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Alliance of Residents Concerning O'Hare and Mothers Against Airport Pollution O'Hare Flight Expansion "OMP" FEIS Comments

FILED IN PROTEST: FAA NOT RESPONSIVE, PROCESS TO FAST FOR AMOUNT OF DOCUMENTATION, ETC.

Overall and total non-responsiveness to appendices.

The FAA has, in their responses to AReCO's DEIS Comments, demonstrated that they are really not interested in honest, detailed criticism of their environmental analyses of the probable impacts from the planned, massive O'Hare expansion, of which the FAA appears to be fully supportive. This is crystallized in FEIS response 18 (p. U.4-300): "The FAA's mission is to provide the safest most efficient airspace system in the world." This mission statement is notably devoid of components related to the environment and public health, and the FAA's prosecution of the O'Hare OMP EIS, especially the FEIS, clearly shows that these factors are of minimal priority.

It is not enough for the FAA, with degrees of complicity from "cooperating agencies", to produce thousands of pages of documentation to create "form", without properly addressing "substance". And AReCO's extensive substance has been largely dismissed, minimized and discounted with statements such as "The FAA reviewed AReCO Appendix D in responding to the comments contained in the main text of this [AReCO DEIS Comments] letter regarding the same issues." This is not just disingenuous but is instead a blatant statement that "we do not intend to address such extensive issues". Even a cursory review shows that, in fact, the FAA indeed did not even attempt to address most of the issues "...in responding to the comments contained in the main text...".

AReCO made it abundantly clear in our DEIS Comments that the Comments appendices were to be considered an integral part of the Comments, not just a compendium of information for the FAA's reference. This is set forth, for example, in the line following the topic of Air Quality Dispersion Modeling (DEIS Comments, p.11), where it is stated: "Reference Appendices D, D1 and E for all AReCO comments in this category." Thus, a mere "reviewing" of these Comments is a dismissal of those extensive and detailed comments and issues.

AReCO is forced by these FAA actions to resubmit here our unanswered DEIS Appendices D, D1, E, F, H and I. See below. We demand specific responses to the specific issues and questions presented in these appendices, not just dismissals, along with appropriate actions and resolutions, not just platitudes.

Mitigation recommendations by the FAA acknowledge problems for which proposed solutions are woefully inadequate to protect public health, quality of life, our living environment, etc. We have not seen a full accounting of the projected costs of mitigation in the EIS, along with funds allocations plans; obviously, funds must be identified and allotted.

The FAA's scope and purpose is too narrow to allow any reasonable or better alternatives; thus, defeating the heart and soul of NEPA. By clever design, the only FAA alternative of the damaging affects of aviation is more aviation.

The FAA also tries to wash its hands of its liability and responsibility being of being the key federal authority, with general disclaimers; in fact, as the federal agency that is responsible for approving this massive "almost new" airport expansion, it strongly shares liability with the city of Chicago and others.

Comments relative to FAA's responses to specific other AReCO DEIS issues/questions.

[Lack of comment here regarding any of FAA's responses to AReCO's DEIS comments does not necessarily imply agreement with the FAA.]

In reference to FAA comments #:

7) The FAA's key informational web site remains inaccessible, as tested by at least four different computer systems and knowledgeable individuals. It is NOT "publicly accessible". Requests to the FAA to test (in)accessibility by their staff from their homes and not office network, went unanswered. In fact, by not holding hearings in at least the affected neigborhoods in the city of Chicago proper, we believe it was an intended purpose to exclude the large majority of Chicagoands that are affected and strongly opposed to the airports expansion. Furthermore, the FAA only supplied one copy of the EIS documents to the Harold Washington Library downtown and none to other area libraries.

10) The FAA's answer, "The EIS addresses the entire O'Hare environment, including locations where employees work." is wrong. There were no dispersion analyses "receptors" (analysis points) located at key employee working areas, for instance the outdoor gate areas, de-icing stations, etc. The nearest receptors were placed in the public roadway "curbside" areas, e.g. R1, R2, etc. This is one of the reasons why AReCO stated that OSHA should have been one of the "cooperating agencies" (and still believes that). Thus we continue to disagree with the FAA's continuing position to exclude OSHA.

11) AReCO had expressed in detailed fashion significant concerns that the EIS analyses of air quality excluded any consideration or quantifications for on-board aircraft passengers while the plane was "buttoned up" and still on the ground (e.g. taxiing, being de-iced, etc.), knowing that outside polluted air is ingested into the aircraft through its on-board ventilation system. The FAA states, "The EIS addresses the entire O'Hare environment, including locations utilized by passengers." This is blatantly false in this regard.

17) The FAA states, "FAA has not predicted the future price of oil in developing the forecast used in the EIS. In fact, the FAA annually forecasts the future price of jet fuel (which is the obviously implied issue) in their *FAA Aerospace Forecasts*, looking out at least 10 years. If we are to interpret FAA's comment that that is true but that the FAA does not consider fuel costs in forecasting future flight activity, then the forecasts are inherently wrong.

To that extent, we have petitioned the FAA to immediately produce a mid-year correction to their Aerospace Forecast, and to reflect the unacknowledged high fuel costs in revised O'Hare EIS forecasts. The to-date unanswered petition is attached here for reference [Appendix X].

22) The FAA's assertion that, "The FAA does not believe that the OMP's success is dependent upon theseElgin-O'Hare Expressway [EOH] and/or Western O'Hare Bypass [WOB] projects" flies fully in the face of their own DEIS data, indicating substantial traffic "gridlock" if these (and other "massive infrastructure programs", as AReCO stated) are not concurrently implemented. If the FAA is basing their whole OMP justification ("purpose and need") on several minutes of reduced passenger aircraft delays, while simultaneously disregarding many minutes of increased passenger airport-access delays, the entire project justification is a sham.

AReCO continues to maintain that the FAA cannot claim the benefits of passenger (and freight) delay reductions as project justification without reducing those delay reductions by inclusion of delay increases due to increased congestion and increasing costs to include any expenditures needed to achieve assumed airport access delay reductions. The fact that additional airport access infrastructure funds are not supplied by the FAA or the airlines is irrelevant.

37) The FAA's clarification that, "Multi-family dwellings are eligible for FAA funding as part of an overall mitigation plan" implies that Chicago's existing mitigation program, as administered by ONCC, is exclusionary by choice. Any OMP ROD should clearly state that multi-family dwellings shall be included in any mitigation program by Chicago/ONCC, on equal footing with single-family dwellings.

39) The FAA's statement that, "In addition, the capping of operations is contrary to the purpose and need of this EIS" is absolutely false. The regulatory purpose and need of this EIS is to protect the public, under NEPA and other auspices, from unexpected or unauthorized emissions dangerous to the public health, our living environment and general well-being. The FAA and EPA are delinquent in their duties if emissions impacts are not analyzed on the basis of maximum limits. The FAA's statement that, "[it] believes that the range presented constitutes a reasonable estimate of potential range of alternative levels within the planning horizon" is unacceptable as a regulatory public protection mechanism.

We restate that expanded O'Hare operations must be either capped at the FAA's analyses level or the analyses, (i.e. emissions inventories and dispersion analyses) must be re-run at the expanded OMP maximum capacity (as determined by annual flight delay's equal to those experienced in the 2002 "baseline" assumptions).

40, 41) AReCO's previous requests for detailed summaries of aircraft emissions, by mode, in order to validate the FAA's assertions that "The inventories include emissions from aircraft arriving and departing O'Hare up to an altitude of 2,510 feet (approximately 0.5 miles in altitude)" remain unanswered. The facts that, (a) these summaries should be easily created by EDMS data/report outputting capabilities, (b) there are potential differences between full emissions inventories and the portion used for dispersion analyses within EDMS, (c) that a substantial difference exists between prior IEPA and DEIS inventories, and (d) the DEIS and FEIS state that, "The macroscale and microscale dispersion modeling was performed for ground level emissions only" [p. ES-32], maintains and increases suspicions that the FAA's statement is untrue.

The FAA must publicly validate their position by publishing a summary of emissions factors used, time-in-mode and emissions totals by aircraft type and mode (approach, taxiing, takeoff, climbout), for all of the various emissions analyzed.

42, 43, 44) The FAA's comments, "…limited available data with respect to particulate matter emissions from aircraft engines prevents a more accurate quantification…than that presented in this EIS" implies that the "First Order Approximation" (FOA) method used (based on smoke number correlations) used to calculate non-volatile PM2.5 emissions, and the assumed 3:1 ratio of volatile to non-volatile PM emissions are in fact at least reasonably accurate.

AReCO has disagreed with this in the past, both in DEIS comments and in communiqués with EPA, and restates that the non-volatile PM2.5 calculation method (FOA) is seriously flawed and significantly underestimates the actual probable non-volatile PM emissions. We include here [Appendix Y] a research study that fully validates our position. This study, "Flawed FAA Aircraft PM2.5 Emissions Estimation Method…Archaic "Smoke Number" Use Behind Failure", has also been forwarded to the FAA's EIS cooperating advisory agency, the EPA, which we have asked to declare this method unacceptable for use.

Additionally, the 3:1 ratio of volatile to non-volatile PM has not been scientifically documented in the public eye and is therefore highly questionable. AReCO attempted to procure such documentary support, such as measurement results from the APEX program (18 months ago), from both the FAA and the EPA, without success.

Even if the volatile ratio assumption was reasonable, this means that the FAA's calculations of total PM2.5 (non-volatile plus volatile) emissions are under-calculated to the same significant degree of error as are the basis calculations of the (FOA) non-volatile portions, which the research paper suggests could be too low by factors of 2-10:1.

AReCO strongly notes again that the IEPA has stated that these EIS PM2.5 results will be incorporated in their in-process PM2.5 SIP as the most current and accurate figures available to them. Thus, these results will impact Illinois state programs, which the USEPA will have to approve. That is, the FAA's results will be reflected to a much wider scope than this EIS. Furthermore, since the FAA has chosen to rush these PM calculation methods into EDMS incorporation, these methods and assumptions have nation-wide impact for <u>all</u> airport PM2.5 calculations, thereby similarly being adopted into the PM2.5 SIP's of <u>ALL of the states</u> and committing the USEPA to a de-facto approval of these (seriously flawed) methods and results for these SIPs.

For all of these reasons, the FAA must rectify these serious errors and recalculate PM2.5 (and PM10) emissions based on good, publicly documented, scientific evidence (measurements and engine operating parameter associations), then recalculate related dispersion analyses results, before issuing any final OMP EIS conclusions and ROD.

Additionally, after calculating the improved (yet still too low) PM2.5 dispersion analyses results, the FAA has failed in the FEIS to follow the dispersion analysis protocol established in the EIS for PM2.5. In this regard, AReCO has previously posed the very serious issue that the "worst year" (1990) choice by the FAA/IEPA was in fact not the best choice for "worst year", thereby minimizing probable future expected meteorological conditions that would result in worse NAAQS dispersion results than calculated in the EIS. In order to mute this kind of impact, the official protocols for analysis state that, "Should any of the predicted concentrations be close to (within 10%) an applicable standard, additional years of meteorological data will be simulated…". In fact, PM2.5 Annual dispersion results exceed this criteria, (i.e. 13.5 ug/cu.m.) for ALL program alternatives and schedules, yet no such additional simulations were performed. The FAA must perform these simulations, even without considerations of the probable severe under calculations discussed above.

47, 48) The FAA is wrong in it's conclusion that mercury emissions from O'Hare aircraft (and GSE) are insignificant. The FAA also errs in it's implication that there are no aircraft mercury emissions, based on the Shumway report. In fact, the detection limit in that study was 1 ppb, thus, it must be assumed from that study that the amount of mercury could be as high as 1 ppb. More importantly, other sources tend to contradict Shumway's low results.

