

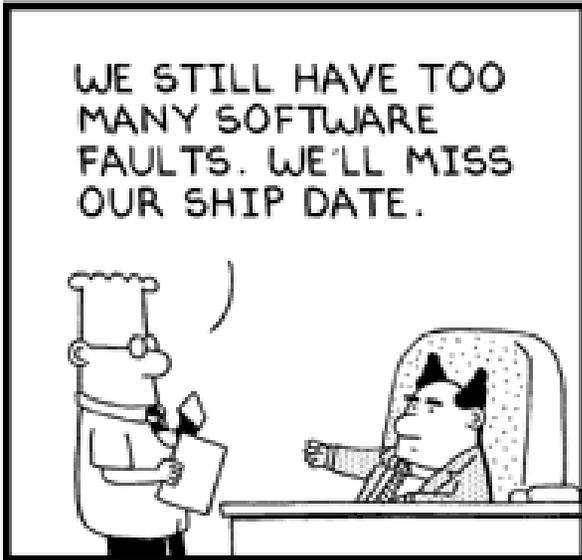
An Abridged History of Emission Inventory and Emission Factor Activities (Tales of a Curmudgeon)

James (Jim) Southerland QEP
Emission Inventory Coordinator

North Carolina Division of Air Quality



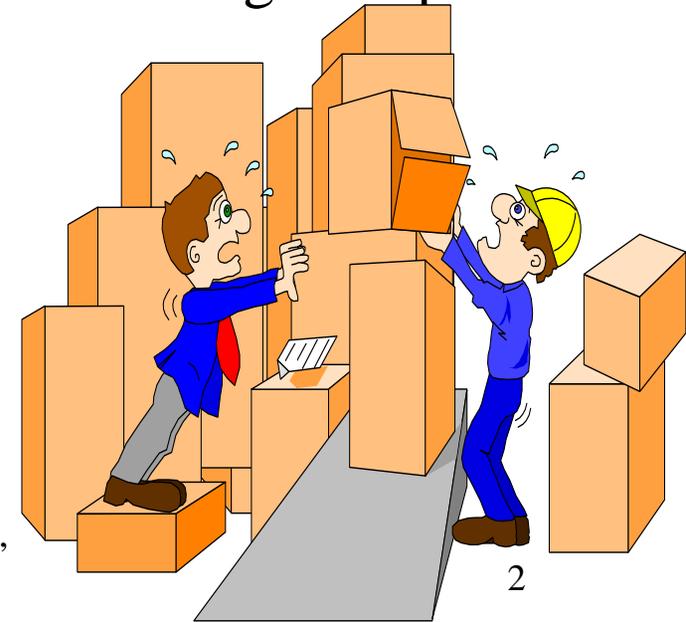
From My Good Friend Dilbert



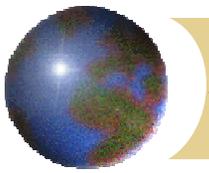
www.dilbert.com scottadams@aol.com

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What do I call this paper? A NON-paper! A stroll through the past?

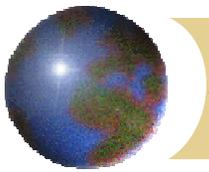


James Southerland QEP, NC DENR, DAQ, April 2002



Abridged History-Where to Begin?

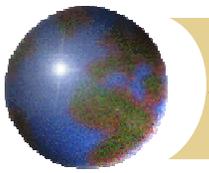
- ❖ “Long, long ago, in a land far, far away,” there were smoke plumes and sources of grit, grime and even “a foul and pestilent congregation of vapours.” (Shakespeare, William H., Hamlet.)
- *I have of late but wherefore I know not lost all my mirth, forgone all custom of exercises; and indeed, it goes so heavily with my disposition that this goodly frame, the earth, seems to me a sterile promontory; this most excellent canopy, the air, look you, this brave o'erhanging firmament, this majestic roof fretted with golden fire why, it appeareth no other thing to me than a foul and pestilent congregation of vapours.
What a piece of work is a man! how noble in reason! how infinite in faculties! in form and moving how express and admirable! in action how like an angel! in apprehension how like a god! the beauty of the world, the paragon of animals*



Emission Inventories and Emission Factors

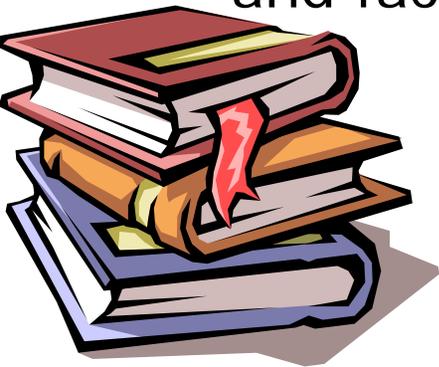


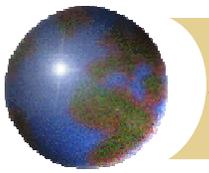
- Emission inventories have long been recognized as a cornerstone of air quality management (JHS+)
- Factors are a critical component for inventories
- Both often overlooked as a priority (Bromberg)



Abridged History-Who and Where?

