EMISSIONS TESTING DATA AND INDOOR AIR QUALITY

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BACKGROUND

- EMITTED POLLUTANTS OF GREATEST CONCERN:
  VOLATILE ORGANIC CHEMICALS (VOCs)
  FORMALDEHDYE (HCHO)

- CONTROLLING INDOOR AIR QUALITY BY CONTROL OF POLLUTION SOURCES

- VENTILATION CAN ALSO REDUCE AIRBORNE CONCENTRATIONS OF POLLUTANTS

- INDOOR POLLUTION CONTROL BY VENTILATION VERSUS SOURCE CONTROL

- LITTLE DISCUSSION OR UNDERSTANDING OF OPTIMUM COMBINATION OF SOURCE CONTROL AND VENTILATION TO ACHIEVE GOOD IAQ

BACKGROUND 2

- USES OF THE EMISSIONS TEST DATA
  - ◊ PRODUCT DEVELOPMENT AND QUALITY CONTROL FOR MANUFACTURING
  - ◊ SELECTION OF PRODUCTS FOR DESIGN OR PURCHASING
  - ◊ ESTIMATION OF CONCENTRATIONS IN BUILDINGS
- USERS INCLUDE
  - ◊ PRODUCT MANUFACTURERS
  - ◊ BUILDING DESIGN PROFESSIONALS
  - ◊ INDOOR AIR INVESTIGATORS AND RESEARCHERS.
- CARPET MANUFACTURERS
  - ◊ QUALITY CONTROL FOR MANUFACTURING
  - ◊ LABELING TO PROVIDE CONSUMER INFORMATION OR PROTECTION
- PRESSED WOOD PRODUCTS (PLYWOOD AND PARTICLEBOARD) FOR USE MANUFACTURED HOUSING AND MOBILE HOMES MUST MEET FORMALDEHYDE CONCENTRATIONS IN A LARGE TEST CHAMBER

- SIMILAR PROGRAMS EXIST IN SOME EUROPEAN COUNTRIES FOR BOTH CARPETS AND PRESSED WOOD PRODUCTS.

LIMITATIONS ON THE USE OF EMISSIONS TEST DATA

MANY SOURCES OF UNCERTAINTY

- ◊ TEST METHODS AND CONDITIONS
- ◊ PRODUCTS BEING TESTED
- ◊ ENVIRONMENTS FOR WHICH THE TEST DATA ARE BEING APPLIED

IMPORTANT VARIABLES

- ◊ AGE AMD CONDITION OF THE MATERIALS BEING TESTED
- ◊ REPRESENTATIVENESS OF THE TEST SPECIMEN
- ◊ THE TEMPERATURE AND VENTILATION RATE OF THE TEST APPARATUS
- ◊ THE VENTILATION RATES IN THE ACTUAL BUILDING
- ◊ METHOD FOR MEASURING THE EMITTED SUBSTANCES, IDENTIFYING THEM, AND DETERMINING THEIR QUANTITIES

VARIOUS METHODS PRODUCE DIFFERENT RESULTS

SAME METHODS IN DIFFERENT HANDS PRODUCES CONSIDERABLE VARIATION

LIMITATIONS ON THE USE OF EMISSIONS TEST DATA 2

- VARIATIONS BETWEEN PRODUCTS TESTED AND THOSE INSTALLED IN BUILDINGS
- PRODUCTS VARY FROM ONE MANUFACTURING RUN TO ANOTHER AND, FOR SOME PRODUCTS, EVEN WITHIN MANUFACTURING RUNS.
- MANUFACTURERS CHANGE FORMULATIONS OR SOURCES OF THE RAW MATERIALS
- TESTING IS CONDUCTED ON NEWLY MANUFACTURED MATERIALS
- PRODUCTS INSTALLED IN BUILDINGS HAVE OFTEN RELEASED CHEMICALS TO THE ENVIRONMENT OR HAVE SUBSTANCES FROM THE ENVIRONMENT DEPOSITED ON THEIR SURFACES

WHAT DO WE NEED TO KNOW?

- HUMAN EXPOSURE TO CONTAMINANTS
- EXPOSURE IS THE PRODUCT OF CONCENTRATION TIMES TIME OF EXPOSURE
- RELATIONSHIPS BETWEEN CONCENTRATIONS, EMISSIONS TEST DATA, AND VENTILATION RATE DATA
- IDENTIFY THE CRITICAL FACTORS THAT CONTROL CONCENTRATIONS IN INDOOR AIR.
- THESE RELATIONSHIPS DETERMINE
  - ◊ IMPORTANCE OF EMISSIONS
  - ◊ USEFULNESS OF EMISSIONS TEST DATA
- CONTROL EXPOSURE TO INDOOR AIR POLLUTANTS EMITTED FROM INDOOR SOURCES

VENTILATION RATES IMPACT ENERGY CONSUMPTION

VALUE OF VENTILATION IN DETERMINING CONCENTRATIONS

USE OF ENERGY IS IMPORTANT DUE TO ITS ECONOMIC AND RESOURCE COSTS AND ASSOCIATED ENVIRONMENTAL IMPACTS (E.G., ATMOSPHERIC POLLUTION, GLOBAL WARMING, OZONE DEPLETION, WATER CONSUMPTION, WASTE PRODUCTION, ETC.)