The USEPA states in their emission factors document AP-42 that the mercury factor is 1.2E-6 lb/MMBtu (1.67E-4 lb/1000gals., 26 ppb) for gas turbines burning number 2 distillate fuel oil, which is similar to aircraft fuel (kerosene).

AReCO calculates [ref. Appendix Z] that mercury emissions form aircraft LTO operations alone, as expanded, will be between 1-24 lbs/year, using these two limits. Addition of mercury emissions from GSE and on-airport. Natural gas combustion increases this range to 72-96 lbs/year. Since it is noted that the EPA and many of the states around Lake Michigan set source reporting requirements at 10 lbs/year, O'Hare mercury emissions certainly would be considered "significant", requiring at minimum that the FAA and EPA impose such reporting requirements (including other sources such as vehicular traffic and construction vehicles) on any O'Hare expansions and directing that those emissions be included in the Lake Michigan states mercury reduction program partnership's data base.

49) Regarding air pollution from de-icing fluids, the FAA's difficult to understand conclusions are totally wrong and in violation of basic physics: "…vaporization during aircraft treatment is appropriate to consider…the ambient temperature is low…At low temperatures these fluids do not evaporate."

We are at a loss to understand this circuitous logic. First, the de-icing fluids are heated to a high temperature (180 degrees F) when applying (spraying), guaranteeing evaporation, independent of the ambient temperature. Secondly, ethylene glycol gases are lighter than air and will thus not sink to the ground. Glycols combined with water molecules will act much the same as "steam" in the winter, dispersing their contents downwind. Finally, the FAA cannot make such statements for de-icing and anti-icing fluids without a clear understanding of the hazardous additives therein (in addition to glycols), of which AReCO continues to ask for full disclosure of said additives, with no response from the FAA or EPA.

We again state that the FAA must include inventories and dispersion analyses for de-icing and anti-icing fluids (glycols and HAP additives) for any and all OMP operational configurations before claiming the EIS is complete and issuing an ROD.

58, 59) The FAA has NOT answered AReCO's question, stated with detail, as to why a HAP's Risk Assessment, based on dispersion analyses, cannot be done, when all the elements exist to do it. The FAA merely replays the same "cop out" statement from the DEIS, as AReCO had already highlighted as the focus of its queries in its DEIS Comments. [See p. U.4-309 under HAPs].

The FAA thus merely maintains this DEIS position in the FEIS, with no change or further illumination, which we consider to be a "brush off" of the entire issue.

The FAA must accomplish this HAP's Risk Analysis and satisfy our call for an evaluation of indirect medical/health costs impacts before the EIS can be considered complete and before issuing any ROD, in order to protect the public.

60) AReCO disagrees with the FAA's statement. The fact is that no pollution-related studies on bird populations have been done. The FAA apparently feels that considerations of pollution impacts on wildlife are not "appropriate" to environmental studies.

Appendix D: Flawed/Missing Criteria Pollutant Dispersion Analysis

There are numerous flaws and deficiencies associated with the FAA's attempt to achieve the overall objective of characterizing and predicting atmospheric pollution content, resulting from airport emissions, in areas where people might be exposed to unacceptable levels of these pollutants that can create potential health and welfare dangers.

BASICS

The purpose of this "tutorial" section is to provide reader context in order to better assess and judge the following DEIS criticisms/comments.

The primary objective of dispersion analysis is to translate emissions into atmospheric concentrations at various geographical locations, at some distance from the emissions source(s), under meteorological and other influences, such as emission and "receptor" altitudes, emission rise (due to elevated temperature), etc. Such analyses are in reality models and methods that largely attempt to simulate the meteorological transport mechanisms that influence emissions movement toward and dispersion during transport from source to receptor (a geographical point in the atmosphere, most often defined to be points where people are or may be present).

There are at least three categories of "people" that need to be included in such analysis: (1) exposure to the public beyond the airport boundary, (2) exposure to the public within airport boundaries, (3) exposure to airport workers (employees and non-employees) within the airport boundaries. In the latter case, airport/airline employees, contract workers, public safety, etc. workers operating within the active aircraft areas are of particular concern (e.g., fuelers, de-icers, baggage handlers, etc.) due to their close proximity and long term exposure working conditions.

Thus models need to be able to accurately (reasonably) simulate conditions over short (10's to hundreds of meters), medium (hundreds to few thousand meters) and longer distances (up to about 15,000 meters). This might result in the need for various models and various sets of historical meteorological data.

Such simulations also assume that the weather in the future, here perhaps 15 years from now, can be adequately characterized as being "the same as" a period from the past. This is of course open to speculation. Nonetheless, the analyst must choose some set of acceptable past data to apply to the model as the assumed future. Sometimes this selection is made on the basis of an attempt to characterize the data as "worst case" (i.e., such that its use has been demonstrated to result in worse case concentration predictions). Historical weather databases are generally obtained from the National Weather Service (NWS).

Emission sources are inventoried as to amount (e.g., grams/second, tons/year, etc.), horizontal and vertical locations and other parameters (e.g., plume rise parameters). Decisions are made as to how to characterize the sources in order to present them to the model, with key types being point, line, and area and volume sources. Since traditional dispersion models cannot deal with dynamic situations, sources are generally averaged over an hour's time. For example, emissions from planes using a given runway will be summed over each hour, then averaged to an emission rate of, say, X grams per second by dividing the sum by 60.

In the case of planes (and roadways), the normal approach would be to model them as line-sources by then taking the emission rate and spreading it uniformly over the planes travel paths, including airborne (both horizontal and vertical parameters), runways and taxiways locations. Where the resulting lines are actually curved (such as a takeoff path), line segments might be implemented to approximate the curve.

Parking lots and the like are often modeled as area or volume sources. Stationary sources are usually modeled as point sources, though a fixed location volume characterization might be useful in some cases as well. Stationary sources with elevated chimney outputs (e.g., heating plants, manufacturing facilities, etc.) generally need additional characterizations related to pollutant plume rise due to buoyant forces (high temperature) and exhaust output velocity. These chimney structures are generally designed to discharge the pollutants high in the air, such that they travel over nearby people locations and are reduced in concentration before reaching people locations on the ground or other places.

All of the input data is then supplied to the dispersion model "core" for analysis. Most of these cores use a Gauissian dispersion approach. (A visual helps here; e.g., consider a chimney with a visible plume of pollutants streaming out in a horizontal direction, as set by the horizontal wind, which has been blowing in the same direction for an extended period of time. If there were no vertical up and down winds, and no crosswinds, the plume would be seen as a constant thickness pencil line across the sky [much like upper atmosphere plane contrails]). But within the "mixing layer" close to earth (generally less than 1000 meters thick), there are considerable circulating up/down/cross winds induced by thermal heating of the earth's surface. These numerous, random circulations, characterized as atmospheric "instability", will cause the plume to widen with distance, becoming non-uniform in cross-sectional concentration, with the non-uniformity characterized as a Gauissian distribution…thus the "Gauissian" model. The degree of instability used in the analysis is normally determined for each hour by the pre-processor, or sometimes set at a fixed value (e.g., "neutral").

It is important to understand that such a Gauissian model first converts the point source into a horizontal line source with the line's emission rate over its length being inversely proportional to the assumed wind speed. For instance, a point source emission of 100 pounds per hour would, with a wind speed of 10mph, be converted into an infinitely thin line source of 10 pounds per hour per mile. Then the atmospheric instabilities would be applied to the line to cause it to spread (disperse) with distance, and how much of this spread reaches the ground (or 6' above it) would be calculated along its length i.e. distance from the original point source.

Instability factor assessment within the simulator (the under-pinning mathematics) has advanced over the decades, but still is associated with restrictions on ranges of applicability. For example, if one plans on doing a dispersion analysis over a distance of ten miles, one must necessarily assume that the atmospheric stabilities determined at a single point, (e.g., O'Hare airport weather station), are unchanged over that entire distance. Alternately, the hourly instabilities could be actually characterized over that distance (area) through use of more extensive atmospheric data sets and/or use of expanded capability simulation models.

On the other hand, for very short distances, in complex physical environments, such as an airport, validity of the use of stability factors, perhaps determined for 10 meters and above, becomes questionable at best when dealing with near-ground sources and receptors (potential people locations). Conditions in a layer immediately above the earth might be even more unstable than higher up in the summer, due to ground heating (e.g., tarmac, and more stable in winter due to frigid and/or snow covered ground) [creating a low altitude inversion layer (i.e., gets warmer as altitude increases)]. The impact of these situations may not be too significant for long-term averages, such as a year, but could be very significant for short-term conditions (e.g., 1-24 hours).

It is clear that lower wind speeds increase the line source's "center line" concentration and that more stable atmospheric conditions will spread it less at a given distance. It is also clear that for any given point source above the ground (think chimney again), that ground level pollutant concentration will be near zero at the base of the chimney, will increase to a peak level at some distance from the chimney, then decrease farther on (all this assumes the simplistic case of a constant wind and stability condition over the distance being considered). Thus, it is incorrect to state that pollutant concentrations always decrease with distance.

Finally, the model core outputs all the hourly calculation data to a post-processor module that converts the numbers into averages over time, creates maps and documentation, etc. The post-processor may be a data base system (e.g., Microsoft Access or a spreadsheet program [e.g., Microsoft Excel, or combinations]). The key requirement here is accuracy of the information retrieval process. That is, one has to be confidant that the value returned for "maximum hourly carbon monoxide level" is indeed the maximum, etc.

The FAA's EDMS analysis system uses a Gauissian modeler core (AERMOD), as do many others, modernized to use a (vertical) probability density function for unstable conditions. It includes a meteorological pre-processor (AERMET), along with various databases and processing capabilities (e.g., handling of line sources via CALINE and mapping). EDMS/AERMOD also includes the capability to model building downwash (plume downwash effects downwind behind a source building) via PRIME.

More advanced modelers exist and are approved for use by the EPA, such as "puff" models like CALPUFF or specialized modelers like the Offshore and Coastal Dispersion Model (OCD). CALPUFF is often particularly useful. To quote the EPA (APPENDIX W TO PART 51—GUIDELINE ON

AIR QUALITY MODELS):

> CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion modeling system that simulates the effects of time- and space-varying meteorological conditions on pollutant transport, transformation, and removal. CALPUFF is intended for use on scales from tens of meters from a source to hundreds of kilometers. It includes algorithms for near-field effects such as building downwash, transitional buoyant and momentum plume rise, partial plume penetration, subgrid scale terrain and coastal interactions effects, and terrain impingement as well as longer range effects such as pollutant removal due to wet scavenging and dry deposition, chemical transformation, vertical wind shear, overwater transport, plume fumigation, and visibility effects of particulate matter concentrations.
>
> (2) CALPUFF may also be used on a case-by- case basis if it can be demonstrated using the criteria in Section 3.2 that the model is more appropriate for the specific application. The purpose of choosing a modeling system like CALPUFF is to fully treat stagnation, wind reversals, and time and space variations of meteorology effects on transport and dispersion, as discussed in paragraph 8.2.8(a).

DEIS DISPERSION ANALYSIS FAILURES and DEFICIENCIES

** Failure to adequately characterize emission source quantities.
The emissions inventories shortfalls enumerated in Appendices B and C and other places, will cause inaccuracies in outputs, generally translating into understatements of any calculated pollutant concentrations (i.e., errors).