- The Smoke Prevention Society, the direct genetic ancestor of today's Air and Waste Management Association (A&WMA), was founded in Pittsburgh by local boiler dudes in 1907
- Not sure who defined first, but California, especially South Coast (Los Angeles) APCD probably should have the credit for thinking up emission inventories and factors (*Route 66 and Rule 66 share a history!*)

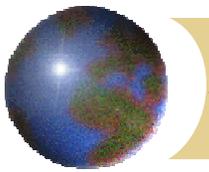




Here Come the 'Feds'

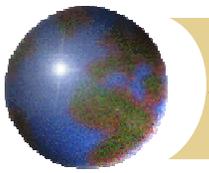


- Public Health Service –
 - One of 7 Uniformed Services
 - In 1960's Part of DHEW
 - Formerly home of Water Quality – Taft Center in **Cincinnati**
- Division of Air Pollution, Bureau of Abatement and Control (aka ~OAQPS – began move to NC about 1967)



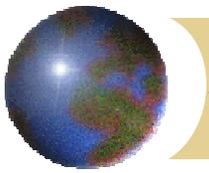
First Broad Scale Guidance

- USPHS “Rapid Survey Techniques” guidance document
- Covered Point and Area (w/Mobile as an area source)
- Mobile Sources were very, very rough!
- Guntis (SAM) Ozlins listed as author but was his refined editing and publication of a collection of group efforts/products



Point Source Emphasis

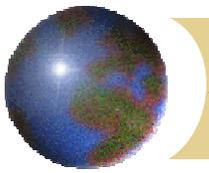
- Many inventories seem to start with a point source emphasis
 - They are obvious
 - In the 50's and 60's they were obvious and most amenable to controls
 - Area sources, including mobile, were soon added as refinements
 - Again LA's 19.6 mph driving cycle



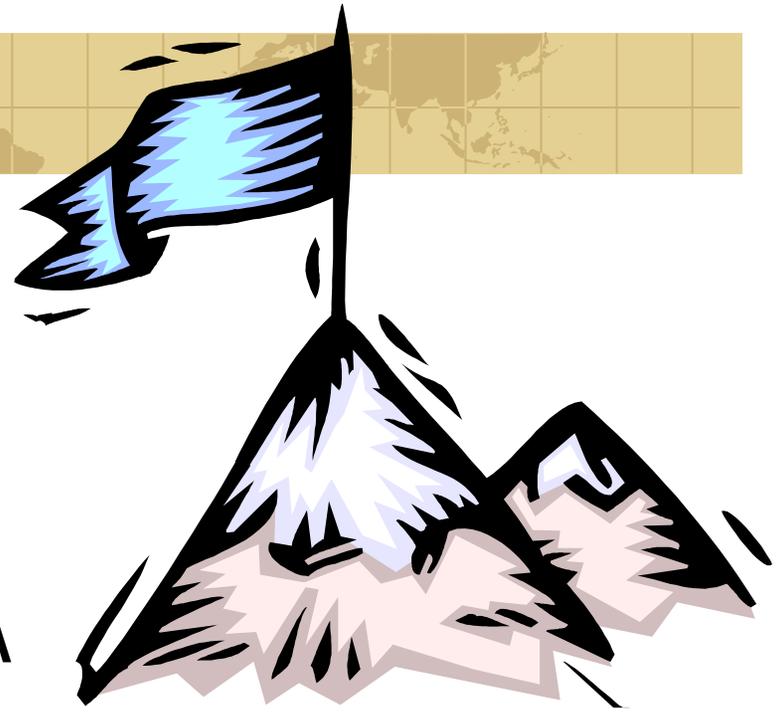
AP-42 Beginnings



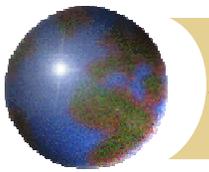
- Emission Factors – The AP-42 legacy
 - Informal paper collection in mid-1960's – Robert Martin of PHS's Taft Sanitary Engineering Center in Cincinnati
 - Compilation of Air Pollutant Emission Factors (not identified as First Edition until there was a 2nd) in 1968 (AP-42) by PHS Officer Robert Duprey (later in Denver EPA RO)