NEED TO EVALUATE ALTERNATIVES TO VENTILATION INVOLVING NON-ENERGY INTENSIVE TECHNOLOGIES THAT CAN BE USED TO REDUCE CONCENTRATIONS

THE MOST IMPORTANT OF THESE IS SOURCE CONTROL, MOST OFTEN, THE SELECTION OF LOW-EMITTING BUILDING PRODUCTS AND MATERIALS

EVALUATION OF ALTERNATIVES CONTROL METHODS INCLUDE EMBODIED ENERGY IN MATERIALS AND IMPACTS ON OPERATIONAL AND MAINTENANCE ENERGY USE

EVALUATION OF ALTERNATIVES: INCLUDE ENVIRONMENTAL IMPACTS SUCH AS NATURAL RESOURCE DEPLETION, HABITAT DESTRUCTION, BIODIVERSITY, AND OTHER.

VENTILATION RATES IN BUILDINGS

VENTILATION RATES VARY BY A FACTOR OF **10** -- FROM **0.4** TO **10.0** ACH

TYPICAL OFFICES, MIN VENTILATION REQUIREMENTS: **7.5** TO **10** L/S/P (~ **0.9** ACH)

DENSER OCCUPANCIES (SCHOOLS, PUBLIC ASSEMBLY), AIR EXCHANGE IS HIGHER

LABORATORY SPACES AND CERTAIN OTHER FUNCTIONS USUALLY HAVE HIGH AIR EXCHANGE RATES, OFTEN ABOVE **6** H^{-1} SCHOOL CLASSROOMS TYPICALLY HAVE MINIMUM REQUIRED AIR EXCHANGE RATES OF **3** TO **6** H^{-1}.

BUILDINGS WITH **VAV** OUTDOOR AIR OPERATE WITH MORE THAN MINIMUMS MUCH OF THE YEAR

"ECONOMIZER" SYSTEMS SUPPLYING **100%** OUTDOOR AIR, MAY BE **5** OR **6** H^{-1}.

REDUCED AIR EXCHANGE WHEN OUTSIDE WEATHER CONDITIONS ARE EXTREME RESULT IN LOW AIR EXCHANGE RATES OF **0.2** TO **0.4** H^{-1} .

USE AND LIMITATIONS OF EMISSION TEST DATA

TOO MUCH FAITH IS PLACED IN EMISSION TEST RESULTS - ACCURACY, PRECISION

FACTORS RELATED TO THE TEST SPECIMENS, THE TEST CONDITIONS AND THE BUILDING CONDITIONS TO WHICH THE TEST DATA ARE APPLIED AFFECT INTERPRETATION AND USE OF INDOOR SOURCE EMISSIONS TEST DATA.

IMPORTANT FACTORS:

- PRODUCT/MATERIAL AGE AND HISTORY OF ENVIRONMENTAL EXPOSURE
- MATERIAL THICKNESS
- MATERIAL DENSITY
- MATERIAL SURFACE CHARACTERISTICS
- MATERIAL INFLUENCE ON SINK EFFECTS, ADSORPTION AND DESORPTION.
- AIR EXCHANGE RATE -- TEST AND BUILDING
- TEMPERATURE -- TEST AND BUILDING
- AIR FLOW AT SURFACE -- TEST AND BUILDING

DOES IT MATTER?

HOW IMPORTANT ARE CONCENTRATIONS OF POLLUTANTS FOUND INDOORS?

FOR MOST CHEMICALS, THE ANSWER IS NOT KNOWN.

FAR LESS IS KNOWN ABOUT THE COMPLEX MIXTURES OF HUNDREDS OF CHEMICALS TYPICALLY FOUND INDOORS.

MØLHAVE FOUND CORRELATIONS BETWEEN GC-FID CONCENTRATIONS OF A DEFINED MIXTURE OF 22 COMPOUNDS AND CERTAIN RESPONSES OF HIS STUDY SUBJECTS. MOST RESPONSES AT CONCENTRATIONS ABOVE TYPICAL INDOOR AIR.

