SYLLABUS FOR CERTIFIED AIR MODELLING PROFESSIONALS

SCHEME REQUIREMENTS

Air modelling professionals are expected to have a clear understanding of the type and scale of air pollution problems, the extensiveness of emission sources to be covered, their atmospheric dispersion, and photochemical transformation characteristics. They must demonstrate the capability to select appropriate model distinguished on the basis of criteria such as the underlying physical concepts, the temporal and spatial scale, type of source, type of component, and type of application. Air modelling professionals should also have an understanding of the errors and uncertainties inherent in the simulation results, the methodology for model performance evaluation, and the application of monitoring and modelling integration techniques.

1 AIR POLLUTION, AIR POLICY, LEGISLATIONS AND REQUIREMENTS

1.1 Air Pollution

- Types and scales of air pollution problems
- Sources of air pollution
  - Urban, industrial, rural, agricultural, and natural, etc.
- Primary and Secondary pollutants and their characteristics and formation including criteria pollutants under HKAQOs, toxic air pollutants, dust, odour, etc.

1.2 Air Quality Policy, Legislations, Standards and Criteria

- Air Pollution Control Ordinance (Cap 311), its subsidiary regulations and other relevant control requirements
- Environmental Impact Assessment Ordinance (Cap 499), Technical Memorandum on Environmental Impact Assessment (EIA) Process
- Air quality objectives (AQO), odour criteria, total suspended particulate criteria, criteria for non-AQO air pollutants, health risk assessment criteria

1.3 Air Quality Modelling Practices and Guidelines for Air Quality Assessment

- Purposes of Air Quality Modelling: environmental impact analysis, plant siting, emergency response planning, accidental release, public relations, economic impacts, air quality forecasting
- Levels of Modelling Effort: Screening, Planning, Compliance
- Modelling guidelines, including the Guidelines for Local-Scale Air Quality Assessment Using Models
  - Guidelines on Assessing the 'TOTAL' Air Quality Impacts
  - Guidelines on Choice of Models and Model Parameters
  - Guidelines on the Use of Alternative Computer Models in Air Quality Assessment
  - Guidelines on the Estimation of 10-minute Average SO2 Concentration for Air Quality Assessment in Hong Kong

2 EMISSION ESTIMATION AND IMPLEMENTATION

2.1 Emission activities

- Anthropogenic, biogenic and natural emissions

2.2 Emission inventory

- Emission processing/modelling and forecasting
- Application of emission models and emission factors, including:
  i. USEPA AP-42: Compilation of Air Emissions Factors
  ii. EMEP/EEA Air Pollutant Emission Inventory Guidebook
  iii. The Best Practicable Means (BPM) for Specified Processes
  iv. EMFAC-HK Model (latest version)
  v. International Civil Aviation Organization (ICAO) Aircraft Engine Emissions Databank and the Aviation Environmental Design Tool (version 3b)
  vi. Guidance on the Determination of Helicopter Emissions
  vii. Study on Marine Vessels Emission Inventory by the HKUST and Current Methodologies in Preparing Mobile Source Port-related Emission Inventories by the USEPA with appropriate updating and adjustments according to local and Greater Bay Area's requirements
    - Temporal (diurnal, weekly, seasonal) variation
    - Spatial distributions
    - Emission characteristics for selection of appropriate source implementation approach (fixed point, line, area and volume and moving sources, etc.)

3 ATMOSPHERIC STRUCTURE AND DYNAMIC

- Adiabatic Process
- Potential Temperature
- Atmospheric Stability; P-G scheme and Monin–Obukhov Length
- Roughness length; relationship between physical height and roughness length
- Friction velocity
- Bowen Ratio
- Albedo
- Convection and mechanical mixing height
- Continuity, Momentum and Diffusion
- Planetary and large scale circulations
- Mesoscale System: Land-sea breezes, monsoon circulation, urban heat island circulation, mountain-wake circulation
- Microscale System: PBL flows, Internal boundary layers, obstacle wakes
- Vertical distribution of dispersion variables: heat flux & Temperature profile, wind and turbulence profiles, mixing height

4 PLUME RISE, SETTLING AND DEPOSITION, CHEMICAL PROCESSES

- Plume Rise; Momentum and Buoyancy effect of emission
- Stack downwash
- Gravitational settling of particles
- Dry deposition, wet deposition
- Transport and chemical transformation of air pollutants in the atmosphere

5 BOX MODELS

- Basic assumptions and boundary conditions
- Treatment of meteorology (winds and mixing height) and chemical transformation (e.g., ozone)
- Selection of appropriate length and time scales
- Application and limitations

6 GAUSSIAN DISPERSION MODELS

- Basic assumptions and benefits of Gaussian dispersion models
- Steady-state Gaussian model vs non-steady-state puff model
- Dispersion parameterization - stability (e.g., P-G Scheme, Monin–Obukhov Length, the relationship between the P-G Scheme and the Monin-Obukhov Length on the atmospheric stability class by Golder 1972)
- Chemical transformations from NO to NO_2 by empirical relationship, Ozone Limiting Method and plume volume molar ratio method
- Application of Gaussian-based models, including AERMOD (The American Meteorological Society / Environmental Protection Agency Regulatory Model) and CALINE4 Model, in air impact assessment:
    - Data preparation / input, validation of input data, quality assurance / quality control procedures, interpretation and review of output data / results, presentation of data and results
- Limitations and uncertainties

7 PHYSICAL MODELLING (E.G. WIND TUNNEL AND WATER TANK)

- The theory of similarity analysis
- Nondimensionalise of the equation of motion
- Model and prototype
- Limitations of the wind tunnel model
- Application of physical models in EIA projects in Hong Kong

8 NUMERICAL DISPERSION MODEL (e.g., COMPUTATIONAL FLUID DYNAMICS (CFD))

- Basic knowledge of the conservation laws (mass, momentum, energy, pollutant species, etc.) that governing CFD simulations
- General understanding on the modules and procedures for setting up a CFD simulation
- Applications, advantages and limitations of CFD simulations
- Selection of appropriate model for case specific needs

9 REGIONAL SCALE AIR QUALITY MODEL

- The concept of Lagrangian model and the Eulerian model
- The meteorological module, emission module and the chemistry and transport module
- Selection of modelling domains, temporal and spatial scale and gird resolutions
- Chemistry Scheme and the associated input data requirements
- Application of regional-scale air quality models, including PATH (Pollutants in the Atmosphere and their Transport over Hong Kong) - 2016 Model, in air impact assessment:
    - Data preparation / input, validation of input data, quality assurance / quality control procedures, interpretation and review of output data / results, presentation of data and results
- Limitations and uncertainties

10 OTHER RELATED ISSUES

10.1 Error / uncertainties of simulation results

- Meteorological simulation / data / input errors
- Emission estimation / implementation / data errors
- Model errors / uncertainties (resulting from inadequate or incorrect representation of physics)
- Inherent uncertainty (due to the stochastic nature of turbulence and diffusion processes, vs the deterministic natural of model on ensemble-averaged results)

10.2 Model performance evaluation

- Methodology: modelling and monitoring statistical agreement, correlation / trend consistency, time and space coupling time-series analysis, cumulative frequency distribution analysis, etc.

10.3 Modelling and monitoring integration

- Reverse modelling
- Post-simulation processing / adjustments
- Data assimilation