# Chapter 2

# Methodology

## 2.1 Information Gathering

The information contained in the directory was acquired through questionnaires distributed to model custodians and/or project managers. The questionnaires addressed both general model characteristics as well as more specific characteristics such as source terms, transport, dispersion, effects, etc. Additionally, as was mentioned in Chapter 1, the APAC provided information for over half of the models contained in this directory. Appendix A contains completed questionnaires for the 64 models included in this directory. The following lists provide a brief description of the questionnaire's general and specific parameters.

Model Questionnaire, General Characteristics

1 Abstract of Model Capabilities (In 100-150 words, provide an abstract of the consequence assessment applications that the model can be used to address)

2 Sponsor and/or Developing Organization (Identify the name, address, phone, fax, and e-mail of the sponsoring organization, and if different, the developing organization)

3 Custodian/Point of Contact (Identify the name, address, phone, fax, and e-mail of the primary individual, and if applicable, secondary individual, that is/are responsible for the care and upkeep of the model)

4 Life-Cycle (In 100-150 words, describe the development history of the model from its beta version to its present version. Indicate any planned enhancements to the code)

5 Model Description Summary (In 200-250 words, describe the key elements of the model)

6 Application Limitations (Briefly describe the limiting model assumptions and address which type of problems the model, in its present version, is unable to address)

7 Strengths/Limitations (Identify 3-5 model strengths and 3-5 model limitations. Indicate any intended enhancements to overcome the model limitations)

8 Model References (Identify up to 5 technical documents that support the model, its algorithms, and its technical basis)

9 Input Data/Parameter Requirements (In 100-150 words, provide a brief synopsis on the input data requirements of the model)

10 Output Summary (In 100-150 words, describe the various types of output products available to the user of this model)

11 Applications (Identify various locations where this model has been successfully applied to consequence assessment problem solving)

12 User-Friendliness (Indicate each type of user interface that is available to assist the user in the execution of the model)

13 Hardware-Software Interface Constraints/Requirements (Identify the computer operating system, computer platform, disk space requirements, run execution time [for a typical problem], programming language, and other computer peripheral information)

14 Operational Parameters (Identify whether the code has any error diagnostic messages to assist the user in troubleshooting operational problems. Identify the setup time for a first-time, and for an experienced user)

15 Surety Considerations (Identify all quality assurance documentation, benchmark runs, validation calculations, and any verification with field experiments that has been performed with respect to this code)

16 Runtime characteristics (Identify average runtimes on different equipment for which the model is compiled)

## Model Questionnaire, Specific Characteristics

### Part A: Source Term Submodel Type

Identify all applicable algorithms that establish the source term from an event. If the model does not have a source term submodel, indicate this in A1 and skip the rest of Part A.

A1 Source Term Algorithm

A2 For Chemical Consequence Assessment Models, identify which chemical source terms the model is capable of addressing from the list below. For each type of source term the model can address, briefly describe the technique utilized.

a) Liquid spill (pool evaporation, particulate resuspension)

b) Pressurized releases (two-phase jets, flashing, entrainment, aerosol formation)

c) Solid spills (resuspension, sublimation)

A3 For Radiological Consequence Assessment Models, identify which radiological source terms the model is capable of addressing from the list below. For each type of source term the model can address, briefly describe the technique utilized.

a) Gaseous releases (noble gases, iodines, other non-reactive gases)

b) Aerosol releases

c) Particulate releases

d) Chemistry, isotopic exchange, or physical properties capability

A4 For Weapons Consequence Assessment Models, identify which source terms the model is capable of addressing from the list below. For each type of source term the model can address, briefly describe the technique utilized.

a) Chemical weapon release characteristics

b) Biological weapon release characteristics

## Part B: Dispersion Submodel Type

Identify all applicable algorithms that treat the atmospheric dispersion component. Describe the model algorithm next to the appropriate type(s) listed below.

B1 Gaussian (straight-line plume, segmented plume, statistical plume, puff, statistical puff)

B2 Similarity (plume, puff)

B3 Stochastic (monte carlo, random walk)

B4 Gradient Transport or K-Theory

B5 Particle-In-Cell

B6 Box

B7 Turbulent Kinetic Energy (TKE)-Driven

B8 Particle

B9 Multiple Capabilities (e.g., Gaussian puff and particle options)

## Part C: Transport Submodel Type

Identify all applicable algorithms that treat the atmospheric transport component. Describe the model algorithm next to the appropriate type(s) listed below.

C1 Prognostic

C2 Deterministic

C3 Stochastic

C4 Frame of Reference (Eulerian, Lagrangian, Hybrid Eulerian-Lagrangian)

## Part D: Fire Submodel Type

Identify all applicable algorithms that treat effects from fires. Describe the model algorithm next to the appropriate type(s) listed below.