AP-42 Beginnings

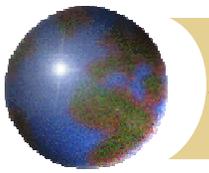


- 1970 CAA
- 1970 Formation of EPA
- The “First Coming” of Bill Ruckelshaus
- NIAPEC Branch
- Need to support states and provide training, funding and procedures (Interstate Regions Emphasis)



What is an Emission Factor, anyway?

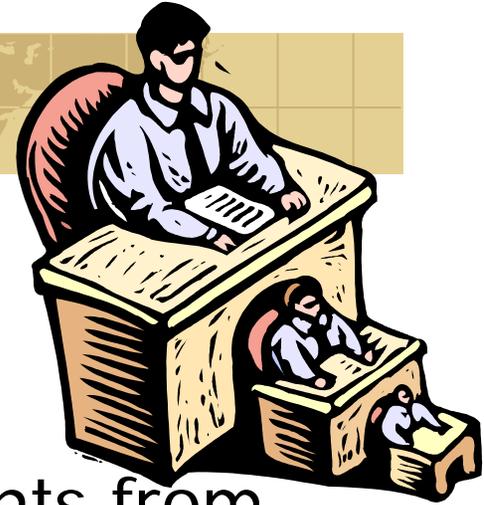
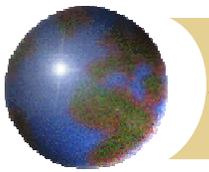
- ❖ An **Emission Factor** is a number which passes as an accurate tool for approximation of emissions,
 - ❖ is prolifically developed from information that is extremely incomprehensible,
 - ❖ calculated with micron level precision,
 - ❖ involving extremely vague assumptions,
 - ❖ based on debatable data from inconclusive tests and incomplete experiments,
 - ❖ using instruments of problematic accuracy,
 - ❖ by persons of marginal reliability and uncertain mentality. (adapted)



AP-42 Beginnings

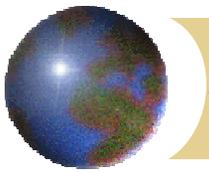
📍 2nd Edition

- ❑ Contract Report by PEDCo – Dick Gerstle was Project Officer/Engineer on consultant side
- ❑ Several references - “personal communications”
- ❑ Desire for an EPA Publication
- ❑ Edited, formatted and ‘hammered on’ by this assigned author and published as 2nd edition
- ❑ Provision & concept for future updates as industry sections revised and finalized w/o entire document
- ❑ Some “heat” to have a new numerical designation



AP-42 Early References

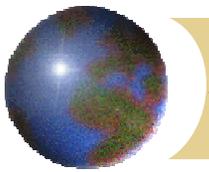
- ❖ A series of industry-specific documents from PHS on emissions, emission factors, controls, etc. provided great detail and information for some industry
- ❖ L A Air Pollution Engineering Manual – AP-40: Revised (Editor Wayne Davis of U of Tennessee) and available from Air and Waste Management Association – some factors



AP-42 Beginnings

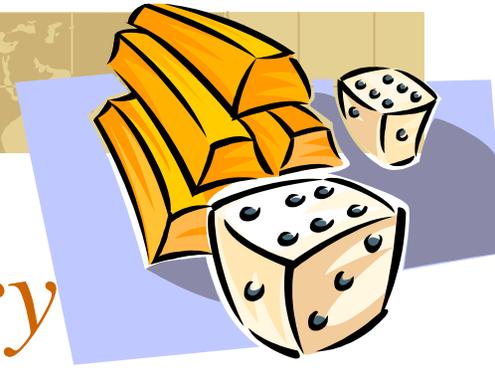
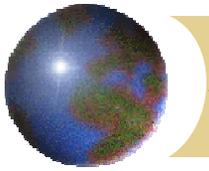
- This author broke away from but was then reassigned to AP-42; 2-3 stints over >25 years.
- Factors ALMOST always the result of scavenged data, designed for another purpose or need w/few \$\$.
- Temporary surges for testing and data came at
 - PM-10 (ORD funded)
 - National Dioxin Study – combustion sources
 - Toxics data collection (few tests available)
 - CAA 1990
 - A few squeaky wheels (e.g. stone)





