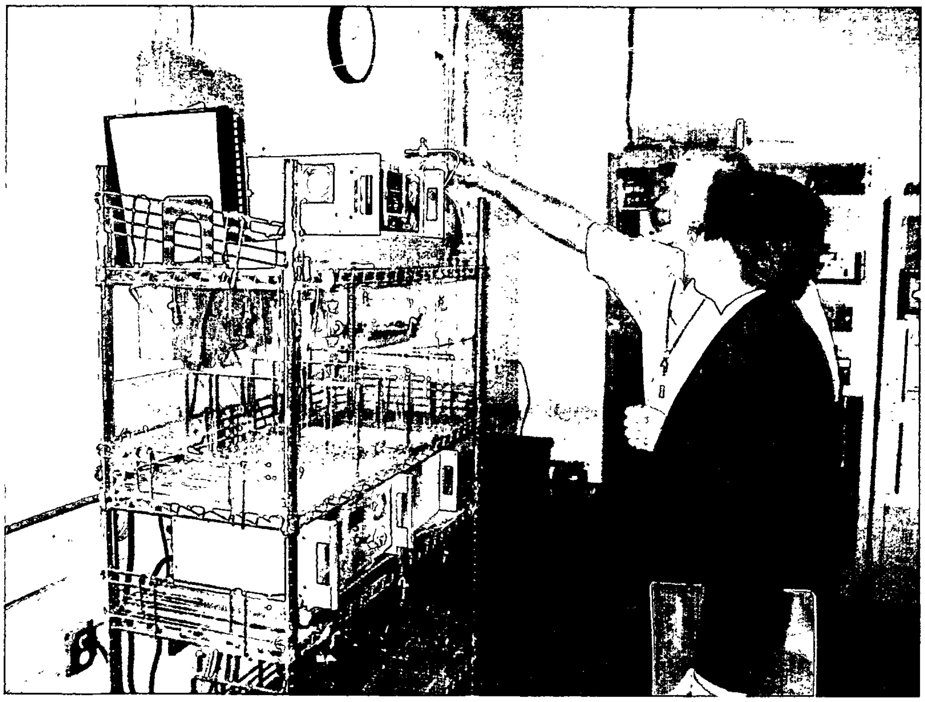

圖 17、光化學評估監測站(PAMS)使用之儀器

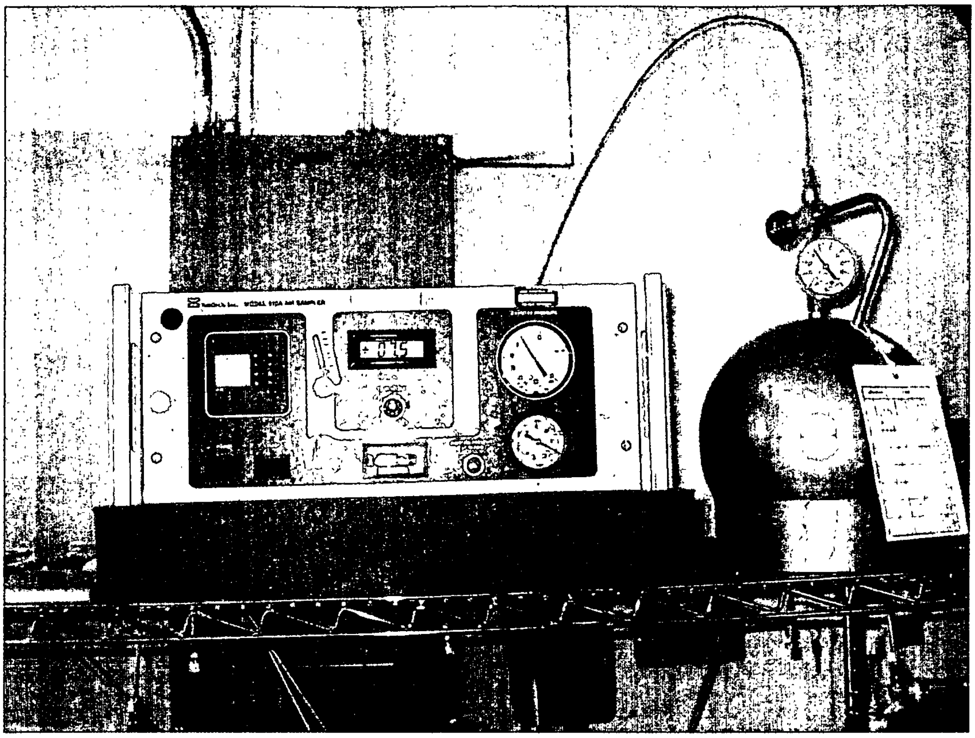

圖 18、光化學評估監測站使用 canister 採樣後分析

(八)其他空氣品質保護措施

1. 彈性上班

加州南灣為解決空氣污染問題，部分公務人員採取每週上班四天之輪班制，以減少上班期間空氣污染問題。

2. 電動汽車

加州南灣推動電動汽車不遺餘力，該辦公室之停車場亦設置了電動汽車之專用停車格與充電站。機關首長與副首長均率先採用。

3. 高速公路高乘載專用車道

為鼓勵車輛共乘以減少車輛數，高速公路上劃有高乘載之專用車道，供高乘載車輛使用。

圖 19、加州南灣空氣品質管理局電動車充電站及專用停車場

圖 20、加州南灣空氣品質管理局電動車充電站及專用停車場

圖 21、加州南灣高速公路高乘載專用車道

三、 加州 $PM_{2.5}$ 監測網設置現況及未來發展

(一)前言

加州 $PM_{2.5}$ 監測網之設置，主要用於提供 $PM_{2.5}$ 質量及化學成份資料，以支持空氣品質保護計畫，$PM_{2.5}$ 監測結果將用於判定 $PM_{2.5}$ 國家空氣品質標準不合格區域、發展及追蹤空氣品質改善計畫，評估區域煙霧(regional haze)，協助健康效應研究，以及支援其他大氣氣膠研究計畫等。

加州 $PM_{2.5}$ 24hr 質量監測網已於 1999 年建立相當完整，共有 82 個測站，目前正加速擴增 $PM_{2.5}$ 連續質量監測及 $PM_{2.5}$ 連續化學成份監測網。

加州自 1999 年開始使用 FRM 監測 $PM_{2.5}$ 質量，由於空氣品質標準之判定須使用連續三年數據，因此，目前僅有二年資料尚不足以用來判定是否符合空氣品質標準，但可用來比較各測站間之監測結果，加州空氣品質管理局 $PM_{2.5}$ 監測站網設置現況如下表。

項目	測站數	測站目的
24 小時質量	82 站	與空氣品質標準比較
連續質量	36 站 (21+15)	媒體發佈、氣膠研究、質量監測及傳輸評估
24 小時成份	17 站 (6+11)	氣膠特性研究、排放管制策略評估及追蹤污染管制計畫進展
連續成份	10 站 (0+10)	
實驗室	8 個	質量監測、濾紙秤重

	(8+0)	

(二)背景說明

由於 PM 對人體健康及能見度之不良影響，各國環保機關對 PM 均相當關心。PM 係指大氣中除了純水外之任何固態及液態物質。PM 粒徑可以從粗粒如風吹揚塵，到微細的燃燒排放微粒，大致上分成 PM_{10} 及 $PM_{2.5}$，(10 微米約為一根頭髮直徑的 1/7)，由於粒徑小，可以進入肺泡深處造成健康不良效應。$PM_{2.5}$ 為 PM_{10} 之一部分，其氣動粒徑在 2.5 微米以下者，會更深入肺泡深處，也是造成能見度降低的主要原因。$PM_{2.5}$ 之健康效應對嬰幼兒特別敏感，其原因在於嬰幼兒有相對較高之通氣速率(relative ventilation rates)、呼吸道較狹窄、器官組織發育中及戶外活動時間比率較高等。因此加州政府也正評估該州之 PM_{10} 與硫酸鹽濃度標準，以確保能保護民眾健康，特別是嬰幼兒。

1997 年 7 月 18 日，USEPA 公告 PM_{10} 及 $PM_{2.5}$ 新的空氣品質標準。根據聯邦法規規定，各州須於每年 7 月 1 日前提送每年之 $PM_{2.5}$ 監測計畫。主要的 $PM_{2.5}$ 監測站使用聯邦核可之採樣監測方法，以確保監測數據品質，可與空氣品質標準比較，並與各地監測結果相比較。

加州 $PM_{2.5}$ 82 個 FRM 監測站為 SLAMS(State and Local Air Monitoring Stations)，其中 20 個測站選為國家級測站(NAMS, National Air Monitoring Stations)，NAMS 為聯邦監測網的一部分，主要用來建立長期 $PM_{2.5}$ 變化趨勢，而 SLAMS (含 NAMS)主要用來蒐集空氣品質維護計畫(SIP)所需之資料。

為確保監測數據品質，使用 21 個同址 FRM(collocated monitoring)作為品保品管之用。有 6 個國家級測站 NAMS 分析 24 小時 $PM_{2.5}$ 成份。21 個站使用連續式監測儀器 $PM_{2.5}$ 質量(2002 年增加 15 個)及 8 個實驗室。

(三)$PM_{2.5}$ 監測網設置目的

$PM_{2.5}$ 質量監測計畫主要目的在於判定 $PM_{2.5}$ 濃度是否超過空氣品質標準(年平均 15μg/m^3 及日平均 65μg/m^3)。美國加州自 1998 年開始設置 $PM_{2.5}$ 監測網，目前共有 82 個測站，使用 FRM 方法，作

為空氣品質標準符合程度之判定。

A. 聯邦參考方法採樣器

1. 監測網設計

為規劃 $PM_{2.5}$ 監測網，加州空氣品質管理局(ARB)根據人口分布、行政區、地形及氣象進行 $PM_{2.5}$ 分區監測規劃。$PM_{2.5}$ 監測網規劃過程，以五個目的為優先考慮。

(1)滿足美國環保署監測規範要求。

(2)代表加州空氣品區及提供地理代表性。

(3)代表高人口密度之高濃度。

(4)瞭解高濃度地區之排放源特性。

(5)考慮進行中特殊健康研究對粒狀物量測之需。

以現有監測站作為 $PM_{2.5}$ 監測站址為優先考慮地點，監測站選址以人口分布、土地利用、氣候、排放源、傳輸，現有監測網特性及進行中的健康研究等。

每個空氣品質區至少一個測站，人口密度高及預期 $PM_{2.5}$ 濃度高之空氣品質區，可酌增測站數，以取得較佳之空間代表性。

2. NAMS 目的之達成

根據聯邦法規要求，部分 $PM_{2.5}$ 測站需作為國家級空氣品質監測站，用以監測長期變化趨勢，及追蹤符合國家標準之進度。2000 年建議 20 個測站作為國家級測站，在選擇做為國家級測站時，係以 PM_{10} 已運轉多年之測站，且該站未來亦將持續運轉。同時亦考慮區域代表性及採樣次數最頻繁者。

國家級測站監測結果用來建立 $PM_{2.5}$ 變化趨勢與該區域之最高濃度。目前因尚無足夠長時間之監測數據，故仍未能評析該等站址是否適宜。

3. 採樣器之選擇

使用於加州之 $PM_{2.5}$ 採樣器，係根據美國聯邦規定之參考方

法(FRM)，加州共使用三種 FRM 採樣器，除了一個測站使用 Rupprecht & Patashnick (R&P)之 Sequential FRM 採樣器，多數採用 Andersen Instruments 製造之 sequential Reference Ambient Air Sampler (RAAS) 2.5-300 或 Rupprecht & Patashnick (R&P)製造之 single-channel Partisol-FRM Model 2000。Sequential FRM 採樣器通常佈設於人口密度較高或 $PM_{2.5}$ 濃度較高地區，以便於較高頻率之採樣，如每日或每三日採樣。美國加州現有 $PM_{2.5}$ 採樣器數量如下表。

表、美國加州現有 $PM_{2.5}$ 採樣器數量

採樣器樣式	製造商	採樣器功能		
		primary	QA/QC	Total
Sequential FRM	Andersen	66	16	82
Sequential FRM	R & P	1	1	2
Single-channel FRM	R & P	15	4	19
Totlal		82	21	103

4. 採樣器之設置

$PM_{2.5}$ 採樣器設置之優先順序係以

(1) 各區(MPA)推估 $PM_{2.5}$ 可能有最大值者。

(2) $PM_{2.5}$ 濃度接近國家空氣品質標準者。

(3) 秋冬季出現 $PM_{2.5}$ 高值之區域

(4) 各環保機關至少有一套。

5. 採樣頻率

29 個 FRM $PM_{2.5}$ 採樣站每日採樣，根據規定每 50 萬人口設置 2 站及光化學測站區域設置一站，其餘地區則每三天採樣一次。

表、加州 $PM_{2.5}$ 監測站採樣頻率

全年採樣頻率統一	11 站	每日採樣
	37 站	每三日採樣
	18 站	每六日採樣
採樣頻率不同者 (10 月至 3 月採樣頻率較高)	2 站	10 月至 3 月每日採樣 4 月至 9 月每三日採樣
	4 站	10 月至 3 月每日採樣 4 月至 9 月每六日採樣
	10 站	10 月至 3 月每三日採樣 4 月至 9 月每六日採樣
總計	82 站	

ARB 將根據 1990 至 2001 年監測結果重新評估採樣頻率，但至少不低於 6 日一次。滿足以下情形

(1)$PM_{2.5}$ 監測結果不超過空氣品質標準。

(2)監測結果與連續監測儀器相關性佳，且其濃度遠低於或高於 $PM_{2.5}$ 標準者。

6. 連續式監測儀器之選擇

當使用 FRM 採樣分析結果與連續監測結果一致者，稱為 CAC(Correlated Acceptable Continuous Monitor)，由 CAC 所得資料不得直接用來直接與國家空氣品質標準比較，在評估監測站降低採樣頻率前，ARB 需彙集足夠之 FRM 與 CAC 平行監測比

對資料來建立二者之關係。對於監測結果接近空氣品質標準者，即檢討其採樣頻率，尤其對於每六日採樣者。由 CAC 所得偵測數據不得用來與空氣品質標準直接比較，亦即不能作為判定是符空氣品質標準之依據。

加州所有 $PM_{2.5}$ 連續質量監測網均使用 β 射線衰減法，經探討各種廠牌間(型號)，期間測結果存在許多差異，為了用來評估降低採樣頻率(包括每日採樣者及每三日採樣者)，必須建立 BAMs 與 FRMs 間之關係。在採樣頻率降低前，必須彙集足夠的平均監測數據，包括高測值之季節，來建立足夠的比測關係。

7. 品質保證計畫及查核

所有執行單位必須發展出保證計畫，包括行政管理、實驗室及採樣現場等。

a. 同址採樣器(Collocated Sampler)

平行比對(同址採樣)及 FRM 功能評估之目的，係來估計不同 $PM_{2.5}$ 採樣器之精密度(precision)及其誤差(bias)。根據美國聯邦法規(40 CFR Part 58，Appendix A)規定，(USEPA，1997)，針對每一種採樣方法，至少必須有 25%的採樣器必須進行平行比對。選擇平行比對站址之原則，根據其重要性分述如下：

(1) 量測或估計 $PM_{2.5}$ 濃度。

(2) 不同的操作單位。

(3) 地理代表性(Geographical representation)。

(4) 須有足夠的採樣空間。

b. $PM_{2.5}$ 實驗室事前認證計畫

為確保 $PM_{2.5}$ 監測數據品質，加州政府現參與 $PM_{2.5}$ 監測網之實驗室軍進行事先認證。認證計畫包括實驗室事前認證問卷及實驗室現場訪查，問卷內容包括各項 $PM_{2.5}$ 質量濃度監測所需遵循之步驟及內容(如 40 CFR Part 50，Appendix L)。目前已有 8 家實驗室通過認證。

(1) 天平可秤至±1μg。

(2) 平均溫度 20~23℃，溫度控制 ±2℃，24hr。

(3) 平均相對溼度 30~40%，當採樣環境相對溼度低於 30% 時，濾紙調理之相對溼度可在環境相對溼度之 ±5%，但不得低於 20%。

(4) 相對溼度控制 ±5%，24hr。

(5) 濾紙調理時間不得少於 24hr。

(6) 濾紙條理程序：

■新濾紙購入，放入溫空環境儲存直到採樣前秤重。

■分析天數與濾紙須置於同一溫空環境，濾紙秤重前不得曝露於其他環境中。

■濾紙在採樣前與採樣後之秤重均須在同一溫控環境中進行(相對溼度 ±5%)。

■採樣前後秤重須使用同一個天平，使用有效之方法去除靜電干擾(電荷中和)，如果可能的話，由同一個分析人員進行分析工作。

■採樣前秤重工作須在採樣日期 30 天內。

■採樣後之秤重工作及濾紙調理，須於採樣後 10 日內完成，否則樣品須保存於 4℃以下低溫環境，且不得超過 30 天。

■樣品空白：新濾紙於採樣前秤重，送至採樣現場，置入採樣器，但不採樣，取回後再行秤重作為品質管制用。

■實驗室空白：每一批 $PM_{2.5}$ 採樣濾紙於秤重後保留於實驗室中(在採樣期間)，於採樣結束後再行秤重作為品管樣品。

c. $PM_{2.5}$ 質量分析系統與績效查核

加州政府執行 $PM_{2.5}$ 實驗室質量分析系統查核，該查核包括完整的實驗室操作系統查核問卷，以及整個量測系統實地視察及評估(樣品採集、樣品分析、資料處理等)，績效查

核包含在系統查核內，含實地審視 $PM_{2.5}$ 秤重天平的準確度、相對溼度、溫度感應器，並檢查實驗室運作，以驗證他們產生可接受品質數據之能力。績效查核(performance audit)每年執行一次，在系統查核(initial system audit)之後。

d. 現場採樣之績效與系統查核

查核計畫主要目的為發掘(identify)系統誤差，以避免產生可疑或無效數據。量化評估採樣器績效包括流量百分誤差、設計流量百分誤差、大氣溫度差異、濾紙溫度差異、大氣壓力差異。此外，對於多濾紙採樣器，查核程序提供了未採樣濾紙溫度差異及 dry gas meter (DGM)溫度差異。

流量百分差異用來表示採樣器標稱流量之準確度，利用查核用傳輸標準與採樣器標稱流量比較之差異計算得出。

設計流量百分差異用來表示在正常操作條件下，採樣口設計流量與採樣器流量之符合程度。大氣溫度、濾紙溫度及大氣壓力差異為查核量測結果與採樣器讀值間之差異。

流量查核使用校正後之傳輸標準質量流量計(Mass flow meter)用來量測採樣器之操作流量、採樣器標稱流量與質量流量計所量得之真實流量相互比較，而採樣器指示流量亦與其設計流量 16.67 l/min 比較，查核技術可能因採樣器型號不同而有所差異。

實地採樣之系統查核為檢查監測站址是否符合 $PM_{2.5}$ 選站標準，以及站址是否清潔與儀器設備是否正確維護。啟始系統查核包括完成站址調查報告，之後每年在執行每個採樣器績效查核時，該站址調查報告須再次檢查其準確度並予以更新(as necessary)，其結果可能因查核發現問題，致數據可能刪除、修正，站址或操作條件可能因而變更。

美國 EPA 要求每年四季查核所有 $PM_{2.5}$ FRM 質量採樣器。加州政府執行其中一次季查核，包括績效與系統查核，其餘三次由地方政府或外包廠商執行。

e. 國家級之績效查核

國家級的績效查核計畫係用以評估 $PM_{2.5}$ FRM 量測系統偏差(bias)之品質保證行為。其執行策略在於收集攜帶式 FRM $PM_{2.5}$ 空氣採樣儀器，設於例行監測之 NAMS/SLAMS 採樣器 1~4 米，再根據 FRM 規定標準操作程序進行採樣，每年選定 SLAMS/NAMS 25%測站，進行一年四次之績效評估。

B. 連續式 $PM_{2.5}$ 質量採樣器

使用連續式質量採樣器之主要目的在於獲得 $PM_{2.5}$ 濃度日夜變化資料。此等數據在於即時資料發布、瞭解細微粒濃度日夜變化與污染事件之特徵、背景監測及傳輸評估等相當有用。目前加州共設置了 21 台自動連續監測儀器。部分測站因站址租約問題被迫中斷。

依據聯邦法規，人口超過 100 萬人的都會地區，必須設置連續式監測站，加州有 8 個城市(地區)符合此標準，目前已有 6 個站設置。聯邦法規亦規定背景監測及傳輸評估監測須採用連續式分析儀。加州目前設了二個背景站及一個傳輸評估用測站，也因為目前有許多不確定性，傳輸評估之測站用地不易決定。

加州 ARB 購置之 $PM_{2.5}$ 連續式採樣器均為 Metone Model 1020，其餘地方機關購置之 PM_{10}/$PM_{2.5}$ 雖然也是 Beta 射線衰減法，但加州 ARB 未規定須為同一廠牌，由於不同廠牌型號之監測結果可能導致重大差異，加州 ARB 進行了不同廠牌型號儀器之相互比較，未來在分析此類數據時須特別留意其間可能之系統性誤差。ARB 也致力於重要的 $PM_{2.5}$ 監測地點其監測儀器須滿足 ARB 的規範。在 2002 年 ARB 也要求 4 個連續式 $PM_{2.5}$ 監測站須進行平行監測。

C. $PM_{2.5}$ 成份監測採樣器

$PM_{2.5}$ 成份監測提供了微粒化學組成資訊，可以作為 $PM_{2.5}$ 污染來源追蹤研判。加州 $PM_{2.5}$ 化學成份監測網包括了兩部分，國家級(NAMS)成份監測站量測 $PM_{2.5}$ 成份之長期變化趨勢，地方級(SLAMS)成份監測站為彙集發展空氣品質維護計畫所須之數據。依據聯邦法規，加州共須七個成份監測站，作為國家級監測站網之一部分。其採樣頻率每三天一個 24 小時採集樣品，除了初期設置階段為每六天採樣一次，目前所選擇之七個測站在各監測站彙集足夠數據前，為試驗性質。

成份監測站由 USEPA 出資，並由 USEPA 指定採樣器型號，以確保全國採樣監測數據品質之一致性與可比較性，為符合規定，SASS (Spiral Aerosol Speciation Sampler)被選為加州 NAMS 成份監測採樣器。

NAMS $PM_{2.5}$ 成份監測分析項目包括：

1. 陰離子(微粒硫酸鹽與硝酸鹽)及陽離子(微粒銨 NH_4^+、Na^+ 及 K^+)
2. 微量元素(約 20 種重要元素，週期表中從 Na 到 Pb)
3. 總碳及未揮發有機氣膠成份
4. 微粒質量

D.氣象監測儀器

氣象監測項目包括風速、風向、大氣溫度及相對溼度，用來作為 $PN_{2.5}$ 傳輸評估及方案來源追蹤等。

E. 背景及傳輸監測

聯邦法規亦規定背景監測及傳輸評估監測須採用連續式分析儀。加州目前設了二個背景站及一個傳輸評估用，也因為目前有許多不確定性，傳輸評估之測站用地尚不易決定。

(四)加州 $PM_{2.5}$ 空氣品質監測站擴充計畫

2002 年加州政府對於 $PM_{2.5}$ 監測網之擴充計畫內容，主要在於連續式質量採樣器、成份監測採樣器、背景監測及周邊設施等。在北部的 Sacramento Valley 使用連續式監測器，對於農地廢棄物燃燒計畫之執行特別有效。

四個連續式監測站的同監測比對，可以作為高 $PM_{2.5}$ 濃度地區不同環境條件下儀器之間績效(功能)比較。加州所有 NAMS 之成份監測站均已完成，2002 年將著重在 SLAMS 監測站，設站前係先進行過去監測數據評估，主要有因素必須納入考慮。

1. 該地區 $PM_{2.5}$ 濃度是否超出國家空氣品質標準，以超過標準或已接近標準（即將超過）空氣品質年平均或日平均標準優先設置。

2. 對於常超過空氣品質標準地區，增設 $PM_{2.5}$ 監測站，用以取得較佳之空間代表性。

加州 $PM_{2.5}$ 空氣品質監測站未來之擴充方向說明如下：

1.以濾紙採樣之 $PM_{2.5}$ 成份監測

經 ARB 評估多種採樣器結果，決定使用 SASS(即 Spiral Aerosol Speciation Samplers)，因 SASS 在操作上及性能均較其他採樣有較佳表現。目前除了南加州(South Coast)外，均使用 SASS。新增之 SASS 監測器在初期濃度高之季節每三天採樣一次，其餘季節則改為每六天一次。

過去加州南灣地區曾使用 Particulate Technical Enhancement Program(PTEP)之成份監測採樣器，該等採樣器將再重新拿來設置，但為能進行不同採樣性能間之評估，加州南灣地將選擇其中二個站使用 SASS 採樣器，以建立過去 PTEP 之數據與未來 SASS 數據之延續性。

根據聯邦規定，濾紙採樣之成份監測站有 10%測站須進行同址監測採樣，以應品質保證及品質管制之目的。

2.連續式 $PM_{2.5}$ 成份監測

加州政府設立了四種 $PM_{2.5}$ 連續式成份監測站，包括連續式硝酸鹽、硫酸鹽、碳黑(aethelometer)以及有機碳/元素碳等，分述如下：

a.硝酸鹽監測

ARB 將設置 8~9 部硝酸鹽連續監測儀，其中包括一部用來同址監測。選址之考慮因素在於根據過去 PM10 成份分析結果，硝酸鹽濃度較高者，未來將再購作備品儀器，以備儀器維修時可以立即替代。

b. Aethelometors

設置七部 Aethelometors 用來量測黑碳(Black Soot)，數據為每小時甚至每五分鐘一筆，其監測結果可用來推估元素碳成份濃度。設置於較高碳成份濃度地區（分析過去 PM10 監測結果）

目前在 Fresno 超級測站設有二部 Aethelometors 用來比較不同原理監測儀器之差異性。

c.有機碳/元素碳監測及硫酸鹽監測

目前有一部有機碳/元素碳連續監測儀器，但與濾紙採樣分析結果比較，其測值普遍偏低，未來將計畫新購 2-3 部有機碳/元素碳。

硫酸鹽監測儀器有二部，未來將再新購一部。

d.背景監測站

背景 $PM_{2.5}$ 監測站之目的在對遠離人口密集地區與重大污染排放地區之區域代表性進行量化。$PM_{2.5}$ 背景濃度定義為沒有人為 PM 排放源或人為排放前驅物質，如揮發性有機物、氮氧化物、硫氧化物等生成二次氣膠。背景監測對於 $PM_{2.5}$ 濃度超過空氣品質標準地區發展 $PM_{2.5}$ 控制計畫相當重要，例如來自海鹽之貢獻、森林大火或沙塵暴等，污染來源之界定相當重要。

(五)監測數據分析與處理

1. 數據分析

$PM_{2.5}$ 監測數據分成二類，包括氣膠質量及化學成份。質量監測結果用研判是否符合空氣品質標準及建立 $PM_{2.5}$ 濃度變化趨勢。$PM_{2.5}$ 成份分析結果則用來評估其變化超勢及用以發展降低氣膠排放源之控制計畫，(與空氣品質維護計畫有關 SIP)，此外，亦包括污染排放資料庫（Inventory）及追蹤污染空制計畫之成效。

(1)$PM_{2.5}$ 超過標準之比例

(2)$PM_{2.5}$ 季節性變化

(3)$PM_{2.5}$ 佔 PM_{10} 比例

2. PM 相關統計摘要

即使二個地區有相同之質量濃度，但造成濃度上升原因大不相同，其面臨之問題亦大不相同。同一地區亦可能因季節性不同而有不同的 PM 問題。

PM_{10} 季節性變化與 $PM_{2.5}$ 類似，而 $PM_{2.5}$ 與 PM_{10} 間之差異在冬季最小，$PM_{2.5}$ 約佔 PM10 80~90%，部分 PM 之污染主要來自粗粒 PM(Coarse)溢散排放，則使 $PM_{2.5}$ 佔 PM_{10} 比例相當低。

$PM_{2.5}$與 PM_{10} 間之差異則在夏季與初秋最大，其原因在於此季節中地質成份（粗粒部分）佔了大部分 PM_{10} 之質量。但冬季則因降雨使得粗粒之排放減少。

3. Area Designations and Network Review

聯邦 PM 空氣品質標準

(1)24 小時 $PM_{2.5}$ 平均濃度之每年 98 百分位數三年平均不得超過 65 $\mu g/m^3$ 在監測區域內任何社區代表測站。

(2)$PM_{2.5}$ 年平均之三年平均不得大於 15 $\mu g/m^3$，單一社區代表測站或社區代表測站之空間平均結果。

(3)PM_{10} 24hr 平均值每年超過 150 $\mu g/m^3$ 次數不大於一次(連續三年)，採樣天數，非每日連續採樣。

(4)連續三年 PM_{10} 之年平均算術平均不超過 50 $\mu g/m^3$，監測區域內任何一站。

加州對於 PM_{10} 空氣品質標準另外設有標準如下：

(1)在一監測區域任一監測站 PM_{10} 24 小時平均不得超過 50 $\mu g/m^3$，但先扣除受不正常事件之影響。

(2)年幾何平均 PM_{10} 不超過 30 $\mu g/m^3$，在連續三年期間，在監測區域內任何一個測站。

根據聯邦法規規定，$PM_{2.5}$ 是否符合標準須有連續三年監測數據，因此在 2003 年方有足夠數據來判定加州那些地區超出 $PM_{2.5}$ 空氣品質標準。在 USEPA 公告空氣品質時，亦同意在判定空氣品質標準符合前，合重新檢討 $PM_{2.5}$ 濃度對健康之效應，預計在 2002 年完成。空氣品質是否符合標準將根據最新蒐集資訊，每年檢討更新。當 $PM_{2.5}$ 資料蒐集後，測值超過 $PM_{2.5}$ 24 小時標準之數據，將評估是否受到自然/異常事件(natural/ekceptional events)影響所致，USEPA 允許 $PM_{2.5}$ 符合自然/異常事件所導致 $PM_{2.5}$ 之高濃度可以在判定空氣品質符合時被排除不納入許可計算。

4. 資料完整性

$PM_{2.5}$ FRM 質量監測網主要目的係用來判定各該地區 $PM_{2.5}$ 是否符合空氣品質標準。對於不符合空氣品質標準地區可能產生經濟上之衝擊，因此對於所蒐集之 $PM_{2.5}$ 監測數據量與品質均

須足以用來佐證該地區是否符合空氣品質標準。監測站網設計與評估程序在於確保監測資源可以提供足夠的監測數據品質與數量。

根據聯邦規定，用來與空氣品質標準年平均或日平均標準比較時，必須每季排定之採樣數量達到 75%有效樣品連續三年，方可稱為具有代表性數據。

因此，此等要求對於每六日採樣一次之地點，是很難達到的（按每六日採樣一次，則每季十五個樣品，其 75%須達 11.25，故僅四個樣品失敗，即無法滿足標準之要求）即使其他各季均達 100%資料完整性亦然。特定異常情形是被允許的，而且係取決於是用來證明符合或不符合空氣品質標準。

當欲證明該地區符合空氣品質標準時，可以經該區域主管核可使用低於 75%完整性之數據。當滿足下列條件時，可以使用數據來替代數據遺失之日期。

- 各排定之監測站之採樣數連續三年各季至少有 50%監測數據。
- 說明替代數據當季排放源與氣象條件與數據遺失當季之排放源與氣象條件。
- 以不完整數據比較空氣品質標準須合格（亦即使用已蒐集數據比較須符合標準）

遺失之數據可以用下列方法替代

- 使用同址監測所得之 $PM_{2.5}$、PM_{10} 或 TSP 數據替代，數據須與原預定採樣日期同一日或前後二日。當使用同址監測數據時，必須將同址監測所得全部用來替代該數據，而非僅用來替代部分日期之數據。
- 使用同一地點三年各季 $PM_{2.5}$ 最高濃度來替代遺失數據。

當欲證明該地不符合空氣品質標準時，相關規定較不嚴苛。對於 24 小時標準不合格之判定，如年的 98 百分位數大於 24 小時標準，即使數據蒐集百分比未達 75%亦可納入計算，亦如果一年中僅有一筆數據但超過標準，亦可納入計算。在此情形下，一地區原欲每日採樣，亦可根據該數據判定為不合格地區。

當欲證明 $PM_{2.5}$ 年平均標準不合格時，如果年平均計算結果超過標準，那麼每季僅至少十一個樣品即可納入計算，此時對於每日採樣地點，一年僅須四十四個樣品即可用來判定該定區不合格（約 12%之數據），在某些情形區域主管（Regional Administrator）可以授權使用樣品數低於十一個之季監測數據。

四、 美國環保署 $PM_{2.5}$ 監測執行現況

(一) 前言

$PM_{2.5}$ 監測網之設置在執行國家新的 $PM_{2.5}$ 空氣品質標準時，為重要之工作。1997 年 7 月公佈新的空氣品質標準以來，美國聯邦除了有關微粒研究經費，已投入超過 1 億 2800 萬美元，來建立 $PM_{2.5}$ 監測網。$PM_{2.5}$ 監測網相關規定係依美國聯邦法規 Title 40,Code of Federal Regulations(40 CFR)，Parts 50, 53, 58。(1997 年 7 月 18 日印行)。根據國家空氣品質標準規定，$PM_{2.5}$ 監測網所得數據將用於決策應用、判定空氣品質符合與否、發展經濟有效之控制計畫及追蹤評估空氣品質改善計畫之進度表。

(二) 監測網設計概念及主要計畫內容

監測網所得數據主要用作

1. $PM_{2.5}$ 空氣品質標準比較
2. 發展及追蹤空氣品質維護計畫
3. 評估區域性塵霾
4. 協助健康效應研究與氣膠特性研究等

$PM_{2.5}$ 監測網設計將綜合此四項計畫目標，結合測站選址及儀器選擇等。聯邦參考方法(Federal Reference method, FRM)採樣器之設計與監測網規劃理念，如以社區導向(Community-oriented)監測，指以民眾生活、戶外活動、工作等曝露情形監測，而非以最大濃度發生地區，可用作於 $PM_{2.5}$ 之健康效應評估所需數據。FRM 採樣器使用之主要目的在於定義為 $PM_{2.5}$ 之微粒指標，用以支持 $PM_{2.5}$ 空氣品質標準所須健康影響資料。因 FRM 儀器設計需求，規定了特定之設計需求，而非以其功能來作規範，以提高量測之精密度，避免類似 PM_{10} 監測所產生之不確定。而因為 $PM_{2.5}$ 採樣器無法提供氣膠濃度時間解析(逐時數據)或其化學組成特性資料，所以在 $PM_{2.5}$ 監測網間使用之儀器會包括連續式分析儀以及化學成份分析用之採樣器。

(三) 監測網設計內容及變更(自 1998 年後)

1. 質量監測

主要用來與國家空氣品質標準之日平均及年平均比較，作為決定空氣品質是否符合標準之判定，監測網設計以人口密集區域，強調大區域範圍濃度暴露之代表性(社區代表性)。全國 $PM_{2.5}$ 監測網約有 1050 FRM 監測站，其中 850 個站為法規要求最低設置站數(2000 年 3 月已有 1022 個 FRM 測站運轉中)，至於非屬法規要求的大約 200 個站，其設站目的在於提供足夠站數來涵蓋人口密集區或為特殊目的設置之測站。原先規劃約 1400 個 FRM 測站，在 1998 年 3 月，經檢討後建議質量監測站減少，但增加化學成份監測站及連續式監測站(The National Academy of Science's report)，美國環保署接受建議減少質量監測站約 350 個，將多餘之人力、物力轉而投注在連續式監測與化學成份監測。監測網設計修訂及監測現況如下表。

Table 1. $PM_{2.5}$ Network Design Impacts from 1999 NAS Report & Current Operating Status.