** Failure to analyze beyond airport "fence line".
Failure to promulgate the dispersion analysis beyond the airport boundaries (fence line) is just unacceptable. The analysis must go out to a minimum of at least a 5-mile radius around the airport boundaries (10 miles is preferred).
Justification that the fence line represents the "maximum" pollutant concentrations, without any supporting simulation evidence is unwarranted and unacceptable. In fact, pollutant concentrations can be higher at more distant points, especially if the emission sources are substantially elevated and/or close to the fence line (e.g., the north runway under light south winds).

**Failure to properly place receptors around the airport.
Receptors were apparently purposely placed on the airport "fence line" in most cases. Since major roads border the airport, this "conveniently" decreases maximum receptor values for some (many) conditions where roadway emissions are removed from receptor impact by wind directions (or where one chemical's concentration is diminished by another's).

For example, with a south wind, airport receptors along the north periphery would include effects from aircraft activity on the north runway, but would not include any effects from roadway traffic on the I-90 expressway. Those living in Des Plaines, just north of I-90 would be fooled into believing that the calculated receptor values approximately represented the levels of pollutant concentrations they would be exposed to. If the receptors were instead placed just north of I-90 (maybe a shift of only several hundred feet), they would now register much higher calculated values (southerly winds) due to the combined effects of the north runway (and all other airport activities south of there) and the I-90 traffic and the general prevailing winds for the summer months.

This appears to be a planned deception, since, supposedly, the emissions from roadway traffic are taken into consideration when calculating receptor values via dispersion analysis. ["The emission inventories include contributions from vehicles on major arterials in the vicinity of the airport." P. J-111]

Even more, the magnitude of the deception is not small, as exhibited by the fact that motor vehicles are stated to make major contributions to the total emissions inventories, for instance 15,589 tons per year of CO out of a total of 28,838 tons per year, for 2002 "base" conditions. [Table J.2-71, p. J-142]

Receptor placement in the near-airport area must be revised to be placed on both sides of the "major arterials" from the airport, and analyses rerun.

**Failure to consider situations where pollutants are drawn into building ventilation systems. The "convenience" of terminating the dispersion analysis at the airport fence line obviates the need to consider situations where the pollutants are drawn into rooftop building ventilation systems, thereby exposing all of the occupants to potentially dangerous conditions. These buildings are of particular concern as they are usually multi-story and vulnerable to pollutants lofted into the air from the airport operations, such as from elevated chimney structures or airborne aircraft.

Office workers, etc. spend great parts of their time at their place of work (8-12 hours per day, everyday) and expect the building owner and their business management to provide a safe environment. The DEIS analysis does not validate such expectations.

Tourists and visitors staying in expensive hotels, such as the O'Hare Hilton on the airport property or in nearby Rosemont, and employees, expect a safe environment and therefore need to be assured that airport emissions entry will not compromise that safety. The DEIS analysis does not provide such assurance.

Multi-story apartment residents nearby, such as along River Road. in Schiller Park or just northeast of O'Hare, do not expect a hazardous atmosphere for their family (including young children, pregnant mothers, the elderly and other "sensitive" groups) when opening their windows for summertime ventilation. Yet the DEIS does not even address those expectations, let alone assuring safety.

The dispersion analyses must be re-run with additional receptors located coincident (horizontally and vertically) with key surrounding building ventilation intakes, including:

> All airport terminals, airport located office buildings (e.g., U.S. P.S., etc.), O'Hare Hilton, Rosemont Hotels, the office building at Lawrence and Mannheim, and any other office building or hotel located within 5 miles of the airport perimeter.

Additionally, receptors must be located coincident with any multi-story apartment building within 5 miles of the airport perimeter. Each location must have receptors located vertically at the second floor height, as well as the top floor and building vertical mid-point (as one does not know, apriori, which height will experience the highest pollutant concentration level).

**Failure to analyze HAPs at all.

Limited Hazardous Air Pollutants (HAPs) are considered, documented and inventoried in endless pages (J-1 to J161) of the DEIS. Yet in the end, no dispersion analysis at all is done, even to the airport's fence line (which would seem, at minimum, of value to protect airport employees, especially those working outside on airport property).

**Questionable decision on "worst case" weather year.

The DEIS uses 1990 as the "worst-case" weather year, "…for the five-year period (1986-1990)…based on discussions with IEPA…" [p. J-155, Teleconference with IEPA, 11/22/02]. The DEIS does not clarify why or how 1990 was chosen as worst, though there is an implication that some dispersion analyses were run for those years in order to choose "worst". The DEIS also does not clarify why the period of 1986-1990 was chosen for examination as contrasted to, say 1986-2000.

Much of this DEIS is "borrowed" from the (now reincarnated as part of OMP) World Gateway project proposal, which was also under IEPA guidance. There, 1994-1999 was examined and 1995 was picked as the worst year, based on dispersion run screens. [WGP p. I-14] So is 1990 a "worst" year, or perhaps 1995, or maybe some other year, say 1993…

To complicate matters further, in order to run screening dispersion analyses to pick a worst year to use as the model for future characterizations, one logically must input the meteorological data for each year within the chosen range into the model. EDMS, being used for FAA analyses here, uses a weather pre-processor (AERMET) to ensure quality in the data finally submitted to the dispersion analyzer (AERMOD). Any deficiencies noted by the pre-processor are flagged to the analyst for correction. Human intervention here, though warranted, leaves open the possibility that a truly "bad" year for dispersion might be converted to a not-so-bad year for entering into the model. The DEIS must document any changes that were made to the (NWS) meteorological databases before entering into the dispersion model for analysis. [See also "Calms", below.]

**Failure to characterize "calms" meteorology (wind speed) situations and residual pollutant effects, which combined are usually the "worst-case" pollution scenarios, instead just disregarding them because of EDMS in capabilities. [See Appendix D1] A more capable modeler must be applied, such as CALPUFF.

**Probable mis-measurement determination of true "calms" conditions by the O'Hare weather station due to local wind disturbances from nearby landing/takeoff aircraft (i.e., makes it appear officially windier than it actually is in the airport area.

**Failure to consider building downwash and other structure effects; failure to adequately define the terminal roadways (curbsides) areas models.

The DEIS dispersion results today tend to show high(est) pollutant concentrations in the terminal curbside areas. These areas are located next to building structures, often in semi-enclosed environments. At a minimum, the DEIS must document exactly how these complex areas were physically modeled, along with any associated assumptions, either in the DEIS body or in reference EPA agreed-upon "protocols." This documentation must include whether or not EDMS building downwash modeling (PRIME) was implemented for any sources and which.

Additionally, the assumptions used to model the terminal area roadways (curbsides) are incomplete and suspect. The only information provided is that they "...were modeled as line sources located next to the on-Airport roadways immediately in front of the various terminals." "Next to" does not define how distant from the roadway centerline a line source was placed nor on which side of the centerline it was placed, both of which can make substantial differences in the calculated results (from vehicle emissions). Nor is it clarified as to exactly where the modeled receptors (R1-R8, 15 total) were placed.

Line source placement should be instead on the road centerlines for both upper and lower curbsides. The lower levels must be modeled, where physically appropriate, as two adjacent roadways, with a center island between them. Receptors must be placed on the pickup/dropoff areas adjacent to and, in the case of the lower levels, on the island between the two roadways.

Even given these modeling improvements, it is a matter of debate as to how accurate the EDMS dispersion analysis portrays the complex nature of these areas. There must be documentation included in the DEIS that clarifies the methods used.

**Failure to treat numerous, location shifting airport sources with statistical methods in order to properly assess risks.

Mobile airport emission sources are just that...mobile (i.e., they are in a constant state of moving around). The technically correct way to model this situation is to use a statistical approach, not the EDMS approach of trying to "average" everything. [See Appendix F]

**Failure to characterize airborne aircraft as airborne line sources.
The DEIS appears to not characterize airborne aircraft emissions, or if it does (which is a serious question here), does not place the emissions on a line-source trajectory, in order to then include as a source in the dispersion analysis, even if the trajectories are assumed "nominal" vs. real world spreads (note that most important trajectories, closer to airport, are reasonably well defined).

**Failure to document exactly how the aircraft airborne emissions were characterized as sources. Sometimes analysts take shortcuts and calculate aircraft airborne emissions but artificially place them in the model as point sources at the end of the runways (takeoff or landing ends). This can introduce errors in pollutant concentration results and should not be done except for special cases, and then well documented.

**Failure to distribute aircraft on runways/taxiways as line sources.

The DEIS indicates that:

> "Aircraft emissions occur on the taxiways, at the end of the active runways, and on the runways themselves. These emissions were simulated as a set of stationary point sources at each terminal apron area next to aircraft gate locations." [p. J-151]

Though this may have provided simplification for the analyst, or was done as an artifice to allow "worst-case" analysis of the aircraft emissions on terminal areas, it is basically wrong.

This act will result in a reduction of modeled emissions concentrations in some areas (i.e., in proximity to where the emissions actually occurred). For example, artificially moving all of the proposed north runway emissions to the center of the airport (apron areas) will substantially reduce the calculated effects in Des Plaines under south wind conditions (i.e., the runway source is now [artificially] much farther away). Another example might be locations where planes actually taxi by or queue up in a takeoff waiting line now have (artificially again) these sources moved to more distant locations.

Furthermore, consolidating more distant aircraft line sources much closer to receptors (e.g., terminal curbsides) can actually cause a reduction in the calculated receptor concentrations. Consider a simple example: a distant, say 1600 meters, point source is directly upwind from a receptor, but offset 100 meters. A substantial amount of the source pollutants will arrive at the receptor due to horizontal dispersion as the pollutants move towards it. Now place the same source, say, and 200 meters directly upwind from the receptor and again 100 meters offset. Very little of the pollutant will reach the receptor as the source "plume" has little horizontal spread at the receptor's location.

This simplifying approach should not have been taken. If run as a separate "worst-case" analysis, great care must be taken as to artificial source consolidation locations and wind directions. [Ideally, several artificial source location alternatives should be test-runned, with variable direction winds to determine "worst-case".]

**Failure to publish methods used to determine annual averages of simulated results, from which the "highest" was picked.
It is not clear whether EDMS automation or analyst manual methods of determining 3 hour, 8 hour, 24 hour and yearly averages are done in exactly the proper fashion proscribed by the EPA in setting the various pollutant concentration regulatory limits.

For example, one of the CO limits is an 8-hour average. Was that determined in EDMS for 3 discrete 8-hour periods in the days, or several overlapping 8-hour periods, or by some form of moving average? And how does that method compare to EPA methods requirements?

This must be well documented.

**Failure to do second level analyses that clarify and state what the major source was behind any high receptor values, even if not, by current calculations, in exceedance of limits.

Such analysis is required in order to (a) assess what are actually the "drivers" of the high numbers, (b) to allow judgment of viability and sensitivity and, (c) to allow consideration of possible mitigation methods, including airport design changes. It is critical to situational understanding to be able to quantify the relative source contributions to any receptor location for the various pollution sources in the analysis. Without this characterization, one is totally unable to understand, for example, what the major CO contributor to curbside conditions is. Is it primarily vehicles, or aircraft/GSE, or a nearby heating/refrigeration plant, or ?

Appendix D1: Slight Of Hand…How the potentially highest predicted pollutant concentrations "disappear"!

CALMS

Question: When is pollution really bad? When the weather is "calm". This generally means, as most who live in major urban areas know, when the wind speed goes to zero, or close to it, especially if it stays that way for hours (or days). So one would of course expect that a dispersion modeler, such as EDMS, would indeed predict the highest levels of pollutant concentrations to occur during hours of the year that are defined as "calm." You would be sorely disappointed!

The reason is that all hours of the year that are defined as "calm"…get discarded!