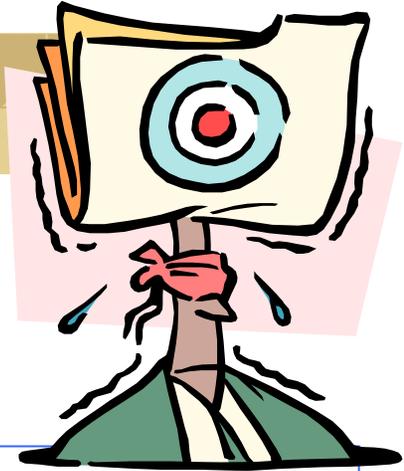
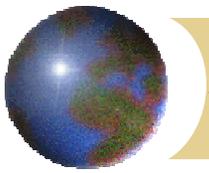
AP-42 and the 1990 CAA

- The CAA of 1990 resulted in ~\$6 Million for development of emission factors
- Pressures
 - Spend it all funds productively within 2-3 years and fulfill all needs for factors
 - Use for other non-EF projects
 - 5th Edition was born – collect, review, rework, document, state/industry review –recycle again!
 - Propose a longer testing effort to develop or validate factors covering all HAPs and criteria pollutants
- GHG \$ 'Raids' by Gore and Browner
- Flash in the Pan! Back to no funds.



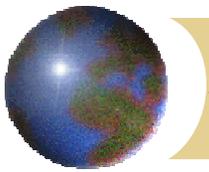
Early References to Accuracy

- The 1962 USPHS, but California-written field manual describes the inventory as “intended to specifically provide some accurate data (emphasis added) on all equipment sources of air pollution in all industrial-commercial establishments in the pollution zone,” lending an implied measure of quality and validation.



Emission Factor “Accuracy”

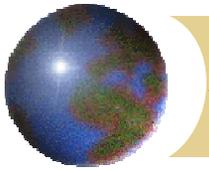
- ❖ Modelers Creed says that if the model gives the wrong results, then the input data are wrong!
- ❖ **NO MATTER HOW CAREFUL, HOW COMPLETE AND HOW LIBERALLY ESTIMATED, EI ALWAYS NEEDS TWO TIMES THE AMOUNT OF VOC ESTIMATED TO MODEL CORRECTLY!**



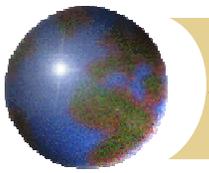
Studies of Emission Inventory

Error Are Not New

- ❖ Early 1970's - Source Inventory and Emission Factor Analysis (SIEFA) - EPA – (Bosch & PEDCo)
- ❖ Late 1970's - An Emission Inventory Quality Assurance Program
- ❖ Late 1980's DARS
- ❖ Late 1980's & Early 1990's - Several papers on Emission Factor Uncertainty
- ❖ Early 1990's Studies by US General Accounting Office – “Do More Tests!”

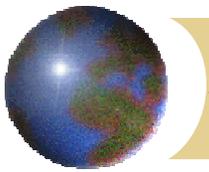


***An inventory may not always be right, but
it ain't never wrong!***



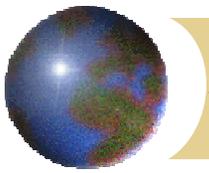
How much for Good Emission Factors for Most Sources?

- ❖ Statisticians “like to have” ~30 data sets from a population, but let’s say 10 are acceptable
- ❖ Assume there are ~250 major source categories (AP-42), with 10 significant processes (with factors needed) each
- ❖ Assume it costs \$100,000 for a test series of three runs and 10 main pollutants



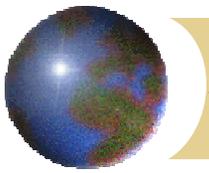
Emission Factors

- ⊕ Therefore, for this conservatively low exercise, you can see that it would cost approximately **\$2.5 Billion!** This would barely scratch the surface
- ⊕ **This "ain't" gonna happen!**



National Emissions Data System

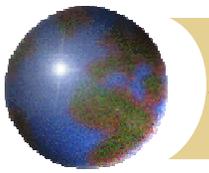
- ❖ EPA “needs” to have data to analyze grew and national emission estimates and reports were launched
- ❖ Needed more and more complete data
- ❖ Jim Hammerle led the charge to develop the National Emissions Data System – IBM cards with most of the same key fields as in NET/NIF today. John Bosh completed cards!
- ❖ Mailed boxes of paper back to states to verify, modify, etc.