Network Element	Original # of Sites in 1997	Current # of Planned Sites	# of Sites Operating as of 3/1/00
Compliance(FRM) sites	1,392	1,050	1,022
Chemical Speciation	~300 sites sampling either 1 in 6 or 1 in 12 days.	54 "trends" sites sampling lin3;~40 sites used to support Supersites, sampling 1 in 3 generally;~10 sites sampling daily to support ongoing health studies;~200 sites used to support SIP and other work, sampling 1 in 6	13
IMPROVE network expansion	108	110	35
Continuous mass	100	~210	115

sites			
Supersites	4 to 9	8 (based upon award)	Atlanta site operated in 1999; remainder expected in 2000-01.

2. 連續監測 $PM_{2.5}$

根據 40 CFR 58, Appendix D, § 2.8.2.3 規定，在全美 52 個大的都會區域須設置 $PM_{2.5}$ 連續監測儀器，目前全美各州約走 115 個連續式監測站，未來可能擴增到 200 站。連續式 $PM_{2.5}$ 監測結果將用作公佈即時短期間測數據，提供細微粒日夜變化及污染特徵，作為科學健康評估瞭解暴露型態(exposure pattern)使用。

目前連續式監測儀器多數使用 TEOM 儀器，其他儀器包括 BAM, nephelometers 及 CAMMS。美國環保署已經建立一個連續監測工作小組(與地方州政府)，對連續監測方式、品保品管及相關議題，提供好的討論空間。

3. 化學成份採樣及分析

環保署對於 $PM_{2.5}$ 監測網之設置大部分的努力係放在化學成份監測站的設置。

美國環保署瞭解 $PM_{2.5}$ 監測網數據為發展污染排放管制及追蹤控制策略進展之重要資訊來源，化學成份分析資料之基本目標為發展全國空氣中氣膠季節性及全年之化學特性。化學分析結果將用作污染源貢獻分析，評析污染排放資料庫與空氣品質模式，支援健康相關研究與區域性塵霾評估等。值得注意的是單比較空氣品質模式預測結果與質量監測結果，不能提供足夠的模式測試之需且複雜，其因在於部分質量監測結果之誤差可能來自採樣。成分分析結果則提供了豐富的資訊（與質量監測結果比較），可以提供模式更多訊息，有助預測可信度之提昇。

- 54 個化學成份趨勢監測站每三天採樣一次，環保署與外部專家發展數據品質目標(化學成份趨勢監測站)，將原先每六天採樣改為每

三天採樣一次。

- 這 54 個趨勢監測站中有 10 個站每天採樣一次，使用額外的採樣器或半連續式採樣器來達成。

- 2001 年第四季完成設置，以增加現場測試並評估新發展出的採樣技術。

目前已商業化之可用採樣器設計，用來作為化學成份監測者，多為濾紙採樣方法，使用結合 Teflon, nylon 與 quartz 濾紙來達到蒐集不同化學組成之目的，包括元素、元素碳與有機碳，及主要離子，包括硝酸鹽、硫酸鹽、氯離子及銨等。然而此領域被期待將有重大變革，未來連續式化學成份監測方法也將被開發出來。環保署也期待超級測站計畫將作為有效界面提供轉移新的採樣技術作為例行監測使用。

環保署也正發展實驗室標準操作程序(SOPs)，該程序也將與目前由不同環保機關或研究單位使用於空氣中粒狀物成份監測之方法一致(相容)。於技術上保留彈性但須付出因不同方法所致之不確定性，成份採樣監測計畫最大的不確定性在於實驗室分析(protocol)，因此環保署將進行實驗室分析之標準化作業。環保署已建立一個國家實驗室分析的合約來支援化學成份監測計畫，幾乎所有化學成份監測將使用此實驗室。所有建立趨勢之監測站都將使用此一國家合約來進行濾紙分析。唯一例外者為 Interagency Monitoring of Protected Visual Environments (IMPROVE)計畫，該計畫擁有獨立的中心實驗室。

成份分析監測站將有 300 個，各有不同採樣頻率，其中 54 個站依據聯邦法規將用作建立長期變化趨勢，而這 54 個監測站將設置於高人口密度區域，以及特定污染排放影響區域，例如光化學評估監測站之第二種類型監測站，或者其他同址監測地點。此外，有將近 40 個監測站將配合各州之研究計畫，包括超級測站計畫等。

由於化學成份監測結果將為科學界感興趣，美國環保署鼓勵各地方州政府諮詢當地或國家級之進行健康效應研究人員。在超級測站附近地區增加採樣頻率或某特定時段增加採樣頻率等，所需經費係由州政府出資。

4. 超級測站(supersites)

超級測站之前身為 1998 年 3 月推動之特別化學成份研究(special chemical speciation studies)，超級測站之主要目的為支持空氣品質改

善計畫(SIP)之行動，提供健康效應研究所需資訊，評估國家空氣品質標準及協助測試先進之採樣技術。前述較例行性之成份分析監測將用來支援上述目的，然而這些例行性監測可能會需要更密集的監測數據，以瞭解區域性空氣污染過程及增進後續空氣品質維護計畫之發展程序。對於技術性工具之評估，例如污染源鑑定技術、污染排放資料庫、空氣品質預測模式等，均可由增加時間、空間及化學成份解析度之監測數據得到改善。長久以來，正規之空氣品質維護計畫常因未使用該等技術性工具進行密集研究而受到質疑，為解決這個問題，環保署建立了超級測站提供空氣品質評估所需相關資訊。美國環保署 2001 年 1 月公佈超級測站相關計畫如下：

- Atlanta. Advanced methods evaluation leveraged with multiple air quality and related studies. Monitoring was conducted during the Summer 1999.
- Fresno. Methods evaluation with transition to routine networks leveraged with a major air quality study (CRPAQS) and several potential health related studies. Monitoring began in the Summer 1999 and will continue to Spring 2001 as the "CA Supersite Phase II". The Principal Investigator is John Watson, Desert Research Institute.
- Houston. David Allen, University of Texas at Austin, "Gulf Coast Aerosol Research & Characterization Program."
- St Louis. Jay Turner, Washington University, "St. Louis-Midwest Supersite"
- Los Angeles. John Froines, University of California Consortium, "Southern California Particulate Matter Supersite."
- Baltimore. John Ondov, University of Maryland, "Baltimore Supersite: Highly Time & Size Resolved Concentrations of Urban $PM_{2.5}$ & its Constituents for Resolution of Sources & Immune Responses."
- Pittsburgh. Spyros Pandis, Carnegie Mellon University, "The Pittsburgh PM Supersite: A Multidisciplinary Consortium for Atmospheric Aerosols Research."
- New York City. Ken Demerjian, ASRC, State University of New York "$PM_{2.5}$ Technology Assessment & Characterization Study in New York."

超級測站由環保署科學與技術部門提供，2000 萬美元。超級測

站採樣及分析結果可以提供氣膠粒徑分布與化學組成特性之日夜變化，此外，也提供了二次氣膠前驅物與中間產物，例如硝酸、氨、二氧化氮與其他 NOy 成份，peroxides 及 peroxy radicals 均可被量測，提供空氣品質模式中化學機制之測試。而這些量測也同時提供臭氧與沈降評估，其因在於許多物理、化學程序是跨越多種污染物種的會影響到多種污染物。

5. IMPROVE 監測

根據 40 CFR 51 有關區域塵霾法規，1999 年 4 月 22 日要求監測能見度。該規定使得 Class I 地區的監測資料變得更重要，因地方州政府須據此決定是否繼續減少更多的污染排放，以符合能見度目標，IMPROVE 監測共規劃 110 個監測站。

(四) 美國環保署 $PM_{2.5}$ 監測網之執行進度

表. USEPA $PM_{2.5}$ 監測網執行進度

ACTION	MILESTONE
40 CFR 50,53, and 58 $PM_{2.5}$ regulation	July 18,1997 Part 58 available on AMTIC* Parts 50 and 53 available on TTN Airlinks (http://www.epa.gov//ttn) Subsequent correction notice on 2/17/98;
States & Reqions develop & approve network designs	September 1997- June 30, 1998 Review & approval on July 1 of each year.
States establish 1050 $PM_{2.5}$ sites	September 1997- December 31, 1999
"Guidance for Network Design & Optimum Site Exposure for PM"	December 15,1997- Available on AMTIC under Network Design*
Award for national procurement contract to buy 46.2mm Teflon filters for use in FRMs.	January 31, 1998
Summary of Guidance: Filter Conditioning & Weighing Facilities & Procedures for $PM_{2.5}$ Reference and Class I Equivalent Methods"	February 27,1998
"Particulate Matter ($PM_{2.5}$) Speciation Guidance (Draft to work group for review on February 25,1998)	February 25, 1998-1st draft July 1998 – Recommendations from Expert Panel October 7, 1999 - Final
Model QA Project Plan Guidance Document	March 6, 1998(final draft) March 31, 1998 final version signed by each Region
U.S.EPA awards nat'l $PM_{2.5}$ sampler proc. Contract & makes first orders (info on # and type of samplers must be compiled by Regions and to OAQPS by March 2, 1998.)	March 25, 1998 contract award April 1998 first set of FRM orders June 1998 second set of FRM orders
FRM/FEM designations granted (Specific samplers and vendors listed here. This is a continuing process, however, and other samplers may go through with designation in the future)	BGI single channel & portable 4/16/98 R&P single channel & sequentials 4/16/98 Andersen single channel & sequentials 6/11/98 Thermo Env. Instr. single channel 10/29/98 Andersen portable audit 3/11/99 R&P portable audit 4/19/99

QA Handbook (Red Book) with final Method 2.12 "Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods"	May 14, 1998 Final June 2000-Next revision-to incorporate info learned from 1st year
U.S.EPA/NARSTO Workshop on the Supersites program design with scientific community	May 19,1998 Steering Committee mtg. June 11,1998 Workshop
U.S.EPA/AWMA Training on $PM_{2.5}$ Laboratory and Sampling Equipment	May 20-21,1998 in RTP, NC
Vendors deliver first orders FRM samplers to States	June 1, 1998- November 3, 1998
"Guidance for Using Continuous Monitors in $PM_{2.5}$ Monitoring Networks"	June 5, 1998
FRM Performance Evaluation Program QA Project Plan	June 1998
States submit final 1998 $PM_{2.5}$ network descriptions to Regions	July 1, 1998
Regions approve final $PM_{2.5}$ network descriptions	July 31, 1998
FRM Performance Evaluation Program Implementation Plan	August 28, 1998
FY99 § 103 grant guidance to Regions from OAR(Draft in March)	October 23, 1998 (Final)
Portable QA FRM audit samplers delivered to PEP Auditors	October 30, 1998
FRM Performance Evaluation Program Standard Operating Procedures	November 2, 1998
"Field Program Plan for the $PM_{2.5}$ Chemical Speciation Sampler Evaluation Study.	November 23,1998
Speciation laboratory analysis contract award	December 1998
Development of the Data Quality Objectives (DQOs) for the 54 Trends Sites	December 16, 1998
Quality assurance project plans approved by Regions	December 31, 1998- December 31,1999
Supersites research public solicitation	March 9, 1999
$PM_{2.5}$ Data Validation Template for use with mass data	April 6, 1999
Stategic Plan for Development of the Particulate Matte($PM_{2.5}$) Quality System for the Chemical Speciation Monitoring Trends Sites"	May 19, 1999
"Visibility Monitoring Guidance" EPA-454/R-99-003	June 1999
States submit final 1999 $PM_{2.5}$ network descriptions to Regions	July 1, 1999
Atlanta Supersite data collection activities	Summer 1999
Fresno Supersite data collection activities, Phase 1 & 2	Summer 1999 to Spring 2001
"Quality Assurance Project Plan: $PM_{2.5}$ Speciation Trends Network".	October 27, 1999(3rd Draft)
Deployment of initial chemical speciation sites ("mini-trends")	November 1999(Equipment delivery & training) February 2000 (1st data collection) May 2000 (study completion)
1,050 $PM_{2.5}$ FRM sites are established + all required continuous monitoring sites & States begin "routine"data collection.	December 31, 1999
Supersites award announcement at the PM2000 Conference in Charleston, SC	January 25, 2000 Sampling to begin in 2000-2001
Chemical Speciation Program Satellite Broadcast	March 21, 2000
$PM_{2.5}$ Monitoring Quality Assurance & Data Analysis Workshop (targets State, local and tribal monitoring agencies)	May 22-25, 2000 in RTP
States submit 2000 $PM_{2.5}$ network descriptions to Regions, which includes chemical speciation sites.	July 1, 2000
Deployment of all chemical speciation trends sites (54 total including 10 daily sites), and speciation sites used to support Supersites activities(~40)	December 31, 2000
Deployment of supplemental chemical speciation sites	October 2000- October 2001

(~200)	

*For $PM_{2.5}$ information on the Ambient Monitoring Technology Information Center (AMTIC), see http://www.epa.gov/ttn/amtic/amticpn.html

(五) 修訂粗微粒國家空氣品質標準

由於環保署訂定 $PM_{2.5}$ 新的空氣品質標準，(仍保留 1987 年 PM_{10} 標準)，工業界提出異議，美國法院認為 PM_{10} 包含了細微粒部分 ($PM_{2.5}$)，因此 PM_{10} 並非粗微粒之良好指標，環保署此刻也正尋找使用粗微粒指標 PM_C 在現行空氣品質標準來代替 PM_{10} 之可能性，。PM_C 定義為 PM_{10}-$PM_{2.5}$，其量測方法將由目前 PM_{10} 與 $PM_{2.5}$ 同址監測結果相減得到（24 小時採樣)。

環保署對於 $PM_{2.5}$ 與 PM_{10} 量測也將制定相關規定，例如 $PM_{2.5}$ 與 PM_{10} 最大與最小距離、採樣高度差、資料輸出格式、濾紙稱重、操作程序及相關品保作業。環保也將考慮相關新的功能與測試需求是否需另行訂定。

(六)使用連續式 $PM_{2.5}$ 監測儀器之目的

1.減少赴測站次數及降低監測網操作費用

2.決定增加或減少人工採樣頻率，以便於與國家空氣品質標準比較

3.提供即時監測資訊，作為警報發布或執行短期性空制策略，例如燃燒控制(burning bans)，無車日(no-drive days)

4.評估人體曝露於戶外空氣之日夜變化

5.界定監測站之代表區域及污染源影響區域

6.瞭解高濃度 $PM_{2.5}$ 及 PM_{10} 物理與化學特性

除非連續分析儀通過等同方法(equivalent method)之認可程序，否則其監測數據不得用來作空氣品質符合與否之判定。

(七)環境技術證計畫

為驗證 $PM_{2.5}$ 相關監測技術，(包括質量及化學成份監測)，在美國環保署贊助主辦的環境技術驗證計畫（Environmental Technology Verification, ETV)，進行了 $PM_{2.5}$ 監測技術功能的定量評估(如附件)。

肆、建議事項

一、 本次考察加州南灣空氣品質管理局空氣品質監測站，該局空氣品質監測站操作及維護制度值得本署參考。各個測站之測項並不相同，其中以 SO_2 測項站數最少，其原因主要為 SO_2 環境中濃度已遠低於空氣品質標準，因此站數減少，僅保留 7 個設置於污染源附近。該局空氣品質監測站減站原則，在檢討空氣品質監測站數時，凡監測結果符合空氣品質標準(環境中濃度遠低於空氣品質標準)，則可減少該測項之監測，如 SO_2、Pb 等，測站減少時，則以鄰近區域各該測站測值相關性進行檢討，當有數個測站相關性高，且符合測站減少原則，此時保留測值高之測站繼續監測，測值低而與高測值測站相關性高者，可進行減站，可以供本署未來空氣品質監測站規劃參考。

二、 加州 $PM_{2.5}$ 24hr 質量監測網已於 1999 年建立，共有 82 個測站，目前正加速擴增 $PM_{2.5}$ 連續質量監測及 $PM_{2.5}$ 連續化學成份監測網，以提供 $PM_{2.5}$ 質量及化學成份資料，支持空氣品質保護計畫，$PM_{2.5}$ 監測結果將用於界定不合格區域、發展及追蹤空氣品質改善計畫，評估區域煙霧，協助健康效應研究，以及支援其他大氣氣膠研究計畫等。加州執行 $PM_{2.5}$ 監測網相關經驗值得本署參考。

三、 $PM_{2.5}$ 監測網之設置在執行國家新的 $PM_{2.5}$ 空氣品質標準時，為重要之工作。1997 年 7 月美國環保署公佈新的空氣品質標準以來，美國聯邦除了有關微粒研究經費，已投入超過 1 億 2800 萬美元，來建立 $PM_{2.5}$ 監測網。美國環保署細懸浮微粒($PM_{2.5}$)監測網大致上分成三大類：質量監測、例行化學成分分析、及特殊研究目的之超級測站。美國環保署空氣品質監測之規劃與發展方向，可以作為國內業務推動之參考。

附　　件　　一

Division 3. Air Resources Board

Chapter 1. Air Resources Board

Subchapter 2. Smoke Management Guidelines for Agricultural and Prescribed Burning

Article 1. General Provisions

§ 80100. Definitions.

The Smoke Management Guidelines for Agricultural and Prescribed Burning, henceforward referred to as Guidelines, are to provide direction to air pollution control and air quality management districts (air districts) in the regulation and control of agricultural burning, including prescribed burning, in California. The Guidelines are intended to provide for the continuation of agricultural burning, including prescribed burning, as a resource management tool, and provide increased opportunities for prescribed burning and agricultural burning, while minimizing smoke impacts on the public. The regulatory actions called for are intended to assure that each air district has a program that meets air district and regional needs.
NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 39011, 39053, 41850, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80101. Definitions.

(a) "Agricultural burning" is defined in Health and Safety Code section 39011 as follows:

(1) "Agricultural burning" means open outdoor fires used in agricultural operations in the growing of crops or raising of fowl or animals, or open outdoor fires used in forest management, range improvement, or the improvement of land for wildlife and game habitat, or disease or pest prevention.

(2) "Agricultural burning" also means open outdoor fires used in the operation or maintenance of a system for the delivery of water for the purposes specified in paragraph (1).

(3) "Agricultural burning" also means open outdoor fires used in wildland vegetation management burning. Wildland vegetation management burning is the use of prescribed burning conducted by a public agency, or through a cooperative agreement or contract involving a public agency, to burn land predominantly covered with chaparral, trees, grass, or standing brush. Prescribed burning is the planned application of fire to vegetation to achieve any specific objective on lands selected in advance of that application. The planned application of fire may also include natural or accidental ignition.

(b) "Air Pollution Control District" (APCD), "Air Quality Management District" (AQMD), "air district," or "district" means an air pollution control district or an air quality management district created or continued in existence pursuant to provisions of Health and Safety Code section 40000 et seq.

(c) "Air quality" means the characteristics of the ambient air as indicated by state ambient air quality standards which have been adopted by the state board pursuant to section 39606 of the Health and Safety Code and by National Ambient Air Quality Standards which have been established pursuant to sections 108 and 109 of the federal Clean Air Act pertaining to criteria pollutants and section 169A of the federal Clean Air Act pertaining to visibility.

(d) "Ambient air" means that portion of the atmosphere, external to buildings, to which the general public has access.

(e) "ARB" or "state board" means the Air Resources Board.

(f) "Basinwide air quality factor" means an air quality factor which equals the 4:00 am to 6:00 am two hour average soiling index (COH*10) ending at 6:00 am PST. The basinwide council may use other particulate matter measurements as an indicator of air quality if appropriate for its program.

(g) "Burn plan" means an operational plan for managing a specific fire to achieve resource benefits and specific management objectives. The plan includes, at a minimum, the project objectives, contingency responses for when the fire is out of prescription with the smoke management plan, the fire prescription (including smoke management components), and a description of the personnel, organization, and equipment.

(h) "Burn project" means an active or planned prescribed burn or a naturally ignited wildland fire managed for resource benefits.

(i) "Class I Area" means a mandatory visibility protection area designated pursuant to section 169A of the federal Clean Air Act.

(j) "Designated agency" means any agency designated by the Air Resources Board as having authority to issue agricultural burning, including prescribed burning, permits. An air district may request such a designation for an agency. The U.S. Department of Agricultural (USDA) Forest Service and the California Department of Forestry and Fire Protection (CDF) are so designated within their respective areas of jurisdiction.

(k) "Fire protection agency" means any agency with the responsibility and authority to protect people, property, and the environment from fire, and having jurisdiction within a district or region.

(l) "Forty-eight hour forecast" means a prediction of the meteorological and air quality conditions that are expected to exist for a specific prescribed burn in a specific area 48 hours from the day of the prediction. The prediction shall indicate a degree of confidence.

(m) "Land manager" means any federal, state, local, or private entity that administers, directs, oversees, or controls the use of public or private land, including the application of fire to the land.

(n) "Marginal burn day" means a day when limited amounts of agricultural burning, including prescribed burning, for individual projects in specific areas for limited times is not prohibited by the state board and burning is authorized by the district consistent with these Guidelines.

(o) "National Ambient Air Quality Standards (NAAQS)" mean standards promulgated by the United States Environmental Protection Agency that specify the maximum acceptable concentrations of pollutants in the ambient air to protect public health with an adequate margin of safety, and to protect public welfare from any known or anticipated adverse effects of such pollutants (e.g., visibility impairment, soiling, harm to wildlife or vegetation, materials damage, etc.) in the ambient air.

(p) "Ninety-six hour trend" means a prediction of the meteorological and air quality conditions that are expected to exist for a specific prescribed burn in a specific area 96 hours from the day of the prediction.

(q) "No-burn day" means any day on which agricultural burning, including prescribed burning, is prohibited by the state board or the air district in which the burning will occur.

(r) "Open burning in agricultural operations in the growing of crops or raising of fowl or animals" means:

(1) The burning in the open of materials produced wholly from operations in the growing and harvesting of crops or raising of fowl or animals for the primary purpose of making a profit, of providing a livelihood, or of conducting agricultural research or instruction by an educational institution.

(2) In connection with operations qualifying under paragraph (1):

(A) The burning of grass and weeds in or adjacent to fields in cultivation or being prepared for cultivation.

(B) The burning of materials not produced wholly from such operations, but which are intimately related to the growing or harvesting of crops and which are used in the field, except as prohibited by district regulations. Examples are trays for drying raisins, date palm protection paper, and fertilizer and pesticide sacks or containers, where the sacks or containers are emptied in the field.

(s) "Particulate matter (PM)" means any airborne finely divided material, except uncombined water, which exists as a solid or liquid at standard conditions (e.g., dust, smoke, mist, fumes or smog).

"PM2.5" means particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers.

"PM10" means particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (including PM2.5).

(t) "Permissive-burn day," or "burn day" means any day on which agricultural burning, including prescribed burning, is not prohibited by the state board and burning is authorized by the district consistent with these Guidelines.

(u) "Pre-fire fuel treatment" means techniques which can reasonably be employed prior to prescribed burning in order to reduce the emissions that would otherwise be produced in a prescribed fire.

(v) "Prescribed burning" - see (a) (3). Tule burning in wildlands or wildland/urban interface is considered to be prescribed burning.

(w) "Prescribed fire" means any fire ignited by management actions to meet specific objectives, and includes naturally-ignited wildland fires managed for resource benefits.

(x) "Range improvement burning" means the use of open fires to remove vegetation for a wildlife, game, or livestock habitat or for the initial establishment of an agricultural practice on previously uncultivated land.

(y) "Region" means two or more air districts within an air basin or adjoining air basins that sign a memorandum of understanding to implement a coordinated regional smoke management program pursuant to the requirements of Article 2 of this regulation.

(z) "Residential burning" means an open outdoor fire for the disposal of the combustible or flammable solid waste of a single-or two-family dwelling on its premises. Residential burning is not considered to be prescribed burning.

(aa) "Seventy-two hour outlook" means a prediction of the meteorological and air quality conditions that are expected to exist for a specific prescribed burn in a specific area 72 hours from the day of the prediction.

(bb) "Smoke Management Plan" means a document prepared for each fire by land managers or fire managers that provides the information and procedures required in section 80160.

(cc) "Smoke management prescription" means measurable criteria that define conditions under which a prescribed fire may be ignited, guide selection of appropriate management responses, and indicate other required actions. Prescription criteria may include, but are not limited to, minimizing smoke impacts, and safety, economic, public health, environmental, geographic, administrative, social, or legal considerations such as complying with Health and Safety Code section 41700, public nuisance statute.

(dd) "Smoke Management Program" means the program defined in these Guidelines.

(ee) "Smoke sensitive areas" are populated areas and other areas where a district determines that smoke and air pollutants can adversely affect public health or welfare. Such areas can include, but are not limited to, towns and villages, campgrounds, trails, populated recreational areas, hospitals, nursing homes, schools, roads, airports, public events, shopping centers, and mandatory Class I areas.

(ff) "State ambient air quality standards" means specified concentrations and durations of air pollutants which reflect the relationship between the intensity and composition of air pollution to undesirable effects, as established by the state board pursuant to Health and Safety Code section 39606.

(gg) "Wildfire" means an unwanted wildland fire.

(hh) "Wildland" means an area where development is generally limited to roads, railroads, power lines, and widely scattered structures. Such land is not cultivated (i.e., the soil is disturbed less frequently than once in 10 years), is not fallow, and is not in the United States Department of Agriculture (USDA) Conservation Reserve Program. The land may be neglected altogether or managed for such purposes as wood or forage production, wildlife, recreation, wetlands, or protective plant cover.

For CDF only, "Wildland" as specified in California Public Resources Code (PRC) section 4464(a) means any land that is classified as a state responsibility area pursuant to article 3 (commencing with section 4125) of chapter 1, part 2 of division 4 and includes any such land having a plant cover consisting principally of grasses, forbs, or shrubs that are valuable for forage. "Wildland" also means any lands that are contiguous to lands classified as a state responsibility area if wildland fuel accumulation is such that a wildland fire occurring on these lands would pose a threat to the adjacent state responsibility area.

(ii) "Wildland fire" means any non-structural fire, other than prescribed fire, that occurs in the wildland.

For CDF only, "wildland fire" as specified in PRC section 4464(c) means any uncontrolled fire burning on wildland.

(jj) "Wildland/urban interface" means the line, area, or zone where structures and other human development meet or intermingle with the wildland.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 39011, 39025, 39053, 41853, 41854, 41855, 41856, 41857, 41858, 41859, 41861, 41862 and 41863, Health and Safety Code.

REFERENCE

§ 80102. Scope and Applicability.

(a) These Guidelines apply to the Air Resources Board and all air districts in California, and regulate agricultural burning, including prescribed burning. These Guidelines are intended to provide flexibility to districts in the development and implementation of their smoke management programs. Such programs shall be developed in consultation with the ARB and focus on minimizing any significant impacts that agricultural or prescribed burning may have on air quality or public health. These Guidelines are also intended to assure adequate state oversight, including initial program approval and periodic program assessment.

(b) Although any local or regional authority may establish stricter standards for the control and the regulation of agricultural burning, including prescribed burning, than those set forth in these Guidelines, no local or regional authority may ban agricultural or prescribed burning.

(c) These Guidelines are not intended to permit open burning on days when such burning is prohibited by public fire protection agencies for purposes of fire control or prevention.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41856, 41857, 41858 and 41859, Health and Safety Code.

REFERENCE

§ 80110. Permissive-Burn, Marginal Burn, or No-Burn Days.

(a) The ARB shall specify each day of the year as a permissive burn day, or a no-burn day for each air basin or other specified area.

(b) The ARB shall announce by 3:00 p.m. every day for each of the state's air basins or other specified areas whether the following day is a permissive burn day or a no-burn day, or whether the decision will be announced the following day. If conditions preclude a forecast until the next day, the decision shall be announced by 7:45 a.m. Such notices shall be based on the Meteorological Criteria for Regulating Agricultural Burning and Prescribed Burning, set forth in sections 80179 through 80330 of these Guidelines.

(c) The ARB may declare a marginal burn day if meteorological conditions approach the criteria contained in sections 80179 through 80311 for permissive burn days, and smoke impacts are not expected. A marginal burn day allows a district to authorize limited amounts of burning for individual projects in an air basin or other specified area if the air district demonstrates that smoke impacts to smoke sensitive areas are not expected as a result of that burning. The ARB shall announce by 3:00 p.m. every day for each of the state's air basins or other specified areas whether the following day is a marginal burn day, or whether the decision will be announced the following day. If conditions preclude a forecast until the next day, the decision shall be announced by 7:45 a.m.

(d) Agricultural burning, including prescribed burning, is prohibited on no-burn days, except as specified in section 80120(e), section 80145(n), and section 80160(h).

(e) A district and the ARB may develop mutually agreeable procedures to allow a district to demonstrate that a given day is a marginal burn day or a burn day through its own analysis of the expected meteorological conditions in the air basin and a comparison to the meteorological criteria in Article 3.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41855, 41856, 41857, 41858, 41861 and 41862, Health and Safety Code.

REFERENCE

§ 80120. Burning Permits.

(a) No person shall knowingly set or allow agricultural or prescribed burning unless he or she has a valid permit from a district or designated agency. No burning shall be conducted pursuant to such permit without specific district approval consistent with these Guidelines. Burning conducted pursuant to each permit must comply with all conditions specified on the permit. A violation of this subsection is a violation of section 41852 of the California Health and Safety Code.

(b) The form of burning permits shall be prepared by the air districts in consultation with the designated agencies.

(c) The form of the permit shall contain the following words or words of similar import: "This permit is valid only on those days during which agricultural burning, including prescribed burning, is not prohibited by the State Air Resources Board or by an air district pursuant to section 41855 of the Health and Safety Code, and when burning on the lands identified herein has been approved by the air district."

(d) Each air district shall provide the designated agencies within the district with a copy of these Guidelines, related information on state laws, air district rules and regulations, and other information as appropriate.

(e) An air district may, by special permit, authorize agricultural burning, including prescribed burning, on days designated by the ARB as no-burn days if the denial of such permit would threaten imminent and substantial economic loss. In authorizing such burning, a district shall limit the amount of material which can be burned in any one day and only authorize burning which is not likely to cause or contribute to exceedences of air quality standards or result in smoke impacts to smoke sensitive areas.

(f) Permits issued by designated agencies shall be subject to these Guidelines and to the rules and regulations of the district. Designated agencies shall submit to the air districts information as specified by the air district.

(g) Each applicant for a permit shall provide information required by the designated agency for fire protection purposes.

(h) Each applicant for a permit shall provide information requested by the district.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41852, 41853, 41854, 41855, 41856, 41857, 41858, 41859, 41861, 41862 and 41863, Health and Safety Code.

REFERENCE

§ 80130. Burning Report.

(a) A report of agricultural burning, including prescribed burning, conducted pursuant to these Guidelines during each calendar year shall be submitted to the ARB by each air district within 45 days of the end of each calendar year. The report shall include the estimated tonnage or acreage of each waste type burned from open burning in agricultural operations and the estimated tonnage of waste from prescribed burning, and the county where the burning was performed.

(b) A report of special permits issued pursuant to subsection (e) of section 80120 during each calendar year shall be submitted to the ARB by each air district within 45 days of the end of the calendar year. The report shall include the number of such permits issued, the date of issuance of each permit, the person or persons to whom the permit was issued, an estimate of the amount of wastes burned pursuant to the permit, and a summary of the reasons why denial of each permit would have threatened imminent and substantial economic loss, including the nature and dollar amounts of such loss.

(c) The ARB Executive Officer may, on a district-by-district basis, alter the frequency or contents of the reports required pursuant to subsections (a) and (b) of this section, based on information needed to conduct or evaluate smoke management programs. The Executive Officer shall provide a justification and reasonable schedule for implementing any revisions.