Yes, it's true. The dispersion analysis core modeler (AERMOD) in EDMS, like most "Gauissian" models, is incapable of doing its job when the wind speed is defined as "calm", so when it encounters a "calm" wind speed in the meteorological file sent to it, it marks the calculated pollutant concentration as zero and sets a flag in the output file to let the analyst know.

The "calm" definition comes to AERMOD from the EDMS meteorological preprocessor (AERMET), which gets its input from a historical National Weather Service (NWS) file. Now it gets a little worse.

The NWS measures wind speed with an instrument that has a threshold speed measurement capability, usually in the range of range of 0.5-1.0 m/s. But the NWS theoretically never reports lower than 0.5 m/s, so even if a file shows a speed of, say, 0.3 m/s, it is set to 0.5 by AERMET. [This is believed to be the case…older modelers (e.g., ISC set the speed to 1.0 m/s).]

> …This condition is not likely to occur since the minimum wind speed reported by NWS is 1 knot (about 0.5 m/s), excluding calm winds. … [Ref. AERMET Users Guide]

What happens if the NWS reports that the wind was "calm" for 8 hours in a row? That's correct, it all gets marked as "zero"/flagged!

Now, if a few hours of what would have been high readings get set to zero concentration and some 8760 hours (a year) of concentration calculations are being averaged to calculate a yearly average number, not a big impact. But what about averages over 24 hours (PM2.5, PM10, SO2) or 8 hours (ozone, CO) or 3 hours (SO2) or… 1 hour (i.e., "that hour" [ozone, CO])? Then it makes a big potential difference!

How this is handled is explained in the "calms-processing routine", demonstrated in these references:

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APPENDIX W TO PART 51—GUIDELINE ON AIR QUALITY MODELS
9.3.4 Treatment of Near-calms and Calms
9.3.4.1 Discussion
a. Treatment of calm or light and variable wind poses a special
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problem in model applications since steady-state Gauissian plume models assume that concentration is inversely proportional to wind speed. Furthermore, concentrations may become unrealistically large when wind speeds less than 1 m/s are input to the model. Procedures have been developed to prevent the occurrence of overly conservative concentration estimates during periods of calms. These procedures acknowledge that a steady-state Gauissian plume model does not apply during calm conditions, and that our knowledge of wind patterns and plume behavior during these conditions does not, at present, permit the development of a better technique. Therefore, the procedures disregard hours which are identified as calm. The hour is treated as missing and a convention for handling missing hours is recommended.

9.3.4.2 Recommendations

a. Hourly concentrations calculated with steady-state Gaussian plume models using calms must not be considered valid; the wind and concentration estimates for these hours must be disregarded and considered to be missing. Critical concentrations for 3- , 8- , and 24-hour averages must be calculated by dividing the sum of the hourly concentrations for the period by the number of valid or non-missing hours. If the total number of valid hours is less than 18 for 24- hour averages, less than 6 for 8-hour averages or less than 3 for 3-hour averages, the total concentration must be divided by 18 for the 24-hour average, 6 for the 8-hour average and 3 for the 3-hour average. For annual averages, the sum of all valid hourly concentrations is divided by the number of noncalm hours during the year. For models listed in Appendix A, a post-processor computer program, CALMPRO114 has been prepared, is available on the SCRAM Internet Web site (subsection 2.3), and must be used. b. Stagnant conditions that include extended periods of calms often produce high concentrations over wide areas for relatively long averaging periods. The standard steadystate Gaussian plume models are often not applicable to such situations. When stagnation conditions are of concern, other modeling techniques should be considered on a case-by-case basis (see also subsection 8.2.8). c. When used in steady-state Gaussian plume models, measured site specific wind speeds of less than 1 m/s but higher than the response threshold of the instrument should be input as 1 m/s; the corresponding wind direction must also be input. Wind observations below the response threshold of the instrument be set to zero, with the input file in ASCII format. In all cases involving steady-state Gaussian plume models, calm hours must be treated as missing, and concentrations must be calculated as in paragraph (a) of this subsection. [40 CFR Ch. I (7-1-03 Edition) Pt. 51, App. W] {Emphasis added…Ed]

"When calm wind conditions are encountered, AERMET does not perform any computations and inserts missing data indicators into the output files for the boundary layer parameters... [Ref. AERMET Users Guide]

The AERMOD model uses the same routines for processing calm hours as ISCST3, namely, hourly concentrations are not considered valid and are treated as missing, and concentrations for 3-, 8-, and 24-hour averages are calculated by dividing the sum of the hourly concentrations for the period by the number of valid (non-calm) hours. If the total number of valid hours is less than 18 for 24-hour averages, less than 6 for 8-hour averages or less than 3 for 3-hour averages, then the total concentration is divided by 18 for the 24-hour average, 6 for the 8-hour average and 3 for the 3-hour average. For annual averages, the sum of all valid hourly concentrations is divided by the number of non-calm hours during the year. However, the NOCALM option available in ISCST3, which models the calm hour by setting the wind speed to 1.0 m/s, is not available in AERMOD, since AERMOD uses a full profile of wind speeds, and is considered valid for cases when the wind speed is below 1.0 m/s but above the instrument threshold. A calm hour in AERMOD is identified by a reference wind speed of 0.0 m/s in the surface meteorological data file generated by AERMET. [Ref. http://home.pes.com/aerfaqs.htm]

...This condition is not likely to occur since the minimum wind speed reported by NWS is 1 knot (about 0.5 m/s), excluding calm winds. ... [Ref. AERMET Users Guide]

It is notable that no mention of "1-hour average" is made here, as there is no such thing (i.e., the minimum period is one hour).[1] Thus, in say a 24 hour period, where there was perhaps 8 calm hours, there is now 16 hours of valid data and 8 hours of invalid (to be not counted). Similarly, if a given year (8760 hours) is picked as the "worst case" for use in predicting the highest levels of CO, the perhaps 760 "calm" hours of concentrated pollution would be discarded and the only the highest calculated value from the remaining 8000 hours would be reported! Think about that when considering the CO limit requirement which is, "not to be exceeded more than once each year"! The top 760 probables were just tossed.

<u>RESIDUALS</u>

Another "quirk" of modelers such as EDMS is that they inherently assume that no residual pollutant concentrations from emission sources exist from hour to hour. That is, each hour of analysis assumes that the location being considered (a grid point) was pure, clean air that then is polluted by the calculated emission source(s) impact. ["Background" concentrations are added in later.]

This is a reasonable approximation as long as the wind speed is not small/zero and doesn't reverse direction, as any pollutants that move into an area (say a cubic meter around your head) are offset by removal of pollutants due to the same wind that brought in the new ones. But what

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[1] Though vector addition of winds might be done within the hour in order to calculate the 1-hour number.

if happens in a relatively "calm" condition where wind speed is near zero and the direction meanders back and forth under the influence of local conditions (e.g., thermals, passing vehicles, etc?). The pollutants from the first hour are still there in the second hour…and perhaps the third, fourth, etc.

These residuals, combined with the calm conditions, cause a gradual buildup of pollutant concentrations not characterized at all by EDMS (since it doesn't handle "calms" in the first place). Residual effects can also be realized in an area even for non-zero speed wind reversals or meanders. These situations are typical of conditions of "stagnation" that can occur in all seasons, typically due to the influence of relatively non-moving high pressure centers that park themselves over an area for an extended period, and the typical dispersion modeler does not work for these conditions, which indeed are usually the "worst case" scenarios (where people sicken and die).

Appendix E: Missing HAPs Dispersion Analysis

AReCO first expresses fundamental disagreements with the implied "what HAPs problems?" conclusions related to the DEIS section 1.2.1 [p. I-126] "IEPA's Chicago O'Hare Airport Air Toxic Monitoring Program". These disagreements and comments are captured in a requested critique of that report* and have been in the public eye (www.areco.org) for more than 2 years and the FAA is derelict in not providing that critique document in the DEIS.

{*TECHNICAL NOTE Date: Tue, 04 Jun 2002 [Revised 9/21/02]
Comments on IEPA "Final Report, Chicago O'Hare Airport Air Toxic Monitoring Program"}

The critique in entirety is included here as Appendix K and should be addressed by the FAA/EPA.

Inexplicably, there were no HAPs dispersion analyses done for the DEIS. This is even more mind-boggling since the DEIS quotes the recent past Oakland Airport (OAK) as a key reference (see appendix I, p.I-41), and OAK in-fact ran HAPs dispersion analyses! (The question again arises; is someone trying to cover-up?)

Nothing more can be said than it needs to be done and it needs to be modeled out to a distance that is sufficient to guarantee no problems in populated or public-use areas. A 10-mile distance from the airport boundary is recommended.

As with Criteria pollutants, there are at least three areas that need to be included in the analysis: (1) exposure to the public beyond the airport boundary, (2) exposure to the public within airport boundaries, (3) exposure to airport workers (employees and non-employees) within the airport boundaries. In the latter case, airport/airline employees, contract workers, public safety, etc. workers operating within the active aircraft areas are of particular concern (e.g., fuelers, de-icers, baggage handlers, etc.) due to their close proximity and long term exposure working conditions.

In addition to analyzing the impact of the specific HAPs emissions discussed in Appendix I (but not, again inexplicably, in the main body (e.g., associated with Air Quality), critical attention must be paid to personnel and public exposures to vaporized ethylene/propylene glycols from de-icing/anti-icing fluids and, importantly, to the HAPs contained therein, as the many "additives" included in these solutions. While normal temperature evaporation of these fluids is minimal, the de-icing and anti-icing processes heat the fluids to relatively high temperatures (180 degrees F) and vaporization is significant. Further, ethylene glycol gas is lighter than air, increasing its ability to maintain itself within the local atmospheric environment.

The FAA may defend a position of not addressing these HAPs by claims that the additive chemicals are manufacturer's "company secrets". This "don't know, can't tell" position is ridiculous, particularly given that the FAA's main charter is "safety" for the air transportation system and passengers (we assume that includes airport workers as well). [AReCO has sued the airports on this issue in the past and many of the chemicals we exposed under discovery are now public knowledge; the FAA and EPA are fully aware of said chemicals, as they were our co-plaintiffs in one of our lawsuits.]

The glycols and additives must be defined, both in content and in source emission rates, as part of the overall HAPs emission inventory, then analyzed for impact along with the rest by dispersion analyses. Also, dispersion to the atmosphere due to runoff from aircraft leaving the ground must be included in the analyses.

Appendix F: Proper statistical analysis methods for airport related dispersion analyses conclusions.

Mobile airport emission sources are just that…mobile (i.e., they are in a constant state of moving around. The technically correct way to model this situation is to use a statistical approach instead of the typical (EDMS) approach of trying to "average" everything. The source types are "averaged", their emission rates are "averaged", their locations are fixed at "average" choices, meteorological conditions are "averaged", etc. Past a certain point it becomes doubtful what the end result of subsequent dispersion analysis means, other than some kind of ill-defined "average". The problem here is that even a calculated "highest concentration value" of a pollutant at a given receptor is, in fact, then not the highest!

That is, all "averages" must be accompanied by some distribution description, such as a "sigma" associated with the average/mean. For instance, assume a calculated "highest value" of 1.0 was associated with a "normal" distribution, with a sigma 0.2.

Then it could be said that the "highest value" would be exceeded approximately 50% of the time or, alternately, that one is only 50% confident that the "highest value" is indeed the highest value. Consulting standard statistical tables, one could also state that one is 84% confident that the highest value is less than (mean + one sigma) 1.2, 95% confident that it's less than (mean + 1.65 sigma) 1.33 and 98% confident that it's less than (mean + 2.05 sigma) 1.41.

Since the EPA and others would consider a 98-percentile conclusion to be acceptable, the real "highest value" must be stated as 1.41, with 98% confidence.