Regional Air Pollution Study

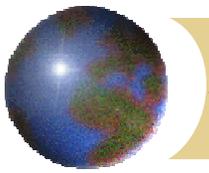
(RAPS)

- ❖ Early 60's Pioneering Air Quality Management studies done in S L
- ❖ In 1970's, a new thrust by OAQPS and ORD to renew studies and go further
- ❖ Highly detailed (from chase cars to boiler steam charts) – Months and Millions resulting in improved methods and emission factors/inventories; point, area, & mobile
- ❖ Jim Hammerle, Chuck Masser were main players



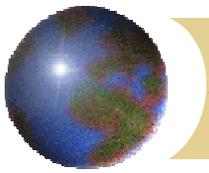
NECRMP (Knee Cramp)

- ❖ NorthEast Corridor Regional Modeling Project – Inventory hand-in-hand with modeling – Co-lead by OAQPS EI and modelers- D.C. Northward, primarily
- ❖ States and EPA Regions were heavy participants – resulting in multi-year efforts: “No small undertaking!”



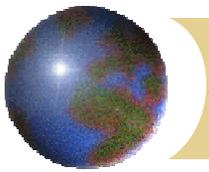
AIRS

- ✚ A “new beginning”
- ✚ A leap beyond NEDS – cursed almost as much?
- ✚ An involvement of actual IT staff and Research Labs with OAQPS
- ✚ Still complex and time consuming
- ✚ Great Graphics
- ✚ Shut down as too much!



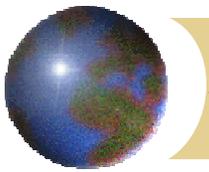
Phoenix Bird – From the Ashes

**History not learned is
history to be repeated!**



El Conferences: Raleigh 1977

- ✚ **Topics** (out of a total of 25 papers of up to 80 pages long – each)
 - ✚ “Analysis of Data for Hydrocarbon Sources in Non-Attainment Areas”
 - ✚ “A Format for the Storage of Area Source Emission Data”
 - ✚ “Commercial Bakeries as a Major VOC Source”
 - ✚ “Hydrocarbon Emissions from Floating Roof Storage Tanks”
 - ✚ “An Organic Specie Emission Inventory for Stationary Sources in LA”
 - ✚ “Highway Motor Vehicle Emission Factors” (by MVMA)
 - ✚ “Biogenic Hydrocarbon Emission Inventories”

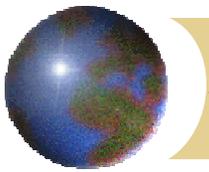


El Conferences - Anaheim, 1978



Topics

- ❏ "Emissions from Vegetation, Asphalt, Bakeries, Oil Shale & Urban Solvents"
- ❏ "Fine Particle Emissions; Size Distributions and Chemical Composition"
- ❏ "Emission Inventory Requirements for Photochemical Simulation Models"
- ❏ "Reliability of Inventory Data"
- ❏ "Inventory Software"
- ❏ "Use of Inventories for Offsets and PSD Baselines"
- ❏ "RAPS Emission Inventory"
- ❏ "Emission Inventory Data for Acrylonitrile,Carbon Black, Synthetic Ammonia, Ammonium Nitrite...."



El Conferences- Kansas City, 1982

● **Topics**

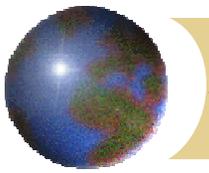
- "Emission Inventories for Photochemical Modeling"
- "Matching an Emission Inventory to an Air Quality Dispersion Model"
- "Data Adequacy, Uncertainties and Policy Implications"
Coauthored by author
- "IF Not AP-42, What?"
- "Developing a Database for the Area Source Inventory"
- "Role of Receptor Models in Air Quality Management"
- "Emission Inventory Data for Acid Rain Studies:"



EI Conferences: The A&WMA Years

● Themes

- ❏ Emission Inventories in the 1990's, Durham, NC, September 9-12, **1991**
- ❏ Emission Inventory Issues, Durham, NC, October **1992**
- ❏ Emission Inventory: Perception and Reality, Pasadena, CA, October 18-20, **1993**
- ❏ The Emission Inventory: Applications and Improvement, Raleigh, NC, November 1-3, **1994**
- ❏ The Emission Inventory: Programs and Progress, Research Triangle Park, NC, October 11-13, **1995**
- ❏ The Emission Inventory: Key to Planning, Permits, Compliance and Reporting, New Orleans, Louisiana, September 4-6, **1996** (During Hurricane Fran in NC)
- ❏ Emission Inventory: Planning for the Future, Research Triangle Park, NC, October 28-30, **1997**
- ❏ Emission Inventory: Living in a Global Environment, New Orleans, LA, December 8-10, **1998**
- ❏ The Emission Inventory: Regional Strategies for the Future, Raleigh, NC, October 26-28, **1999**

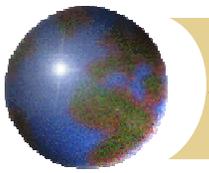


EI Conferences:

The Dombrowski Era (stay tuned!)