NOTE: Authority cited: Sections 39515, 39516, 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 39515, 39516, 41852, 41853, 41854, 41856, 41857, 41858, 41859 and 41862, Health and Safety

REFERENCE

Division 3. Air Resources Board

Chapter 1. Air Resources Board

Subchapter 2. Smoke Management Guidelines for Agricultural and Prescribed Burning

Article 2. District Smoke Management Plan

§ 80140. General.

(a) Each air district shall adopt, implement and enforce a smoke management program consistent with these Guidelines. Each air district or region shall develop its smoke management program in coordination with the ARB, the appropriate fire protection agencies, the land managers having jurisdiction within the district, any other affected parties, and the public.

(b) Two or more districts choosing to implement a regional smoke management program shall meet the following additional requirements:

(1) Execute a signed memorandum of understanding with participating districts that sets forth procedures for the coordination, implementation, and enforcement of shared responsibilities to comply with state smoke management program requirements.

(2) Describe the regional smoke management program requirements, including the following elements, in the memorandum of understanding: a list of district and region boundaries; participating federal and/or state land managers, and other local entities within the region; the decision-making structure of the regional smoke management program; and the joint workplan for implementing the regional smoke management program.

(3) The regional smoke management program will include compliance provisions for each participating air district.

(4) Each participating air district shall implement its responsibilities under the smoke management program in coordination with other regional air districts/burn entities.

(c) The smoke management program of the Sacramento Valley is designated as a regional smoke management program.

(d) Districts shall adopt the elements of their smoke management program according to the following schedule:

(1) Upon the effective date of this regulation, all air districts shall implement the prescribed burning elements of their programs, including the provisions of section 80160, unless exempted pursuant to section 80170.

(2) By July 1, 2001, all air districts shall adopt smoke management programs that meet all applicable requirements of this regulation.

(3) The ARB may extend the scheduled dates by up to six months if an air district demonstrates that, for good cause, additional time is needed.

(e) The ARB shall either approve or indicate its intent to disapprove any program, portion of a program, or amendment of a program within 120 days after submittal.

(f) Prior to disapproval, the ARB Executive Officer shall confer with the air district regarding the reasons for the proposed disapproval. Following such conference, a decision to approve or disapprove the program, portion of a program, or amendment of a program shall be made by the ARB Executive Officer.

(g) The air district may appeal the decision to the ARB. At the request of an air district or, in the case of a regional program, the districts in that region, the Air Resources Board itself, and not the ARB executive officer, shall hold a public hearing on the matter in the district or region affected.

(h) If a program is disapproved, the ARB shall return the program to the air district(s) for amendment. The air district(s) shall amend the program to address ARB concerns within 180 days.

(i) If the program or amendment of such program is disapproved, or if a program or amendment is not submitted by the specified date, the ARB, after a public hearing in the basin affected, shall adopt an alternative program.

(j) The program approved pursuant to subsection (e) or adopted pursuant to subsection (i) shall be enforced by the air district(s).

(k) After an air district smoke management program is approved by the ARB, amendments to the program shall be submitted to the ARB for approval, and shall not be effective until approved. Each program or amendment shall be submitted to the ARB for approval within 30 days after adoption by the district.

(l) After an air district smoke management program is approved by the ARB and the ARB finds that changes are necessary, the ARB shall discuss the findings with the air district and, in consultation with the district, establish an appropriate schedule for revising the smoke management program.

NOTE: Authority cited: Sections 39515, 39516, 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 39515, 39516, 41856, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80145. Program Elements and Requirements.

The district smoke management programs shall include all of the elements in section 80145. Procedures and other requirements contained in subsections 80145(a) through (n) of this section shall be approved by district board resolutions or adopted as rules and regulations:

(a) A daily burn authorization system that regulates agricultural burning, including prescribed burning, in order to minimize smoke impacts on smoke sensitive areas, avoid cumulative smoke impacts, and prevent public nuisance. The burn authorization system shall not allow more burning on a daily basis than is appropriate for the meteorological or air quality conditions. The daily burn authorization system shall specify the amount, timing and location of each burn event. The burn authorization system shall be developed by the air district in consultation with the ARB, shall be commensurate with the air quality impacts from burning, and shall consider the following factors as necessary:

(1) air quality;

(2) meteorological conditions expected during burning, including wind speeds and directions at the surface and aloft, and atmospheric stability;

(3) types and amounts of materials to be burned;

(4) location and timing of materials to be burned;

(5) locations of smoke sensitive areas; and

(6) smoke from all burning activities, including burning in neighboring air districts or regions which may affect the district or region.

(b) If requested in writing by a district, the Executive Officer may approve an alternative burn authorization system for agricultural burning (excluding prescribed burning), provided the Executive Officer determines that the alternative system is likely to achieve the objectives of the daily burn authorization system. In making such determination, the Executive Officer shall consider the rules and regulations of the district relating to agricultural burning, historical data on the amount, types, location, and impacts of agricultural burning in the district (excluding prescribed burning), and the effectiveness of the smoke management program in place in the district, and other documentation provided by the district. The decision, along with the reasons for the decision, shall be in writing.

(c) A description of the meteorological and air quality monitoring data to be used to provide data for determining the basinwide meteorological and air quality conditions.

(d) A description of the personnel resources for meteorological support and burn coordination that will be used to operate the burn program.

(e) Procedures for issuing notice of permissive-burn, marginal burn or no-burn days. Air districts shall coordinate these procedures with fire protection agencies. A no-burn day notice shall be issued for agricultural burning, including prescribed burning, by the air district when open burning is prohibited by fire protection agencies for fire control or prevention.

(f) Procedures for issuing 48-hour forecasts, 72-hour outlooks, and 96-hour trends for specific prescribed burns. The air district may request that the ARB provide these forecasts for specific prescribed burns.

(g) Procedures for authorizing burning, including a procedure for authorizing individual prescribed burns 24 hours prior to ignition of the fire, recognizing that any burn decision made 24 hours in advance is always subject to change if meteorological conditions or conditions affecting smoke dispersion are different from those anticipated.

(h) Procedures for acquiring information on amounts of material burned on each day, on planned and unplanned wildland fires, and other information needed to establish the burn authorization for the following day, as specified in subsection (a).

(i) Procedures for addressing cross-jurisdictional smoke impacts by coordinating with neighboring air districts, regions, or states.

(j) The form of permit(s) required by subsection (c) of section 80120 and the form of the information required by subsection (f) of section 80120.

(k) Procedures for enforcement.

(l) Plans to provide for an analysis and periodic assessment of actions that are undertaken to minimize smoke through the use of pre-fire fuel treatment practices and non-burn alternatives.

(m) If necessary, procedures for prioritizing agricultural burning, including prescribed burning, that districts can use to minimize smoke impacts. In considering priorities, districts shall consider the public benefits of burn projects, including safety, public health, forest health and wildfire prevention, ecological needs, economic concerns, and disease and pest prevention. Efforts to reduce smoke emissions, such as removal of excess material, shall also be considered.

(n) As applicable, each district shall consider additional provisions with respect to permitting, on no-burn days, the burning of empty sacks or containers which contained pesticides or other toxic substances, providing the sacks or containers are within the definition of "open burning in agricultural operations in the growing of crops or raising of fowl or animals," as specified in section 80101(r);

(o) Rules and regulations or, until April 1, 2003, other enforceable mechanisms that:

(1) Require the material to be burned to be free of material that is not produced on the property or in an agricultural or prescribed burning operation. Material not to be burned includes, but is not limited to, tires, rubbish, plastic, treated wood, construction/demolition debris, or material containing asbestos.

(2) Require the material to be arranged so that it will burn with a minimum of smoke, when feasible.

(3) Require material to be reasonably free of dirt, soil and visible surface moisture.

(4) Require the material to be dried for minimum periods with separate specifications for the following: (A) trees and large branches, (B) prunings and small branches, (C) wastes from field crops that are cut in a green condition, and (D) other materials.

(5) Regulate hours of ignition and burning.

(6) Limit the ignition of fires to approved ignition devices.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 40702, 41850, 41854, 41856, 41857, 41858, 41859, 41862 and 41863, Health and Safety Code.

REFERENCE

§ 80150. Special Requirements for Open Burning in Agricultural Operations in the Growing of Crops or Raising of Fowl or Animals.

(a) The district smoke management program shall include rules and regulations or, until April 1, 2003, other enforceable mechanisms that:

(1) Require rice, barley, oat, and wheat straw to be ignited only by stripfiring into the wind or by backfiring, except under a special permit of the district issued when and where extreme fire hazards are declared by a public fire protection agency to exist, or where crops are determined by the district not to lend themselves to these techniques.

(2) Require burning hours to be set so that no field crop burning shall commence before 10:00 a.m. or after 5:00 p.m. of any day, unless local conditions indicate that other hours are appropriate.

(b) A district with no agricultural operations in the growing of crops or raising of fowl or animals within its jurisdiction may request to be exempted from the requirements of this section.

(c) Rice Straw Burning Requirements. Districts within the boundaries of the Sacramento Valley Air Basin and the San Joaquin Valley Air Basin shall also include in the program rules and regulations that:

(1) Require all rice harvesting to employ a mechanical straw spreader to ensure even distribution of the straw, except that rice straw may be left in rows, provided it meets drying time criterion prior to a burn as described in paragraph (2) below. Rice straw may also be left standing provided it is dried and meets the crackle test criteria described below prior to burning.

(2) Require that after harvest no spread rice straw shall be burned prior to a three-day drying period, and no rowed rice straw shall be burned prior to a ten-day drying period, unless the rice straw makes an audible crackle when tested just prior to burning with the following testing method: When checking the field for moisture, a composite sample of straw from under the mat, in the center of the mat, and from different areas of the field shall be taken to ensure a representative sample. A handful of straw from each area will give a good indication. Rice straw is dry enough to burn if a handful of straw selected as described above crackles when it is bent sharply.

(3) Require that after a rain exceeding 0.15 inch (fifteen hundredths of an inch), rice straw shall not be burned unless the straw makes an audible crackle when tested just prior to burning with the testing method described in paragraph (2), above.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 40702, 41850, 41856, 41857, 41858, 41859, 41863 and 41865, Health and Safety Code.

REFERENCE

§ 80155. Sacramento Valley Basinwide Program.

The Sacramento Valley Basinwide Air Pollution Control Council (Basinwide Council) shall submit a smoke management program to the ARB for review and approval. The smoke management program shall apply to all areas of the Sacramento Valley Air Basin. In addition to all other applicable requirements, it shall contain:

(a) A daily basinwide acreage equation establishing a theoretical maximum daily allocation which includes a basinwide meteorological factor (B.M.F.--determined from Tables 4 and 5 of section 80320) and a basinwide air quality factor.

(b) Procedures for refining the theoretical maximum allocation in order to establish an initial actual allocation, including consultation between the ARB duty meteorologist and the basin coordinator and considering additional real-time air quality and meteorological information.

(c) Procedures for distributing acreage allocations to each air district. The total acreage distributed shall not exceed the initial actual allocation determined by the ARB in consultation with the basin coordinator. The program may specify procedures to update the initial actual allocation, based on real-time meteorological information and the progress of burning the initial actual allocation.

(d) The hours to be permitted for burning.

(e) A description of the meteorological and air quality monitoring networks to be used to provide data for determining the basinwide meteorological and air quality factors.

(f) Other clarifying details mutually agreed upon by the Basinwide Council and the ARB.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41856, 41857, 41858, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80160. Special Requirements for Prescribed Burning and Prescribed Fires in Wildland and Wildland/Urban Interface Areas.

The district smoke management programs shall include rules and regulations or, until April 1, 2003, other enforceable mechanisms that:

(a) Require registration of all planned burn projects annually or seasonally, including areas considered for potential naturally-ignited wildland fires managed for resource benefits, with updates as they occur.

(b) Require the submittal of smoke management plans for all burn projects greater than 10 acres in size or estimated to produce more than 1 ton of particulate matter. Smoke management plans must contain, at a minimum, the following information:

(1) Location, types, and amounts of material to be burned;

(2) Expected duration of the fire from ignition to extinction;

(3) Identification of responsible personnel, including telephone contacts; and

(4) Identification and location of all smoke sensitive areas.

(c) Require that smoke management plans for burn projects greater than 100 acres in size or estimated to produce more than 10 tons of particulate matter contain, at a minimum, the information contained in subsection (b) and the following additional information:

(1) Identification of meteorological conditions necessary for burning.

(2) The smoke management criteria the land manager or his/her designee will use for making burn ignition decisions.

(3) Projections, including a map, of where the smoke from burns are expected to travel, both day and night.

(4) Specific contingency actions (such as fire suppression or containment) that will be taken if smoke impacts occur or meteorological conditions deviate from those specified in the smoke management plan.

(5) An evaluation of alternatives to burning considered; if an analysis of alternatives has been prepared as part of the environmental documentation required for the burn project pursuant to the National Environmental Policy Act (NEPA) or the California Environmental Quality Act (CEQA), as applicable, the analysis shall be attached to the smoke management plan in satisfaction of this requirement.

(6) Discussion of public notification procedures.

(d) If smoke may impact smoke sensitive areas, require smoke management plans to include appropriate monitoring, which may include visual monitoring, ambient particulate matter monitoring or other monitoring approved by the district, as required by the district for the following burn projects:

(1) projects greater than 250 acres;

(2) projects that will continue burning or producing smoke overnight;

(3) projects conducted near smoke sensitive areas; or

(4) as otherwise required by the district.

(e) Require, as appropriate, daily coordination between the land manager or his/her designee and the air district or the ARB for multi-day burns which may impact smoke sensitive areas, to affirm that the burn project remains within the conditions specified in the smoke management plan, or whether contingency actions are necessary.

(f) Alternate thresholds to those specified in sections (b), (c), and (d) may be specified by a district consistent with the intent of this section.

(g) Require district review and approval of smoke management plans. Districts shall provide notice to the ARB of large or multi-day burns as specified in (d) or (e) and consult with the ARB on procedures for ARB review and approval of large or multi-day burns as specified in (d) and (e).

(h) Require that when a natural ignition occurs on a no-burn day, the initial "go/no-go" decision to manage the fire for resource benefit will be a "no-go" unless:

(1) After consultation with the district, the district decides, for smoke management purposes, that the burn can be managed for resource benefit; or

(2) For periods of less than 24 hours, a reasonable effort has been made to contact the district, or if the district is not available, the ARB.

(3) After 24 hours, the district has been contacted, or if the district is not available, the ARB has been contacted and concurs that the burn can be managed for resource benefit.

A "no-go" decision does not necessarily mean that the fire must be extinguished, but that the fire cannot be considered as a prescribed fire.

(i) Require submittal of smoke management plans within 72 hours of the start of the fire for naturally-ignited wildland fires managed for resource benefits that are expected to exceed 10 acres in size.

(j) Require the land manager or his/her designee conducting a prescribed burn to ensure that all conditions and requirements stated in the smoke management plan are met on the day of the burn event and prior to ignition.

(k) Require a post-burn smoke management evaluation by the burner for fires greater than 250 acres.

(l) Require procedures for public notification and education, including appropriate signage at burn sites, and for reporting of public smoke complaints.

(m) Require vegetation to be in a condition that will minimize the smoke emitted during combustion when feasible, considering fire safety and other factors.

(n) Require material to be burned to be piled where possible, unless good silvicultural practices or ecological goals dictate otherwise.

(o) Require piled material to be burned to be prepared so that it will burn with a minimum of smoke.

(p) Require the permit applicant to file with the district a statement from the Department of Fish and Game certifying that the burn is desirable and proper if the burn is to be done primarily for improvement of land for wildlife and game habitat. The Department of Fish and Game may specify the amount of brush treatment required, along with any other conditions it deems appropriate.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41850, 41853, 41854, 41855, 41856, 41857, 41858, 41859, 41861, 41862 and 41863, Health and Safety Code.

REFERENCE

§ 80170. Exemptions.

A district with no prescribed burning in wildlands or urban interfaces within its jurisdiction may request to be exempted from the requirements of section 80160. A district may exclude specific range improvement burns for livestock habitat or the initial establishment of an agricultural practice on previously uncultivated land from the provisions of section 80160 of these Guidelines provided the air district determines that smoke impacts are not expected in smoke sensitive areas.

NOTE: Authority cited: Sections 39600, 39601, 41852.5, 41856 and 41859, Health and Safety Code. Reference: Sections 41850, 41852.5, 41856, 41857, 41858, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80175. Wildland Vegetation Management Burning.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41856, 41857, 41858, 41859 and 41863, Health and Safety Code.

REFERENCE

Division 3. Air Resources Board

Chapter 1. Air Resources Board

Subchapter 2. Smoke Management Guidelines for Agricultural and Prescribed Burning

Article 3. Meteorological Criteria for Regulating Agricultural Burning

§ 80179. General.

The ARB may use, on a test basis in cooperation with the air basin affected, for three years for developing new criteria, alternate criteria to those specified in this article to establish burn days, no-burn days, and marginal burn days.

NOTE: Authority cited: Sections 39600, 39601, 41855, 41856 and 41859, Health and Safety Code. Reference: Sections 40702, 41850, 41855, 41856, 41857, 41858, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80180. North Coast Air Basin.

(a) Above 3,000 feet mean sea level* (msl), a permissive-burn day will be declared when the following criteria are met:

(1) Near 4:00 a.m., the mean 500 millibar (mb) height over the Basin is less than the limiting mean height given in Table 1 of section 80320.

(2) The expected 4:00 p.m. mean 500 mb height over the Basin is less than the limiting mean height given in Table 1 of section 80320.

(b) Below 3,000 feet msl*, a permissive-burn day will be declared when at least 3 of the following criteria are met:

(1) Near the time of day when the surface temperature is at a minimum, the temperature at 3,000 feet above the surface is not warmer than the surface temperature by more than 10 degrees Fahrenheit, except that during July through November it is not warmer by more than 18 degrees Fahrenheit.

(2) The expected daytime temperature at 3,000 feet above the surface is colder than the expected surface temperature by at least 11 degrees Fahrenheit for 4 hours.

(3) The expected daytime wind speed at 3,000 feet above the surface is at least 5 miles per hour.

(4) The expected daytime wind direction in the mixing layer has a component from the east and a speed of 12 miles per hour or less.

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* In place of the standard 3,000 feet msl level, the elevation may be specified in increments of 500 feet on a day-to-day basis as determined from vertical temperature soundings.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80190. San Francisco Bay Area Air Basin.

(a) The North Section of this basin includes Marin and Napa Counties, the San Francisco Bay Area Air Basin portions of Sonoma and Solano Counties, and that portion of Contra Costa County lying north and east of a line beginning at the intersection of Vasco Road and the Alameda County line; then north along the eastern side of Vasco Road to the intersection of Camino Diablo Road and Walnut Boulevard; then continuing north along the eastern side of Walnut Boulevard to the intersection of Marsh Creek Road; then west along the northern side of Marsh Creek Road to the intersection of Deer Valley Road; then north along the eastern side of Deer Valley Road to intersection of Lone Tree Way; then west and north along the eastern side of Lone Tree Way until it becomes "A" Street; then continuing north along the eastern side of "A" Street and its northern extension to the Sacramento County line.

(b) A permissive-burn day will be declared in the North Section when the following criteria are met:

(1) Near the time of day when the surface temperature is at a minimum, the temperature at 2,500 feet above the surface is not warmer than the surface temperature by more than 13 degrees Fahrenheit except that during May through September it is not warmer by more than 18 degrees Fahrenheit.

(2) The expected daytime temperature at 2,500 feet above the surface is colder than the expected surface temperature by at least 10 degrees Fahrenheit for 4 hours.

(3) The expected daytime wind speed at 3,000 feet above the surface is at least 5 miles per hour.

(c) The South Section of this basin includes San Francisco, San Mateo, Santa Clara and Alameda Counties, and that portion of Contra Costa County lying south and west of a line beginning at the intersection of Vasco Road and the Alameda County line; then north along the eastern side of Vasco Road to the intersection of Camino Diablo Road and Walnut Boulevard; then continuing north along the eastern side of Walnut Boulevard to the intersection of Marsh Creek Road; then west along the northern side of Marsh Creek Road to the intersection of Deer Valley Road; then north along the eastern side of Deer Valley Road to the intersection of Lone Tree Way; then west and north along the eastern side of Lone Tree Way until it becomes "A" Street; then continuing north along the eastern side of "A" Street and its northern extension to the Sacramento County Line.

(d) A permissive-burn day will be declared in the South Section when the following criteria are met:

(1) Near the time of day when the surface temperature is at a minimum, the temperature at 2,500 feet above the surface is not warmer than the surface temperature by more than 11 degrees Fahrenheit except that during May through September it is not warmer by more than 16 degrees Fahrenheit.

(2) The expected daytime temperature at 2,500 feet above the surface is colder than the expected surface temperature by at least 10 degrees Fahrenheit for 4 hours.

(3) The expected daytime wind speed at 3,000 feet above the surface is at least 5 miles per hour.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80200. North Central Coast Air Basin.

(a) Above 3,000 feet msl *, a permissive-burn day will be declared when the following criteria are met:

(1) Near 4:00 a.m., the mean 500 mb (mb is millibar (mb) height over the Basin is less than the limiting mean height given in Table 2 of section 80320.

(2) The expected 4:00 p.m. mean 500 mb height over the Basin is less than the limiting mean height given in Table 2 of section 80320.

(b) Below 3,000 feet msl * in the Northwest Section of this Basin (including Santa Cruz County and that portion of San Benito and Monterey Counties north and west of a line beginning at the intersection of Highway 156 and the Santa Clara/San Benito Counties line; then continuing southerly along Highway 156 to the intersection of Fairview Road; then southerly along Fairview Road to the intersection of Highway 25; then southwesterly to Fremont Peak; then southeasterly along the crest of the Gabilan Range to McPhails Peak; then southwesterly through the middle of Chualar Canyon into the Salinas Valley, along Chualar Canyon Road, and continuing to Mt. Toro; then southeasterly along the crest of the Sierra de Salinas to Arroyo Seco Road; then west southwesterly along Arroyo Seco Road to Arroyo Center; from there westerly to Pfeiffer Point on the Pacific Ocean), a permissive-burn day will be declared when the following criteria are met:

(1) The maximum mixing depth is expected to be at least 1,500 feet msl.

(2) The expected daytime resultant wind speed in the mixing layer is at least five miles per hour.

(c) Below 3,000 feet msl * in the Southeast Section of this Basin (including that portion of San Benito and Monterey Counties south and east of a line beginning at the intersection of Highway 156 and the Santa Clara/San Benito Counties line; then continuing southerly along Highway 156 to the intersection of Fairview Road; then southerly along Fairview Road to the intersection of Highway 25; then southwesterly to Fremont Peak; then southeasterly along the crest of the Gabilan Range to McPhails Peak; then southwesterly through the middle of Chualar Canyon into the Salinas Valley, along Chualar Canyon Road, and continuing to Mt. Toro; then southeasterly along the crest of the Sierra de Salinas to Arrcyo Seco Road; then west southwesterly along Arroyo Seco Road to Arroyo Center; from there westerly to Pfeiffer Point on the Pacific Ocean), a permissive-burn day will be declared when the following criteria are met:

(1) The maximum mixing depth is expected to be at least 1,500 feet msl.

(2) The expected daytime resultant wind speed in the mixing layer is at least five miles per hour.

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* In place of the standard 3,000 feetmsl level, the elevation may be specified in increments of 500 feet on a day-to-day basis as determined from vertical temperature soundings.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80210. South Central Coast Air Basin.

(a) Above 3,000 feet mean sea level* (msl), a permissive-burn day will be declared when both of the following criteria are met:

(1) Near 4:00 a.m., the mean 500 millibar (mb) height over the Basin is less than the limiting mean height given in Table 2 of section 80320.

(2) The expected 4:00 p.m. mean 500 mb height over the Basin is less than the limiting mean height given in Table 2 of section 80320.

(b) Below 3,000 feet msl* in Ventura County and that portion of Santa Barbara County south of a line described as follows: Beginning at the Pacific Ocean outfall of Jalama Creek and running east and north along Ja- lama Creek to a point of intersection with the west boundary of the San Julian Land Grant; then south along the San Julian Land Grant boundary to its southwest corner; then east along the south boundary of the San Julian Land Grant to the northeast corner of partial Section 20, T. 5 N, R. 32 W, San Bernardino Base and Meridian; then south and east along the boundary of the Las Cruces Land Grant to the southwest corner of partial Section 22, T. 5 N, R. 32 W; then northeast along the Las Cruces Land Grant boundary; then east along the north boundaries of Section 13, T. 5 N, R. 32 W, and Sections 18, 17, 16, 15, 14, 13, T. 5 N, R. 31 W, and Sections 18, 17, 16, 15, 14, 13, T. 5 N, R. 30 W, and Sections 18, 17, 16, 15, T. 5 N, R. 29 W; then south along the east boundary of Section 15, T. 5 N, R. 29 W; then east along the north boundaries of Sections 23 and 24, T. 5 N, R. 29 W, and Sections 19, 20, 21, 22, 23, 24, T. 5 N, R. 28 W, and Sections 19 and 20, T. 5 N, R. 27 W; then south along the east boundary of Section 20, T. 5 N, R. 27 W; then east along the north boundaries of Sections 28, 27, 26, 25, T. 5 N, R. 27 W and Section 30, T. 5 N, R. 26 W; then south along the east boundary of Section 30, T. 5 N, R. 26 W; then east along the north boundaries of Sections 32, 33, 34, 35, T. 5 N, R. 26 W; then south along the east boundary of Section 35, T. 5 N, R. 26 W to the township line common to T. 4 N and T. 5 N; then east along this township line to the Santa Barbara-Ventura County boundary; a permissive burn day will be declared when both of the following criteria are met:

(1) The maximum mixing depth is expected to be at least 1,500 feet msl.

(2) The expected afternoon onshore airflow is expected to be at least five miles per hour.

(c) Below 3,000 feet msl* in San Luis Obispo County and that portion of Santa Barbara County north of the line described in (b) above, a permissive burn day will be declared when both of the following criteria are met:

(1) The maximum mixing depth is expected to be at least 1,500 feet msl.

(2) The expected afternoon onshore airflow is expected to be at least five miles per hour.

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* In place of the standard 3,000 feetmsl level, the elevation may be specified in increments of 500 feet on a day-to-day basis as determined from vertical temperature soundings.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41850, 41854, 41855, 41856, 41857, 41858, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80220. South Coast Air Basin.

(a) A permissive-burn day will be declared when at least one of the following criteria is met:

(1) The expected height of the inversion base, if any, near 6:00 a.m. at Los Angeles International Airport is 1,500 feet msl or higher.

(2) The expected maximum mixing height during the day is above 3,500 feet above the surface.

(3) The expected mean surface wind between 6:00 a.m. and noon is greater than five miles per hour.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80230. San Diego Air Basin.

Except that portion which lies east of a line beginning at the U.S.-Mexico border and running north along the range line common to R. 7 E and R. 6 E, San Bernardino Base and Meridian; to the southeast corner of T. 16 S, and R. 6 E; then west along the township line common to T. 16 S and T. 17 S to the southwest corner of T. 16 S, R. 6 E; then north along the range line common to R. 6 E and R. 5 E to the southeast corner of T. 14 S, R. 5 E; then west along the township line common to T. 14 S and T. 15 S to the point of intersection with the east boundary of Cuyamaca Park; then north along the east boundary of Cuyamaca Park to the point of intersection with the range line common to R. 5 E and R. 4 E; then north along this range line to the point of intersection with the south boundary of the San Felipe Land Grant; then east and north along the land grant boundary to the eastern most corner; then continuing west and north along the land grant boundary to the point of intersection with the range line common to R. 5 E and R. 4 E; then north along this range line to the point of intersection with the township line common to T. 10 S and T. 9 S; then west along this township line to the point of intersection with the range line common to R. 4 E and R. 3 E; then north along this range line to the San Diego-Riverside County boundary. Criteria for this portion are those of the Salton Sea Air Basin.

(a) A permissive-burn day will be declared when the following criteria are met:

(1) Above 3,000 feet msl *:

(A) Near 4:00 a.m., the inversion top is less than 3,000 feet msl or the temperature difference through the inversion is less than seven degrees Fahrenheit.

(B) The expected daytime resultant wind speed between 3,000 and 6,000 feet msl is at least 5 miles per hour.

(2) Below 3,000 feet msl *:

(A) The maximum mixing depth is expected to be at least 1,500 feet msl.

(B) The expected daytime resultant wind direction in the marine layer has a westerly component.

(C) The expected daytime resultant wind speed in the marine layer is at least five miles per hour.

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* In place of the standard 3,000 feet msl level, the elevation may be specified in increments of 500 feet on a day-to-day basis as determined from vertical temperature soundings.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80240. Northeast Plateau Air Basin.

(a) A permissive-burn day will be declared when the following criteria are met:

(1) Near 4:00 a.m., the mean 500 mb height over the Basin is less than the limiting mean height given in Table 1 of section 80320.

(2) The expected 4:00 p.m. mean 500 mb height over the Basin is less than the limiting mean height given in Table 1 of section 80320.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80250. Sacramento Valley Air Basin.

(a) Above 3,000 feet msl*, a permissive-burn day will be declared when the following criteria are met:

(1) Near 4:00 a.m., the mean 500 mb height over the Basin is less than the limiting mean height given in Table 1 of section 80320.

(2) The expected 4:00 p.m. mean 500 mb height over the Basin is less than the limiting mean height given in Table 1 of section 80320.

(b) Below 3,000 feet msl*, a permissive-burn day will be declared when the daily basinwide acreage allocation is greater than zero acreage. This allocation shall be determined daily by the state board and will vary with the existing and projected meteorology and air quality. The basinwide allocation shall be calculated from the basinwide acreage allocation equation contained in the approved approved Smoke Management Program required in section 80155.

(c) Special situations in the Basin are:

(1) If, when a no-burn day decision is declared, the state ambient air quality standard for ozone, carbon monoxide, suspended particulate matter (PM10), or visibility is expected to be exceeded during the valid period, a note to this effect shall be appended to the announcement.

(2) A permissive-burn or no-burn day decision that has been announced may be changed by the Air Resources Board at any time prior to 10:00 a.m. if the meteorological and air quality situation that actually unfolds so warrants it.

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*In place of the standard 3,000 feet msl level, the elevation may be specified in increments of 500 feet on a day-to-day basis as determined from vertical temperature soundings.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80260. San Joaquin Valley Air Basin.

(a) The North Section of this basin includes San Joaquin, Stanislaus, and Merced Counties.

(b) A permissive-burn day will be declared in the North Section when the following criteria are met:

(1) Near the time of day when the surface temperature is at a minimum, the temperature at 3,000 feet above the surface is not warmer than the surface temperature by more than 13 degrees Fahrenheit.

(2) The expected daytime temperature at 3,000 feet above the surface is colder than the expected surface temperature by at least 11 degrees Fahrenheit for 4 hours.

(3) The expected daytime wind speed at 3,000 feet above the surface is at least 5 miles per hour.

(c) The South Section of this basin includes Madera, Fresno, Kings, and Tulare Counties, and the San Joaquin Valley Air Basin portion of Kern County.

(d) A permissive-burn day will be declared in the South Section when the following criteria are met:

(1) Above 3,000 feet msl*:

(A) Near 4:00 a.m., the mean 500 mb height over the Basin is less than the limiting mean height given in Table 2 of section 80320.

(B) The expected 4:00 p.m. mean 500 mb height over the Basin is less than the limiting mean height given in Table 2 of section 80320.

(2) Below 3,000 feet msl*:

(A) Near the time of day when the surface temperature is at a minimum, the temperature at 3,000 feet above the surface is not warmer than the surface temperature by more than 13 degrees Fahrenheit.

(B) The expected daytime temperature at 3,000 feet above the surface is colder than the expected surface temperature by at least 11 degrees Fahrenheit for 4 hours. (C) The expected daytime wind speed at 3,000 feet above the surface is at least 5 miles per hour.

(e) Special situations in the Basin are:

(1) If, when a no-burn day decision is declared, the state ambient air quality standard for ozone, carbon monoxide, suspended particulate matter (PM10) or visibility is expected to be exceeded during the valid period, a note to this effect shall be appended to the announcement.

(2) A permissive-burn or no-burn day decision that has been announced may be changed by the Air Resources Board at any time prior to 10:00 a.m. if the meteorological and air quality situation that actually unfolds so warrants it.

(3) A conditional permissive-burn day may be declared in the North Section of the Air Basin during the months of November through February for the burning of almond and walnut prunings (from not more than 300 acres of orchard in each county) following three or more consecutive no-burn days, provided that two of the three criteria set forth in section 80260(b) for permissive-burn days are met, and provided further that the state board determines that under expected meteorological conditions the burning of such prunings will not have an adverse effect on air quality.

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*In place of the standard 3,000 feet msl level, the elevation may be specified in increments of 500 feet on a day-to-day basis as determined from vertical temperature soundings.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80270. Great Basin Valleys Air Basin.

(a) A permissive-burn day will be declared when the following criteria are met:

(1) Near 4:00 a.m., the mean 500 mb height over the Basin is less than the limiting mean height given in Table 2 of section 80320.

(2) The expected 4:00 p.m. mean 500 mb height over the Basin is less than the limiting mean height given in Table 2 of section 80320.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80280. Salton Sea Air Basin.