The average of the average of the average…approach to analysis was often taken in decades past because of computational limitations, since the statistical approach requires making numerous simulation runs, each time changing the parameters in random fashions (with some range for each source here). EDMS was itself originally designed for "IBM PC's" running DOS, which in comparison to today's affordable PC's (e.g., 2GHz Pentium) would be equivalent to still flying on post-WWII prop planes. Thus, any rationalization that proper statistical analysis approaches cannot be accomplished today is totally without merit.

Appendix H: FAA "Mandated" EDMS Modeler Not Validated

"Validation" in the strictest sense means that sufficient testing of observed versus predicted values has been done in order to determine that the subject simulator, or "modeler", "does what it is supposed to do, under the conditions and within the limits it is designed for, and does it accurately".

Determining the degree of accuracy is always a main validation objective. From a scientific perspective, +/-10% would be considered reasonably accurate in this category of prediction. However, when it comes to the regulatory aspect of protecting human health and welfare, "accurately" means that the predicted values of pollutant concentrations should always be greater than what will be actually observed. That is, +/-10% is unacceptable but +10-20% error is acceptable. [Obviously +100-125% still protects the public, but it is excessive in error and might be considered "inaccurate".]

A modeler that is inaccurate in the regulatory sense might have its fundamental codes modified, or have additional limits placed on its use, or have procedural changes made, all to increase its accuracy to an acceptable degree. This is not a simple task when dealing with complex application environments, as it is necessary to determine exactly why the inaccuracy exists in order to fix it with confidence.

The FAA's current version of its "mandated" EDMS airport pollution simulator has never been validated as to operational predictability and accuracy for the relatively short distances, complex infrastructure, and complex emission sources, such as aircraft, associated with today's airports. This is obviously necessary before any conclusions of airport dispersion analyses could be considered…valid.

A program to do just this was initiated at the United States Department of Transportation/Volpe Center in 2001, using CO measurements/observations to compare to the predictions of EDMS (v. 4.1). Unfortunately, though the gathering of all data was accomplished in January 2002, only an interim report was published in 4/03 (modified 6/03), said report containing no results of comparisons of measured/observed vs. predicted. [See paper extracts below.]

AReCO believes the now three-year wait for results publishing means that, in fact, good correlation and thus validation was not demonstrated. If we are wrong, the DEIS must be re-issued with a copy of a final results version published to demonstrate that.

Another, but similar reason for not publishing (lack of?) validation results, is that these possibly negative results may have been fed back to the EDMS scientists in order to modify EDMS to move it toward improved accuracy. For example, EDMS v.4.1, used for this analysis, was released on Oct. 2002, according to the FAA's web site. Subsequently, v.4.1.2 was released in Oct. 2003, carrying significant GSE emissions changes and aircraft engine default changes. Then v.4.2 was released in Sept. 2004, with PM2.5 capabilities added (but not for aircraft), improved modeling for multi-level parking lots and allowing identification and locations of each airport building (affecting point-source plume modeling (e.g., "downwash"). Of course, this scenario leaves us still with the fact that no published validation exists for EDMS v.4.1.2, which was used for DEIS analyses.

Validation of FAA's Emissions and Dispersion Modeling System (EDMS): Carbon Monoxide Study **Paper # 69607** {Published 4/2003, Emphasis added….Ed.}

ABSTRACT

Air quality at airports has received substantial attention in recent years. In a 2000 report by the U.S. General Accounting Office (GAO), air quality was cited as the number two environmental concern (after noise) by the 50 busiest airports in the United States.[1] Accurate air quality models are needed to properly analyze air pollution in the vicinity of airports, develop appropriate mitigation and policies, and to plan for increased growth. The FAA's Office of Environment and Energy (FAA/AEE) and the Environmental Measurement and Modeling Division at the United States Department of Transportation's John A. Volpe National Transportation Systems Center (Volpe Center) are engaged in a multi-year validation effort of FAA/AEE's Emissions and Dispersion Modeling System (EDMS). EDMS is the FAA required tool for assessing aviation emissions and concentrations near airports. A systematic validation effort is needed to assess the

accuracy of the model and identify any needed refinements.
This study involved the measurement of carbon monoxide (CO) concentrations at 25 locations at a major U.S. international airport. In addition to the CO measurements, a detailed accounting of all related airside and landside activity was also done. This additional data included aircraft types and runways, ground support equipment activity, auxiliary power unit activity, roadway and parking lot traffic activities, stationary sources, and meteorological data.
The airside and landside data are currently being input to EDMS. EDMS-predicted concentration levels will then be compared with measured concentrations, and a detailed statistical assessment of the AERMOD dispersion algorithm within the model will be conducted. As such the information contained in this report is interim, with more detailed results to follow.

Excerpt-------

As background information, EDMS was developed in the mid-1980s as a complex source microcomputer model (i.e., multiple air pollution sources at an airport) to assess the air quality impacts of proposed airport development projects. EDMS is designed to assess the air quality impacts of aircraft, auxiliary power units, ground support equipment, stationary sources, fueling operations, motor vehicles, and training fires. The model uses the latest aircraft engine emission factors from the International Civil Aviation Organization (ICAO) Engine Exhaust Emissions Data Bank[2], vehicle emission factors from the Environmental Protection Agency's (EPA) MOBILE5a[3], and stationary source/fueling emission factors from AP-42.[4] Since 1993, EDMS has been an EPA "Preferred Guideline" model for use in civil airports and military air bases. In 1998, the FAA revised its policy on air quality modeling procedures to identify EDMS as the required model to perform air quality analyses for aviation sources. This revised policy ensures the consistency and quality of aviation analyses performed for the FAA.
In response to the need for increased accuracy and flexibility by the air quality analysis community, the FAA, in cooperation with the United States Air Force (USAF), reengineered and enhanced EDMS in 1997 and released Version 3.0.[5] The FAA has continued to improve EDMS. To take advantage of new data and algorithm developments, the FAA released Version 4.0 in May 2001. EDMS 4.0 was developed under the guidance of a government/industry advisory board composed of experts from the scientific, environmental policy, and analysis fields.
A primary enhancement of the Version 4.0 release of EDMS was the incorporation of the EPA's next-generation dispersion model, AERMOD[6,7]. The manner in which AERMOD is used in EDMS is based on guidance from the American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC), which is responsible for developing AERMOD and introducing state-of-the-art modeling concepts into the EPA's local-scale air quality models. In theory, the incorporation of AERMOD should result in substantial improvements in EDMS accuracy, but validation using appropriate field measured data is desirable to substantiate this assumption and refine the manner in which airport emission sources are characterized using AERMOD. Although AERMOD has been validated for stationary sources, the dispersion algorithms of AERMOD have not been validated with regard to the many and varied sources found at an airport, particularly aircraft. Complete sets of data, including measured concentrations and

associated operational data are lacking.
Because AERMOD, the emission calculation procedures, and the emission factors used in EDMS are well established and EPA developed and/or recommended, the purpose of this study is not to evaluate these parts of the analysis process. Rather, the manner in which AERMOD is being used to characterize dispersion from airport sources is being evaluated and quantified so that FAA can refine how AERMOD is applied in EDMS to model airport sources. This evaluation is needed because there is no official EPA guidance on how AERMOD should be used to model airport sources, (e.g., should aircraft be modeled as an area or a volume source). EPA has given FAA guidance on applying AERMOD in EDMS, but in an effort to maximize model accuracy FAA is evaluating EPA's guidance and will refine the source characterization where possible.

CONCLUSIONS
A substantial database has been assembled. It includes CO concentrations for eighteen, one-hour periods from January 8th to January 10th, 2003. The database also includes a detailed quantification of both airside and landside activity at the airport during the entire measurement period. Over the coming months, **[three years ago...Ed.]** these data will be utilized to assess the performance of the AERMOD dispersion algorithm recently incorporated into FAA's EDMS. As deemed necessary, enhancement to AERMOD and/or recommendations on its use within the context of EDMS will be documented in a final comprehensive report, which will be made available to the modeling community. Final results of the study will be available on the FAA website at www.faa.gov.

Appendix I OZONE MODELING

The DEIS does not translate their calculations of ozone pre-cursors into ozone impacts, which in turn substantially and negatively impacts the public health and well being of millions of people in the Chicago ozone "non-attainment" area.

AReCO does not agree at all with the FAA's rationalization as to why this is not done:

> The dispersion model that will be used in the OMP analysis does not have the capability of predicting concentrations of O3 for comparison with the AAQS. The formation of O3 in the atmosphere is complex to model on a local scale and the effects of elevated O3 concentrations are generally realized on a regional scale rather than a local level. However, where possible, the air quality analyses for the OMP will include information relevant to the new standard.

The fact that EDMS was "mandated" by the FAA for use in analyzing airport situations has nothing to do with off-airport ozone conditions and analyses. Though "mandated" by the FAA, importantly here, **"[T]he regulator is also the air traffic services provider**"2. In fact, the FAA and project proponents are not limited to use of only EDMS.

Indeed, the capability to successfully model photochemical ozone creation processes has existed for many years, for instance with Environ's CAMx modeler, which was well performing in 1997 and is up to version 4 at this time. CAMx has the ability to use nested grids, down to sizes in the 500-1000 meter range; using 1000 meters would even allow O'Hare airport to be gridded into at least 9 grid zones. Further, individual emission sources can be tracked, traced and checked for their contributions to the net ozone modeled results.[3]

As a matter of fact, the Urban Airshed Model (UAM) was used by the State of Illinois (IEPA/LADCO) in year 2000 for simulation of the areas ozone situations, in order to evaluate and set forth plans for their "NOx SIP Call". Quoting from the paper, "Midwest Subregional Modeling: 1-Hour Attainment Demonstration for Lake Michigan Area (Sept. 18, 2000)":

> "Grid resolution was 12[k]m for most model runs and 4km for a few runs." and "In summary, it is reasonable to conclude that model performance is acceptable and that the model can be used for regulatory application in the Lake Michigan area."

The DEIS statement that "…O3 effects are generally realized on a regional scale than on a local level." is purposely misleading, attempting to imply that individual sources, such as an O'Hare airport "bubble" could not be adequately and accurately treated. Not only that, the statement is also disingenuous and patently incorrect, since the IEPA did exactly that, "way back" in year 2000, when they wanted to evaluate the impact of proposed new emissions, "…from combustion turbine electrical generating units recently permitted in Illinois."![4]

Here was a case where modeler runs were made to calculate ozone level changes in the gridded region surrounding and including the Chicago metropolitan area, due to additional point source emissions from power plants, including 10 in the Chicago area, each of which generated only

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[2] The International Herald Tribune, "Emissions by airliners leave Europe and U.S. split," Mar. 19, 2005. Comments by Carl Burleson, director of the FAA Office of Environment and Energy.

[3] Published CAMx results of analyses demonstrates that, typically, around 50% of ozone concentrations are caused by nearby sources of less than about 25km. (15.5 miles) distance.

[4] "Ozone Attainment Demonstration for the Chicago Nonattainment Area (December 21, 2000)", Chapter I

about 10% of the total NOx generated by O'Hare (not even counting associated "roadways" emissions). Modeled results were able to detect and show ozone concentration changes of only 1-3ppb out of average levels of >100ppb.

Finally, it is not at all clear that if the limits for pre-cursors were just met in the area (including O'Hare NOx and VOC contributions), that this would imply a good ozone situation (i.e., ozone levels always below EPA NAAQS limits), since the pre-cursor limits are based on their own human health hazards, not ozone hazards. Additionally, O'Hare airport NOx and VOC emissions are deposited in the atmosphere in a spectrum of altitudes, from ground level to miles, which would generally result in considerably different ozone formation impacts than near ground level emissions (and where airport analyses receptors are placed i.e., "human environment"). Even if constrained to those deposited in the "mixing layer", deposition altitudes extend to about 1000 meters.