Themes

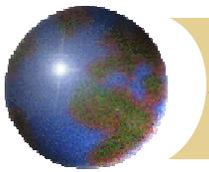
- ❖ International Emission Inventory Conference, "One Atmosphere, One Inventory, Many Challenges." Denver, CO, April 30, **2001**.
- ❖ International Emission Inventory Conference "Emission Inventories - Partnering for the Future," Atlanta, GA, April 15-18, **2002**.
- ❖ International Emission Inventory Conference "Emission Inventories - Applying New Technologies," San Diego, CA, April 28 - May 1, **2003**.
- ❖ International Emission Inventory Conference, "Working for Clean Air in Clearwater," Clearwater, Florida, June 7 - 10, **2004**.
- ❖ Transforming Emission Inventories, "Meeting Future Challenges Today," (Here and Now! It's a gamble!). **2005**



EI Conferences – Key to change or reflection of “something”?

📍 Observations:

- 📍 Enlightening to see many of the same topics that are still on the “plate” today – little change
- 📍 See progress made on many of these topics
- 📍 Some of the authors of the time continue to be familiar and still active in the field
- 📍 This period has helped them establish their role as pioneers and/or stalwarts in the field-A place in history
- 📍 The topics remain similar but new folks come to the field that need to pick up the challenge and lead **ONWARD & UPWARD!**



A Toast to North Carolina *and David Mobley's Passion for BBQ!*

by Leonora Martin and Mary Burke Kerr, adapted/corrupted

Here's to the land of the long leaf pine, The summer land where the sun doth shine, Where the weak grow strong and the strong grow great, Here's to "Down Home," the Old North State!

Home of the best BBQ!

Here's to the land of the cotton bloom white, Where the scuppernong perfumes the breeze at night, Where the soft southern moss and jessamine mate, 'Neath the murmuring pines of the Old North State!

Home of the best BBQ!

Here's to the land where the galax grows, Where the rhododendron's rosette glows, Where soars Mount Mitchell's summit great, In the "Land of the Sky," in the Old North State!

Home of the best BBQ!

Here's to the land where maidens are fair, Where friends are true and cold hearts rare, The near land, the dear land, whatever fate,

Home of the best BBQ!



- Carl Spangler

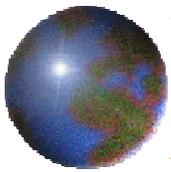
- Frank Noonan

- Tom Lahre

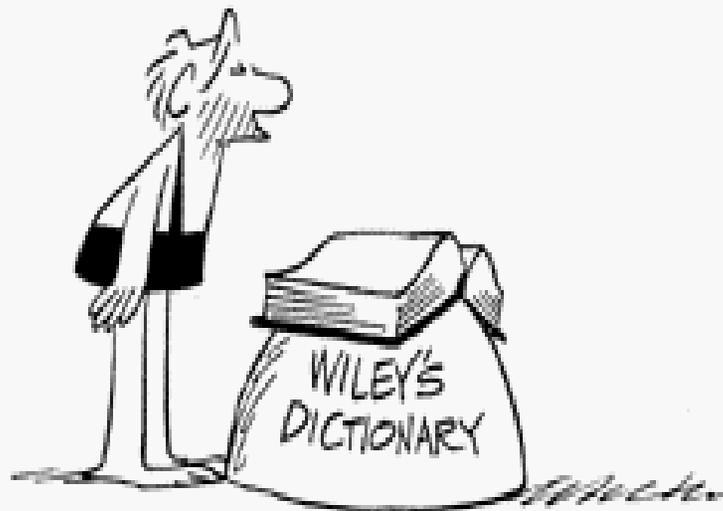
- Arch MacQueen (the Original Emission Factor Curmudgeon)

- All of which were former friends and close professional associates, with whom the employee/employer relationship was more than something to tolerate to get the next pay check - RIP

Questions? Comments?



relative humidity



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