(a) For the Salton Sea Air Basin and that portion of the San Diego Air Basin which lies east of a line beginning at the U.S.-Mexico border and running north along the range line common to R. 7 E and R. 6 E, San Bernardino Base and Meridian; to the southeast corner of T. 16 S, R. 6 E; then west along the township line common to T. 16 S and T. 17 S to the southwest corner of T. 16 S, R. 6 E; then north along the range line common to R. 6 E and R. 5 E to the southeast corner of T. 14 S, R. 5 E; then west along the township line common to T. 14 S and T. 15 S to the point of intersection with the east boundary of Cuyamaca Park; then north along the east boundary of Cuyamaca Park to the point of intersection with the range line common to R. 5 E and R. 4 E; then north along this range line to the point of intersection with the south boundary of the San Felipe Land Grant; then east and north along the land grant boundary to the easternmost corner; then continuing west and north along the land grant boundary to the point of intersection with the range line common to R. 5 E and R 4 E; then north along this range line to the point of intersection with the township line common to T. 10 S and T. 9 S; then west along this township line to the point of intersection with the range line common to R. 4 E and R. 3 E; then north along this range line to the San Diego-Riverside County boundary.

(b) A permissive-burn day will be declared when at least three of the following criteria are met:

(1) Near the time of day when the surface temperature is at a minimum, the temperature at 3,000 feet above the surface is not warmer than the surface temperature by more than 13 degrees Fahrenheit.

(2) The expected temperature at 3,000 feet above the surface is colder than the expected surface temperature by at least 11 degrees Fahrenheit for 4 hours.

(3) The expected daytime wind speed at 3,000 feet above the surface is at least 5 miles per hour.

(4) The expected daytime wind direction in the mixing layer is not southeasterly.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80290. Mountain Counties Air Basin.

(a) A permissive-burn day will be declared when the following criteria are met:

(1) Near 4:00 a.m., the mean 500 mb height over the Basin is less than the limiting mean height given in Table 1 of section 80320.

(2) The expected 4:00 p.m. mean 500 mb height over the Basin is less than the limiting mean height given in Table 1 of section 80320.

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80300. Lake County Air Basin.

(a) A permissive-burn day will be declared when the following criteria are met:

(1) Near the time of day when the surface temperature is at a minimum, the temperature at 3,000 feet above the surface is not warmer than the surface temperature by more than 10 degrees Fahrenheit, except that during July through November it is not warmer by more than 18 degrees Fahrenheit.

(2) The expected daytime temperature at 3,000 feet above the surface is colder than the expected surface temperature by at least 11 degrees Fahrenheit for 4 hours.

(3) The expected daytime wind speed at 3,000 feet above the surface is at least 5 miles per hour.
NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80310. Lake Tahoe Air Basin.

(a) A permissive-burn day will be declared when the following criteria are met:

(1) Near 4:00 a.m., the mean 500 mb height over the Basin is less than the limiting mean height given in Table 3 of section 80320.

(2) The expected 4:00 p.m. mean 500 mb height over the Basin is less than the limiting mean height given in Table 3 of section 80320.
NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80311. Mojave Desert Air Basin.

(a) A permissive-burn day will be declared when the following criteria are met:

(1) Near the time of day when the surface temperature is at a minimum, the temperature at 3,000 feet above the surface is not warmer than the surface temperature by more than 13 degrees Fahrenheit.

(2) The expected temperature at 3,000 feet above the surface is colder than the expected surface temperature by at least 11 degrees Fahrenheit for 4 hours.

(3) The expected daytime wind speed at 3,000 feet above the surface is at least 5 miles per hour.
NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

§ 80320. Tables Referred to in Articles 2 and 3.

Limiting Mean 500-Millibar Heights* by Month

Month	*Table 1**	*Table 2**	*Table 3**
January	5710*	5750*	5630*
February	5710	5740	5620
March	5710	5740	5630
April	5720	5760	5660
May	5770	5800	5710
June	5820	5850	5780
July	5850	5880	5830
August	5870	5880	5840
September	5850	5870	5810
October	5820	5850	5760
November	5770	5810	5700
December	5730	5780	5630

* All heights in meters.

[There is no difference from text in CCR. The table itself is just a style change to make it easier to read.]

Agricultural Burn Meteorological Factors

(Sacramento Valley Air Basin)

Table 4 *A.M. STABILITY* °F	M.F.	*Table 5* *WIND SPEED* MPH	M.F.
≥17	0.0	0 to 2	0.0
15 or 16	0.1	3	0.1
13 or 14	0.2	4	0.2

Table 4 *A.M. STABILITY*		*Table 5* *WIND SPEED*	
11 or 12	0.3	5	0.3
9 or 10	0.4	6	0.4
7 or 8	0.5	7	0.5
5 or 6	0.6	8	0.6
3 or 4	0.7	9	0.7
1 or 2	0.8	10	0.8
0 or (-1)	0.9	11	0.9
≤(-2)	1.0	≥12	1.0

The basinwide meteorological factor (B.M.F.) is equal to the arithmetic mean of the meteorological factors (M.F.) from Tables 4 and 5.

A.M. Stability: 3,000-foot temperature (a.m.) (°F) minus surface minimum temperature (°F).

Wind Speed: Surface to 3,000 feet average wind speed (mph).

NOTE: Authority cited: Sections 39600, 39601, 41856 and 41859, Health and Safety Code. Reference: Sections 41855, 41856, 41857 and 41859, Health and Safety Code.

REFERENCE

§ 80330. General Criteria for Announcement of Permissive Burn, Marginal Burn or No-Burn Day.

Notwithstanding the criteria listed in the preceding for each air basin, the Air Resources Board may announce permissive-burn, marginal burn, or no-burn days based on expected meteorological conditions and on the estimated effect on air quality of the agricultural burning and prescribed burning.

NOTE: Authority cited: Sections 39600, 41856 and 41859, Health and Safety Code. Reference: Sections 41854, 41855, 41856, 41857, 41859 and 41863, Health and Safety Code.

REFERENCE

Division 3. Air Resources Board

Chapter 1. Air Resources Board

Subchapter 2.5. Compliance Schedule Regarding Visible Emissions from Specified Vessels

§ 85000. Compliance Schedule for United States Navy Vessels.

NOTE: Authority cited: Sections 39600, 39601 and 41704.5, Health and Safety Code. Reference: Sections 41701, 41704(j), 41704(k) and 41704.5, Health and Safety Code.

REFERENCE

Division 3. Air Resources Board

Chapter 1. Air Resources Board

Subchapter 2.6. Air Pollution Control District Rules

§ 86000. Amendments to New and Modified Stationary Source Review Rules for San Joaquin, Stanislaus, Merced, Madera, Fresno, Tulare, Kings and Kern County Air Pollution Control Districts.

NOTE: Authority cited: Sections 39002, 29600, 39601, 41502 and 40504, Health and Safety Code. Reference: Sections 40001, 41500, 40504 and 41505, Health and Safety Code; and *Avco Community Developers, Inc. v. South Coast Regional Com*. (1976) 17 Cal.3d 785.

REFERENCE

附　件　二

PM SUPERSITES PROGRAM BACKGROUND

The "PM Supersites" is an ambient monitoring research program that will provide information of value to the atmospheric sciences, and human health and exposure research communities.

Based on an extensive review of the scientific criteria and standards for PM, on July 18, 1997, the EPA Administrator published revised National Ambient Air Quality Standards (NAAQS) for PM and added standards for PM2.5. In taking this action, the Administration recognized the scientific uncertainty associated with effects, exposure, concentrations, and source-receptor relationships, as well as management alternatives for PM2.5. These revised standards, and the associated scientific findings and uncertainties, stimulated national concern about exposure to, and health effects from, PM. This concern resulted in Executive and Congressional direction and funding to EPA. In its direction, Congress called for a broad spectrum of research by parties within and outside EPA based on recommendations prepared by the National Research Council (NRC) and funds appropriated by Congress for EPA. The success of much of the intended research depends on the availability of air pollution samples and data obtained through ambient air quality monitoring. Congress emphasized that the Agency is to be guided by the National Research Council's Committee on Research Priorities for Airborne Particulate Matter and the Committee's recommendations contained in the March 1998 report "Research Priorities for Airborne Particulate Matter: I. Immediate Priorities and a Long-Range Research Portfolio." Electronic copies of this and the second report in the subject series, released in August 1999, "Research Priorities for Airborne Particulate Matter: II. Evaluating Research Progress and Updating the Portfolio" can be obtained from "http://www.nap.edu/".To plan and prioritize activities, EPA developed a PM "Supersites Conceptual Plan" (U.S. EPA, Office of Air Quality Planning and Standards and Office of Research and Development). The PM Supersites Conceptual Plan benefitted from scientific discussions held during a public PM Measurements Research Workshop held in Chapel Hill, N.C. on July 22 and 23, 1998, which was attended by about 200 members of the atmospheric, exposure, and health effects research communities. To commence the PM Supersites Program, EPA selected two initial sites: Atlanta GA and Fresno CA. These sites, henceforth referred to as Phase I Supersites, were non-competitively selected by virtue of 1) ongoing and planned research activities (objectives for which very closely align with those of the PM Supersites Program), and 2) distinctly different airsheds (e.g., atmospheric chemistry, sources, etc.) represented. Seven additional sites, henceforth referred to as Phase II Supersites, were competitively selected cooperative agreements awarded in January 2000. The Phase II Supersites are as follows:

Location	Institution	Principal Investigator
Baltimore MD	University of Maryland at College Park	John Ondov
Fresno CA	Desert Research Institute	John Watson
Houston TX	University of Texas at Austin	David Allen
Los Angeles CA	University of California at Los Angeles	John Froines
New York NY	University at Albany, State University of New York	Kenneth Demerjian
Pittsburgh PA	Carnegie Mellon University	Spyros Pandis
St. Louis MO	Washington University	Jay Turner

Each Phase II recipient developed, as part of the pre-award application competition, a project-specific hypothesis-based data analysis plan, details of which were incorporated into each Supersite application. These hypotheses were developed by each recipient, and can be categorized according to the three general program objectives defined in the PM Supersites Conceptual Plan:

(1) Characterize particulate matter: to obtain atmospheric measurements to characterize PM, its constituents, precursors, co-pollutants, atmospheric transport, and source categories that affect the PM in any region. This information is essential for understanding source-receptor relationships and the factors that affect PM at a given site (e.g., meteorology, sources, transport distances). This information is also essential for improving the scientific foundation for atmospheric models that investigate exposure and risk management questions.

(2) Support health effects and exposure research: to obtain atmospheric measurements to address the research questions and scientific uncertainties about PM source-receptor-exposure- effects relationships. Examples of these questions include, "What is the relationship between sources, ambient PM concentrations, human exposures, and health effects such as respiratory tract disease and mortality?" and "What is the biological basis for these relationships?"

(3) Conduct methods testing: to obtain atmospheric measurements that will compare and evaluate different methods of characterizing PM (e.g., emerging sampling methods, routine monitoring techniques, and Federal Reference Methods). Testing new and emerging measurement methods ultimately may advance the scientific community's ability to investigate exposure and effects questions significantly.

To augment Phase I and II project-specific data analyses, EPA solicited applications (7/00 through 9/00) for an "Integrated Data Analysis Project" (IDAP). The principal goal of PM Supersites IDAP is to address each of the three program objectives, as described above, from a broader (i.e., national, regional) perspective that requires synthesis of data beyond that collected by any individual Supersite. Award of this 'third phase' cooperative agreement is expected during March / April 2001.

Objectives of the PM "Supersites" Monitoring Program

Executive Summary

This document describes EPA's rationale and underlying objectives for implementing a Supersites monitoring program, and provides background information prior to the July 22-23, workshop to be held in Chapel Hill, NC in 1998.

This program is being designed to conduct special, detailed chemical and physical characterization studies in geographic areas with a range of characteristic $PM_{2.5}$ source-receptor and health risk situations. The scope and specific details of this program, termed "Supersites," are being developed through substantial input from the scientific community, including the July 22-23rd workshop. The scope of this program includes the sampling and analysis of ambient aerosols and gases used to supplement particulate matter measurement, modeling, exposure and health risk assessment programs.

The EPA has not preselected geographic study areas, nor have we determined overall project design, the scope of measurements or sampling systems to be used. Development of the Supersites program is consistent with EPA's desire to engage the scientific community in the design and operation of ambient air monitoring programs, and is responsive to recommendations in the National Academy of Sciences Report, *Research Priorities for Airborne Particulate Matter: I. Immediate Priorities and a Long-Range Research Portfolio*. As a focus for workshop discussions, several examples of research needs and associated measurements intended for coverage by this program are discussed below. These examples are meant to provide a common understanding of EPA's objectives by a very diverse community of air quality professionals.

The geographic areas of the Supersites program (e.g., 4-7) ought to include regional variations in air pollution across the United States and include areas with unique characteristics (e.g., climatology, source distributions, air quality, population/demographics). For example, we know that differences exist in the composition and seasonality of aerosols in Southeastern, Northeastern, and Western U.S. cities. The number of Supersites will depend on the availability of sufficient resources to conduct high-quality, intensive and advanced measurement studies for ambient aerosols at each site commenced.

A single site viewed in isolation cannot address air quality issues that have strong regional components. Accordingly, these Supersites must be viewed as a complementary and intersecting activity to the regulatory monitoring network being deployed by the state and local agencies (Appendix C). Ideally, Supersites will be located where other major field studies (including exposure and health effects studies) either are in progress or being planned.

A major motivation for assembling the workshop is to bring together researchers from the atmospheric/physical science, health effects/exposure science, and regulatory communities to ensure that multiple objectives for studies in different disciplines can be addressed and coordinated across relevant programs. While the technical and scientific perspectives and objectives of these communities may differ, we suspect that major areas of common information needs exist. For example, epidemiological studies need to address co-pollutant interactions, which lead to the collection of the major components of particulate matter, as well as other gaseous species such as peroxides and ozone. Analogously, atmospheric processes underlying the formation of secondary aerosols are chemically coupled to oxidative species, including ozone and peroxides as examples. Ideally, this Supersites program will foster an environment across disciplines resulting in optimum use of environmental sampling resources. Accordingly, we acknowledge that the Supersites program is just one piece within an array of measurement and related studies.

There are three major Agency objectives common to all of the "Supersite" study areas:

1) support development of State Implementation Plans (SIP's) through improved understanding of source-receptor relationships leading to improved design, implementation, and tracking of control strategy effectiveness in the overall PM program;

2) development of monitoring data and samples to support health and exposure studies to reduce uncertainty in National Ambient Air Quality Standards setting and to enable improved health risk assessments; and

3) comparison and evaluation of emerging sampling methods with routine techniques to enable a smooth transition to advanced methods.

The first two objectives should provide an opportunity to increase temporal, chemical, phase, and size fraction resolution of PM related measurements relative to "routine" monitoring programs that typically are limited, for example, to intermediate averaging times (e.g., 24 hours) and single size ranges. These knowledge gains will improve the scientific basis for setting standards and their implementation. The last objective recognizes the physical/chemical complexities of aerosols and associated sampling/analysis methodologies and the desire to accommodate and promote the use of emerging techniques.

Examples of the types of scientific and programmatic questions that will be supported through the Supersites program in coordination with other efforts are provided in Appendix A.

Program Objectives

Program objectives include three broad categories: 1) support for State Implementation Plans (SIP), 2) development of improved data for health and exposure studies and health risk assessments and 3) sampling method development and inter-comparisons. Since the Supersites program is an interdisciplinary effort bridging physical/chemical science and health assessment communities, a discussion of these objectives is provided to foster improved communications across these disciplines.

State Implementation Plan (SIP) Support

SIP support covers a very wide spectrum of activities that can be viewed as the atmospheric sciences component of this Supersites program. Activities that support both the development of effective emission control strategies and the continuous assessment of such strategies constitute SIP support. These activities range from developing qualitative insights regarding the nature and cause of a particular air pollution problem (e.g., regionally dispersed sulfate and carbon constitute the majority of $PM_{2.5}$ aerosols), to a comprehensive application of complex three-dimensional gridded air quality simulation models. Included in the mix of SIP support tools are various source attribution/apportionment tools, air quality simulation models and observational approaches, and methods to characterize trends in air quality to track progress. These tools support planning of emissions control strategies and enable mid-course adjustments. A more detailed discussion of each of the following SIP activities, their role in SIP development, and their corresponding measurement needs is provided in Appendix B:

- Air Quality Characterization (beyond the routine chemical speciation program)
- Evaluation of Emission Estimates
- Air Quality Simulation Model Evaluation and Application
- Receptor and Observation-Based Models: Evaluation and Application of Advanced Methods
- Air Quality Trends and Tracking Progress of Control Programs

SIP activities use ambient measurements to drive and/or to evaluate the basic air quality management tools used to characterize and predict air quality in terms of temporal, spatial, size delineation and chemical composition coordinates. Each has a common objective of developing and tracking success of effective emissions strategies. The underlying SIP support tools include regional/urban scale air quality simulation models (e.g., MODELS 3) and a suite of more empirically-based observational methods. Air quality simulation models require emissions and meteorological input; whereas observational methods rely on ambient measurements to infer source to receptor relationships or preferred control strategy approaches. These latter methods include source apportionment techniques (e.g., CMB8, SAFER), and a group of methods that infer a generalized preferred precursor reduction approach without specifying source categories (e.g., nitrogen oxides limit ozone formation more than volatile organic compounds at a particular location and time).

Supersites provide an important diagnostic complement to the routine monitoring program needed for air quality modeling and emissions inventory efforts. Supersites in a SIP context provide highly resolved measurements to diagnose the effectiveness of existing tools by uncovering their strengths and weaknesses. Supersites do not independently support SIP development as they clearly provides only a small fraction of the data needed for state implementation planning. The Supersites do provide operational support, e .g., direct input into source receptor models, and can be distinguished by recognizing their diagnostic support. Perhaps the largest area of technical criticism confronting the regulatory community over the last decade has been the lack of diagnostic measurements and techniques to support operational tools.

Exposure and Health Risk Assessments

Improved characterization of ambient particles and associated "toxic" constituents or co-pollutants are needed to address critical exposure and health effect issues. These issues include:

- Characterizing human exposure and the relationship of exposure to specific PM characteristics and related measurements collected at ambient monitoring sites,

- Identifying the causal agents and mechanisms for the acute and chronic health effects that are associated with $PM_{2.5}$.

Hypotheses regarding the potential causative agents, toxic mechanisms and potential for human exposures would be given consideration in selecting the chemical and physical methods to be deployed at the Supersites. For example, to evaluate the hypotheses that ultra fine particles, soluble metals, or electrophilic organic compounds are the causative agents, these species or properties would need to be measured. In addition, spatial and temporal factors will be considered to ensure that both acute and chronic effects and related exposures can be related to the ambient measurements at these sites and that sufficient temporal resolution and frequency of measurements will allow these hypotheses to be tested. Geographic considerations that require further study are the past observations suggesting that the health risks of $PM_{2.5}$ are similar across diverse air sheds with different sources and background aerosols. To further explore this observation, it will be important to include a full range of geographic and source variations. Supersites, for example, may be augmented by additional neighborhood sites to assess the relationship among different exposure microenvironments of concern. Ideally, emerging information identifying and characterizing the nature of the "toxic" components of PM will be incorporated into the Supersite measurement program.

The Supersites, in addition to advancing the understanding of the chemical and physical nature of PM and directly supplying ambient measures for exposure, epidemiologic, and clinical field studies, will potentially be an important resource for toxicology studies. For example, various types of samples of ambient particles could be collected for in-vitro and in-vivo toxicology studies addressing mechanistic questions.

Specific human exposure, dosimetry, toxicology, and epidemiology studies will be supported through resources available outside the Supersites program by EPA and other funding sources.

Monitoring Methods Development Platforms

Multiple and constantly changing demands are placed on the ambient air sampling and analysis community. There is a demand for information that provides greater resolution in chemistry, size distributions, and time which closely parallel new instrumentation developments. However, a transition (or collaboration with the expert community) is necessary before advanced methods can be used routinely by state and local agencies. As an example, increased time resolution of speciated aerosol measurements is often desired. State-of-the-science, continuous, in-situ, speciation samplers have now been developed. However, many of these methods require testing and comparison with standard methods to characterize the differences between techniques and to develop standard operating procedures. New methods must be evaluated before they are used at routine monitoring sites. The Supersites program represents an excellent opportunity to test new methods side-by-side with existing techniques and to allow for a smooth transition for the routine use of more advanced methods. Ideally, method comparisons should be performed in several different air sheds of varying characteristics to identify the weaknesses and strengths of various approaches. Clearly, these intercomparisons will identify several regional differences in performance between the Federal Reference Methods and techniques designed to capture all mass components. More exciting is the opportunity to accelerate deployment of continuous methods, improve organic carbon sampling and analysis techniques, and other methods providing particle-specific information. These sites should provide a vehicle for collaborations between the expert community (including universities, privateR&D groups, industry, states & local agencies, and EPA) and State/local air monitoring organizations responsible for implementing "routine" monitoring platforms.

Relationships between Supersites and other components of the $PM_{2.5}$ Monitoring Network

The Supersites complement the monitoring network in two very important ways: 1) as test platforms for application of advanced methods in routine networks, and 2) supply high resolution temporal, chemical, and size distribution data to enhance the less resolved data from routine sites. In turn, the routine networks complement the Supersites by providing strong spatial complements to the intensive Supersites. Appendix C provides an "Overview of the National

$PM_{2.5}$ Monitoring Networks" including the routine chemical speciation program that will be enhanced by the Supersites.

Supersites will provide inter-comparison platforms for "routine" speciation samplers and Federal/Equivalent Reference Method mass samplers. Several issues related to the comparability of data from routine and advanced methods call for inter- and intra-method comparison. Supersites and routine sites need to be established and maintained to ensure progress in applying advanced methods routinely, and to reduce uncertainty in data trends interpretations brought about by changing methodologies.

The more resolved data from Supersites supports a wider spectrum of SIP and health risk assessment activities than provided by routine measurements alone. These include; air quality model evaluation, emissions evaluation, application of source-receptor methods, and support of health risk assessments.

Air quality is strongly influenced by multiple interacting spatial scales calling for characterization across super-regional, regional, urban, and local scales and various land use categories. A single site in an air shed is not capable of characterizing spatial gradients, background concentrations or transport phenomena that collectively interact to affect air quality at a specific location. Similarly, one site generally cannot reflect exposure everywhere in a large urban area with heterogeneous mix of sources. Consequently, a network of sites reflecting spatially disparate conditions is needed for most air quality assessments. Supersites should address both spacial and temporal characterization and may be complemented by the routine chemical speciation sites (e.g., which may serve as satellites). The Supersites could also provide vertical scale resolution (through optical techniques, elevated platforms, periodic aircraft flights) not expected to be part of routine networks.

In addition to routine monitoring programs, the Supersites design should take into account both existing and planned field studies conducted as by universities, industry and public-private organizations such as NARSTO. For example, the Supersites will likely focus on populated areas where health studies may also be conducted through other programs. Ideally, these "urban" sites should be coupled with intensive regional/background sites to delineate differences across different spatial regimes.

Appendix A: Questions Addressed Through Support of the Supersites Program

Examples of scientific and programmatic questions that will be supported through the Supersites program in coordination with other efforts are provided below:

Air Quality Management/Atmospheric Processes

What fraction of PM is locally, versus regionally, versus naturally (e.g., biogenic emissions) generated?

What are the various source categories contributing to PM and how much does each source category contribute to each of the above fractions?

What limiting conditions for the formation of $PM_{2.5}$ exist now and over time with respect to coupled PM precursors (e.g., ammonia, nitrogen oxides, sulfur oxides, volatile organic compounds)?

How is the total PM, and the contributions of the various source categories, changing over time?

Are these changes in agreement with the expected changes based on increases of decreases in known, measured or estimated emission rates?

How well can regional scale and/or urban scale air quality models simulate the observed hourly, horizontal and vertical distribution of PM parameters and components?

Can a data base of hourly, horizontal, and vertical PM parameters and related components are used to improve air quality models? What are the spatial three-dimensional and temporal distributions of PM and oxidant precursors, PM components, PM and oxidant sinks and how are each transported at the surface, aloft, and in between?

How does the partitioning across gaseous and solid/liquid phases affect the fate of aerosol compounds?

What precursors (ammonia, nitrogen, and sulfur oxides, semi-volatile and volatile organic compounds) are most important to regional and local formation of secondary aerosols, and how is their relative importance expected to change over time?

How well can regional scale and/or urban scale air quality models simulate the observed hourly, horizontal, and vertical distribution of PM parameters and components?

Can a data base of hourly, horizontal, and vertical PM parameters and components be used to improve air quality models?

What are the important chemical and physical coupling processes between oxidants and aerosols that affect the development of strategies targeted at both ozone and particulate matter? What regions of the country and over what seasons are coupling processes quantitatively important in developing co-pollutant emission strategies? How are these processes further coupled to deposition and toxics assessments?

What particle parameters, over and beyond those ordinarily measured, are useful in understanding sources? Examples include: particle number, particle surface area, particle size distribution, particle composition by size, light scattering, nonvolatile mass, nonvolatile plus semi-volatile mass, etc.

Exposure Assessment

Which parameters and components of PM are sufficiently evenly distributed across an urban area to provide a valid average community concentration (for use as a surrogate for the community average personal exposure)?

What exposure measure and time resolutions better predict the acute health effects than the 24-hr average? For example, is the maximum hourly concentrations or the 8-hour maximum concentration an independent exposure parameter or is it highly correlated with the 24-hour average?

What is the relationship between the ambient site measurements and human exposure?

Health Effects (Epidemiology/Toxicology)

What constituents of PM or associated pollutants are most highly associated with toxicity or adverse health effects?

What time resolution of ambient pollutant measures are the best predictors of adverse health effects (considering that this will vary with the type of health effect being studied and will be different between acute and chronic effects)?

To what extent does the presence of co-pollutants modify the effects of PM exposure?

Monitoring Methods

What is the difference in $PM_{2.5}$ that is characterized by Federal Reference Method techniques and techniques that capture a more comprehensive range of aerosol components?

How do such differences vary seasonally and geographically?

What is the difference in $PM_{2.5}$ that is characterized by Federal Reference Method techniques and techniques that capture a more comprehensive range of aerosol components?

How do such differences vary seasonally and geographically?

What operational and technical obstacles exist in applying emerging in-situ continuous methods for total $PM_{2.5}$ mass and spectate components, PM precursors, and oxidants/intermediates (peroxides, nitrogen dioxide, peroxyl radicals, OH radical, nitrate radical)?

What steps must be deployed to move emerging methods into routine application?

Appendix B: SIP Support Activities and Data Needs

Examples of SIP support activities are provided here to illustrate how the Supersites program will support SIP's. The discussion is not intended to completely explain the technical approaches underlying the SIP process. Additional materials (Demerjian et al, 1995; EPA, 1996) provides a more thorough explanation of how the complementary uses of SIP support tools provide a solid underpinning of control programs. Throughout the discussion an emphasis is placed on how more detailed chemical, temporal and size distribution information from a Supersites will complement the routine chemical speciation program (Appendix C) which provides 24 hours averaged samples of major components (e.g., total organic carbon, not individual compounds) at less than daily sampling periods for one size cut (2.5 microns).

- **General Air Quality Characterizations.** Characterizing air quality through reconstructing component mass balances that identify the relative fractions of major components [e.g., major ions (sulfate, ammonium, nitrate), carbon (total elemental and organic), and elements (particularly crustal elements)] is an initial step leading to qualitative assumptions regarding principal impact sources and further refined analyses. This effort largely will be achieved through the routine chemical speciation program, which typically provides these measurements on 24-hour filter based samples. Since the routine program often will collect measurements on a 1/6 or 1/3 day sampling schedule, the Supersites program will enhance these general characterizations by providing daily (and probably continuous) measurements of the same components. This will allow for site-specific testing of the statistical adequacy of routine sampling schedules and allow for recommended adjustments to the routine program.

- **Evaluation of Emission Estimates.** Emissions are the major input into air quality simulation models and generally a source of considerable uncertainty. Emissions estimates include direct primary emissions, such as fugitives and soil/agricultural dust, incomplete combustion products, and condensible organic compounds; and precursors to secondarily formed aerosols, such as ammonia, nitrogen and sulfur oxides, and volatile organic compounds. While some of the precursor gases such as nitrogen and sulfur oxides are believed to be reasonably well characterized for major point sources, there remains large uncertainties in fugitives, ammonia and condensible organic compound sources. Many emission categories (and their near field concentration profiles) exhibit strong diurnal and seasonal patterns (e.g., mobile sources, biogenics), and emit specific organic compounds that are not analyzed routinely with standard chemical speciation protocols that sample over a 24-hour period. Similarly, assumptions regarding particle growth and related emissions size distributions (or particle number) incorporated in emissions models have large uncertainties that demand testing with observed data. Clearly, the

Supersites program will provide ambient data, which under certain conditions, will allow for evaluation (i.e., reality check) of modeled emissions estimates for certain species. Thus, the Supersites complements the routine networks by providing continuous (or at least higher time resolution) measurements and detailed species specific chemical information over various size fractions.

- **Application and Evaluation of Air Quality Simulation Models.** Emissions driven Air Quality Simulation Models (AQSM's) are valuable spatial, temporal, and chemical interpolators that require considerable validation with surface and aloft ambient measurements of both predicted values and process formulations. These modeling systems operate over multiple spatial scales (domains of over 1000 km and grid resolution down to 2-4 km, with capability for subgrid scale specific plume characterization), in near continuous time (effectively 1 hour increments) and considerable chemical definition. Given the enormous time, space, and chemical detail of modern AQSM's, there is no limit on the variety of ambient data that can provide useful testing information. While data from the routine programs (e.g., chemical speciation, PAMS) provide valuable evaluation data, those data fall short in either temporal (24 hours when hourly data are needed), chemical, or vertical resolution. Especially important is the availability of measurements that allow for true diagnostic[1] evaluation of the robustness of a model's ability to generate realistic emissions strategies by testing whether the model truly is capable of integrating transport and chemical process dynamics. In addition to common products (e.g., sulfate, nitrate, ozone) and precursor observations (nitrogen and sulfur oxides, volatile organic compounds); additional chemical data (that Supersites can provide) on precursors, such as ammonia; sinks (or removal species), such as peroxides and nitric acid (which also behaves as a precursor for aerosols), and important short lived and photochemical dynamic species, such as peroxyl radicals and nitrogen dioxide allow for such testing. Due to the atmospheric chemical coupling between oxidants and aerosols, any evaluation of modern AQSM's supported by the Supersites benefits both ozone and aerosol implementation programs. An array of meteorological measurements

[1] Diagnostic activities attempt to determine whether the assessment tools truly recreate physical and chemical processes in the atmosphere. For example, an air quality model often is evaluated with data that are available. Historically, ozone model applications relied on available ground level ozone data. The resulting model evaluation provides some limited confidence that the model works as it should; however, so many coupled chemical and physical pathways potentially create circumstances where accurate ozone predictions result from compensating errors in process characterizations (e.g., underestimated mixing and emissions fields). These errors compromise the model's future predictive ability when applied to various emission scenarios. A diagnostic approach to evaluation would provide measurements of key chemical components in near continuous time to test whether the model is capturing important processes, to ensure confidence in reproducing various emission scenarios. In addition, measurements extending vertically clearly are needed given large spatial gradients that often exist in the atmosphere. The problem is magnified with aerosols, where routine measurements typically are aggregated over 24 hours, whereas significant transient changes in atmospheric mixing and emissions occur over much smaller time periods. Moreover, aerosol model evaluations are challenged by additional complexities of multiple phases and size distributions of varied chemistry.

which capture three-dimensional characteristics of wind velocity, temperature, pressure, relative humidity, and other parameters useful for defining structural features for mixing purposes is especially critical for model evaluation.

- **Application of Receptor[2] and Observation-Based[3] Models.** A suite of source apportionment techniques that relate chemically-spectate ambient data to chemical features specific to particular source emissions will be applied to attempt to delineate the principal source categories and their quantitative impacts at a specific location. Examples of these techniques include the Chemical Mass Balance Model version 8 (CMB8) and various multivariate approaches, such as multiple linear regression, constrained factor analyses (e.g., SAFER/UNMIX), and Principal Component Analysis. The multivariate approaches require the simultaneous use of many ambient samples, but have the potential of avoiding the need for externally-supplied source profiles, as in the case of CMB8. An additional promising but relatively unexplored source apportionment technique is the use of the chemical and morphological features of the individual particles composing an ambient PM sample, as determined from scanning electron microscopy (SEM) analysis. All of these techniques are limited by the richness of available data. Thus, while routine 24-hour averaged samples of chemical constituents can be used to drive these techniques, it is often preferable to use data aggregated over smaller time periods that reflect diurnal emissions release patterns (e.g., mobile sources) and/or meteorologically stable periods. Also, specific chemical markers that associate closely with known sources enhance source apportionment analyses. The Supersites are expected to provide specific organic compound data not routinely collected that should enable apportionment, for example, between sources such as (1) diesel- vs. gasoline-powered vehicles, (2) nominally similar vehicles but with very different emissions characteristics (hot-stabilized vehicle emissions vs. "smokers"), and (3) food processing/cooking vs. biomass-derived emissions.

- **Air Quality Trends and Tracking Progress of Control Programs.** A

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[2] Source apportionment is a very broad term that can extend to the more deterministic Eulerian models which develop source-receptor relationships. Depending on perspectives, there may or may not be much delineation between the terms source apportionment and source-receptor. For clarification, we will use source apportionment to refer to the more observation driven approaches such as chemical mass balance receptor models.