MØLHAVE FOCUSED ON PARTICULAR COMBINATION OF CHEMICALS. IT IS NOT KNOWN HOW APPLICABLE THE RESULTS ARE TO OTHER MIXTURES OR EVEN TO DIFFERENT RATIOS OF THE SAME CHEMICALS STUDIED BY MØLHAVE

INVESTIGATORS HAVE FOUND POSITIVE, NEGATIVE, AND NO CORRELATIONS BETWEEN VOC CONCENTRATIONS AND SICK BUILDING SYNDROME (SBS) SYMPTOMS

WHY THE DIFFERENCES?

TVOC CONCENTRATIONS ALONE ARE POOR PREDICTORS OF HEALTH EFFECTS AND HUMAN RESPONSES. TOO LITTLE IS KNOWN TO PREDICT OCCUPANT REACTIONS TO NON-SPECIFIC MIXTURES OF VOCS

PRELIMINARY DATA FROM THE EUROPEAN AUDIT PROJECT SHOW VERY LITTLE TO NO CORRELATION BETWEEN VOC CONCENTRATIONS AND SBS SYMPTOMS.

FURTHERMORE, THE SENSORY EVALUATIONS REPORTED DID NOT CORRELATE WITH REPORTED SBS SYMPTOM PREVALENCE.

RESULTS FROM MAJOR EPIDEMIOLOGIC STUDIES LITTLE CORRELATION BETWEEN VOC EXPOSURE AND SBS

MOST FIELD STUDIES HAVE NOT MEASURED VOCS IN THE SAME TEMPORAL CONTEXT AND MICROENVIRONMENT AS THAT OCCUPIED BY THE STUDY SUBJECTS.

M. HODGSON *ET AL:* POSITIVE ASSOCIATION BETWEEN VOCS MEASURED IN SUBJECTS' MICROENVIRONMENT AND PREVALENCE OF SBS SYMPTOM REPORTS

CONCLUSION

WHAT IS APPROPRIATE LEVEL OF CONFIDENCE AND USE OF EMISSIONS TEST DATA?

THE RANGE OF VALUES FROM ONE PRODUCT TO ANOTHER IS VERY LARGE, AND EVEN WITH A SIMILAR PRODUCT TYPE, IT IS VERY LARGE

ALTERNATIVE PRODUCT CHOICES FOR THE SAME BUILDING FUNCTION CAN VARY BY TWO ORDERS OF MAGNITUDE

THUS, THE CHOICE OF PRODUCTS MAY BE QUITE SIGNIFICANT IF SOURCE STRENGTH IS AN IMPORTANT DETERMINANT OF IAQ

THESE VARIATIONS CAN RESULT FROM DIFFERENCES IN PRODUCT FORMULATION, DESIGN, MANUFACTURE, TREATMENT, STORAGE, INSTALLATION, CURING, AND OTHER FACTORS

BECAUSE THESE DIFFERENCES MAY PRODUCE LARGE VARIATIONS IN EMISSIONS, IT IS IMPORTANT TO SELECT LOW EMITTING PRODUCTS TO KEEP ONCENTRATIONS LOW

CONCLUSION - 2

IT IS IMPORTANT NOT TO PLACE TOO MUCH CONFIDENCE IN A SPECIFIC TEST RESULT OR TO IMPUTE MORE PRECISION OR ACCURACY THAN IS EITHER APPROPRIATE OR TRULY USEFUL.

MEASUREMENTS OF CONTAMINANTS CANNOT BE MEANINGFULLY INTERPRETED WITHOUT CONCOMITANT MEASUREMENTS OF VENTILATION.

ESTIMATES OF CONCENTRATIONS CANNOT BE MADE FROM EMISSION TEST DATA WITHOUT KNOWLEDGE OF THE VENTILATION RATES USED FOR THE TEST AND EXPECTED IN THE ACTUAL BUILDING.

VENTILATION RATES IN BUILDINGS CANNOT BE ESTABLISHED TO ACHIEVE A GIVEN CONCENTRATION ABSENT KNOWLEDGE OF THE SOURCE STRENGTHS THAT WILL BE PRESENT.

CONCLUSION - 3

THERE IS VERY LITTLE INFORMATION AND ALMOST NO DATA THAT ALLOWS US TO DISTINGUISH THE CONTRIBUTIONS OF PEOPLE, THEIR ACTIVITIES, BUILDING MATERIALS, AND OTHER SOURCES IN INDOOR AIR.

UNTIL SUCH DETAILED DATA ARE AVAILABLE AS WELL AS MORE UNDERSTANDING OF THE HEALTH EFFECTS OF VOC EXPOSURE, WE MUST USE BOTH VENTILATION AND SOURCE CONTROL TO ACHIEVE GOOD INDOOR AIR QUALITY.

ABSENT CONVINCING EVIDENCE TO THE CONTRARY, IT IS PRUDENT TO AVOID EXPOSING PEOPLE UNNECESSARILY TO HIGH CONCENTRATIONS OF CONTAMINANTS FROM INDOOR SOURCES.