In summary, AReCO believes that the DEIS short-cutted this important issue and that O'Hare related emissions indeed have a significant ozone effect in the area and that such effect could and must be calculated via simulation.

Appendix X

July 18, 2005

VIA FACSIMILE and regular mail

To:
Marion Blakey, Administrator
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From: Jack Saporito
President, American Working Group for National Policy
Executive Director, Alliance of Residents Concerning O'Hare

Subject: Grossly Erroneous Oil/Fuel Price Forecasts Used For U.S. Air Transportation Demand Projections Drive Excessive Air Transportation Demand Forecasts.

The American Working Group for National Policy, Inc. (AWGNP) and The Alliance of Residents Concerning O'Hare, Inc. (AReCO) hereby petition the Federal Aviation Administration (FAA) to produce a mid-year correction to your "FAA Aviation Forecast 2004", released in February 2005. This petition is based on what we believe to be gross errors in the forecast for aircraft fuel prices for the next decade. The impact of fuel prices is already, and will continue to be, much higher than forecasted and will substantially raise air transport operational costs and force much higher passenger ticket and freight prices, reducing demand below that which is forecasted.

The importance of a fast response in creating this mid-year correction is heightened by the fact that numerous, very expensive, United States airport expansion programs are in various stages of approval by the FAA and that these approvals will be based on the existing airport capacity projections, as derived from the demands developed in this "FAA Aviation Forecast 2004". Thus, the justifications for many of these airport expansion plans are seriously flawed and the FAA cannot go forward with any such approvals until this serious error is corrected.

AWGNP and AReCO therefore also petition the FAA to cease and desist any approvals of U.S. airport expansion programs until such mid-year forecast is completed and any affected airport expansion programs are appropriately adjusted for the expected substantial changes in demands.

Specifics:
It is clear that the FAA's fuel price forecasts (below) represent a total denial of reality in the issue of world oil supply and demand in the foreseeable future. The forecast is only six months old and is already totally out of sync with the actual current pricing situation.

Jet fuel price (daily gulf coast prices, per gallon) began 2004 at about $0.75 and ended the year at about $1.25, with a brief excursion to around $1.60 (due primarily to 2004 hurricane impacts on gulf supplies). But the upward trend could already be seen as early as the beginning of 2002 when the price was near $0.50/gal. [Note: These prices are, of course, much lower than the costs for passenger vehicles and trucks, due to their on-going exemption from numerous taxes.] Fuel prices bounced back up to $1.68 on April 5, 2005, returning to their apparent (3 year) trend line of about +44% year, which, of course, may not continue at that rate; however, this trend is so much greater than the FAA forecast, as to make their forecast useless.

It is understood that the FAA refers to the Office of Management and Budget (OMB), Congressional Budget Office (CBO) and others for base information. Yet the more knowledgeable agency, the Department of Energy, fully supports a position of on-going higher petroleum prices, as is seen in their most current forecast (see Attachment).

It appears ridiculous to assume that the air transportation industry will experience the forecasted $0.759/gal price average that is currently forecasted for 2005. Even if pricing stabilizes at current levels, the average will be above $1.50/gal, essentially <u>twice as high as forecasted</u>. And it is highly probable that it will instead experience a continuing rise, perhaps to as much as $2.25/gal by years end.

The continuing irrationally optimistic view by some that oil and fuel pricing will eventually return to even close to the currently projected levels must be rejected in the face of:
* Tremendous oil demand growth by the Chinese and other developing countries,
* Little to no expectations of future world oil supply growth from present levels, which are already only a percent or so above demand,
* Global warming impacts (now in consensus), further increasing fuel demands (e.g., for electricity, etc.) while negatively impacting supply (e.g., many more gulf coast oil source hurricane disruptions),
* Existing and future shortages of fuel refining capacities,
* The falling dollar (foreign oil producers will raise prices in inverse proportion),
* Out-of-control U.S. debt and trade imbalances, especially with the Chinese,
* The resulting probable purchase of U.S. (and/or foreign owned) major oil companies (witness the current Chinese bid for Unocal), in order to capture oil holdings as well as technologies,
* The failure of the "western world" to solve the Islamic terrorism issues.

Any forecast that expects the price of oil and fuel derivatives to be only 6% higher than 2004 -- 11 years from now, and actually cheaper than 2004 when discounted (0.67/gal vs. 0.80.9/gal, in 2003 dollars), must be discarded and immediately redone.

From the "FAA Aviation Forecast 2004":

"OMB projects that energy prices (as measured by the oil and gas deflator) will increase by 0.7 percent in 2004, decline by 10.0 percent in 2005, and then increase at an annual rate of 1.8 percent over the remainder of the forecast period. Over the entire 12-year period, the OMB forecast assumes that nominal energy prices will increase by only 0.7 percent annually. In real terms, OMB expects energy prices to decline at an annual rate of 1.5 percent over the 12-year period. CBO forecasts a 1.5 percent annual increase in nominal fuel prices and an annual decline of 0.9 percent in real prices. Global Insight projects nominal fuel prices to increase by 1.8 percent a year—a decline of 0.5 percent annually in real terms."

TABLE 16
U.S. LARGE AIR CARRIER FORECAST ASSUMPTIONS
JET FUEL PRICES

	DOMESTIC	
FISCAL YEAR	CURRENT $ (Cents)	FY 2003 $ (Cents)
Forecast		
2004	82.1	80.9
2005	75.9	73.7
2006	75.7	72.3
2007	76.6	71.6
2008	77.7	71.1
2009	79.0	70.5
2010	80.3	69.8
2011	81.6	69.3
2012	82.9	68.7
2013	84.3	68.1
2014	85.7	67.5
2015	87.1	67.0

ATTACHMENT

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U.S. Department of Energy

July 12th, 2005 Release (Next Update: August 9th, 2005)

2005 Summer Motor Fuels Outlook Update (Figure 1)

Retail regular-grade gasoline prices moved up from about $2.12 per gallon at the beginning of June to $2.33 on July11. Gasoline pump prices for the summer (April-September) are now projected to average $2.25 per gallon, 8 cents per gallon higher than last month's projection and about 35 cents per gallon above the year-ago level. Crude oil prices are expected to remain high enough to keep quarterly average gasoline prices above $2.20 per gallon through 2006. The projected average for retail diesel this summer is $2.33 per gallon, up about 56 cents per gallon from last summer. Nationally, annual average diesel fuel prices are expected to remain above regular gasoline prices through 2006. Currently, this pattern is evident in all major regions of the country.

Crude Oil and Petroleum Products (Figures 2 to 8)

The WTI crude oil price averaged over $56 per barrel in June and is now expected to average $59 per barrel for the third quarter of 2005, approximately $6 per barrel higher than projected in the previous Outlook and $15 per barrel above the year-ago level. Monthly average WTI prices are projected to remain above $55 per barrel for the rest of 2005 and 2006. Oil prices remain sensitive to any incremental oil market tightness. Imbalances (real or perceived) in light product markets could cause light crude oil prices to average above $60 per barrel.

Several factors are contributing to the expectation of continued high crude oil prices. First, worldwide petroleum demand growth is projected to remain robust during 2005 and 2006, although not as strong as in 2004. Worldwide oil demand is projected to grow at an annual average of about 2.1 million barrels per day in 2005 and 2006, representing a 2.5-percent annual average growth rate compared with 3.4 percent growth in 2004. Chinese demand growth, which averaged about 1 million barrels per day in 2004, is projected to be slower but still robust at an annual average of 600,000 barrels per day in 2005 and 2006. In addition, total projected oil demand for countries outside the Organization of Economic Cooperation and Development (OECD) is higher than in previous Outlooks because EIA has increased its estimate of historical (2003-2004) demand in the non-OECD countries by 200,000 barrels per day.

Second, production growth in countries outside of the Organization of Petroleum Exporting Countries (OPEC) is not expected to accommodate incremental worldwide demand growth. Non-OPEC supply is projected to grow by an annual average of 0.8 million barrels per day during 2005 and 2006, below the annual average growth rate seen in the 2002 through 2004 period. Third, worldwide spare production capacity has recently diminished; in practice, only Saudi Arabia has any spare crude oil production capacity available, and the Saudis would need to steeply discount their heavy oil in order to market it effectively. Despite projected capacity additions in Saudi Arabia and other Persian Gulf countries in 2005 and 2006, world spare capacity could decline from 2004 levels over the next 2 years if world oil demand grows more rapidly than expected. Fourth, downstream sectors, such as refining and shipping, are expected to remain tight. Finally, geo-political risks, such as the continued insurgency in Iraq and possible problems in Nigeria and Venezuela, are expected to keep the level of uncertainty in world oil markets high.

Another factor that could influence the U.S. oil market over the next few months is the severity and location of hurricanes. The end of summer and the beginning of fall are the prime months for hurricane activity that can affect oil and natural gas production and refinery operations in the Gulf of Mexico region. With limited spare global crude oil production capacity and U.S. refinery utilization rates in the upper 90-percent range for much of the summer, oil prices are likely to react strongly to any disruption of or damage to petroleum infrastructure. While Hurricane Dennis was the immediate concern at the beginning of July, there are also likely to be other hurricanes that will threaten Gulf of Mexico oil facilities and increase the potential for temporary price spikes. How long prices remain elevated due to a particular storm, however, will ultimately be determined by the severity of damage to petroleum facilities.

High levels of production from OPEC members contributed to inventory builds in the OECD countries in the first half of this year, with these stocks moving towards the upper end of the 5-year historical range. However, OECD stocks have not grown in terms of days supply (the number of days that inventories would satisfy demand) because demand has grown rapidly as well. EIA's forecast includes little additional growth in OECD commercial oil inventories over the next 2 years. U.S. crude oil inventories, now above the historical range, are much improved compared to this time last year. However, some of this improvement is expected to dissipate over the forecast period.

U.S. petroleum demand growth during the 2-year period is projected to average about 1.3 percent per year, down from the much stronger 3.5-percent increase seen in 2004. Motor gasoline demand growth is projected to average 130,000 barrels per day during the 2-year period, or 1.5 percent, per year, below the 1.9-percent growth in 2004.

Jet fuel demand is expected to rise by an average 2.9 percent per year, slightly below 2004's 3.3-percent growth. Distillate demand is projected to climb steadily by an average of 1.9 percent per year, well below the 3.3-percent growth recorded for 2004. Residual fuel oil demand, having increased by 12 percent last year, is projected to register an overall decline in deliveries during the forecast interval.

Appendix Y

Flawed FAA Aircraft PM2.5 Emissions Estimation Method
Archaic "Smoke Number" Use Behind Failure

R. E. Ruthenberg 9/01/05

Abstract

The FAA has officially put forth its estimate method for jet aircraft PM2.5 particulate matter emissions, mandated for use in all U.S. environmental impact statements (EIS), based on a "first order approximation" correlation to historically measured "smoke numbers", which measurement system was put in place in the early '70's and has not changed since.

We describe here that the ICAO[5] smoke number measuring system is incapable of adequately measuring any particles of diameter less than about 0.5 microns. Though this was not a serious problem in the early years of commercial jet aviation as the smoke, for which the test was intended, was comprised of relatively large particles, e.g. 1-10 microns in diameter, it is a very serious problem when attempting to correlate smoke numbers to engine (non-volatile) particulate mass emissions, targeted at placing such mass calculations in a PM2.5 context, when the predominant portions of such emitted particles fall into the ultra fine category emitted by modern aircraft, with diameters in the 0.01-0.05 micron diameter range.