[3] Observational Models require ambient data as explicit inputs to drive model calculations; more deterministic air quality simulation models are driven principally through emissions and meteorological input fields. A class of observational methods infer "preferred" general control strategy approaches based on atmospheric chemistry conditions. For example, the smog production algorithms (Blanchard et al., 1992) and the Georgia Tech OBM (Cardelino and Chameides, 1995) indicate whether ozone is preferentially reduced through reductions in Nitrogen oxides or volatile organic compounds, rather than identifying a particular source category such as a coatings operation or specific combustion source. Techniques for identifying the relative importance of ammonia and nitrogen dioxide for nitrate aerosols recently have been developed (Blanchard..., 1997).

continuous tracking of air quality is required as a basic accountability measure of ensuring that 1) planned emission strategies are implemented as designed, and 2) such programs achieve acceptable results. Such accountability is absolutely required given so many predictive uncertainties in atmospheric processes and related technical tools as well as unknowns associated with forecasting economic and demographic change. The atmosphere includes complex nonlinearities[4] as well as negative and positive feedbacks[5] that demand constant assessment of the effectiveness of emissions strategies. [These same concerns demand that AQSM's undergo diagnostic level testing.] The routine chemical speciation program will provide the basic information to test programmatic effectiveness. While the routine program should provide a measured signal indicating program effectiveness, it is unlikely that routine programs will be capable to explain the "why" or "how" behind unfulfilled program objectives, given the complexity of aerosol and oxidant systems. Clearly, the long term availability of detailed chemical, size and time-resolved data enhances our ability to diagnose the successes and failures of implemented programs, and ensure needed adjustments to optimize air quality management. Similarly, the uncertainties associated with relating specific PM mass components to adverse health impacts demand that a long term tracking system exist to retrospectively review associations as research provides more insight into the relationship between specific PM components and health effects.

4 A proportionate reduction in a pollutant precursor does not result in a proportionate reduction in the targeted pollutant

5 A reduction in a precursor can lead to an increase or decrease in targeted pollutant level

Appendix C: Overview of National $PM_{2.5}$ Monitoring Networks

The current planned scope of the national $PM_{2.5}$ network consists of three major components: mass monitoring, routine chemical speciation, and special study areas termed "Supersites." In very broad terms, the network, as a whole, supports three principal regulatory objectives: 1) determining nationwide compliance with the NAAQS; 2) State Implementation Plan (SIP) development (e.g., source attribution analysis and air quality model evaluation; and 3) tracking trends and progress of emissions reduction strategies. The EPA recognizes that, with care in design and execution, components of this program can also provide significant support for priority research needs. The following brief description is intended to provide background for understanding the context and relationship between these components and between them and EPA's research program. The attached table outlines for each category below a synopsis of the budgeted number, major purposes, and potential flexibility for integration with PM research programs.

MASS MONITORING (1100)

1. **Core mass monitoring (850).** Approximately 850 NAMS/SLAMS sites, required according to EPA guidance to the States, will be dedicated to mass monitoring. A breakdown of these 850[6] sites includes 750 required for NAAQS compliance and 100 sites for characterizing background and transport. The regulation requires a continuous sampler to be collocated with an FRM/FEM at the 52 largest cities (greater than 1,000,000 population).

2. **Mass samplers for spatial averaging and special purpose monitoring (SPM)(200).** Roughly 200 additional sites to accommodate spatial averaging[7] and special purpose monitoring needs are expected to be deployed. The SPM sites are those established to identify unique source location or communities, and are not required to be compared to the NAAQS if operating less than 2 years (or a sampler without FRM/FEM designation).

3. **Continuous monitoring (50).** In addition to the required collocated 52 continuous monitors, plans include deployment of an additional 50 continuous samplers. Collectively,

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[6] EPA network guidance (40CFR58) requires 850 NAMS/SLAMS sites; however, 100 of those sites are to be designated as background or transport sites (2 per State) which can use the IMPROVE sampler, which is not designated as an FRM/FEM and therefore would not be used for NAAQS comparisons.

[7]The annual $PM_{2.5}$ standard is specified as reflecting an area-wide distribution or spatial average of a representative single monitor or the average of multiple monitors. States have requested additional monitors to provide for spatial averaging.

at least 100 continuous samplers will be deployed, and probably more, since the States can elect to purchase and operate continuous samplers for sites designated as special purpose monitoring.

Principal objectives for mass monitoring:

(a) FRM/FEM samplers and NAMS/SLAMS. The primary objective for mass monitoring, especially the designated NAMS/SLAMS[1] sites are for comparison to the $PM_{2.5}$ NAAQS. In addition, 100 NAMS/SLAMS will serve as background and transport sites, integrated with other efforts such as IMPROVE, to characterize regional transport and background concentrations.

(b) Continuous samplers. Continuously operating samplers will provide a real time estimate of $PM_{2.5}$ levels and allow for input into public information displays (similar to current ozone mapping efforts that reach local weather forecast venues) as well as the Pollutant Standards Index (PSI). Other objectives for continuous samplers include developing statistical relationships with FRM/FEM's to serve as potential surrogates for compliance indicators, and characterizing diurnal patterns of exposure and emissions.

© Special Purpose Monitors (SPM's). The SPM's samplers are intended to provide flexibility for State and local agencies to investigate areas that may have exceedances without the repercussion of regulatory requirements associated with a NAAQS violations. The purpose of SPM's is to encourage monitoring where it might otherwise be discouraged due to fear of associated regulatory requirements. The SPM's are expected to be located in unique or rural communities subject to localized sources, or enhance the regional/background/transport network to better characterize multiple spatial scale interactions. Samplers for SPM's purposes can be FRM/FEM that operate less than 2 years, or non-FRM/FEM samplers. Many State and local agencies are expected to operate continuous samplers within the classification of SPM's sites.

ROUTINE CHEMICAL SPECIATION (300).

The routine chemical speciation program consists of two components: 50 required NAMS, and up to 250 additional sites (EPA's contribution to the IMPROVE program technically is similar to the routine speciation program but addressed separately due to budget considerations). The major purpose of these sites is to assess long-term trends in major $PM_{2.5}$ components, as well as to provide useful information for source apportionment, evaluating current and future control programs, and health risk assessments.

1. **NAMS (50).** The regulation requires 50 speciation sites across the country, located mostly in urban areas (e.g., all PAMS cities will have a speciation site). These 50 sites will be designated as NAMS and will follow sampling and analysis protocols similar to the

existing Interagency Monitoring of Protected Visual Environments (IMPROVE) program. Filter sampling techniques (Teflon, nylon and quartz media) for 24-hour periods will be analyzed for principal mass components: most elements through X Ray Fluorescence; major ions through Ion Chromatography/Colorimetry (nitrates, sulfates, chloride/ammonium); and organic and elemental fractions of carbon through Thermo analysis. The sampling methodology and frequency (1-in-6 day or greater) are being evaluated in light of peer review comments. Prescriptive protocols for sampler selection, analytes, and sampling frequency will be adhered to ensure national consistency across space and time.

2. **Other "Routine" Speciation Sites (250).** In addition to the NAMS, resources are expected to be available to support up to 250 additional sites. These sites will be less prescriptive than the NAMS and will be subject to a balance among competing needs for national consistency (50 sites are not adequate to characterize the U.S., suggestions for more frequent sampling), and flexibility to address local-specific issues such as winter time wood smoke, or the need to support related scientific studies, which might require more intensive seasonal sampling and analysis. This component of the program does provide true flexibility for State and local agencies. Certain States (e.g., California) have expressed an interest in establishing more advanced methods capable of in-situ, near continuous measurements of principal species. Given the flexibility of this component of the national program, substantial opportunity exists to interact with the health and atmospheric chemistry research communities. With the exception of the Supersites program, however, all of these components are funded by State Grants, which provide hardware and related capitol costs, laboratory analyses, and salaries for State and local agencies to operate the network. Consequently, the dialogue must involve EPA, State and local agencies, and the research community.

3. **IMPROVE Sites (108).** In addition to 30 existing EPA supported sites, 78 new IMPROVE sites are being added, in or near Class I Federal areas (e.g. national parks and wilderness), to address the requirements of the forthcoming Regional Haze regulations. These sites conduct speciation sampling similar to the 50 NAMS, but on a 1/3 day sampling interval. These sites are considered as part of the entire $PM_{2.5}$ National network, recognizing that the technical connections (e.g., sources/ambient characterizations, measurement techniques) between $PM_{2.5}$ and visibility require integration. Although funded through State Grant funds, this program is managed by the IMPROVE Steering Committee, and most of the technical work conducted by Universities and the Federal Land Managers.

SUPERSITES (4-7). See main text.

Scientific Review of Network Components

The use of $PM_{2.5}$ mass as an "indicator" for PM standards was recommended by the Clean Air Scientific Advisory Committee (CASAC) at the conclusion of their review of the scientific criteria and standards. Both the Federal Reference Method for measuring $PM_{2.5}$ mass and EPA's guidance for establishing the mass compliance network were peer reviewed by the Fine Particle Technical Monitoring Subcommittee of CASAC in 1996. The more recent plans for speciation measurements, continuous monitors, and Supersites are in partial response to the subcommittee's recommendations for monitoring beyond 24-hour $PM_{2.5}$ mass. The approach for the required speciation monitoring network was recently reviewed by an expert scientific panel in Seattle. The approach and objectives for the super site program will be the focus of a major 2-day workshop in July. A workshop planning group, including a number of recognized scientific experts in health, exposure, atmospheric sciences, and monitoring met in May and is continuing to develop materials for the program. In addition to providing periodic updates on this program to the NAS panel, EPA intends to present its approach for integrating the "routine" speciation network with the super site monitoring and research programs for review by the Fine Particle Monitoring Technical Subcommittee of CASAC in the Fall.

List of Acronyms

$PM_{2.5}$ = Particles with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
PM = Particulate Matter
EPA = Environmental Protection Agency
NAMS = National Air Monitoring Station
SLAMS = State/Local Air Monitoring Station
NAAQS = National Ambient Air Quality Standards
FRM = Federal Reference Methods
FEM =Federal Equivalency Methods
SPM = Special Purpose Monitoring
IMPROVE = Interagency Monitoring of Protected Visual Environments
PSI = Pollutant Standards Index

Overview of National $PM_{2.5}$ Network

Site Category	Projected Number	Major Purpose	Potential Flexibility for Research
Core Sites	850 FRM/FEM measure $PM_{2.5}$ mass. Also 50 collocated monitors measure continuous mass	Minimum required for designations. FRM and network design peer reviewed by CASAC. Continuous required for PSI reporting.	Limited. States follow EPA guidance on location according to population, other factors. Frequency of sampling could be adjusted at some.
Spatial Averaging/ Special Purpose	200 FRM/FEM, other	States requested additional monitors for spatial averaging for attainment designations. SPMs limited duration (<2 yr), e.g. source attribution study	Locations determined by States according to local circumstances. SPM might be adjusted to accommodate research
IMPROVE	100 additional IMPROVE monitors	Supports regional haze rules in class I areas and $PM_{2.5}$ transport assessment. Chemical speciation.	Limited to class I areas.
Chemical Speciation	300 sites with "routine" chemical analyses	Trends, source attribution of major chemical species, for source apportionment, risk assessment. Regional variations encouraged.	Substantial flexibility to accommodate health and other research subject to resource limitations on frequency.
Continuous	50 additional continuous $PM_{2.5}$ mass monitors	PSI reporting and further delineation of source/exposure patterns	Substantial flexibility to support exposure studies.
Total	**1500 Sites**		

In addition 4 to 7 Supersites not included in above with research grade instrumentation will be established for health risk and source assessment work integrated with research program. The design of this program is fully flexible for incorporation into other priority scientific research on PM.

Update
$PM_{2.5}$ Monitoring Implementation
3/1/00

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Update - $PM_{2.5}$ Monitoring Implementation

Introduction

The deployment of a new $PM_{2.5}$ monitoring network is a critical component in the national implementation of the new $PM_{2.5}$ National Ambient Air Quality Standard (NAAQS). To date, over $128 million in federal funding has been provided to support a national monitoring network as described within President Clinton's Directive of July 16, 1997, in addition to those funds provided for particulate matter research. The $PM_{2.5}$ network follows the regulations provided in Title 40 of the Code of Federal Regulations (40 CFR), Parts 50, 53, and 58, and published in the ***Federal Register*** on July 18, 1997. As described in the NAAQS packages, the ambient data from this network will drive an array of regulatory decisions, ranging from designating areas as attainment or nonattainment, to developing cost-effective control programs, and to track the progress of such programs.

This document provides a summary of progress to date, and an outline of the remaining actions that will be taken to complete the $PM_{2.5}$ monitoring network. A copy of the original $PM_{2.5}$ Monitoring Implementation Plan (3/98) is provided as an attachment for reference. The 1998 plan was used to describe the rationale underlying the network and its components; to establish and affirm major products (e.g., training programs, procurements) and timelines required to implement the network; to define roles and responsibilities of organizational groups and individuals; and to generate consensus among those responsible for network deployment and operation. Much work has gone into the program since 1998, and this summary attempts to describe how the program has evolved over that time period, and to highlight the major accomplishments.

A. Network Conceptualization and Major Program Components

Data from this program will be used for (1) $PM_{2.5}$ NAAQS comparisons, (2) development and tracking of implementation plans, (3) assessments for regional haze, and (4) assistance for health studies and other ambient aerosol research activities. The $PM_{2.5}$ network design addresses these four program objectives through a combination of siting and instrumentation strategies. The federal reference method (FRM) sampler design and network concepts like community-oriented monitoring (including "spatial averaging") are predicated on the need to produce data commensurate with those health studies underlying the development of the $PM_{2.5}$ NAAQS. The principal objective of the FRM sampler is to measure a particulate matter "indicator" which defines $PM_{2.5}$ and which tracks back to those measurements used in the health studies supporting the $PM_{2.5}$ NAAQS. The requirement that these instruments rely on specific design elements, rather than performance criteria alone, is structured to produce greater measurement precision and to avoid the data measurement uncertainties experienced in the PM_{10} monitoring program. Because the FRM $PM_{2.5}$ samplers do not provide temporally resolved data or full chemical characterization of ambient aerosols, other sampling instruments including continuous analyzers and speciation samplers constitute a major part of the $PM_{2.5}$ network.

Network Elements & Changes to Network Design Since 1998.

Compliance (mass) monitoring. The network design focus for compliance of both the annual and 24-hour $PM_{2.5}$ NAAQS strives to locate monitoring sites in populated areas, with a major emphasis on communities exposed to concentrations representing larger areas, or area-wide concentrations. This emphasis on area-wide concentrations again reflects the need to be consistent with studies underlying the $PM_{2.5}$ NAAQS, analogous to the rationale for the FRM specifications.

The national $PM_{2.5}$ network includes approximately 1,050 FRM sites, of which 850 sites are required as a minimum by the 40 CFR 58 regulation. (As of March 2000, 1,022 of these FRM sites are operating.) The sites that are not required to meet regulatory minimums (~200) are necessary in order to provide for adequate coverage of populated areas and for special purpose monitoring work. In 1997, the FRM network was designed to include nearly 1,400 sites. In March 1998, the National Academy of Science's report Research Priorities for Airborne Particulate Matter: Immediate Priorities and a Long-Range Research Portfolio[1], made the recommendation that the mass portion of the network be reduced, and that the chemical speciation and continuous monitoring efforts be increased. EPA responded to this report, and the FRM network size was reduced by approximately 350 sites. This reduction allowed for a shifting of resources to continuous mass and chemical speciation measurements described below. Table 1 illustrates how the network design has been modified, and provides an indication of how many sites are operating at this time.

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[1]Published by the Committee on Research Priorities for Airborne Particulate Matter, National Research Council, National Academy of Sciences, March 1998.

Table 1. $PM_{2.5}$ Network Design Impacts from 1999 NAS Report & Current Operating Status.

Network Element	Original # of Sites in 1997	Current # of Planned Sites	# of Sites Operating as of 3/1/00
Compliance (FRM) sites	1,392	1,050	1,022
Chemical Speciation	~300 sites sampling either 1in6 or 1in 12 days.	54 "trends" sites sampling 1in3; ~40 sites used to support Supersites, sampling 1in3 generally; ~10 sites sampling daily to support ongoing health studies; ~200 sites used to support SIP and other work, sampling 1in6.	13
IMPROVE network expansion	108	110	35
Continuous mass sites	100	~210	115
Supersites	4 to 9	8 (based upon award)	Atlanta site operated in 1999; remainder expected in 2000-01.

The description of the $PM_{2.5}$ FRM is included in 40 CFR 50, Appendix L, published as a final rule in the Federal Register on July 18, 1997. Essentially, the $PM_{2.5}$ FRM is a gravimetric method that acquires deposits over 24-hour periods on Teflon®-membrane filters from air drawn at a controlled flow rate through a tested $PM_{2.5}$ inlet. The inlet and size separation components are specified by design as published in the Code of Federal Regulations. There are a number of designated federal reference method samplers at this time including:

Single channel FRM samplers:

- Andersen Model RAAS2.5-100 $PM_{2.5}$ Ambient Air Sampler; designated 6/11/98.
- BGI Inc. Model PQ200 Ambient Fine Particle Sampler; designated 4/16/98.
- Rupprecht & Patashnick Partisol®-FRM Model 2000 Air Sampler; designated 4/16/98.
- Thermo Environmental Instruments, Inc. Model 605 "CAPS" Sampler; designated 10/29/98.

Sequential FRM samplers:

- Andersen Model RAAS2.5-300 $PM_{2.5}$ Sequential Ambient Air Sampler; designated 6/11/98.
- Rupprecht & Patashnick Partisol®-Plus Model 2025 Sequential Air Sampler; designated 4/16/98.

Portable FRM audit samplers (used in the quality assurance program):

- Andersen Model RAAS2.5-200 $PM_{2.5}$ Ambient Audit Air Sampler; designated 3/11/99.
- BGI Inc. Model PQ200A Ambient Fine Particle Sampler; designated 4/16/98.
- Rupprecht & Patashnick Partisol® Model 2000 Audit Sampler; designated 4/19/99.

The $PM_{2.5}$ federal equivalent methods (FEM) vary from this basic FRM definition and are divided into three categories, Class I, II, and III. Definitions for each of these are provided in 40 CFR §53.1, published as a final rule in the Federal Register on July 18, 1997. The three classes of equivalent methods are used to describe the degree of variation between each equivalent $PM_{2.5}$ method and the $PM_{2.5}$ FRM design. There are no designated equivalent $PM_{2.5}$ methods at this time, nor have any manufacturers formally pursued this type of designation.

It is important to emphasize that all $PM_{2.5}$ sampling sites that provide data for comparison to either the 24-hour or the annual $PM_{2.5}$ NAAQS for the purposes of addressing attainment and nonattainment decisions must employ designated FRM/FEM sampling techniques.

Continuous sampling. The 40 CFR 58, Appendix D, §2.8.2.3 regulation requires that a continuous sampler be placed in each of the nation's 52 largest metropolitan areas or cities. At present, State and local agencies are operating approximately 115 continuous monitoring sites, and this number is expected to increase to approximately 200 by the end of 2000. Continuous $PM_{2.5}$ data will provide useful data for public reporting of short-term concentrations, for understanding diurnal and episodic behavior of fine particles, and for use by health scientists investigating exposure patterns.

State and local agencies have reported that they are using the TEOM method at a majority of these sites. Other methods to be used include beta gauge (BAM) monitors, nephelometers, and the CAMMS. EPA has established a continuous monitoring work group with the State and local agencies which has been a useful forum for discussing measurement approaches for continuous monitoring, quality assurance and control issues, and related topics.

Chemical speciation sampling and analysis. A large part of EPA's efforts to finish the $PM_{2.5}$ network deployment is focused on the deployment of the chemical speciation sites. This program element has received and will continue to receive a great deal of attention. Beginning in early 1999, the General Accounting Office, under direction from the Congress, conducted an audit of EPA's actions to address the National Academy of Sciences' report mentioned previously. This audit was completed in August 1999, and the GAO's only recommendation read: "We recommend that the Administrator, Environmental Protection Agency, ensure that all remaining monitors planned for the $PM_{2.5}$ network undergo and successfully pass full laboratory and full field testing and evaluation under actual operating conditions to ensure that the monitors meet data quality objectives before large-scale deployment of these monitors is authorized." The GAO report describes "full field testing" as "an evaluation of the monitor under actual field conditions where temperature, humidity, and other factors, such as season of the year, are not simulated," and the "remaining monitors" include the chemical speciation samplers. The EPA agreed that the remaining monitors planned for the $PM_{2.5}$ network should undergo and successfully pass the full laboratory and full field testing evaluation, and we have taken steps to ensure that this work is completed.

The U.S.EPA recognizes that the $PM_{2.5}$ network will be the major source of information for developing emission mitigation strategies and for tracking the success of implemented control programs. The basic objective of the chemical speciation analysis is to develop seasonal and annual chemical characterizations of ambient aerosols across the nation. These chemically resolved data will be used to perform source attribution analyses, evaluate emission inventories and air quality models, and support health related research studies and regional haze assessments. Note that comparisons of air quality model predictions and mass measurements alone provide unsatisfactory tests of model behavior and are complicated further by the inherent uncertainties in mass measurements due to sampling artifacts. Speciated data provide a wealth of information (as opposed to mass concentrations alone) that potentially can uncover model flaws and lead to greater confidence in model predictions. Development of this program element is being made in consultation with State and local agency representatives and the scientific/research community and in consideration for national scientific programs such as the Inner City Asthma Study and the Supersites programs.

The previously mentioned NAS report and all related recommendations from the speciation expert panel, and the GAO report have changed the implementation of the speciation program in the following ways:

- The 54 trends sites will sample every third day. EPA, in conjunction with an external group of experts (expert panel), developed data quality objectives for the trends network which indicated a benefit in moving from an every sixth day schedule to an every third day schedule.
- Ten of the 54 trends sites will be designated as "daily sampling" sites. The every third day sampling schedule at these sites will be complimented by a combination of additional integrated and/or semi-continuous sampling methods.
- The full deployment of the speciation program will extend into the 4th quarter of 2001 in order to increase the field testing and assessment of emerging sampling techniques.

The current commercially available sampler designs for the chemical speciation network are largely filter-based methods which use a combination of Teflon®, nylon, and quartz filters to capture the various constituents of most interest including elements, elemental and organic carbon, and major ions including nitrate, sulfate, chloride, and ammonium. However, technology in this area is expected to change and continuous chemical speciation methods are expected to be available in the future. EPA expects that the Supersite program will provide a useful interface to transition new speciation sampling technologies into routine applications.

The EPA is developing laboratory standard operating procedures (SOPs) that will be consistent with techniques used by various agencies and research groups currently operating ambient air particulate matter speciation programs. Sampling for speciation purposes is a developing science, and as such, the U.S.EPA encourages creative approaches to speciation measurements. Retaining flexibility by not prescribing speciation sampling methods should be interpreted as a technology driver. Of course, the penalty for flexibility is some degree of data uncertainty stemming from different methods. The greatest uncertainty of the speciation sampling and analysis program exists in the laboratory protocols; therefore, the EPA is requiring greater standardization for the laboratory analysis component. The EPA has established a national laboratory analysis contract to support the chemical speciation program, and feedback from State and local monitoring agencies indicates that nearly all chemical speciation sampling programs will use this laboratory. All trends sites will use the national contract for filter analyses. The single exception to this is the Interagency Monitoring of Protected Visual Environments (IMPROVE) program, which has its own centralized laboratory.

The speciation program has been funded at a level to accommodate approximately 300 sites at the various sampling frequencies previously mentioned. This total of 300 sites reflects a planning estimate. Fifty-four speciation sites are required by 40 CFR 58, Appendix D, §2.8.1.5 regulation, and will serve as speciation trends sites. These 54 sites will be located in high population areas and in areas with emissions of interest such as the existing Photochemical Assessment Monitoring Stations (PAMS) #2 sites or at other sites with collocated FRM/FEM samplers. Additionally, approximately 40 sites will be used to coordinate the States' speciation programs with those of the Supersites. The balance between the 54 trends sites with the 40 Supersites support sites, and 300 planned sites reflects the need to tailor certain sites to area-specific needs. For example, some areas may choose to focus on episodes or specific seasons, such as winter time wood smoke. States will have some flexibility with these supplemental sites to design their speciation networks appropriately, for example, to operate fewer sites on more frequent schedules than an every sixth day schedule, or to adopt seasonal sampling regimes during periods of high particulate loadings. It is possible, and even likely, that some of these activities will be more resource intensive, particularly if additional types of analyses are needed or if advanced methods are used. These things will need to be taken into account in funding the program, and as necessary and technically warranted, they will impact the total number of supplemental (i.e., non-trends) speciation sites that will be installed. Alternative speciation approaches will be considered on a case-by-case basis through negotiation with appropriate EPA Regional Offices and the Office of Air Quality Planning and Standards (OAQPS).

Because data from the chemical speciation sites is of interest to the scientific community, the U.S.EPA encourages State and local agencies to develop their chemical speciation networks in consultation with local and national researchers who are conducting health effects studies. Funding to increase sampling frequencies at selected sites near Supersite study areas, and for a limited amount of daily speciation sampling is being provided through the State and local agency grant program.

Supersites (referred to as the "Special chemical speciation studies" in the March 1998 Implementation Plan). The primary objectives of the Supersites are to support SIP development activities, to provide information to support health effects studies and the reviews of the particulate matter NAAQS, and to assist in the testing of advanced sampling methods. The more "routine" chemical speciation program described above is a critical tool that will support both of these activities; however, they may need to be supplemented by more intensive data collection activities in order to better understand region-specific air pollution processes and to improve on the subsequent SIP development process. Assessments of technical tools such as source attribution techniques, emission inventories, or air quality models which predict over continuous time and space frames benefit from monitoring that has increased spatial, temporal, and chemical composition resolution. Historically, regulatory air programs have been criticized for not more fully utilizing special intensive studies to test the technical tools used for planning. To address these concerns, the U.S.EPA has established the Supersites which is dedicated to conducting specialized monitoring to address some of the rigorous demands involved in air quality assessments. The Supersite awards were announced in January 2000 and they include the following projects:

- Atlanta. Advanced methods evaluation leveraged with multiple air quality and related studies. Monitoring was conducted during the Summer 1999.
- Fresno. Methods evaluation with transition to routine networks leveraged with a major air quality study (CRPAQS) and several potential health related studies. Monitoring began in the Summer 1999 and will continue to Spring 2001 as the "CA Supersite Phase II". The Principal Investigator is John Watson, Desert Research Institute.
- Houston. David Allen, University of Texas at Austin, "Gulf Coast Aerosol Research & Characterization Program."
- St. Louis. Jay Turner, Washington University, "St. Louis - Midwest Supersite."
- Los Angeles. John Froines, University of California Consortium, "Southern California Particulate Matter Supersite."
- Baltimore. John Ondov, University of Maryland, "Baltimore Supersite: Highly Time & Size Resolved Concentrations of Urban $PM_{2.5}$ & its Constituents for Resolution of Sources & Immune Responses."
- Pittsburgh. Spyros Pandis, Carnegie Mellon University, "The Pittsburgh PM Supersite: A Multidisciplinary Consortium for Atmospheric Aerosols Research."
- New York City. Ken Demerjian, ASRC, State University of New York "$PM_{2.5}$ Technology Assessment & Characterization Study in New York."

The sampling and analysis may result in diurnal profiles of size-resolved and chemically speciated aerosols. In addition, secondary aerosol precursor and intermediate species such as nitric acid, ammonia, nitrogen dioxide and other NO_y constituents, peroxides and peroxy radicals could be measured to provide challenging tests of chemical mechanisms within air quality models. These measurements offer the peripheral advantage of supporting ozone and deposition assessments as well, since many of the physical and chemical processes operate across several pollutant categories.

Additional Supersites activities include enhancing some of the existing field studies, supporting existing programs, epidemiological and other health studies, and developing focused approaches on unique problem areas. The Supersites are being coordinated with ongoing national and regional activities in order to take full advantage of these efforts and available funding.

Funding for the Supersites is provided by EPA's Science and Technology (S&T) funds rather than §103 grant funds as for other program elements. The total funding package includes $20 million provided through the OAQPS, and $ million provided through the ORD.

IMPROVE Monitoring. There are a variety of strong technical connections between visibility and fine aerosols monitoring that support a comprehensive monitoring program that services both $PM_{2.5}$ and visibility assessments. The new $PM_{2.5}$ monitoring regulations encourage the placement of $PM_{2.5}$ monitors outside of population centers to facilitate implementation of the $PM_{2.5}$ NAAQS and to augment the existing visibility fine particle monitoring network. The coordination of these two monitoring objectives will facilitate implementation of a regional haze program and lead to an integrated monitoring program for fine particles. The 40 CFR 51 Regional Haze Regulation, published in the ***Federal Register*** on April 22, 1999, includes visibility monitoring requirements (www.epa.gov/oar/vis). This proposed haze regulation makes monitoring data representative of class I areas important to the State and local agencies since they are the basis for determining whether additional emission reductions would be needed to meet visibility targets.

The IMPROVE Network is operated by a Steering Committee that includes representatives of EPA, National Oceanic and Atmospheric Administration (NOAA), and the federal land managers (FLM) who are responsible for preserving and improving air quality over the lands in their charge (National Park Service, Forest Service, Fish and Wildlife Service and Bureau of Land Management). The IMPROVE Steering Committee also includes representatives from three state-based organizations (State and Territorial Air Pollution Program Administrators (STAPPA), Western States Air Resource Council (WESTAR), and Northeast States for Coordinated Air Use Management (NESCAUM)) in recognition of the States' interest in this program. Funding for basic IMPROVE network comes from the §105 funding, and resources to cover the IMPROVE expansion has been available through the §103 $PM_{2.5}$ grant budget. The IMPROVE Steering Committee has worked closely with the States to design the expanded IMPROVE network of 110 sites. Additionally, there are several State and tribal air monitoring agencies that have decided to purchase, install, and operate 11 additional IMPROVE type sites as part of their chemical speciation network in rural areas. We expect that the IMPROVE network expansion will be completed in 2000.

Quality Assurance and Data Assessment. The quality assurance (QA) program strives to ensure that the network produces $PM_{2.5}$ data of the quality necessary to support the objectives of the program. The quality assurance program covers many areas:

1. Establishment of data quality objectives that will ensure the usability and defensibility of

the $PM_{2.5}$ data in regulatory actions. At this time, EPA has started an evaluation of the $PM_{2.5}$ air quality data to determine if the monitoring system's performance meets these objectives. We intend to provide a report on the 1999 initial data in August/September 2000.

2. Development and implementation of a program for designating federal $PM_{2.5}$ reference and equivalent methods, ensuring that each type of monitoring instrument will operate within similar bias and precision limits.

3. Development of standardized operating procedures for field, sample handling, and laboratory activities, to ensure data comparability. This effort has been completed.

4. Requirements for a broad range of standardized quality control activities to evaluate and control measurement uncertainties or errors, including a template for State and local agencies to use to validate $PM_{2.5}$ data. This effort has also been completed.

5. Collocation of samplers to quantify measurement precision. As noted earlier, EPA will include information on the monitoring network's precision in a report on the 1999 initial data in August/September 2000.

6. Performance of a federally implemented independent FRM performance evaluation program (PEP) to quantify system bias. EPA will include information on the monitoring network's bias and PEP results in a report on the 1999 initial data in August/September 2000.

7. Implementation of qualitative assessments at the local and Federal level to ensure the proper development and operation of the quality assurance program. This includes, for examples, technical systems audits and management system reviews.

8. Development and implementation of a data analysis plan for the currently operating 13 minitrends chemical speciation sampler intercomparison, and other speciation sampler intercomparisons as necessary (e.g., using advanced methods, comparisons between the IMPROVE and trends samplers.)

9. Work with the continuous monitoring work group to provide State and local agencies with approaches for correlating continuous measurements to FRM air quality data for use in Air Quality Index (AQI) reporting. AQI reporting is required for cities over 350,000 in population, as listed in 40 CFR 58, Appendix G.

10. Provide continuing technical support and evaluation including activities such as the OAQPS operated monitoring platform used to evaluate methods and measurement

approaches.

B. Implementing the Program: Milestones, Mechanisms, Training, and Resources

Schedules and Milestones. Table 2 provides an update to the original listing of the major actions, training, and milestones for the implementation of the $PM_{2.5}$ monitoring network. This list includes only the major milestones.

Table 2. $PM_{2.5}$ Monitoring Implementation Schedule.

ACTION	MILESTONE
40 CFR 50, 53, and 58 $PM_{2.5}$ regulation	July 18, 1997 Part 58 available on AMTIC* Parts 50 and 53 available on TTN Airlinks (http://www.epa.gov/ttn) Subsequent correction notice on 2/17/98;
States & Regions develop & approve network designs	September 1997 - June 30, 1998 Review & approval on July 1 of each year.
States establish 1,050 $PM_{2.5}$ sites	September 1997 - December 31, 1999
"Guidance for Network Design & Optimum Site Exposure for PM"	December 15, 1997 - Available on AMTIC under Network Design*
Award for national procurement contract to buy 46.2mm Teflon® filters for use in FRMs.	January 31, 1998
"Summary of Guidance: Filter Conditioning & Weighing Facilities & Procedures for $PM_{2.5}$ Reference and Class I Equivalent Methods"	February 27, 1998
"Particulate Matter ($PM_{2.5}$) Speciation Guidance (Draft to work group for review on February 25, 1998)	February 25, 1998 - 1st draft July 1998 - Recommendations from Expert Panel October 7, 1999 - Final
Model QA Project Plan Guidance Document	March 6, 1998 (final draft) March 31, 1998 final version signed by each Region
U.S.EPA awards nat'l $PM_{2.5}$ sampler proc. contract & makes first orders (info on # and type of samplers must be compiled by Regions and to OAQPS by March 2, 1998.)	March 25, 1998 contract award April 1998 first set of FRM orders June 1998 second set of FRM orders
FRM/FEM designations granted (Specific samplers and vendors listed here. This is a continuing process, however, and other samplers may go through with designation in the future.)	BGI single channel & portable 4/16/98 R&P single channel & sequentials 4/16/98 Andersen single channel & sequentials 6/11/98 Thermo Env. Instr. single channel 10/29/98 Andersen portable audit 3/11/99 R&P portable audit 4/19/99

QA Handbook (Red Book) with final Method 2.12 "Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods."	May 14, 1998 Final June 2000 - Next revision–to incorporate info learned from 1st year.
U.S.EPA/NARSTO Workshop on the Supersites program design with scientific community.	May 19, 1998 Steering Committee mtg. June 11, 1998 Workshop
U.S.EPA/AWMA Training on $PM_{2.5}$ Laboratory and Sampling Equipment	May 20-21, 1998 in RTP, NC
Vendors deliver first orders for FRM samplers to States	June 1, 1998 - November 3, 1998
"Guidance for Using Continuous Monitors in $PM_{2.5}$ Monitoring Networks"	June 5, 1998
FRM Performance Evaluation Program QA Project Plan	June 1998
States submit final 1998 $PM_{2.5}$ network descriptions to Regions	July 1, 1998
Regions approve final $PM_{2.5}$ network descriptions	July 31, 1998
FRM Performance Evaluation Program Implementation Plan	August 28, 1998
FY99 §103 grant guidance to Regions from OAR (Draft in March)	October 23, 1998 (Final)
Portable QA FRM audit samplers delivered to PEP Auditors	October 30, 1998
FRM Performance Evaluation Program Standard Operating Procedures	November 2, 1998
"Field Program Plan for the $PM_{2.5}$ Chemical Speciation Sampler Evaluation Study"	November 23, 1998
Speciation laboratory analysis contract award	December 1998
Development of the Data Quality Objectives (DQOs) for the 54 Trends Sites	December 16, 1998
Quality assurance project plans approved by Regions	December 31, 1998 - December 31, 1999
Supersites research public solicitation	March 9, 1999
$PM_{2.5}$ Data Validation Template for use with mass data.	April 6, 1999
Strategic Plan for Development of the Particulate Matter ($PM_{2.5}$) Quality System for the Chemical Speciation Monitoring Trends Sites"	May 19, 1999
"Visibility Monitoring Guidance" EPA-454/R-99-003	June 1999
States submit final 1999 $PM_{2.5}$ network descriptions to Regions	July 1, 1999
Atlanta Supersite data collection activities	Summer 1999
Fresno Supersite data collection activities, Phase 1 & 2	Summer 1999 to Spring 2001
"Quality Assurance Project Plan: $PM_{2.5}$ Speciation Trends Network"	October 27, 1999 (3rd Draft)

Deployment of initial chemical speciation sites ("mini-trends")	November 1999 (Equipment delivery & training) February 2000 (1st data collection) May 2000 (study completion)
1,050 $PM_{2.5}$ FRM sites are established + all required continuous monitoring sites & States begin "routine" data collection.	December 31, 1999
Supersites award announcement at the PM2000 Conference in Charleston, SC	January 25, 2000 Sampling to begin in 2000-2001.
Chemical Speciation Program Satellite Broadcast	March 21, 2000
$PM_{2.5}$ Monitoring, Quality Assurance & Data Analysis Workshop (targets State, local and tribal monitoring agencies)	May 22-25, 2000 in RTP
States submit 2000 $PM_{2.5}$ network descriptions to Regions, which includes chemical speciation sites.	July 1, 2000
Deployment of all chemical speciation trends sites (54 total including 10 daily sites), and speciation sites used to support Supersites activities (~40).	December 31, 2000
Deployment of supplemental chemical speciation sites (~200).	October 2000 - October 2001

For $PM_{2.5}$ information on the Ambient Monitoring Technology Information Center (AMTIC), see http://www.epa.gov/ttn/amtic/amticpm.html

Major National Procurements. The U.S.EPA developed national procurement contracts for elements of the program that benefit from centralized (or regional) coordination. The benefits from these including a net reduction in administrative burden, the advantage of economies of scale, consistency in services/products supplied, and the increased ability to account for expenditure of State Grant funds. National procurement vehicles include:

1. Multi-vendor, 5-year, National $PM_{2.5}$ Sampler Procurement Contract for the purchase of samplers including FRM/FEM (both single channel and sequential varieties), speciation samplers, and portable FRM audit samplers, and associated accessories for each. The Request for Proposals was published on October 29, 1997, the vendor pre-proposal conference was held on November 6, 1997, and contract award was made on March 25, 1998.

2. National 5-year contract for purchasing the 46.2 mm Teflon® filters used for the $PM_{2.5}$ FRM/FEM; and a national purchasing vehicle for the 37 mm Teflon® filters used for dichotomous samplers.

3. Field and laboratory support for national FRM Performance Evaluation Program; awarded and operational by January 1, 1999.

4. Laboratory services for chemical speciation filter analyses, awarded to Research Triangle Institute.

These procurement efforts are a service provided by the U.S.EPA, and although State/local agency participation is not mandatory, we have experienced an extremely high level of participation in these efforts.

Resources and Grant Allocations. Funds to support the complete deployment and operation of the $PM_{2.5}$ network were provided under authority of the Clean Air Act §103 in FY-98 ($35.6 million), FY-99 ($50.7 million), and FY-00 ($42.5 million). Since several aspects of the monitoring program involve national procurement, substantial levels of Grant funds have been withheld to meet these expenditures (~20-25%). Categories subject to grant withholding include funding for samplers purchased from the National $PM_{2.5}$ Sampler Procurement Contract (FRM/FEM, portable FRM audit samplers, and speciation samplers), filters, chemical speciation analyses, IMPROVE samplers, and national FRM performance evaluation program costs.

The FY-00 budget of $42.5 million is the level of funding that will be needed to fund the State and local agency operated portions of the $PM_{2.5}$ network as it is currently designed.

Training. The implementation of the $PM_{2.5}$ ambient monitoring program has required a significant amount of training in a number of diverse subjects. This training has been arranged by EPA (as listed in the milestone table), by the equipment manufacturers, and by State and local air quality monitoring agencies. The U.S.EPA's training program focuses on four areas: $PM_{2.5}$ network design, sampler operations, laboratory procedures, and quality assurance/quality control for field and laboratory activities. The U.S.EPA is using a number of mechanisms for both formal and informal training with stakeholders in the $PM_{2.5}$ monitoring program. A listing of these mechanisms follows:

- **Workshops** - The Regional offices have hosted workshops for their States on several occasions, and the OAQPS has hosted one workshop for all States in May 1998. OAQPS will host another $PM_{2.5}$ Monitoring, Quality Assurance, and Data Analysis Workshop on May 22-25, 2000 in Research Triangle Park, NC.
- **Satellite Training** - Satellite training workshops have been used to provide an initial overview for managers and a technical program for monitoring and laboratory technicians with an interactive component. These productions are available on video tape for later viewing.
- **Technical Assistance** - U.S.EPA is providing expert assistance from OAR, the Regional Offices and the Office of Research and Development (ORD) scientists and engineers in the design and implementation of specific $PM_{2.5}$ monitoring networks.
- **Courses** - The U.S.EPA is revising its existing Air Pollution Training Institute (APTI) courses to incorporate $PM_{2.5}$ monitoring information. Courses will take the form of on-

site training, satellite broadcasts, or self-instructional courses.

- **Guidance Manuals**
- **Web Site** - Technical information pertaining to $PM_{2.5}$ monitoring is posted on the AMTIC, URL address http://www.epa.gov/ttn/amtic/amticpm.html. A public forum area is also available on this page which allows users to submit questions on the $PM_{2.5}$ monitoring program directly to U.S.EPA contacts on these subjects.

C. **Options for a Revised Coarse Particle NAAQS**

On May 14, 1999, the U.S. Court of Appeals for the District of Columbia Circuit issued an opinion in response to challenges to the NAAQS filed by industry and others (American Trucking Association v. U.S.EPA) that vacated the revised coarse particle (PM_{10}) NAAQS. (The 1987 PM_{10} NAAQS is still in place.) While the Court did find "ample support" for EPA's decision to regulate coarse particulate pollution, they did find that PM_{10} is "a poorly matched indicator for coarse particulate pollution" because PM_{10} contains fine particles.

EPA is now investigating the possibility of using a coarse particle indicator (PM_c) instead of the PM_{10} indicator in the currently applicable NAAQS. This coarse particle indicator would be defined as PM_{10} - $PM_{2.5}$. The measurement approach would be to determine PM_c through taking the difference between concurrent, collocated measurements of PM_{10} and $PM_{2.5}$ (24 hour integrated measurements).

Our current thinking suggests that the $PM_{2.5}$ measurement would be as currently specified in 40 CFR Parts 50, 53, and 58, with the possible exception that specified-color filters and/or filter cassettes may be required to clearly distinguish between the PM_{10} and $PM_{2.5}$ samples. The PM_{10} measurement would also be as currently specified for $PM_{2.5}$ measurements in 40 CFR Parts 50, 53, and 58, with the following exceptions:

- The WINS shall be replaced by a straight tube (explicitly specified by drawing) [or by a "PM_{12}" WINS or modified inlet impactor to be developed (and explicitly specified by design), pending the results of inlet bounce tests to begin shortly].

- Specified-color filters and/or filter cassettes may be required to clearly distinguish between PM_{10} and $PM_{2.5}$ samples.

- PM_{10} samplers used for PM_c measurements must be clearly differentiated from PM_{10} samplers currently designated as meeting the original Appendix J or M PM_{10} requirements. This could result in two "classes" of PM_{10} samplers.

For both the $PM_{2.5}$ and PM_{10} measurements, EPA would expect to specify parameters such as the proximity (minimum and maximum separation and differential inlet height) of $PM_{2.5}$ and associated PM_{10} samplers; possibly the sampler data output string so that uniformity among all samplers and compatibility with AIRS is achieved; and the filter weighing, operational protocol, and quality assurance procedures for both PM_{10} and $PM_{2.5}$ to be matched. EPA would need to consider whether new performance and test requirements for sequential samplers may be necessary as well. Current thinking regarding the federal equivalent methods (FEMs) for PM_c includes various classes of equivalent methods such as:

Class I - same definition as for Class I $PM_{2.5}$ FEMs (i.e. minor deviations from PM_c FRM requirements).

Class II - similar definition as for Class II $PM_{2.5}$ FEMs (filter based, $PM_{10}/PM_{2.5}$ differential method having non-minor deviations from PM_c FRM requirements) with both PM_{10} and $PM_{2.5}$ measurement techniques to be closely matched as to design and operation.

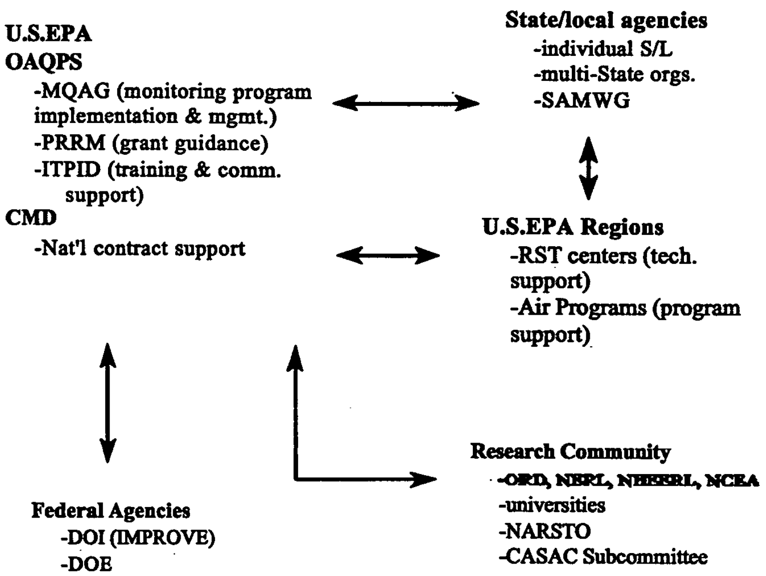
Class III - any candidate FEM not meeting Class I or Class II definition.

Obviously, significant effort will be necessary through the coming months in this area.

D. Communications

The roles and responsibilities described in the March 1998 Implementation Plan have not changed significantly over the course of the last 2 years, with the exception of how involved the scientific community has become. This is particularly true with regard to the chemical speciation program design and the Supersites program. The program has benefitted greatly from the expertise of external experts, and we intend to maintain this communication system. As presented in March 1998, Figure 1 provides an overview of the principal communications pathways.

Figure 1. Overview of Principal Communication Lines.



Common Acronyms

AIRS - Aerometric Information Retrieval System (maintained by the U.S.EPA)

ALAPCO - Association of Local Air Pollution Control Officials

AMTIC - Ambient Monitoring Technology Information Center, from U.S.EPA Internet site at http://www.epa.gov/ttn/amtic. Particulate matter information is available at http://www.epa.gov/ttn/amtic/amticpm.html.

APDLN - Air Pollution Distance Learning Network, U.S.EPA

APTI - Air Pollution Training Institute, U.S.EPA

AWMA - Air and Waste Management Association

CAA - Clean Air Act

CASAC - Clean Air Scientific Advisory Committee

CFR - Code of Federal Regulations

CMD - Contracts Management Division (within the Office of Acquisition Management, U.S.EPA)

CMZ - Community monitoring zone

CORE - Community-oriented monitoring

DOI - U.S. Department of Interior

DOPO - Delivery order project officer(s)

DQA - Data quality assessment

DQO - Data quality objectives

EORG - Education and Outreach Group, Information Transfer and Program Integration Division, Office of Air Quality Planning and Standards, U.S.EPA

FACA - Federal Advisory Committee Act

FLM - Federal land manager

FRM/FEM - Federal Reference Method/Federal Equivalent Method as approved by U.S.EPA

GPRA - Government Performance and Results Act

IMPROVE - Interagency Monitoring of Protected Visual Environments

ITPID - Information Transfer and Program Integration Division (within U.S.EPA OAQPS)

MARAMA - Mid-Atlantic Regional Air Managers Association

MQAG - Monitoring and Quality Assurance Group (within Emissions, Monitoring & Analysis Division of the Office of Air Quality Planning and Standards, U.S.EPA)

MSR - Management Systems Review

NAAQS - National Ambient Air Quality Standard

NARSTO - North American Research Strategy for Tropospheric Ozone

NAMS - National Air Monitoring Station(s)

NCEA - National Center for Environmental Assessment, U.S.EPA

NERL - National Exposure Research Laboratory (within the Office of Research and Development, U.S.EPA)

NESCAUM - Northeast States for Coordinated Air Use Management

NHEERL - National Health and Environmental Effects Laboratory, U.S.EPA

NOAA - National Oceanic and Atmospheric Administration

NPAP - National Performance Audit Program

NPS - National Park Service, U.S. Department of Interior

OAQPS - Office of Air Quality Planning and Standards, Office of Air and Radiation, U.S.EPA

OAR - Office of Air and Radiation

OPMO - Office of Program Management Operations, Office of Air and Radiation, U.S.EPA

ORD - Office of Research and Development, U.S.EPA

PAMS - Photochemical Assessment Monitoring Station

PM - Particulate matter, also further described for fine particles ($PM_{2.5}$), PM_{10}, and coarse particles (PM_c).

PRRMS - Planning, Resources, and Regional Management Staff (within U.S.EPA OAQPS)

PTFE - polytetrafluoroethylene

QA - Quality assurance

QAPP - Quality assurance project plan

RO - U.S.EPA Regional Office

RST - Regional Science and Technology laboratories/centers, U.S.EPA Regional Offices

RTP - Research Triangle Park, North Carolina

SAMWG - Standing Air Monitoring Work Group

SIP - State implementation plan

SLAMS - State or Local Air Monitoring Station(s)

SOP - Standard operating procedure

SPM - Special purpose monitor

STAPPA - State and Territorial Air Pollution Program Administrators

TSA - Technical systems audit

XRF - X-ray fluorescence

WESTAR - Western States Air Resources Council

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Environmental Technology Verification Program

Advanced Monitoring Systems Pilot

Test/QA Plan for Verification of Ambient Fine Particle Monitors

ETV ETV ETV

TEST/QA PLAN

FOR

VERIFICATION OF AMBIENT FINE PARTICLE MONITORS

June 14, 2000

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ACRONYMS

AMS - Advanced Monitoring Systems

APNM - Ambient Particulate Nitrate Monitor

APSM - Ambient Particulate Sulfate Monitor

ARB - Air Resources Board (same as CARB)

BAM - Beta attenuation monitor

CAC - Correlated acceptable continuous

CAMM - Continuous Ambient Mass Monitor

CARB - California Air Resources Board (same as ARB)

CRPAQS - California Regional Particulate Air Quality Study

DOE - United States Department of Energy

DRI - Desert Research Institute

EC - Elemental carbon

ELPI - Electrical low pressure impactor

EPA - United States Environmental Protection Agency

ETV - Environmental Technology Verification

FEM - Federal equivalent method

FRM - Federal reference method

NAAQS - National Ambient Air Quality Standard

NAMS - National Air Monitoring Station

NETL - National Energy Technology Laboratory

OC - Organic carbon

PAMS - Photochemical Assessment Measurements Station

PM - Particulate matter

$PM_{2.5}$ - Particulate matter with an aerodynamic diameter less than 2.5 μm

PM_{10} - Particulate matter with an aerodynamic diameter less than 10 μm

QA - Quality assurance

QC - Quality control

QMP - Quality management plan

SJVUAPCD - San Joaquin Valley Unified Air Pollution Control District

SOP - Standard operating procedure

TEOM™ - Tapered Element Oscillating Microbalance

TOR - Thermal optical reflectance

UORVP - Upper Ohio River Valley Project

WINS - Well-Impactor Ninety Six

1. INTRODUCTION

1.1. Background

1.1.1 ETV

This test/QA plan provides detailed procedures for a verification test of monitors that continuously indicate the mass or chemical composition of fine particulate matter in ambient air. The verification test will be conducted under the auspices of the U.S. Environmental Protection Agency (EPA) through the Environmental Technology Verification (ETV) program. The purpose of ETV is to provide objective and quality assured performance data on environmental technologies, so that users, developers, regulators, and consultants can make informed decisions about these technologies. ETV verification does not imply approval, certification, or designation by EPA, but rather provides a quantitative assessment of the performance of a technology under the specified test conditions.

The verification test will be coordinated by Battelle, of Columbus, Ohio, which is managing the ETV Advanced Monitoring Systems (AMS) pilot through a cooperative agreement with EPA (CR 826215-01-1). The scope of the AMS pilot covers verification of monitoring technologies for contaminants and natural species in air, water, and soil. In performing the verification test, Battelle will follow the procedures specified in this test/QA plan, and will comply with the data quality requirements in the "Quality Management Plan for the ETV Advanced Monitoring Systems Pilot" (QMP).[1]

1.1.2 Fine Particulate Monitoring

The EPA promulgated changes to the National Ambient Air Quality Standard (NAAQS) for particulate matter (PM) in 1997.[2] Those changes call for revision of the existing PM_{10} standard and the addition of a new standard for $PM_{2.5}$. The revised standard also calls for the use of "correlated acceptable continuous" (CAC) monitors to supplement $PM_{2.5}$ sampling at community oriented (CORE) monitoring sites in large metropolitan areas. Additionally, a need to determine the chemical components of particulate matter has been identified,[3] and consequently, a network of speciation monitoring sites has been initiated.[4] As a result of these needs there has been substantial effort in the development of methods for PM monitoring.

Methods used for measurement of PM mass and chemical composition include both manual, filter-based methods, requiring sampling and subsequent laboratory analysis, and continuous or automated methods which provide results in real time or nearly real time.[5] Manual sampling methods are well established, and several commercial devices for such sampling have received Federal Reference Method (FRM) or Federal Equivalent Method (FEM) designation,[6] and are currently in widespread use for PM_{10} and $PM_{2.5}$ monitoring. However, these filter-based methods suffer from a number of limitations including relatively poor time resolution (i.e., typically 24 hour), and the fact that they are rather labor intensive and typically require a number of activities to obtain a single result. As a result of these limitations, data from time-integrated filter-based methods are not suitable for some valuable non-compliance purposes, such as assessing short-term variability in PM, tracking source contributions, and monitoring human exposures. Furthermore, an additional limitation of these methods is the potential for the introduction of error, by improper handling, or the loss of volatile PM components.

In contrast, the primary advantages of continuous or automated monitors lie in their ability to continuously and rapidly assess particulate matter levels or composition with relatively little operator effort. The collection of real-time data of this type without the labor constraints imposed by the manual methods makes continuous monitors invaluable tools for some particulate matter monitoring applications. Indeed, many of these monitors have already been used for research purposes when rapid time response is needed in PM monitoring. However, only a few continuous monitors have received FEM designation status for PM_{10} monitoring, and none has received that status for $PM_{2.5}$ monitoring. This, along with a lack of independent verification data for these monitors, has limited their credibility and acceptance. Consequently, they are not yet widely used, despite considerable interest within the air monitoring and research communities. The aim of this verification test is to provide potential purchasers, users, and regulators of these monitors with quality assured performance data, with which informed decisions can be made about these monitors.

1.2. Test Objective

The purpose of this verification test is to evaluate the performance of a number of commercially available continuous, or semi-continuous monitors[a] of ambient fine particulate matter under realistic operating conditions. The performance of these monitors will be evaluated primarily by comparisons with specific reference methods to determine their ability to predict the results of those reference methods.

Specific objectives of the verification test for these monitors include:

- To assess the degree of agreement between these continuous technologies and time-integrated reference methods when possible, or the degree to which the technologies being verified can predict the results of the reference methods,
- To determine the intra-method precision of these continuous monitors by comparing simultaneous results from duplicate monitors,
- To evaluate the effects of meteorological conditions on the performance of the continuous monitors,

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[a]For the purpose of clarity, technologies capable of monitoring ambient levels or composition of particulate matter either continuously or semi-continuously will be referred to as "continuous" monitors throughout this test/QA plan.

- To determine the influence of ambient precursor gases on the instrumental response of the monitors being verified,
- To investigate the capabilities of these technologies to monitor short term changes in ambient particulate matter, through comparisons to reference method samples collected over various sampling durations,
- To evaluate the reliability and general ease-of-use of these technologies over the course of the testing period.

To address these objectives, verification of these monitors will involve field testing in two separate phases. The degree to which the results from these monitors agree with those of the reference methods, or can be used to predict the results of the reference methods, will be established based on statistical comparisons of the results from each phase. Similarly, statistical comparisons of the results from duplicate monitors will be used to assess the intra-method precision for these continuous methods. The two separate phases will be conducted in different geographic locations, and during different seasons to assess the effects of temperature, humidity, particulate matter concentration, and chemical composition on the performance of the monitors being verified. In addition, this verification test will report on other operational characteristics including the reliability, necessary maintenance, and ease of operation of these monitors. Verification results from this test will also summarize additional information which may be relevant to potential users, including power and shelter requirements, data output, and the overall cost of these monitors.

The results from these performance evaluations will be made publically available with the goal of providing credible information to potential purchasers, regulators, and permitters of these technologies. **Note:** Verification of these technologies under ETV is a quantitative evaluation of the performance of the monitors based on the techniques and procedures described in this test/QA plan. This test is not meant to be, and should not be construed as, an alternate for any form of the Federal Reference or Equivalency designation which is required for $PM_{2.5}$ or PM_{10}

compliance reporting purposes. Verification does not imply acceptance, certification, or endorsement, by EPA.

1.3. Test Applicability

This test/QA plan is applicable to the verification testing of ambient fine particulate matter monitors. The devices to be tested under this plan are capable of providing real-time, or nearly real-time, indications of the ambient level of fine particulate matter,[b] and do not require discrete manual steps for sample collection, preparation, and laboratory analysis. Although not necessarily designed to monitor the same physical quantity or property of ambient particulate matter, each of these devices can be useful for PM monitoring by providing rapid assessment of various properties of ambient fine particulate matter. In accordance with the intent of the ETV program, the monitors to be tested are commercially available, and not developmental products or prototypes.

2. Technology Description

The monitors to be tested under this test/QA plan are all continuous particulate matter monitoring instruments, however their designs and principles of operation cover a wide range of analytical capabilities. Nonetheless, they each exhibit a rapid, quantitative response to ambient particulate matter, and therefore, may be useful in ambient PM monitoring research applications. Based on the principle of operation of these monitors, each can be grouped into categories for measuring either (1) chemical composition, or (2) mass or "surrogate mass." The technologies

[b] For this test, fine particulate matter is defined as that fraction of particles with aerodynamic diameters below 2.5 µm ($PM_{2.5}$). This is a general definition and will be adopted for all monitors to be tested unless otherwise noted. Individual vendors may wish to adopt a different definition for their monitor, however, in all cases, the definition of fine particulate matter will be clearly indicated in each verification report resulting from this test.

that fall within the former category provide nearly continuous indication of some aspect of the chemical composition of ambient particulate matter. The technologies within the latter category are used to monitor mass, or what may be called "surrogate mass," in that they measure a physical property that should correlate with the mass of fine particulate matter present. That is to say, particle mass itself is not necessarily measured by these techniques, but they may provide valuable indicators of particle mass. A brief summary of some of the monitors in these general measurement categories is provided below. This list is not meant to be exhaustive and is representative of the monitors which can be verified under this test/QA plan. Descriptions of additional monitors may be added as needed and these monitors may also be verified under this test/QA plan. More complete descriptions of these technologies can be found in the EPA "Guidance for Using Continuous Monitors in $PM_{2.5}$ Monitoring Networks.[7]

2.1. Chemical Composition

Chemical composition monitors perform automated and repetitive procedures to determine some portion of the chemical composition of fine particles in nearly real time. The classes of particulate compounds for which there are continuous analyzers include carbonaceous material, both elemental and organic, and ionic species such as nitrate and sulfate.

Analysis of carbon-containing particulate matter can be used to quantify both the elemental carbon (EC) and organic carbon (OC) ambient concentrations. The thermal volatilization or conversion to carbon dioxide (CO_2), of these two classes of carbon particulate occurs at very different temperatures. Consequently, by heating particulate samples and monitoring the CO_2 generated at different temperatures, the EC and OC concentrations can be determined. Some carbon analyzing technologies, such as the Series 5400 Automated Carbon Particulate Monitor (ACPM, Rupprecht & Patashnick, Co., Inc.) include two sample collectors which can be used alternately for collection and analysis steps, thereby allowing continuous monitorir

In addition to total EC and OC concentrations, specific chemical classes of organic particulate can be measured in-situ. One such class of compounds is particulate-bound polycyclic aromatic hydrocarbons (PAHs). Measurement of PAHs is based on UV photoionization of the particulate PAH and subsequent measurement of the ionization current formed by the emitted electrons. Monitors of this type respond to the sum of all PAH compounds in the particle phase, and do not respond to vapor-phase PAH. EcoChem Analytics provides a commercial version of the PAH monitor, in the form of the PAS 2000 instrument. This monitor has also been used to monitor overall EC levels.

The concentration of ambient "elemental carbon" or "black carbon" particulate can be measured by light absorption using an aethalometer (Andersen Instruments). In these devices, light is passed through a filter, or a sample spot on a continuous tape, and detected. Particulate deposition on this filter results in the attenuation of the light in proportion to the loading of light absorbing particulate on the filter. Using appropriate conversion factors, the degree of light attenuation is converted to "black carbon" concentration.

Automated monitors have been developed to measure particulate nitrate or sulfate concentrations. These monitors use flash volatilization of a filter sample, entrainment of the evolved oxides in an inert carrier stream, and chemiluminescent or gas-phase fluorescent detection to determine particulate nitrate or sulfate concentrations, respectively. Examples of these monitors are the Series 8400N Ambient Particulate Nitrate Monitor (APNM, Rupprecht & Patashnick, Co., Inc.), and the Series 8400S Ambient Particulate Sulfate Monitor (APSM, Rupprecht & Patashnick, Co., Inc.).

2.2. Mass or Surrogate Mass

There are a variety of particle properties which can be related to, and ultimately can be used to predict, particle mass. A number of techniques have been developed to probe these physical properties.

The Tapered Element Oscillating Microbalance (TEOM®, Rupprecht & Patashnick, Co., Inc.), directly measures particulate matter mass in real time by drawing air through a hollow tapered element on which an exchangeable filter is mounted. The tapered element is mechanically oscillated and as particulate matter deposits on the filter, the frequency at which the tapered element oscillates changes. This change in the frequency of oscillation has a direct relationship to the mass of the deposited particulate matter. By "continuously" monitoring (once every two seconds) the oscillation frequency, the TEOM is able to obtain near real-time measurements of the deposited mass. These measurements can then be used to calculate an average mass over time periods ranging from 10 minutes to 24 hours. Mass flow controllers are used to maintain a constant air mass flow rate which, when adjusted for ambient temperature and pressure, remains within the appropriate specifications for volumetric flow rate. From the data for both mass and flow, the TEOM calculates an ambient concentration for $PM_{2.5}$.

Beta Attenuation Monitors (BAMs) provide an indication of particulate matter mass by measuring the attenuation of beta radiation through a filter on which particulate matter is deposited. As the fine particles deposit, fewer of the beta particles penetrate the filter and reach the detector. By measuring the intensity of beta particle penetration before and after, or during a period of air sampling, a measure of the mass deposited on the filter can be obtained. The degree to which the beta radiation is attenuated is approximately proportional to particle mass based upon the Beer-Lambert law, but is also dependent upon the chemical composition of the particulate matter. Commercial versions of beta attenuation monitors are available from Andersen Instruments, Met One Instruments, and Opsis AB.

The Continuous Ambient Mass Monitor (CAMM, Andersen Instruments) measures the drop in pressure across a porous membrane filter to monitor particle mass. As air is drawn through the filter, particulate matter is deposited on the filter and obstructs the air flow through the filter. This flow obstruction results in an increasing pressure differential across the filter which can be measured and correlated to the mass of the deposited material.

Several techniques involve the use of light scattering to quantify the concentration and size of ambient particulate matter. Among the more common of the instruments exploiting light scattering for particulate matter monitoring are nephelometers. In these devices, a fixed volume of aerosol sample is illuminated by an incident beam of light, and the total intensity over a range of scattering directions is detected. The scattering intensity can be used to estimate particle mass concentration.

Some continuous particle sizing instruments can also be used to provide an indication of particulate mass. Light scattering monitors such as the Aerodynamic Particle Sizer (APS, TSI Inc.) provide real time size distributions which can be related to mass concentrations. In the APS, sampled air is drawn into a flight tube where the transit time of particles through overlapping light beams is measured. Size classification is based on the relationship between this transit time and the aerodynamic size of the particles being interrogated.

The Electrical Low Pressure Impactor (ELPI, Dekati, Ltd.) operates on the basis of charging, inertial classification, and electrical detection of aerosol particles. Sampled air is drawn through a corona discharge which imparts an electrical charge to the particles. The particles are then separated based on their aerodynamic size in an inertial impactor. The individual stages of the impactor are electrically isolated from one another and individually monitored by an electrometer which monitors the charge collected on each stage. Real-time size distributions are determined from the current produced on each stage.

3. VERIFICATION APPROACH

3.1. Scope of Testing

The overall objective of the verification test is to provide quantitative performance data on fine particle monitors under realistic operational conditions. To meet this objective, testing will occur in two phases, at established sites with ongoing particulate matter monitoring programs conducted with appropriate quality assurance/quality control (QA/QC) efforts. The field sites will be located in two geographically distinct regions of the United States to allow exposure to different particulate matter concentration levels and chemical composition. At each site, the technologies will undergo intensive testing for a period of at least one month focusing on the season in which local $PM_{2.5}$ levels are likely to be highest.

Performance verification will be based, in part, on comparisons to the established reference methods[c] already in place as part of the monitoring programs at the field sites, or provided by Battelle specifically for this test. Collocation of the technologies being verified with systems for time-integrated monitoring of fine particulate mass and chemical speciation will provide the basis for assessing the degree of agreement and/or correlation between the continuous and time-integrated methods. Other parameters to be assessed during the verification test include the effects of meteorological conditions and the influence of interfering gases on technology performance. Consequently, each test site will be equipped with continuous monitors to record meteorological conditions and the concentration of key precursor gases (O_3, NO_x, SO_2, etc.). Additionally, other performance characteristics of the technologies being verified, such as reliability, maintenance requirements, and ease of operation will be assessed by field operators and reported. Instrumental features which may be of interest to potential users (e.g., power and shelter requirements, data output, and overall cost) will also be reported.

Although aerosols of known composition and size distribution can be created in a laboratory, such aerosols are limited in their representativeness of actual ambient fine particulate matter. It is beyond the scope of this verification test to generate aerosols in the laboratory which are representative of the wide range of aerosol composition typically found in ambient air. This

[c] Throughout this document the term "reference method" will refer to methods which are used as a basis of comparison for the purposes of technology verification. These reference methods may be, but are not necessarily, Federal Reference Methods (FRM), or Federal Equivalent Methods (FEM)

verification test will be limited to comparisons of data collected in the field under realistic operating conditions. Consequently no laboratory evaluations will be performed as part of this test.

3.2. Site Selection

The first phase of this verification test will be performed at the DOE/National Energy Technology Laboratory (NETL) site near Pittsburgh, PA. This phase will be conducted for a one month period late in the summer of 2000. The second phase of the test will take place at the California Air Resources Board (CARB) First Street site in Fresno, CA. This second phase of the test will be conducted over a period of one month in the winter of 2000/2001. General descriptions of each site are provided below.

These sites were selected based on a number of criteria including some common characteristics between the sites as well as some key differences. Common to these sites are:

- a wide variety of on-going ambient monitoring activities, including appropriate reference methods,
- sufficient space and facilities for verification testing of participating technologies,
- trained site personnel or subcontractors,
- appropriate site security, and
- established QA/QC protocols and procedures.[8, 9, 10]

The key difference between these sites is the location of these sites in distinctly different regions of the country, which results in exposure to different climates and meteorological conditions, as well as different levels and chemical composition of particulate matter. These factors, along with the willingness of the site management to collaborate with this verification test, were among the primary considerations for the selection of these sites.