As such, these correlations, the results of which have now been officially incorporated into the FAA's EDMS emissions tool, are seriously flawed and the actual emission masses are substantially under calculated, perhaps by factors of as much as 10:1. Since the FAA has also recently put forth the conclusion that volatile engine exhaust particulates are estimated to be three times the non-volatile component, the total calculated (volatile + non-volatile) particulate mass emissions, also now encapsulated into EDMS, are in error as well, in the same proportion. Any airport-related environmental (e.g. EIS) conclusions on particulate matter inventories and dispersion analyses are therefore seriously compromised.

Background

The FAA has been under heavy pressure to provide quality information and guidance on particulate matter (PM) emissions from commercial jet aircraft in order to provide accurate calculations of ground-level and low altitude PM emissions inventories for use in airport environmental impact statements (EIS), as well as for high altitude global climate change impact studies. This has been problematical, to say the least, as the FAA and EPA have not adequately pursued actual aircraft engine measurements and characterizations in the past. Nor has the international United Nations organization, ICAO, been strongly motivated to do so.

This shortage of information led to the development of a "first order approximation" (FOA) of particulate matter emissions from aircraft[6], which the FAA has embraced as their "best estimate" of (non-volatile) PM emissions from jet aircraft, incorporating it already into their EDMS simulator ("mandated" by the FAA for use in airport EIS analyses).

This FOA takes the approach of using aircraft certification "smoke numbers" to correlate to PM

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[5] International Civil Aviation Organization.
[6] "Derivation of A First Order Approximation of Particulate Matter From Aircraft", Wayson, Fleming, Kim and Draper, 4/15/03.

mass emissions, for each aircraft (engine) type. The "smoke number" (SN) is a very old[7] method originally used to determine how "smoky" an aircraft's exhaust would be and to set standards to drive "smokiness" downward in order to reduce public complaints of air pollution around airports. To that extent, it was effective in that (1) the measurement process that resulted in a given aircraft engine SN characterization was fairly well adapted to engine exhaust characteristics of the period (70's) and (2) engine manufacturers had a specific test and standard to design/redesign engines to (as well as the consideration of other factors, e.g. fuel constituents, operational parameters, etc.).

The prime smoke culprits at the time were relatively large diameter particles, often due to unburnt fuel or "rich" fuel-to-air ratios in these engines. Non-volatile particles at the time were generally characterized as "soot", with mean mass particle diameters generally greater than 0.5 microns, and probably mainly in the range of 1-10 microns. Since visible light wavelengths fall in the 0.4-0.7 micron range, clouds of these particles (smoke) would be quite visible in the atmosphere (i.e. size greater than light wavelengths).

The smoke numbers for an engine were determined for varying degrees of engine thrust, generally corresponding to taxiing (7%), approach (30%), takeoff (100%) and climb out (65%) modes. A predetermined, fixed quantity of exhaust[8] was drawn from near the point of engine exhaust, passed through heated lines and through a paper (cellulose) filter, collecting the particulate matter on the filter paper. The paper was placed on a reflectometer before the test and calibrated to be 100%, i.e. white and highly reflective. After the filter paper was stained by the particulates, it was measured again on the reflectometer and the resulting percentage reflection was the SN. For example, if reflectivity dropped from 100% to 35%, the SN was 35.

The subsequent FOA to correlate the SN to actual particulate density in the exhaust plume, typically in terms of micro-grams/cu. meter, was done in the early 70's (D.L. Champagne) and 80's (Whyte).[9] This was then in turn converted to particulate mass generated per kg. of fuel burned, assuming stoichiometric[10] burn conditions.

This then resulted in the first order equation:

$$ER_{j\text{Mass of PM}} = 0.6\,(SN)^{1.8}\,(FF)$$

Where:

$ER_{j\text{Mass of PM}}$ = emission rate: mg of PM emitted per second per engine type j

SN = the ICAO reported smoke number

FF = the ICAO reported fuel flow by mode in kilograms/sec

The Problem

[7] Originally implemented by the EPA in 1973. Associated with SAE ARP 1179 test procedures. Currently in ICAO procedures Annex 16 of Part 1, volume 2, Appendix B.

[8] Exhaust sample size is 16.2kg. per square meter of filter sampling area at STP, as adjusted by the gas law, PV=nRT, for sampling pressure, temperature and volume.

[9] See the FOA paper for more details.

[10] Stoichiometric meaning that the combustion occurs with exact proportions of constituents involved in the net chemical reaction; the proportions of oxygen, nitrogen, etc., combined with exact proportions of fuel chemicals, resulting in given amounts of gases, such as CO2, and heat, along with determination of the volume of these combustion products gases.

The big problem that causes these results to be quite inaccurate and the "first order" characterization to likely be in error by factors of 2-10 on the conservative side (under estimation) of particulate mass predictions based on smoke number, lies in the measurement process that determines the smoke number itself. That is, smoke numbers are almost meaningless for modern aircraft engines!

Wayson hints at the reason for this in the FOA paper: "Small particles are not well represented by the smoke number, the combustion process varies by engine design, and the fuel-to-air ratio will change with each mode." We agree fully with the latter two issues but focus on the first, that being the issue of "Small particles are not well represented by the smoke number…"

As previously indicated, early engines (70's/80's) were quite smoky, emitting relatively large quantities of relatively large non-volatile particulates. The smoke number measuring system was constructed to match this environment. Modern engines are almost "smokeless", with most of the non-volatile particulates being of very small size, generally characterized as "ultra-fine". Whereas, early engine particulates were concentrated in the range of 0.5-10 microns (mean diameter), today's particulates are concentrated in a 0.01-0.1 micron range, often even narrower in the 0.02-0.05 range.[11]

It is understandable that the key to using the smoke number measuring system and procedures is to capture all of the particulate matter in the exhaust sample on the filter paper, such that it becomes stained (dark) thereby reducing reflectivity and thus, determining the smoke number. <u>What has been missed in all of these approximations is that, in fact, the specified filter paper, Whatman #4, which remains unchanged for the last 30 years, does not effectively capture ultra-fine 0.01-0.1 diameter particles.</u>

That is to say, if the filter paper does not capture the exhaust particulates, then the (pseudo) smoke number physically cannot represent the nature (number and mass) of those particles. The end result is first, that any resulting smoke number would still be determined largely by any small amount of large particulates captured on/in the filter and so the concept of a relation to "smokiness" of the exhaust may still be relevant, though subsequent particulate size growth "down-plume" might even render this number as useless.[12]

Secondly, the more important issue here is that if the bulk of particulate emissions are ultra-fine and the filter capture little to none, then any resulting smoke number cannot predict the amounts of these ultra-fine emissions.

Stepping back, the current context of particulates is to characterize them as PM2.5, meaning that this includes all particulates of diameters from 0.0-2.5 microns. In reality, the smoke number does not characterize PM2.5 but, instead, measures a range of x-y microns and, if we assume exhaust particulates have an upper mean diameter of 10 microns, then the measured range is x-10

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[11] Early engines may have had a bi-modal particulate distribution, i.e. one concentration in the 0.5-10 micron range and another in the 0.01-0.1 range.

[12] Consider a filter that captures none of the ultra-fine particulates, indicating a smoke number of zero, i.e. no smoke at all. But these particles downstream in the plume have grown to larger size through accumulation/agglomeration and adsorption mechanisms to now become visible, i.e. smoke.

microns, with x being unknown.

A literature search, admittedly not perfect,[13] could not find any discussion of smoke number related filter characteristics as a function of particulate size, especially for the specified Whatman #4 filter. The key characteristic would be filter efficiency[14] versus particle diameter and an ideal PM2.5 filter would be characterized by an efficiency of 100% for particle diameters less than 2.5 microns and 0% for diameters larger than 2.5 microns.

Notably, Whatman's description of their grade 4 filter media is:

> "Grade 4: 20-25μm
>
> Extremely fast filtering with excellent retention of coarse particles and gelatinous precipitates such as ferric hydroxide and aluminium hydroxide. Very useful as a rapid filter for routine cleanup of biological fluids or organic extracts during analysis. Used when high flow rates in air pollution monitoring are required and the collection of fine particles is not critical." {Emphasis added.}

Because of this dearth of information, the Whatman Company (U.K.) was contacted and they graciously agreed to test a few grade 4 filter samples. Three samples were challenged by an aerosol of cold DOP[15] particles at a face velocity of 10.5 fpm, with results shown in table 1.[16]

Table 1

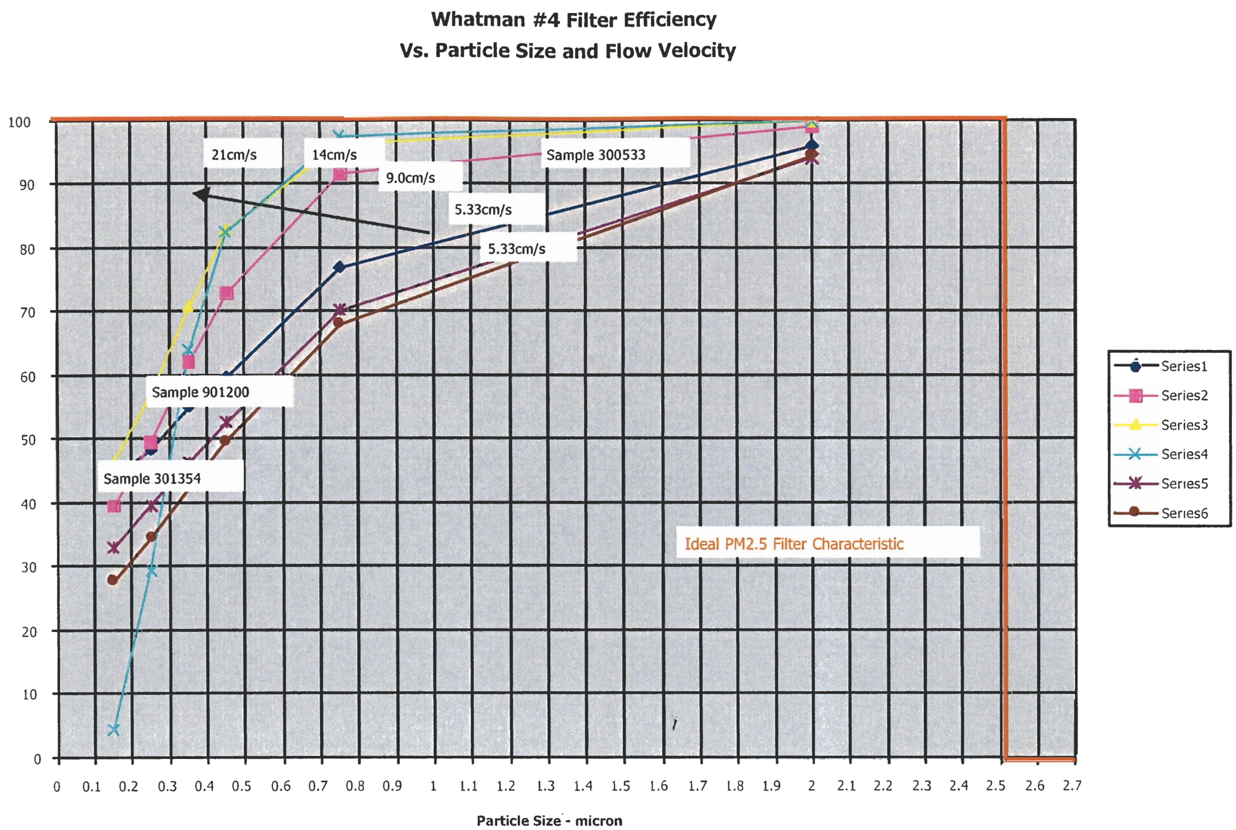
Particle Size Range (μm)	**Efficiency Sample 90120 (%)**	**Efficiency Sample 301354 (%)**	**Efficiency Sample 300533 (%)**
0.1 to 0.2	33.0	27.8	43.9
0.2 to 0.3	39.6	34.5	48.3
0.3 to 0.4	46.4	42.5	55.1
0.4 to 0.5	52.6	49.7	59.8
0.5 to 1.0	70.2	68.0	76.9
1.0 to 3.0	94.0	94.5	96.0

[13] A continuing problem is that many or most technical papers are "locked up" in association journals and can be accessed only by association members or piecemeal at high cost. Examples include ICAO, Waste Management Association, etc. Even government-funded studies (read: at taxpayer cost) are often not easily accessible and/or the data/information is held back from the public for extended periods. Example: The APEX studies of engine exhaust measurements.