It is recognized that verification of these monitors at only two sites for one season each represents only a small portion of the potential conditions under which these monitors are likely to be used. As such, the verification reports which result from this test will clearly indicate the conditions of the verification test and will not make generalizations about the performance of these monitors under different conditions. It is beyond the scope of this verification test to evaluate the performance of these monitors under all conditions in which these monitors are likely to be used. Instead, these two test sites will provide a demonstration of instrumental performance under a set (albeit limited) of realistic operational conditions.

3.2.1 Phase I

Phase I of testing will be conducted at the DOE/NETL research site located in South Park, PA, approximately eight miles south of Pittsburgh. This site is operated by NETL as part of the Department of Energy - Office of Fossil Energy's Ambient Fine Particulate ($PM_{2.5}$) Research Program,[11] which has three primary objectives:

- Monitor and analyze ambient fine particulate matter
- Characterize the emissions from fossil fuel based power systems
- Develop and evaluate effective control technologies.

The largest component of this research effort is the Upper Ohio River Valley Project (UORVP). The UORVP is focused on ambient monitoring along the upper Ohio River corridor in eastern Ohio, northwestern West Virginia, and western Pennsylvania, including the South Park site. This region is characterized by a relatively high concentration of both urban and industrial activities. Approximately 2 million residents live within the metropolitan Pittsburgh area, and heavy industries such as steel and coke making are important components of the local economy. Additionally, the UORVP region has a relatively high number of coal-fired power plants.

Consequently, this area is an excellent candidate for ambient air quality studies owing to the wide variety of potential emission sources.

Within the UORVP there are a number of ambient fine particulate monitoring sites, of which the South Park site is one. Monitoring objectives at this site include a general assessment of the relative contributions to ambient air quality from both anthropogenic and biogenic sources, as well as specific goals in the areas of:

- Emission trend analysis
- Equipment development and performance evaluation
- Source apportionment
- Management strategy development
- Health study correlations.

To address the monitoring and analysis efforts of the UORVP program, the DOE/NETL site at South Park is equipped with a variety of PM samplers, including FRM and speciation, as well as continuous particulate monitors, for the collection and characterization of ambient $PM_{2.5}$. To support these measurements, a variety of continuous meteorological and gas monitors are on-site to characterize the ambient conditions during sample collection. A partial list of the ambient air parameters to be monitored at this site is provided in Table 1.

The verification test objectives will be addressed at this site primarily through comparisons of the technologies being verified to samples collected daily by the various reference methods. The sampling duration for the FRMs, speciation sampler, and PAH sampler will each be 24 hours. The collected samples will be analyzed and used as the basis for comparison for mass measurements, chemical speciation, and particulate PAH concentration, respectively, as measured by the continuous monitors.

Testing at the DOE/NETL site will be conducted in the summer, when data show that the composition of fine particulate matter will be dominated by secondary aerosol components (sulfate, nitrate, and ammonium), with a significant amount of both organic and elemental carbon content as well.

Table 1. Parameters Being Monitored by DOE/NETL at Pittsburgh Site

Monitored Parameter	Monitoring Equipment	Avg Time	Frequency
Filter-Based Mass and Chemical Composition			
$PM_{2.5}$ mass	R&P 2025 sequential FRM sampler	24-hr	daily
PM_{10} mass	Andersen high volume sampler	24-hr	daily
$PM_{2.5}$ mass, elements, ions, carbon	Andersen RAAS2.5-400 $PM_{2.5}$ speciation sampler	24-hr	daily
Continuous Monitors			
$PM_{2.5}$ mass	R&P 1400a TEOM™ $PM_{2.5}$ sampler equipped with an AccuSampler	1-hour	daily
Polycyclic aromatic hydrocarbons	EcoChem PAS 2000 continuous PAH monitor	10-min	daily
$PM_{2.5}$ organic and elemental carbon	R&P 5400 continuous carbon analyzer	3-hour	daily
Precursor Gases			
O_3, SO_2, NH_3, NO_y, NO_x, CO, H_2S	API continuous gas monitors	5-min	daily
Meteorology			
Wind speed/direction	High accuracy sensor	5-min	daily
Temperature	High accuracy sensor	5-min	daily
Relative humidity	High accuracy sensor	5-min	daily
Solar Radiation	High accuracy sensor	5-min	daily
Barometric pressure	High accuracy sensor	5-min	daily
Rain fall	High accuracy sensor	5-min	daily

3.2.2 Phase II

The second phase of the verification test will be conducted in Fresno, California. The Fresno site, which is operated by the California Air Resources Board (CARB),[10] is part of both the California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS), and the National Air Monitoring Stations (NAMS) network. Additionally, under the direction of the Desert Research Institute (DRI), it is one of the host sites for the EPA Supersites program.[12]

The different programs which are being operated at the Fresno site are each designed around a unique set of program objectives. For example, NAMS sites are focused on long-term monitoring to assess trends in air quality and community exposure as well as determining compliance with air quality standards. The monitoring efforts in place throughout the NAMS network will be useful in assessing national trends and in supporting decisions based on those trends. The CRPAQS program is designed with a number of specific objectives described in the study program plan.[9] These objectives focus on collecting air quality data in central California which can be used, in part, to characterize the nature and the causes of particulate matter to determine the spatial distribution and temporal variation of PM, and to quantify source contributions in the region. Additional objectives relating to determining specific population exposures, characterizing zones of influence, and understanding transport and diffusion phenomena are also addressed in the program plan. The EPA Supersites program is designed to establish $PM_{2.5}$ monitoring sites to: (1) characterize PM in terms of regional concentrations, chemical composition, and transport phenomena in order to understand source-receptor relationships; (2) obtain air quality data to support health effects and human exposure research; and (3) provide sites which can be used for methods development and advanced monitoring efforts. Owing to the diverse set of objectives encompassed in these programs, the Fresno site houses a wide variety of equipment for routine air quality monitoring, as well as for research purposes, and is an ideal candidate site for verification testing. A list of the ambient air parameters to be monitored at this site, and the planned sampling schedules in the programs listed above, are provided in Table 2.

Table 2. Parameters Being Monitored by CARB/DRI at Fresno Supersite

Monitored Parameter	Monitoring Equipment	Avg Time	Frequency
Filter-Based Mass and Chemical Composition			
TSP Mass	Hivol w/ quartz filter	24-hr	12th day
PM_{10} mass, sulfate, nitrate, chloride, ammonium, carbon	Hivol SSI w/ quartz filter	24-hr	6th day
PM_{10} and $PM_{2.5}$ mass, elements	Collocated dichotomous sampler with Teflon filter	24-hr	6th day
$PM_{2.5}$ mass	Collocated sequential FRM w/ Teflon filter)	24-hr	daily for primary sampler and 3rd day for collocated sampler
Toxic (metals, chromium VI, aldehydes)	Xontec 920 Sampler	24-hr	12th day
$PM_{2.5}$ mass, light absorption, elements, and ions	Sequential FRM w/ Teflon filters	24-hr	6th day
$PM_{2.5}$ mass, elements, ions, carbon, nitric acid, ammonia	Five channel speciation sampler w/ denuders and backup filters)	24-hr	6th day
PM_{10} single particles, elements	MiniVol w/ Nuclepore filter for microscopic analysis	24-hr	6th day
$PM_{2.5}$ mass, elements, ions, carbon	Two channel sequential filter sampler w/ denuders and backup filters	24-hr	daily
Continuous Surrogate Mass			
Light scattering	Heated nephelometer	5-min	daily
Light scattering	Ambient temperature nephelometer	5-min	daily
Light scattering	Photometer	5-min	daily
Light scattering	Heated nephelometer	5-min	daily

Table 2 (continued)

Monitored Parameter	Monitoring Equipment	Avg Time	Frequency
Continuous Surrogate Mass			
0.003-0.2 μm size distribution	Ultrafine Condensation Particle Counter [a]	5-min	daily
0.3-30 μm size distribution	Optical Particle Counter	5-min	daily
Light absorption	Coefficient of Haze	2-hr	daily
Light absorption	Aethalometer	5-min	daily
Light absorption	7-wavelength aethalometer	30-min	daily
$PM_{2.5}$ mass	BAM	1-hr	daily
PM_{10} mass	BAM	1-hr	daily
Continuous Particle Mass and Chemistry			
$PM_{2.5}$ mass	TEOM™ monitor	1-hr	daily
PM_{10} mass	TEOM™ monitor	1-hr	daily
$PM_{2.5}$ nitrate, sulfate, and carbon	ADI flash volatilization with TEI NO_x, SO_2, and NDIR detectors	10-min	daily
$PM_{2.5}$ organic and elemental carbon	In-situ analyzer	1-hour	daily
Precursor Gases			
NO/NO_x	Continuous chemiluminescence monitor	1-hr	daily
Ozone	UV absorption monitor	1-hr	daily
Carbon Monoxide	Infrared absorption monitor	1-hr	daily
Non-Methane Hydrocarbons	FID	1-hr	daily
NO_y/HNO_3	High sensitivity chemiluminescent monitor with external converters, denuders, and sequencers	5-min	daily
Ammonia	High sensitivity monitor with NO_x scrubbers and oxidizers	5-min	daily

Table 2 (continued)

Monitored Parameter	Monitoring Equipment	Avg Time	Frequency
Organic Gases and Particles			
Toxic hydrocarbons	Xontec 910 canister sampler	24-hr	12th day
Carbonyls	Xontec 925 DNPH sampler	24-hr summer 4 per day	12th day 3rd day
Meteorology			
Temperature	High accuracy sensor	5-min	daily
Wind speed/direction	High sensitivity wind vane and anemometer	5-min	daily
Relative humidity	High accuracy sensor	5-min	daily
Solar radiation	Radiometer	5-min	daily

a May be integrated with scanning mobility particle sizer (0.005 to 1.0 μm).

Located in central California, Fresno is included in the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) and is impacted by a wide variety of both primary and secondary air quality influences. The region is relatively densely populated, with approximately 3 million people living within the 64,000 km^2 which comprise the SJVUAPCD. The primary industry in the region is agriculture, however, other local industries include oil and gas production, refining, waste incineration, transportation, and light manufacturing.

The Fresno site is expected to experience high concentrations of ambient ammonium, nitrate, geological, and carbonaceous material during the winter.[9] During winter, the high local concentration of gaseous ammonia combined with the low temperatures and high humidity conditions in central California favor the equilibrium formation of particulate ammonium nitrate from the available nitrate. Though less than in other seasons, geological material from agricultural activities, construction, road dust, and wind erosion contributes significantly to the $PM_{2.5}$ concentrations during winter. Carbon-containing PM (both organic and elemental) levels are also high in the winter as a result of various activities including fuel combustion, vehicle exhaust, meat cooking, and agricultural burning.

3.3. Experimental Design

The design of this verification test is similar to that of a recent instrument intercomparison study performed for CARB.[13] In that study, a variety of continuous and manual methods were intercompared to assess operational relationships among the different methods. This verification test will be similar to that study in that similar comparisons will be made between the continuous and manual methods. This verification test will be different in that it will expand on some of the comparisons, and will be performed at two different sites and in different seasons. However, in contrast to the CARB study, no intercomparison of the monitors being verified will be made in this verification test.

This verification test will involve collocation of duplicate commercial monitors to be verified at the test sites, which have established reference methods already in place, including both FRM and speciation samplers. The duplicate monitors will be placed in close proximity to each other (< 5 meters) and to reference samplers (<10 meters) to eliminate spatial variability as a source of error in statistical comparisons. Comparisons between the continuous monitors and the reference methods will be made to assess the comparability of the monitors being tested and the reference methods, or the capabilities of the continuous monitors in predicting the results from the reference methods. Comparisons of the results from duplicate monitors will be used to assess intra-method precision for each type of monitor. Continuous measurement of meteorological conditions and the concentration of precursor gases will be used to support these assessments. In this way, the accuracy and variability of the continuous monitors may be assessed under various conditions after adjusting for the influence of those conditions. Additional observations will be made by On-Site Operators and documented to describe general operational characteristics of these monitors, including general performance, reliability, maintenance, and ease of use.

The primary comparison for each monitor will be with the 24-hour time-integrated samples collected by the respective reference methods (see Section 3.4). As a result, the primary comparison will include approximately 25 samples from each month-long phase. In likelihood, the actual number of data points available for use in these comparisons will be somewhat smaller than 25. In addition to the 24-hour samples used for the primary comparisons, a number of shorter term samples (3, 5, 8-hour) will be collected and used for supplemental comparisons. The data sets available for the supplemental comparisons may be larger based on the frequency of data collection (up to 5 samples per day). Continuous meteorological and precursor gas concentration data will also be used to support the primary comparisons. The variability in ambient air parameter levels over the course of the month of data collection is expected to be much larger than the size of error in measurement, allowing for accurate estimation of the relationship between the reference methods and the monitors tested.

In some cases, monitors to be verified in this test are already in use at one or both of the sites. As such, the vendor of a monitor already on site will provide a single additional monitor for verification. The test for that type of monitor will thus include a monitor that has been operating in the field, and one newly installed in the field. In these cases, the history of these monitors may provide useful information about performance issues, and records of performance (including monitoring results and maintenance activities) at the site may be used to support the observations made during the intensive portion of the verification test. When available, monitoring results from these continuous monitors and the reference methods may provide an indication of performance of these monitors during multiple seasons at a given site, and maintenance records may provide an indication of the long-term reliability of these monitors.

When possible, the same monitors will be verified in the two phases of this test. However, when a monitor being tested is part of the site monitoring equipment, a different monitor will necessarily be tested at the other site. The additional monitor provided by the vendor will be used at both sites. In all cases, the verification report will clearly indicate which monitors (by serial number) were tested at the respective sites. Furthermore, as a result of the time difference between the two phases of the verification test, there is a potential that design modifications may be made to one or more of the monitors being tested. If changes of this type are made, the updated version may be used in the second phase. Again, the verification report will clearly indicate what design changes were made. As the statistical analyses will be performed separately for the individual monitors at each site, the potential use of different monitors at different sites will not affect the validity of statistical comparisons made in the verification process. Records indicating which monitors were verified in each phase may be used to explain potential differences in verification results between monitors at a site.

3.4. Reference Methods and Supplemental Measurements

Verification of the performance of continuous ambient fine particle monitors will be based in part on comparisons to appropriate reference methods or procedures. Since no appropriate absolute standards for fine particulate matter exist, the reference methods for this test were selected to provide comparisons of the results from the continuous monitors to those of currently accepted methods for the determination of particulate matter mass or chemical concentration. It is recognized that comparisons of real-time measurements to time-averaged measurements may not fully explore the capabilities of the real-time monitors. However, in the absence of accepted standards for real-time fine particulate matter measurements, the use of time-averaged standard methods which are currently widely accepted is necessary. The limitations associated with the use of these methods (including measurement uncertainties) will be discussed in the verification reports. A summary of each reference method to be used during the verification test is given below.

3.4.1 $PM_{2.5}$ Mass

Comparisons to $PM_{2.5}$ mass will be made relative to the FRM for $PM_{2.5}$ mass determination, i.e., the 24 hour time-averaged procedure detailed in 40 CFR Part 50.[2] This method involves manual sampling using any of a number of designated commercially available filter samplers, followed by gravimetric analysis of the collected sample. In this method a size selective inlet is used to sample only that fraction of aerosol of interest (i.e., <2.5 μm diameter). The air sample is drawn into the sampler at a fixed rate and the aerosol is collected on an appropriate filter for gravimetric analysis. After equilibration of the sample and filter in a temperature and humidity controlled environment, the sample is weighed on an appropriate microbalance. The particulate sample weight is determined by subtracting the weight of the filter alone, determined prior to sampling after similar equilibration. Protocols for sample collection, handling, and analysis are described by EPA and will be followed for this verification test.

FRM samples will be collected daily during each phase of the testing using a BGI PQ200 Sampler (RFPS-0498-116), or comparable sampler, and $PM_{2.5}$ will be determined according to the FRM procedures mentioned above. Results from other single filter or sequential FRM samplers may be used after the comparability of these other samplers and the BGI sampler is established (see Section 3.5.2 and Section 7.3). Time periods shorter than the FRM-prescribed 24-hour sampling will also be used in some cases to assess the short-term capabilities of the continuous monitoring technologies. This short-term $PM_{2.5}$ sampling will augment, rather than replace, the 24-hour FRM sampling.

3.4.2 Speciation

The reference methods to be used for chemical speciation of ambient $PM_{2.5}$ are described in the EPA guidance document "Guideline on Speciated Particulate Monitoring",[14] with the exception of the method for particle-bound PAH analysis. As with the gravimetric mass determination, these reference methods involve time-integrated sample collection and subsequent laboratory analysis, although the collection media and the methods of analysis vary for the different species.

In general, the speciation samplers have individual trains for the determination of specific components of the ambient aerosol. The aerosol is drawn into the sampler through a size selective inlet, and divided into separate streams for collection and subsequent chemical-specific analysis. Alternatively, separate size-selective inlets may be used for each stream. After sampling, the collected fractions are sent for preparation and laboratory analysis. At each field site, one or more approved speciation samplers will be employed as part of the studies performed at those sites. Collected samples from those speciation samplers will be analyzed by contract laboratories selected by Battelle, and the results of those analyses will be used for the data comparisons. Particulate nitrate, particulate sulfate, and elemental/organic carbon are the chemical species for which samples from the speciation samplers will be analyzed. At each site, particulate nitrate and particulate sulfate fractions will be collected on nylon filters downstream from a MgO denuder used to remove gaseous nitric acid. These fractions will subsequently be analyzed by ion chromatography as suggested in the EPA's "Guideline on Speciated Particulate Monitoring".[14] EC/OC fractions will be collected on quartz fiber filters and analyzed by both the IMPROVE thermal optical reflectance (TOR) and the NIOSH 5040 thermal optical transmission (TOT) techniques. At the Fresno site, 24-hour chemical speciation sampling will be augmented with 3, 5, and 8-hour sampling, to allow data comparisons over shorter time periods. At the DOE/NETL site, only 24-hour chemical sampling will be conducted.

For particle-bound PAH measurements, sample collection and analysis procedures based on ASTM Method D-6209-98[16] will be used. Battelle will supply filter/XAD resin sampling trains and appropriate denuders to determine the particle-phase PAH species. After removal of the vapor phase material in the denuder, the total particle-phase PAH will be collected on a quartz fiber filter followed by an XAD-2 resin bed. Particulate matter collected on the combined filter/XAD trains will be analyzed for PAH content by solvent extraction and subsequent gas chromatography/mass spectrometry (GC/MS) procedures. Particulate matter samples for PAH determination will be collected daily over 24-hour periods at each test site, and used to verify the performance of the commercial particulate PAH monitor.

3.4.3 Supplemental Measurements

Various supplemental measurements will be recorded and used to further establish the performance of the continuous monitors being tested. Meteorological conditions will be monitored and recorded continuously throughout each phase of the verification test. These measurements will include at least temperature, relative humidity, wind speed, and direction. Likewise, the ambient concentrations of various precursor gases including ozone and NOx will also be measured continuously during the verification test, and will be used to assess the influence of these parameters on the performance of the monitors being tested.

To supplement the 24-hour samples, additional samples will be collected at the Fresno site over shorter sampling periods (i.e., 3, 5, 8-hour) to help assess the capabilities of the monitors being tested, in indicating short term PM levels. These short-term samples will be collected and analyzed for $PM_{2.5}$ mass, nitrate, sulfate, and carbon fractions. Before use in evaluating the performance of the continuous monitors, these short term sampling measurements will be compared with the corresponding 24-hour results of the reference methods. These comparisons will be used to establish the relationship between the two sets of measurements.

3.5. Data Comparisons

3.5.1 Quantitative Comparisons

Table 3 provides a summary of the primary and supplemental comparisons to be made in evaluating technology performance. These comparisons are intended to evaluate the continuous

Table 3. Summary of Data Comparisons to be Made in Verification of Continuous Monitors

Technology to be Verified	Parameter Measured by Technology to be Verified	Primary Data to be Used for Comparison	Supplemental Data to be Used for Comparisons
Aethalometer	Black Carbon	Daily 24-hour EC/OC samples	3, 5,or 8 hour EC/OC samples;[a] continuous meteorological data
ACPM	EC/OC	Daily 24-hour EC/OC samples	3, 5,or 8 hour EC/OC samples;[a] continuous meteorological data
APNM	NO_3^-	Daily 24-hour NO_3^- samples	3, 5,or 8 hour NO_3^- samples;[a] continuous NO_x, O_3 measurements; continuous meteorological data
APS	Mass	Daily 24-hour FRM samples	3, 5,or 8 hour $PM_{2.5}$ mass samples;[a] continuous meteorological data
BAM	Mass	Daily 24-hour FRM samples	3, 5,or 8 hour $PM_{2.5}$ mass samples;[a] continuous meteorological data
CAMM	Mass	Daily 24-hour FRM samples	3, 5,or 8 hour $PM_{2.5}$ mass samples;[a] continuous meteorological data
ELPI	Mass	Daily 24-hour FRM samples	3, 5,or 8 hour $PM_{2.5}$ mass samples;[a] continuous meteorological data
Nephelometer	Light scattering intensity	Daily 24-hour FRM samples	3, 5,or 8 hour $PM_{2.5}$ mass samples;[a] continuous meteorological data
PAS	PAH and EC	Daily 24-hour PAH and EC samples	3, 5,or 8 hour EC samples;[a] continuous meteorological data
Sulfate Monitor	SO_4^{2-}	Daily 24-hour SO_4^{2-} samples	3, 5,or 8 hour SO_4^{2-} samples;[a] continuous SO_2, O_3 measurements; continuous meteorological data
TEOM	Mass	Daily 24-hour FRM samples	3, 5,or 8 hour $PM_{2.5}$ mass samples;[a] continuous meteorological data

[a] Short-term samples collected at Fresno only.

monitors being verified by comparison to the reference method which most closely matches the quantity measured by the technology. The primary comparisons will be made with the reference methods described above. Additional comparisons will be made with the supplemental measurements to assess (1) the effects of meteorological conditions and precursor gas concentrations on the response of the monitors being tested, and (2) the capabilities of these monitors to indicate short-term levels of ambient PM. The comparisons will be based on statistical calculations as described in Section 7.3 of this test/QA plan.

Comparisons will be made independently for the data from each site, and, with the exception of the intra-method precision calculations, the results from the duplicate monitors will be analyzed and reported separately. Intra-method precision will be determined from a statistical intercomparison of the results from the duplicate monitors.

3.5.2 Qualitative Comparisons

There is evidence that some continuous monitors may be considered comparable with the FRM. For example, a recent study commissioned by the California Air Resources Board to intercompare a variety of PM measuring equipment, has shown high a degree of comparability (slope = 0.91, intercept = 0.80 $\mu g/m^3$, $R^2 = 0.989$) between the $PM_{2.5}$ FRM and a Beta Attenuation Monitor with a Well-Impactor Ninety-Six $PM_{2.5}$ inlet (BAM-WINS).[13] Therefore, in addition to the comparisons outlined in Table 3, additional comparisons may be made with other available methods if appropriate methods are in place at the test site and can be shown to be adequately comparable to the $PM_{2.5}$ FRM. Although less stringent than the criteria for FEM equivalence, the criteria used in this test for a continuous monitor to be considered adequately comparable with the FRM are based on those presented in the EPA guidance document for the use of continuous monitors.[7] These criteria require that the results of the continuous monitor be compared with the reference method and analyzed by linear regression. The results of that statistical analysis must have a slope within three standard deviations of unity, an intercept within three standard deviations of zero, and have a squared correlation coefficient of greater than 0.9, for that monitor to be accepted as a comparable method. The degree to which each monitor being verified meets these comparability criteria will be assessed.

If a monitor being verified in this test meets these criteria, it may be used for comparison with other monitors being verified. If an additional method in use at either test site shows comparability with the FRM, it may be used as a secondary means of comparison for illustration of the temporal response of the monitors being tested. The use of these data will be limited to qualitative comparisons, and no quantitative conclusions about the performance of the monitors tested will be made. However, the temporal features which appear in real-time measurements of $PM_{2.5}$ mass (for example) may correlate with features in the PM mass or composition measurements of the other continuous monitors being verified. Comparisons of this type which can be used to show temporal features will illustrate the utility of the tested methods.

3.6. Roles and Responsibilities

The verification test will be performed by Battelle with the participation of EPA, the vendors who will be having their monitors verified, and the test sites. The organizational chart below shows the individuals from Battelle, the vendor companies, EPA, and the test sites who will have responsibilities in the verification test. The specific responsibilities of these individuals are detailed below.

3.6.1 Battelle

The Verification Test Coordinator will have the overall responsibility for ensuring that the technical, scheduling, and cost goals established for the verification test are met. The Verification Test Coordinator will:

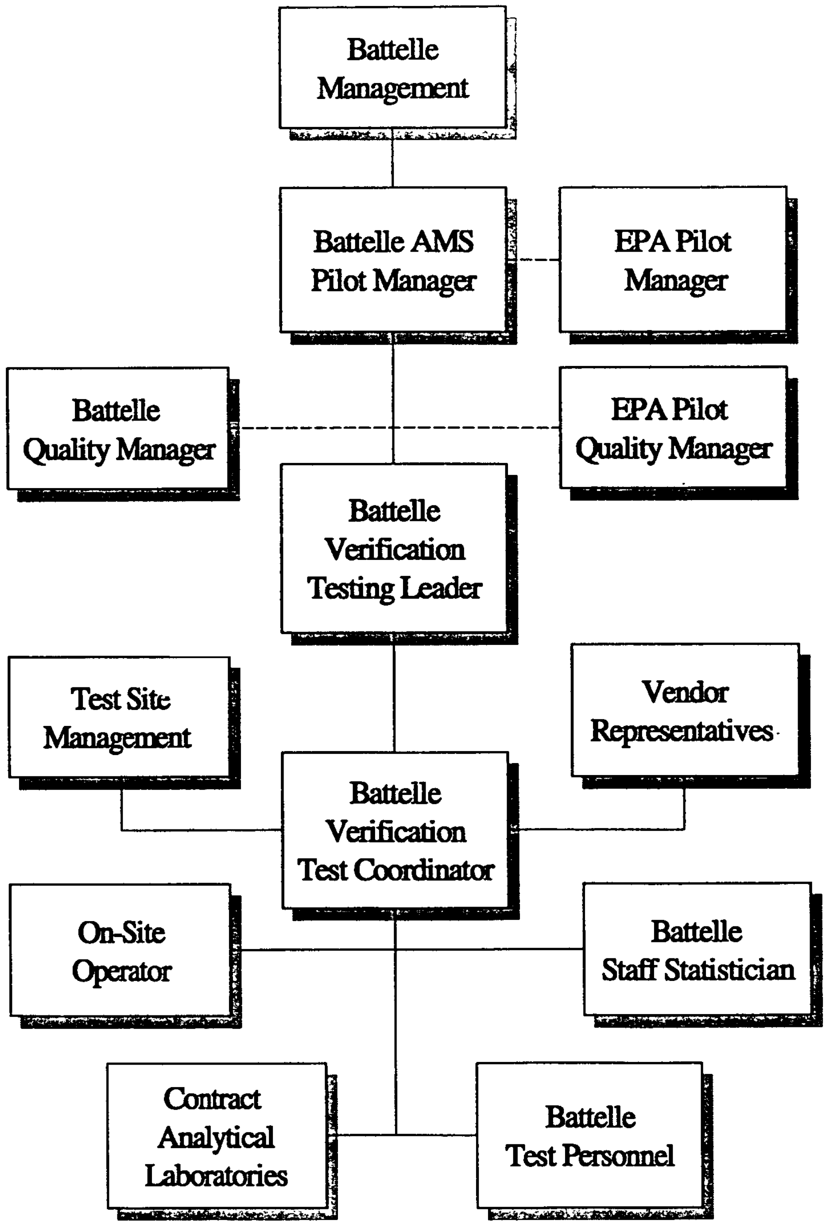

Figure 1. Organizational Chart for Ambient Fine Particle

Monitor Verification Test

- Prepare the draft test/QA plan, verification reports, and verification statements
- Revise the draft test/QA plan, verification reports, and verification statements in response to the reviewers' comments
- Coordinate testing parameters and test schedule with management and technical staff at each testing site
- Arrange for necessary Battelle materials to be available at the test sites when needed
- Ensure that all quality procedures specified in the test/QA plan and in the QMP are followed
- Respond to any issues raised in assessment reports and audits, including instituting corrective action as necessary
- Serve as the primary point of contact for vendor and site representatives
- Establish a budget for the verification test and monitor staff effort to ensure that the budget is not exceeded
- Ensure that confidentiality of vendor information is maintained.

The Verification Testing Leader for the AMS pilot will provide technical guidance and oversee the various stages of verification testing, and will:

- Support the Verification Test Coordinator in preparing the test/QA plan and organizing the testing
- Review the draft test/QA plan
- Review the draft verification reports and statements
- Ensure that confidentiality of vendor information is maintained.

Battelle's AMS Pilot Manager will:

- Review the draft test/QA plan
- Review the draft verification reports and statements
- Coordinate distribution of the final test/QA plan, verification reports and statements
- Ensure that necessary Battelle resources, including staff and facilities, are committed to the verification test
- Ensure that vendor confidentiality is maintained
- Support the Verification Test Coordinator in responding to any issues raised in assessment reports and audits
- Maintain communication with EPA's pilot and quality manager.

Battelle will provide test personnel who will assist as necessary during the verification test. The responsibilities of these test personnel include:

- Assist in the set-up and removal of the monitors and testing equipment as needed
- Train On-Site Operators in operating procedures of Battelle-supplied equipment
- Ensure that confidentiality of vendor information is maintained.

Battelle will provide a Staff Statistician who will support statistical and data analysis activities for this verification test. Specifically the Staff Statistician will:

- Assist in the conversion of verification data from electronic spreadsheet format to appropriate file format for statistical evaluation

- Support the Verification Test Coordinator in performing statistical calculations specified in this test/QA plan on the verification data
- Provide results of statistical calculations and associated discussion for the verification reports as needed
- Support the Verification Test Coordinator in responding to any issues raised in assessment reports and audits related to statistics and data reduction.

Battelle's Quality Manager for this verification test will:

- Review the draft test/QA plan
- Conduct a technical systems audit once during each phase of the verification test
- Review results of performance evaluation audits specified in this test/QA plan
- Audit at least 10% of the verification data
- Prepare and distribute an assessment report for each audit
- Verify implementation of any necessary corrective action
- Issue a stop work order if self audits indicate that data quality is being compromised; notify Battelle AMS Pilot Manager if stop work order is issued
- Provide a summary of the QA/QC activities and results for the verification reports
- Review the draft verification reports and statements
- Have overall responsibility for ensuring that the test/QA plan is followed
- Ensure that Battelle management is informed if persistent quality problems are not corrected
- Interface with EPA's Pilot Quality Manager
- Have overall responsibility for ensuring that the QMP is followed.

3.6.2 Vendors

Vendor representatives will:

- Review the draft test/QA plan and provide comments and recommendations
- Approve the revised test/QA plan
- Provide Battelle with detailed description of installation requirements prior to testing to ensure adequate facilities are available
- Provide duplicate commercial ready monitors for testing for the duration of each phase of the verification test at each site
- Install the monitors to be verified at each site and ensure proper operation before testing (vendors will have access to the test site at least one week in advance of testing during each phase)
- Provide detailed checklist to On-Site Operators of items which should be checked to verify proper operation of monitors
- Provide on-site operator or on-site technical support as needed
- Review and comment upon their respective draft verification report and statement.

3.6.3 EPA

EPA's responsibilities in the AMS pilot and this verification test are based on the requirements stated in the "Environmental Technology Verification Program Quality and Management Plan for the Pilot Period (1995-2000)" (QMP)[15]. The roles of the specific EPA staff are as follows:

EPA's Pilot Quality Manager will:

- Review the draft test/QA plan
- Perform, at her option, one external technical system audit during the verification test

- Notify the Battelle Pilot Manager to facilitate a stop work order if external audit indicates that data quality is being compromised
- Prepare and distribute an assessment report summarizing results of external audit, if performed
- Review draft verification reports and statements.

EPA's Pilot Manager will:

- Review the draft test/QA plan
- Approve the final test/QA plan
- Approve the final verification reports
- Review the draft verification statements.

3.6.4 Test Sites

The verification testing will be conducted in two phases. The first phase will be conducted at the DOE/NETL site in Pittsburgh, PA. The second phase will be conducted at the CARB/EPA supersite in Fresno, CA. The responsibilities of the host sites are:

- Assist in developing a plan to conduct verification tests at the site in collaboration with ongoing measurements
- Allow facility access to vendor, Battelle, and EPA representatives during the scheduled verification testing including set-up and tear-down operations
- Provide adequate working space at the testing site for the duration of verification testing
- Provide sufficient power for the simultaneous operation of all test equipment and technologies being verified

- Provide access to data from equipment collocated at test site, including available reference methods, continuous gas monitors, and meteorological monitors.
- Assist Battelle in arranging for augmented sampling schedules or additional sample analysis
- Cooperate with Battelle's documentation of the host site's QA/QC procedures
- Review portions of the verification report to assure accurate descriptions of the host site operations, and to provide technical insight on verification results
- Provide safety instructions to test and QA personnel for operations at the test site.

3.6.5 On-Site Operators

Battelle will hire On-Site Operators to assist, as necessary, in activities associated with this test that are not already performed by the test sites. The responsibilities of these on-site operators are:

- Observe the operation of the monitors being test and complete checklists for each monitor, as well as make general observations about the performance and maintenance of the monitors being tested
- Perform sampling activities according to this test/QA plan, documented procedures, and as instructed by the Verification Test Coordinator
- Arrange for and ship samples to the respective Contract Analytical Laboratories
- As necessary, inform respective vendors and Battelle of problems associated with the monitors being tested
- Ensure that confidentiality of vendor information is maintained.

3.6.6 Contract Analytical Laboratories

This verification test relies on the results of various analytical measurements. Battelle will secure the services of Contract Analytical Laboratories to conduct these measurements. The responsibilities of these laboratories are:

- Conduct quality assured analytical measurements of collected samples
- Provide Battelle with results of analytical measurements in mutually agreed upon format
- Provide Battelle and EPA, as necessary, with appropriate QA records and documents, including standard operating procedures, calibration records, training records, etc.
- As necessary, allow an external technical systems audit of laboratory facility, personnel, and procedures by Battelle and/or EPA staff.

4. TEST PROCEDURES

Field testing will be conducted in two separate phases. Phase I will be conducted at the DOE/NETL site for an approximately one month period of intensive sampling from Monday, July 31 to Friday, August 25, 2000. Phase II of the verification test is to be conducted at the EPA supersite in Fresno, between December 11, 2000 and January 12, 2001. At each site data from the monitors being tested, the meteorological monitors, and the precursor gas monitors will be collected continuously over the course of the verification test. Samples will be collected by the reference methods (i.e., FRM, speciation, and PAH samplers) according to the schedules in place at the sampling sites. In all cases, the monitoring and sampling equipment will be operated according to the recommendations provided in the respective operator's manual or standard operating procedures for the samplers, and within the procedures and protocols set forth in this test/QA plan or the quality assurance plans[8, 9, 10] in place at the respective sites and the analytical laboratories.

In some cases, monitors being verified are already in operation at the field sites. In these cases, the vendors will be allowed to perform appropriate calibration and maintenance on their respective monitors before testing begins. For those that are not, the vendor will install and ensure the proper calibration and operation of the monitors to be verified at each site. Routine operation during the verification test will be observed by On-Site Operators after appropriate training by vendor staff. Instrumental status will be documented by the On-Site Operators by completing checklists provided by the respective vendors. In the case of instrument failure, the vendor will be notified by the on-site operators and allowed to perform on-site repair if necessary. Since testing at each site will be conducted over a limited time period, it is expected that the vendor will arrange for adequate time for installation and training at each site before testing begins. Testing will not be delayed if installation of the monitors is not complete, and will not be extended to make up for downtime if a monitor being verified fails during the test.

At each site, On-Site Operators will be asked to make observations about the operational performance, maintenance, ease of use and reliability of each technology, as well as provide additional insight concerning general technology performance, and sampling conditions on the respective checklists provided by the vendors. If existing records pertaining to the past performance of one or more of the monitors are available, they may be used in the respective verification report to support discussions of operational performance. Information concerning maintenance and daily operation of these monitors, including data output requirements, will be recorded by site operators and summarized in the verification reports.

4.1. Phase I - Pittsburgh

Table 1 lists the equipment that is scheduled to be operated by DOE/NETL at the Pittsburgh site. The entries in this table are grouped according to the parameter to be measured, and include the monitoring equipment to be used, the averaging time, and the frequency of measurement for each of these instruments. Procedures for the operation of this monitoring equipment are provided in the respective instrument manuals or in the SOPs for the DOE/NETL study.

To augment the measurements made by NETL, Battelle will provide an FRM sampler, and a speciation sampler, with which to collect the reference samples. The speciation sampler provided will be equipped to collect samples for carbon, nitrate, sulfate, and PAH analyses. The procedures to be followed for the daily operation and routine maintenance of the Battelle-supplied FRM and speciation sampler are described in the respective instrument manuals provided by the manufacturers. Procedures for the daily sampling for PAHs are provided below. On-Site Operators responsible for the operation of these samplers will be trained in the procedures for daily operation of this equipment before verification testing begins and will follow these procedures during testing. Gravimetric and chemical analysis of the samples will be performed by Contract Analytical Laboratories according to their respective SOPs. Preparation of the denuders and analysis of the PAH samples will be performed at Battelle according to the procedures described in Section 4.3.

4.2. Phase II - Fresno

A list of the equipment to be operated by CARB/DRI as part of the various studies performed at the Fresno Supersite is provided in Table 2. This table also identifies the parameter to be measured, the average time for measurement, as well as the frequency of measurement. Procedures for the operation of these monitoring and sampling technologies are provided in the respective operator's manuals, or in the site planning documents.[9, 10]

In addition to the instruments listed in Table 2, Battelle will provide a PAH sampler for particulate-bound PAH monitoring. Procedures for the denuder preparation, operation of the PAH sampler, and the analysis of the PAH samples are provided in Sections 4.3. On-Site Operators will be trained by Battelle in the procedures for the daily operation of the PAH sampler.

4.3. PAH Sampler

Particulate PAH data will be obtained for verification of the commercial PAH monitor by means of a denuder/filter/sorbent train that separates vapor- and particle-phase PAHs. The method to be used for PAH determination is based on ASTM Method D-6209-98.[16] The principle of this method is that, as sample air is drawn through the train, vapor-phase PAHs diffuse rapidly to the walls of an annular denuder tube and are captured. Particles pass through the denuder in the sample air stream because of their much slower rate of diffusion, and are collected on a quartz fiber filter backed up by a sorbent trap. The sorbent trap serves to collect any PAH that volatilizes from the filter after particle collection. The particle-phase PAH concentration is determined by extracting and analyzing the filter/sorbent combination together. In addition, if needed the denuder can be extracted for determination of the vapor-phase PAHs.

The procedures for the daily operation of the PAH sampler are summarized below, including the origin, handling, shipping, and installation of the denuders, handling and installation of the sample filters, field sampling, and laboratory analysis.

4.3.1 Denuders

The denuders to be used are based on those developed by Gundel and co-workers,[17] and consist of a glass annular denuder with a sandblasted inner surface coated with finely ground XAD-4 resin. The resin particles collect vapor-phase PAH from the air stream, but are resistant to removal from the glass surface during air sampling, solvent extraction, and handling of the denuder. The primary purpose of the denuder is to provide an air stream free of vapor-phase PAH, so that particle-phase PAH may be collected without artifact from the vapor phase. However, the denuders can also be extracted with solvent for determination of the collected vapor-phase PAH.

The denuders used in this verification test will be commercial units supplied by URG and coated by Restek Corporation. The denuders to be used will be appropriate for use with the sampler being used to collect the PAH samples. Preliminary chamber and field studies will be performed to characterize the performance of these denuders before the verification test.

4.3.2 Other Sampling Components

Cleaned quartz fiber filters and XAD-2 resin traps will be prepared by Battelle. Commercial quartz fiber filters will be cleaned by heating in a muffle furnace in high purity air, and will be stored wrapped in similarly muffled aluminum foil. XAD-2 resin is cleaned by Soxhlet extraction with multiple solvents, and stored in sealed, pre-cleaned glass sampling cartridges. At least one sampling assembly from each batch will be analyzed as a laboratory blank. A blank will be considered acceptable if the mass of each individual PAH species does not exceed 10 ng, and if the blank PAH concentration is less than 10% of the expected ambient concentration (based on historical averages if available).

4.3.3 Shipment of Sampling Components

Sets of denuders, filters, and XAD-2 traps will be shipped to the test site at weekly to twice-weekly intervals in protective shipping containers by overnight delivery service. These materials will be stored at room temperature and kept sealed until the time of use. After sample collection, the sampling components will be resealed in their original containers and kept refrigerated (below 4°C) until enough samples are collected for a return shipment to Battelle. Refrigerated samples will then be returned to Battelle in the same containers used for shipment to the site. Field blank sampling materials will undergo the same handling and shipment procedures as actual samples. Temperature records of the shipped samples will accompany the samples.

4.3.4 Field Sampling for PAH

Sampling for particle-phase PAH is scheduled to take place at the respective test site on each day of both test phases. At least 10 % of the PAH samples collected and analyzed will be field blanks. Field blanks will be collected by inserting the filter/sorbant assembly into the sampler and removing the assembly without sampling.

The air flow rate of the PAH sampler will also be checked as part of the field performance audit schedule at each site as a quality control procedure. The procedures sampler operation and for flow rate checks are provided by the manufacturer in the operator manual.

4.3.5 PAH Analysis

Upon return to Battelle, each quartz fiber filter and its corresponding XAD-2 resin trap will be extracted in methylene chloride using Soxhlet apparatus, and the extracts will be concentrated to less than 1 mL volume. Analysis will be by GC/MS using the electron impact mode of ionization. All samples and blanks will be spiked prior to extraction with perdeuterated PAH as internal standards in the analysis. The particle-phase PAH data obtained from the filter/XAD combinations will be the primary basis for comparison with the continuous PAH monitor.

Performance verification of the continuous PAH monitor will be based on the response of the monitor to only those particle-bound PAH species which are expected to be ionized by the light source employed in the monitor (i.e., the ionization potential is below the photon energy).

5. MATERIALS AND EQUIPMENT

In general, this verification test relies on the materials and equipment in use as part of routine monitoring efforts at each of the two field sites. The equipment in use as part of those studies will be operated and maintained by the personnel at the respective sites. In addition to the on-site equipment operated by the test site, Battelle will provide the following equipment as needed.

5.1. FRM Sampler

A single filter BGI PQ200 FRM sampler will be provided, as needed, to the test sites for use during the verification test. Filter transport cases and extra filter cassettes will be provided, as will a BGI DataTrans module for retrieval of stored sampling information.

5.2. Speciation Sampler

An Andersen RAAS2.5-400 Chemical Speciation sampler, or similar sampler, will be provided, as needed, to the test sites for use during verification. Filter transport cases and extra filter cassettes will be provided.

5.3. PAH Sampler

The sampler to be used for the PAH sampling will be provided by Battelle for each phase of the verification test. The sampler will be equipped with the following components for the separation and collection of particle-phase PAH:

- commercial annular denuder coated with XAD-4 resin
- quartz fiber filter
- glass backup trap containing XAD-2 resin.

These components will be prepared and shipped to the respective sites by Battelle weekly to twice weekly during the individual verification test phases. After sample collection, these assemblies will be properly stored and shipped back to Battelle by site staff for analysis.

The other components of the sampler include the inlet, vacuum system, and pump. These components will be shipped to the respective site before each phase of testing for installation on the sampling platform. These components will be provided as either a stand-alone unit or as a train in a commercial speciation sampler (i.e., Andersen RAAS2.5-400, etc.).

5.4. Sampling Media

All materials necessary for sampling specifically associated with this verification test, including filters, denuders, and sorbant traps, will be supplied by Battelle. Arrangements for delivery dates and locations will be made with the respective Test Site Management or On-Site Operators by the Verification Test Coordinator.

6. Quality Assurance/Quality Control

This verification effort relies in part on the existing QA/QC programs in place at the DOE/NETL and Fresno sites. That is, the QA/QC procedures for the studies ongoing at each site will be adopted as part of this verification test. Each site has established QA/QC activities in accordance with appropriate guidelines from various sources including NARSTO, EPA, and DOE. These procedures cover daily operation of the site equipment, calibration, sample collection and handling, laboratory analysis, data collection and handling, as well as scheduled auditing. These procedures will be followed by site staff throughout the duration of testing at these sites, including the period during which the verification test is conducted. Adherence to those existing data quality procedures that relate to this test will be assessed by Battelle QA personnel, through review of procedures during the field verification periods. Additional QA/QC procedures specific to this verification test are described below.

6.1. Sample Collection/Transfer

Samples collected using Battelle-supplied equipment will be collected by On-Site Operators daily during each phase of the test according to the procedures described in this test/QA plan. After receipt by the On-Site Operators, filters and other necessary sampling materials (i.e., denuders, PUF cartridges) for collection of these samples, as well as for the collection of field blanks, will be kept in a clean, temperature and humidity controlled environment until transported to the test site for sampling. If kept off-site these sampling materials will be transported to the site by the On-Site Operators so as to avoid contamination. Filters and other sampling materials will receive unique codes for identification according to the procedures of the On-Site Operators or Contract Analytical Laboratory depending on which party prepares the materials for sampling. Each sample will be accompanied by a chain-of-custody form during each step of it's transport. Information on these forms will be completed by the sample sender and recipient as needed. Chain-of-custody forms will accompany samples which will be transported to or from the Contract Analytic Laboratories which are independent of the On-Site Operators. Sample run data forms documenting the sampling parameters will be completed by the On-Site Operators for each sample. On-Site Operators will forward these sample run data forms to the Verification Test Coordinator for approval within one week of the sampling date. The Contract Analytical Laboratories will forward the chain-of-custody forms to the Verification Test Coordinator for approval within one week of completion of the sample analysis. Approval of these records will be indicated by the signature of the Verification Test Coordinator on each form. Example forms are shown in Appendix A.

6.2. Data Collection/Transfer

Data from the time integrated and continuous monitors operated at each site and the results of laboratory analyses will be recorded according to the procedures described in the respective test plans for the sites or standard operating procedures, and will transferred to Battelle after validation procedures are performed. The data received by Battelle from each site will be maintained by Battelle's Verification Test Coordinator, and information regarding specific technologies being tested will be kept confidential while under the control of Battelle.

Data generated by Battelle or on behalf of Battelle for this verification test, and that is not already covered by procedures at the test site will be recorded either electronically, on data sheets, or in laboratory notebooks. These data include those associated with particulate PAH measurements, and will include observations on the operation of the monitors being tested, weather observations, and other information. These data will be compiled in electronic format and, excluding confidential information about specific technologies being verified, will be made available to each site upon request.

6.3. Field QA/QC Activities

A variety of QA/QC activities will be performed by the On-Site Operators at the test sites to ensure that the samplers provided by Battelle are operating properly. These activities include flow rate checks, internal and external leak checks, as well as checks of the temperature and pressure sensors in the samplers. QA/QC activities associated with the reference methods supplied by the test sites will be conducted according to the procedures in place at the respective sites and the results will be provided to Battelle. For the reference methods supplied by Battelle, the QA/QC activities to be performed are based on those described in the manuals for the respective samplers and are summarized below.

6.3.1 Flow Rate Check

The flow rate of the reference samplers provided by Battelle will be verified through single point checks to ensure the proper operation of the samplers. These flow rate checks will be conducted based on the procedures described in the respective manuals, and will be conducted at least once before (within one week of the start) and again once after (within one week of the end) each phase of the verification test. The flow rates will be checked using a calibrated flow meter to verify that the sampler is operated at a flow rate within +/- 5 % of the nominal operating flow rate of the sampler. Also, if the sampler includes an internal flow meter, agreement between the audit flow meter and the sampler flow meter must be within +/- 4 %. If +/- 5% agreement between the sampler flow rate and the nominal operating flow rate is not achieved, the sampler flow rate will be manually adjusted to meet this performance criterion. If agreement between the sampler and audit flow meters does not meet the +/- 4% acceptance criterion, recalibration of the sampler flow meter will be performed per the procedures in the operators manual.

6.3.2 Leak Checks

Internal and external leak checks of the reference samplers provided by Battelle will be performed to ensure the integrity of the sampling system. These leak checks will be performed based on the procedures described in the respective sampler manuals and will be conducted at least weekly during each phase of the verification test. Leak checks of the FRM sampler will be conducted after each cleaning of the Well-Impactor Ninety Six (WINS) impactor in the FRM sampler. The WINS impactor will be cleaned at least once every 5 sampling days. Acceptance criteria and corrective actions for these activities are described in the respective manuals for the reference samplers.

6.3.3 Temperature and Pressure Checks

Single point calibration checks of the temperature and pressure sensors in the reference samplers provided by Battelle will be conducted based on the procedures described in the respective manuals. These checks will be performed at least twice during each phase of the verification test, once within one week of the beginning and once within one week of the end of each phase. Acceptance criteria and corrective actions for these activities are described in the respective manuals for the reference samplers.

6.3.4 Field Blanks

Field blanks will be collected and analyzed for all the reference methods supplied by Battelle to assess the contamination levels associated with activities other than sampling. The field blanks will be collected by placing the sampling media in the sampler and removal without sampling. At least 10% of the collected samples will be field blanks. The acceptance criteria and corrective actions for the field blanks will be established based on procedures in place at the respective Contract Analytical Laboratories (based on historical averages if available).

For the field blanks for the PAH sampler, at least one will be collected within the first 3 days of sampling, and again within the last week of sampling of each test phase, with at least one additional blank collected during each phase. Blank levels for the PAH sampler will be considered acceptable if the mass of each individual PAH species, excluding naphthalene, does not exceed 20 ng on the filter/sorbent assembly, and if the blank PAH concentration is less than 10 % of the average ambient concentration. For naphthalene, the acceptance level for the blank sample is 200 ng. If this acceptance criterion is not met, the source of the contamination will be investigated, and the sample will be flagged as of questionable validity.

6.3.5 Collocated Samplers

The precision of the reference methods provided by Battelle will be established by collocation of each reference sampler with an identical or a similar sampler. The collocated samplers will be placed within four meters of each other and will collect at least five 24-hour samples to establish precision. This collocated sampling will be completed at the verification test site, before the start of the verification test sampling.

For the FRM reference method, agreement between the duplicate samples must be within 10% to be considered acceptable. If this agreement criterion is not met, the source of the discrepancy will be investigated, additional samples will be collected, and the analyses will be repeated.

For the chemical speciation (nitrate, sulfate, carbon, and PAH) reference methods, the duplicate samples will be analyzed concurrently, and agreement between the observed concentration of each analyte must be within +/- 35% to be acceptable. If this agreement criterion is not met, the source of the discrepancy will be investigated, and if possible additional samples will be collected, and the analyses will be repeated.

6.4. Laboratory QA/QC Activities

QA/QC practices performed by the laboratories used to conduct all the chemical and gravimetric analyses for this verification test, except for the PAH analysis, are described in their respective standard operation procedures or laboratory quality manuals. These activities include instrument calibration and verification, as well as analysis of laboratory and lot blanks. The acceptance criteria and corrective actions for these activities are described in the respective procedures.

Battelle will conduct the PAH analysis according to procedures based on ASTM Method D-6209-98. QA/QC activities for these analyses include analysis of laboratory blanks, analytical duplicates, and analytical spikes as described below.

6.4.1 Laboratory Blanks

At least one sorbant/filter assembly from each batch of prepared assemblies will be analyzed as a laboratory blank. These blanks will undergo the same preparation and handling procedures as those traps which are shipped to the test sites for sampling, but will not be shipped or exposed to sampling. The laboratory blanks will be analyzed at the same time as the PAH samples. Acceptance criteria and corrective actions for these laboratory blanks will be the same as those for the PAH field blanks.

6.4.2 Analytical Duplicates

For the PAH analyses, an analytical duplicate of one sample will be run for each batch of samples analyzed to assess the precision of the analytical method. Agreement between the results from the duplicate analyses must be within 15% to be acceptable. If this agreement criterion is not met, the source of the discrepancy will be investigated and the analyses will be repeated, if possible.

6.4.3 Analytical Spikes

Analytical spikes will be used to assess the accuracy of the PAH analytical method. Each sample will be spiked prior to extraction with 100 ng each of pyrene-d_{10} and chrysene-d_{12} to serve as surrogate recovery standards. The percent recovery of each standard must be within +/-30% to be acceptable. If this agreement criterion is not met, the source of the discrepancy will be investigated and appropriate corrective action will be taken.

6.5. Assessments and Audits

Independent of site and EPA QA activities, Battelle will be responsible for ensuring that the following audits are conducted as part of this verification test.

6.5.1 Performance Audits

Reference methods supplied by the test sites

Performance evaluation audits of the reference methods supplied and operated by the test sites, and of the laboratory analyses, will be performed according to the procedures and schedules provided in the procedures for the respective sites and Contract Analytical Laboratories, respectively. The audits of the reference samplers may include, among other activities, flow rate checks of the reference method samplers using calibrated flow meters to ensure proper flow during sample collection, and collocation of audit samplers with the reference samplers to assess the precision of the reference methods. Performance evaluation audits for laboratory analysis include calibration checks of balances and other analytical instrumentation, as well as analysis of blank samples. Acceptance criteria and corrective actions for these quality assurance activities are provided in the test plans or in the standard operating procedures for the respective sites or analytical laboratory. When possible Battelle QA staff will be present during the performance of these audits.

Reference methods supplied by Battelle

Performance evaluation audits of the reference method equipment supplied by Battelle will be performed during the verification test. These audits include verification of the sampler flow rate, as well as verification of the temperature and pressure sensors to ensure proper sampler operation.

Performance evaluation audits of the flow rate, as well as the temperature and pressure sensors for the reference samplers provided by Battelle will be conducted according to the procedures described above in Section 6.2 with the same acceptance criteria and corrective actions. These audits will be conducted using sensors with NIST-traceable calibrations that are not those used for the usual checks described in Section 6.2 but may be traceable to the same primary standards. The audits will be observed by Battelle staff when possible, and when possible, will be performed by someone other than the usual On-Site Operator. These performance evaluation audits will be conducted at least once during each phase of the verification test and may be conducted within one month of the beginning of each phase.

6.5.2 Technical Systems Audits

Battelle's Quality Manager will perform a technical systems audit (TSA) at least once during each phase of this verification test. The purpose of this audit is to ensure that the verification test is being performed in accordance with this test/QA plan and that all QA/QC procedures are being implemented. In this audit, the Quality Manager will review the reference methods used, compare actual test procedures to those specified or referenced in this plan, and review data acquisition and handling procedures. This effort will include reviewing the procedures used at the test site for compliance with this test/QA plan and with the SOPs for the respective site. When possible, a TSA of the Contract Analytical Laboratories will be conducted to ensure that analyses are being performed in accordance with the requirements of this test/QA plan and the SOPs of the laboratory. A TSA report will be prepared, including a statement of findings and the corrective actions taken to address any adverse findings.

At EPA's discretion, EPA QA/QC staff may also conduct an independent TSA of the verification test. In any case, EPA QA/QC staff will review Battelle's TSA report, and provide comments on the findings and actions presented in that report.

6.5.3 Data Audits

Battelle's Quality Manager will audit at least 10 percent of the verification data acquired during the verification test. The Quality Manager will trace the data from initial acquisition, through reduction and statistical comparisons, and to final reporting. All calculations performed on the data undergoing the audit will be checked.

6.6. QA/QC Reporting

Each assessment and audit will be documented in accordance with Section 2.9.7 of the QMP for the AMS pilot.[1] Assessment reports will include the following:

- Identification of any adverse findings or potential problems
- Response to adverse findings or potential problems
- Recommendations for resolving problems
- Confirmation that solutions have been implemented and are effective
- Citation of any noteworthy practices that may be of use to others.

6.7. Corrective Action

The Battelle or EPA Quality Managers during the course of any assessment or audit will identify to the technical staff performing experimental activities any immediate corrective action that should be taken. If serious quality problems exist, the Battelle Quality Manager is authorized to stop work. Once the assessment report has been prepared, the Verification Test Coordinator will ensure that a response is provided for each adverse finding or potential problem, and will implement any necessary follow-up corrective action. The Battelle Quality Manager will ensure that follow-up corrective action has been taken.

7. Data Handling and Reporting

7.1. Data Acquisition

A variety of data will be acquired and recorded electronically, or manually, by site or laboratory personnel in each phase of the verification test. After the prescribed validation at the respective test site, these data, including most reference method results, meteorological conditions, precursor gas concentrations, and the data from the technologies being verified, will be transferred to Battelle either electronically or in hard copy for subsequent reduction and analysis. Other data, namely PAH concentrations, will be generated by Battelle. These data will be compiled in electronic format and will be shared with the host sites. In all cases, strict confidentiality of the verification data will be maintained for each participating vendor. This will be accomplished in part by storing electronic data under separate and clearly identifiable computer file names. All hard copy information similarly will be maintained in separate folder files. At no time during verification testing will Battelle engage in any comparison or discussion of test data or intercomparison of different monitors undergoing verification. However, much of the data used in this verification test will be obtained from sources outside of the control of Battelle. Consequently, the same data that are used for technology verification through ETV may be used in intercomparative studies by other organizations.

7.2. Data Review

Records received by or generated by Battelle staff in the verification test will receive a one-over-one review within two weeks after receipt or generation, respectively, before these records are used to calculate, evaluate, or report verification results. These records may include electronic records; laboratory record books; operating data from the test site; or equipment calibration records. This review will be performed by a Battelle technical staff member involved in the verification test, but not the staff member that originally received or generated the record. The review will be documented by the person performing the review by adding his/her initials and date to a hard copy of the record being reviewed. This hard copy will then be returned to the Battelle staff member who received or generated or who will be storing the record.

In addition, data calculations performed by Battelle will be spot-checked by Battelle technical staff to ensure that calculations are performed correctly. Calculations to be checked include determination of predictability or comparability, intra-method precision, and other statistical calculations to assess meteorological and precursor gas effects, and short term monitoring capabilities as identified in Section 7.3 of this test/QA plan.

7.3. Statistical Calculations

Performance verification is based, in part, on statistical comparisons of continuous monitoring data to results from the reference methods. A summary of the calculations to be made is given below.

7.3.1 Comparability

The comparability between the continuous monitors and reference methods will be assessed only for monitors which yield measurements with the same units of measure as the reference method with which it is being compared. The relationship between the two will be assessed from a linear regression of the data using the reference method results as the independent variable and the continuous monitor results as the dependent variable as follows:

$$C_i = \mu + \rho \times R_i + \epsilon_i \qquad (1)$$

where R_i is the i^{th} reference measurement (for a 24 hour period), C_i is the average of the continuous measurements over the same 24 hour time period as the i^{th} reference measurement, μ and β are the intercept and slope parameters, respectively, and ϵ_i is error unexplained by the model. The average of continuous measurements is used as this is the quantity that is most comparable to the reference sampler measurements.

Comparability will be expressed in terms of bias between the continuous monitor and the reference method and the degree of correlation (i.e., r^2) between the two. Bias will be assessed based on the slope and intercept of the linear regression analysis of the data from the reference method and the continuous monitor. In the absence of bias, the regression equation would be $C_i = R_i + \epsilon_i$ (slope = 1, intercept = 0) indicating that the 24 hour average of continuous measurements is simply the reference measurement plus random error. A value of r^2 close to 1 implies that the amount of random error is small, that is, the variability in the continuous measurements is almost entirely explained by the variability in the reference measurements.

Quantities to be reported include sample size, r^2, estimates and standard errors of the intercept and slope parameters, and the numbers of standard errors between the slope estimate and unity and between the intercept estimate and zero.

Comparability will be determined independently for each of the two duplicate monitors being tested and will be assessed separately for each phase of the verification test.

7.3.2 Predictability

Predictability will be assessed for continuous monitors which report results in units which are different than those of the reference method with which it is being compared. In these cases the reported predictability will be representative of the usefulness of that monitor as a surrogate of the reference method, i.e., its ability to predict the measurement made by the reference method. The relationship between the two will be assessed from a linear regression of the data using the reference method results as the independent variable and the continuous monitor results as the dependent variable. The predictability of the continuous monitor will be expressed by the correlation coefficient of a linear regression analysis, and the slope and intercept of the regression analysis can be used to express the relationship between the two. The statistical model to be used is identical to model (1) for comparability. Quantities to be reported include sample size, r^2, and estimates and standard errors of the intercept and slope parameters. Additionally, by reversing the roles of the independent and dependent variables, a 95% percent prediction interval will be calculated for conversion from monitor measurement units to lower and upper bounds on reference method measurement units.

Predictability will be determined independently for each of the two duplicate monitors being tested and will be assessed separately for each phase of the verification test.

7.3.3 Precision

The intra-method precision of the continuous monitors will be determined based on procedures described in Section 5.5.2 of EPA 40 CFR 58, Appendix A, which contains guidance for precision assessments of collocated non-FRM samplers. Simultaneous measurements from duplicate monitors will be paired and the behavior of their differences used to assess precision. The following statistics will be reported for each parameter measured: sample size, mean difference, standard deviation of the difference, coefficient of variation (CV), and a 90% confidence interval for CV. As suggested by the EPA guidance, only measurements above level of detection will be used in precision calculations. The CV is defined as the standard deviation of the differences divided by the mean of the measurements and expresses the variability in the differences as a percentage of the mean.

Precision will be assessed separately for each phase of the verification test.

7.3.4 Meteorological Effects/Precursor Gas Interferences

The influence of meteorological conditions on the correlation between the continuous monitors and the reference methods will be evaluated by using meteorological data such as temperature, humidity, etc. as parameters in multi-variable analyses of the reference/monitor comparison data. The model to be used is as follows:

$$C_i = \mu + \beta \times R_i + \sum \beta_j \times X_{ji} + \epsilon_i \qquad (2)$$

where the X_{ji}'s are meteorological and/or precursor gas measurements for the i^{th} 24 hour time period, the β_j's are the associated slope parameters, and other notation is as before. Comparability and predictability results will be reported again after these variables are adjusted for in the model. Additionally, estimates and standard errors of the β_j's will be provided.

Meteorological effects and precursor gas interferences will be assessed independently for each of the two duplicate monitors being tested and will be assessed separately for each phase of the verification test.

7.3.5 Short-Term Monitoring Capabilities

The capabilities of these monitors will be assessed from comparison to gravimetric samples collected of short sampling periods (3-8 hours) by the reference methods. This assessment will be based on linear regression analysis of the short-term sampling results from the continuous monitors and the reference method to which it is being compared. The analysis will be conducted and the results will be reported in a fashion identical to that for the comparability and predictability results described in Sections 7.3.1 and 7.3.2.

Comparisons of this type will be made only after establishing the relationship between the short-term sampling results and the corresponding 24-hour results. The relationship between the two sets of reference measurements will be made by linear regression using the average of the results from the short-term sampling as the dependent variable and the 24-hour results as the independent variable in the regression analysis. Comparability will be assessed using equation (1), replacing the average of continuous measures with the average of short-term sampler measurements.

The short term sampling results will also be used to assess the effects of meteorological conditions and precursor gas concentrations on the response of the monitors. These short term results will be used in place of the 24-hour measurements in the analysis described in Section 7.3.4.

Independent assessments will be made for the duplicate monitors and the data from each phase of testing will be analyzed separately.

7.3.6 Qualitative Comparisons

As described in Section 3.5.2, additional qualitative comparisons may be made between the monitors being verified and other monitors provided other monitors are in use on site that are adequately comparable to the $PM_{2.5}$ FRM. A continuous monitor will be considered adequately comparable if, under analysis using equation (1), the squared correlation coefficient (r^2) is at least 0.90 and the slope and intercept estimates are within three standard deviations of unity and zero, respectively.

Given an adequately comparable continuous monitor, qualitative comparisons between this monitor and the tested monitor will consist of overlaid time-series plots of measurements. Such plots allow visual inspection of similarities and dissimilarities in measurements an temporal patterns continuously over the entire month of data collection.

Similar overlaid time-series plots will be made with the results from the continuous meteorological and precursor gas monitors when appropriate.

Qualitative comparisons will be made separately for each of the two duplicate monitors being tested and for each phase of the verification test.

7.4. Reporting

The statistical data comparisons that result from each of the tests described above will be conducted separately for each technology being verified, and information on the additional cost factors (i.e., costs associated with calibration gases, etc.) will be reported. Separate verification reports will then be prepared, each addressing an individual technology provided by one commercial vendor. For each test conducted in this verification, the verification report will present the test data, as well as the results of the statistical evaluation of those data.

The verification report will briefly describe the ETV program and the AMS pilot, and will describe the procedures used in verification testing. The parties involved in the verification test will be identified and the roles of each will be described. These sections will be common to each verification report resulting from this verification test. The results of the verification test will then be stated quantitatively, without comparison to any other technology tested, or comment on the acceptability of the technology's performance. Included in the verification report will be descriptions of the following parameters:

- operating conditions during testing,
- instrument settings used during testing,
- and the inlet used during the test.

The preparation of draft verification reports, the review of reports by vendors and others, the revision of the reports, final approval, and the distribution of the reports, will be conducted as stated in the Generic Verification Protocol for the Advanced Monitoring Systems Pilot. Preparation, approval, and use of verification statements summarizing the results of this test will also be subject to the requirements of that same Protocol.

After approval, the final verification reports and verification statements will be made available to the respective vendors in hard-copy, and will be posted on the ETV website (www.epa.gov/etv/). The reports may also be presented or made available at various technical conferences and trade shows.

8. Health and Safety

Before each phase of testing begins, site management will be responsible for reviewing the necessary health and safety requirements and guidance for the respective test sites with Battelle, EPA, and vendor staff. While on site, Battelle staff will operate under these established requirements and guidelines. It is expected that while on site EPA and vendor staff will also operate according to these requirements.

9. References

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[6] A complete list of designated methods can be downloaded from:
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[8] Federal Energy Technology Center, "Test Plan and Quality Assurance Procedures-OST PM2.5 Sampling and Analysis Program", draft prepared by Brigham Young University, Provo, UT, and Federal Energy Technology Center, Pittsburgh, PA., 1999.

[9] Desert Research Institute, "Test Plan for Fresno Supersite", draft in preparation by Desert Research Institute, Reno, Nevada.

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[15] U. S. Environmental Protection Agency, "Environmental Technology Verification Program Quality and Management Plan for the Pilot Period (1995-2000)", EPA-600/R-98/064, Cincinnati, Ohio, May 1998.

[16] American Society for Testing and Materials, "Standard Test Method for Determination of Gaseous and Particulate Polycyclic Aromatic Hydrocarbons in Ambient Air (Collection on Sorbent-Backed Filters with Gas Chromatography/Mass Spectrometric Analysis)", ASTM Method D 6209-98, in *Annual Book of Standards, Vol. 11.03*, West Conshohoken, PA, 1998.

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