[14] "Efficiency" would be 100% if all particles were captured and 0% if none were captured.

[15] DOP-dioctylphthalate, a liquid plasticizer to form an aerosol.

[16] Note that Whatman qualifies that, "The data is based on a non-routine test and does not form part of the product specification."



The results are best visualized in graphical form, as shown above. To clarify the graph a bit, series 5 and 6 plots correspond to filter samples 90120 and 301354, respectively, both at the lower 5.33 cm/sec face velocity. Series 1-4 correspond to sample 300533 at velocities of 5.33, 9, 14 and 21 cm/sec, respectively. Also note that efficiency points represent the mean of the diameter range. For example, the range of 1-3 microns is shown as 2 microns. This can have a distorting effect on the curves. That is, we don't really know whether 2 microns is the true mean…it might be 1.5 or 2.5 or something else within the range. This is generally unimportant to the general interpretations.

It is seen that, even with the lower face velocity (right-most series 1. 5 and 6), the filter efficiency curves are not even remotely similar to an ideal PM2.5 filter, with actual efficiencies dropping rapidly for diameters less than about 1 micron, while maintaining high efficiency above 2.5 microns.

For the single sample, increasing the face velocity increases efficiency for larger particle sizes, most likely due to momentum effects, i.e. faster particles carry increased momentum which increases impaction with filter fibers; it is more difficult for the particles to flow around fibers to make there way through (or into the interior of) the filter.[17]

[17] Millipore's Grade 4 filter paper is 250 microns thick, which is equivalent to about 10 mils (0.01 inches). For mental calibration purposes, household plastic drop cloths are typically 0.5-2 mils thick.

Importantly, at the higher velocities, the rate of filter efficiency degradation for smaller particles increases, dropping to only about 5% for particles of 0.15 micron nominal diameter. It is likely that this is generally due to the fact that the very small particles carry much less individual momentum and can ride around individual fibers, following the gas currents as they flow around the fiber. It should be noted that the highest measured velocity effect (21cm/sec) is equal to the lowest expected velocity seen in ICAO smoke testing, with the highest expected velocity being four times greater (82cm/sec). Thus, this can be considered a best case efficiency representation and it can be surmised that at these even higher face velocities, grade 4 filter efficiencies for particles one-tenth of the lower 0.15 micron measured diameter will be essentially zero, i.e. few or no particles will be captured[18] and that, therefore, no amount of particle mass below about 0.1 micron diameter will contribute to measured smoke numbers.

Other Effects

There are additional physical effects that are most likely to play a role in causing a lack of detection of fine/ultra-fine particles in the standard smoke number measurement.

One of these would be that small particles have a greater chance of burrowing into the filter paper's cellulose fiber mat and becoming more invisible if captured, as a result, as compared to larger particles that tend to be captured on or near the filter surface. This effect will tend to greatly attenuate any filter paper changes in reflectance for these small, buried particles. Any particles captured near the back surface will be indistinguishable in effect from the required standard black measurement background.[19] Captured particles will also become harder and harder to distinguish from the filter paper fibers themselves as they become smaller and smaller.

The reflectometer (actually a reflective densitometer) used to measure the smoke number may be a party to significant error itself. The light source wavelength is about 0.6 microns, so while it could theoretically resolve even individual particles and spaces between them of greater than a few microns, it certainly can't for particles/spaces of less than 0.1 micron. Notably, the original and still main use for densitometers was for printing/press and photography applications, where the former particles (spots) are typically 20-60 micron diameters and the latter 0.2-2 microns (silver halide grains).

Additionally, the densitometer light source is typically directed 45 degrees to the plane of the paper, with the reflected light-sensing photodiodes at 90 degrees. It is clear then that particles buried below the surface will quickly become shielded/shadowed from the light source by the filter fibers. Consider a reasonably dense layer of particles imbedded 25 microns deep in a nominally 250 micron thick filter paper. As compared to the same layer on the surface, the light source must penetrate through about 35 microns of filter paper and then return reflections (lack thereof) back through another 25 microns, experiencing attenuation and diffusion on both path segments. This of course would not be a significant concern with large particle sizes e.g. >1 micron diameter, as per the early smoke number applications, as they would mostly be trapped

[18] Assuming no significant new physics forces, e.g. electrostatic attraction, come into play between 0.01 and 0.1 micron diameters.

[19] Per ICAO Annex 16, section B34.3: "The backing material used shall be black with an absolute reflectance of less than 3 per cent."

It is seen here that filter efficiency has fallen to about an average of 38% for 0.15 micron mean diameter particles, with a large downward gradient implying efficiencies approaching zero for particle diameters in the 0.01-0.04 micron range.

Subsequently, it was noticed that the filter face velocity used for these tests (10.5f/min. or 5.33cm/sec) was considerably lower than that used in the ICAO smoke test procedure. ICAO specifies the filter total stain collection spot diameter to be between 19-37.5mm, thus the face velocity, assuming the required 14L/min. flow velocity, can be calculated to be between 21-82 cm/sec, all considerably higher than the 5.33cm/sec velocity used initially by Whatman. Once again Whatman graciously agreed to run higher velocity tests on a filter sample at 9, 14 and 21cm/sec, in addition to 5.33cm/sec, to characterize the effect. Table 2 summarizes these test results.

Table 2

Sample--->	300533	300533	300533	300533	90120	301354
Mean Particle Size-Micron	*5.33 cm/sec	9.00 cm/sec	14.00 cm/sec	21.00 cm/sec	*5.33 cm/sec	*5.33 cm/sec
0.15	43.9	39.5	46.3	4.5	33	27.8
0.25	48.3	49.5	56.9	29.4	39.6	34.5
0.35	55.1	62.1	70.9	64.1	46.4	42.5
0.45	59.8	73	82.8	82.6	52.6	49.7
0.75	76.9	91.5	96.3	97.5	70.2	68
2	96	99	99.8	99.8	94	94.5

on the surface. Thus, even for very small particles trapped beneath the filter surface, the 45-degree light source direction exacerbates the situation and quickly causes them to optically disappear beneath the surface.[20]

Therefore, even if the filter trapped, say, 50% of the very small particles, i.e. 50% filter efficiency, there would be great attenuation to any resulting smoke number result. If one assumes that trapping is uniform through the filter thickness and that any particles below the top 10% of the filter thickness are basically invisible to the reflectometer, then the efficiency curves above can essentially be increasingly reduced for these small particles in the 90% to 10% efficiency transition region, effectively sharpening the rate of efficiency fall off versus particle diameter.

All of these various factors that relate to net effective filter efficiencies in the transition region will also cause significant test-to-test variation in any smoke number that involves a significant contribution from transition region particles. For instance, there could be a 10:1 shift in measured results just due to a difference (up to 4:1 allowed) in filter face velocity between two testing setups.[21] Also, significant variation in efficiency characteristics could exist between filter paper samples in the transition region and below, as the grade 4 paper was not designed for such applications, nor is it typically characterized and controlled for those applications.

Conclusions

The ICAO smoke number measuring system is basically incapable of adequately measuring any particles of diameter less than about 0.5 microns. This was not a serious problem in the early years of commercial jet aviation as the smoke, for which the test was intended, was comprised of relatively large particles, i.e. >0.5 microns and upwards towards 10 microns in diameter, which became visible in exhausts as the wavelength of visible light is 0.4-0.7 microns. But it is a serious problem when attempting to correlate smoke numbers to engine (non-volatile) particulate mass, targeted at placing such mass calculations in a PM2.5 context, when the predominant portions of such emitted particles fall into the ultra fine category, with diameters in the 0.01-0.05 micron diameter range.

As such, any correlations offered, such as in the FOA paper, the results of which have now been officially incorporated into the FAA's EDMS emissions tool, are seriously flawed and the actual emission masses are substantially under calculated, perhaps by factors of as much as 10:1.[22] Since the FAA has also recently put forth the conclusion that volatile engine exhaust particulates are estimated to be three times the non-volatile component (upon which we do not comment here), the total calculated (volatile + non-volatile) particulate mass emissions, also now encapsulated into EDMS, are in serious error as well, in the same proportion.

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[20] This would certainly have to be the case with a black filter background (at about 250 microns depth), which of necessity must be largely unseen by the densiometer in order not to "wash out" and desensitize the effects of surface layer deposits/stains.

[21] This would not be seen for large particles, where the net efficiency shift might be between perhaps 97 and 94 %.

[22] A better guess might have been made if it was known what specific aircraft (engines) were used for the correlation test of figure 2 in the FOA paper, though it is guessed that most are "old" engines, which may well correlate reasonably to similar associated old smoke numbers. Several attempts to get information on the identities of those engines were unsuccessful.

Appendix Z

Mercury Emissions Calculations

Aircraft

AReCO estimated today's yearly aircraft LTO fuel use of 654,142,125 lbs., assuming an average of about 203 gallons of fuel use per LTO and 492,750 LTO's per year. Assuming the mercury EI is the same as diesel GSE (see below; kerosene jet fuel is similar to diesel fuel), 31 ppb by weight, then yearly mercury emissions are:

Hg= 654,142,125*31E-9 = 20.3 lbs/year. Applying a nominal 1.2 factor for expanded operations yields aircraft mercury emissions of 24.3 lbs/year.

The minimum value, based on Shumway's study is 1 ppb, which yields an expanded operations emission of 0.8 lbs. [Note: 1 ppb seems significantly low in respect to other emission factors, such as below.]

GSE

The EIS does not specifically state GSE yearly fuel use. We derive 2002 diesel fuel use by assuming that 56% of the GSE are reciprocating diesel, emitting benzene, and 44% are non-benzene emitting alternately fueled [p. 5.6-57] and the benzene emission factor is per the FEIS [p.I-155], equal to 0.128 lbs/1000 gallons of fuel burn. We thus calculate an effective benzene EI of 0.022 lbs/ton of fuel burn and, knowing that the total year 2002 GSE benzene emission is 20.303 tons [p. I-57], we derive that 2002 GSE deisel fuel use is 922.9 tons.

Applying the EIS stated GSE mercure emission factor of 0.2 lbs/1000 gallons, using fuel density of 6.5 lbs/gallon, the yearly GSE mercury emissions are computed to be 57.2 lbs. Applying a 1.2 operations expansion factor results in yearly mercury emissions of 69 lbs/year.

Stationary natural gas combustion facilities.

The total yearly natural gas combustion at O'Hare is 991,793,435 cubic feet [p. J-99]. The mercury emission factor is 26.4E-4 lbs/million cubic feet [p.I-155]. Simple multiplication yields a total yearly mercury emission of 2.62 lbs.

Summary

Not counting other mercury emission sources such as from on-airport vehicular traffic, construction vehicles (mostly diesel), etc., the total amount of (1.2 expanded operations) O'Hare mercury emissions will be in the range of about 72-96 lbs, most likely toward the high side.