D1 Radiant Energy

D2 Fireballs

D3 Jet Fires

D4 Flash Fires

D5 Brand Transport Probabilities

## Part E: Energetic Events Submodel Type

Identify all applicable algorithms that treat effects from explosions and energetic events. Describe the model algorithm next to the appropriate type(s) listed below.

E1 Blast Overpressures

E2 Dust Explosions

E3 Deflagrations

E4 Detonations

E5 Vapor Cloud Explosions

E6 Boiling Liquid Expanding Vapor Explosions (BLEVEs)

E7 Missile Generation

E8 High Explosives

E9 Nuclear Detonations

## Part F: Health Consequence Submodel Type

Identify all applicable algorithms that treat community exposure effects. Describe the model algorithm next to the appropriate type(s) listed below.

F1 For Chemical Consequence Assessment Models, describe which type of exposure criteria are used for assessment of human health effects from exposure to hazardous chemicals

a) Health effects (fatalities, cancers, latent cancers, symptom onset)

b) Health criteria (IDLH, STEL, TLV, TWA, ERPG, TEEL, AEGL, WHO, etc.)

c) Zones within flammable limits (UFL, LFL)

d) Blast overpressure regions

e) Fire radiant energy zones

f) Risk quantification

g) Concentration (single value, time-history, integrated dose)

h) Probits

F2 For Radiological Consequence Assessment Models, describe which type of exposure criteria are used for assessment of human health effects from exposure to radionuclides

a) Cloudshine (finite cloud, semi-infinite cloud, other)

b) Groundshine (short-term, long-term)

c) Inhalation (short-term, long-term, Total Effective Dose Equivalent, uptake of respirable fraction of particle spectra)

d) Resuspension (short-term, long-term, Anspaugh)

e) Food/Water Ingestion (dynamic, static)

f) Skin Dose (Absorption, other)

g) Dose Assessment (ICRP-60 criteria, organs, pathways)

h) Health Effects (early, latent)

F3 For Weapons Consequence Assessment Models, describe which type of exposure criteria are used for assessment of human health effects from exposure to biological or chemical weapons

a) Health effects (fatalities, cancers, latent cancers, symptom onset)

b) Health criteria (IDLH, STEL, TLV, TWA, ERPG, TEEL, AEGL, etc.)

c) Risk quantification

d) Concentration (single value, time-history, integrated dose)

e) Probits

## Part G: Effects and Countermeasures Submodel Type

Identify all applicable algorithms that treat community exposure effects and countermeasures that can be taken to reduce exposure. Describe the model algorithm next to the appropriate type(s) listed below.

G1 For Chemical Consequence Assessment Models, describe which type of countermeasures are used for the mitigation of human health effects from exposure to hazardous chemicals

a) Evacuation

b) Sheltering

c) Interdiction

d) Spray/Foam

e) Victim Treatment/Treatment Measures

G2 For Radiological Consequence Assessment Models, describe which type of countermeasures are used for the mitigation of human health effects from exposure to radionuclides

a) Land Contamination

b) Economic Costs (decontamination, interdiction, foodstuff losses, relocation,

facility downtime, denial of facility access, victim treatment)

c) Evacuation

d) Sheltering

e) Interdiction

f) Decontamination

G3 For Weapons Consequence Assessment Models, describe which type of countermeasures are used for the mitigation of human health effects from exposure to radionuclides

a) Land Contamination

b) Economic Costs

c) Evacuation

d) Sheltering

e) Interdiction

## Part H: Physical Features of Model

Identify all applicable physical features that are contained in the model. Describe the model algorithm next to the appropriate feature(s) listed below.

H1 Stability Classification/Turbulence Typing (Pasquill-Gifford-Turner, STAR, Irwin, sigma theta, split sigma, Richardson number, Monin-Obukhov length, roughness length, TKE-driven)

H2 Release Elevation (ground, roof, stack, continuous height range)

H3 Aerodynamic Effects from Buildings and Obstacles (building wake, cavity, K-factors, flow separation)

H4 Horizontal Plume Meander

H5 Horizontal/Vertical Wind Shear

H6 Mixing Layer (trapping, lofting, reflection, penetration, inversion breakup

fumigation, temporal variability)

H7 Cloud Buoyancy (neutral [passive], dense [negative], plume rise [positive])

H8 Cloud Liquid Droplet Formation/Aerosolization

H9 (Radio)chemical Transformation and In-Cloud Conversion Processes

H10 Deposition (gravitational setting, dry deposition, precipitation scavenging, resistance theory deposition, simple deposition velocity, liquid deposition, plateout and re-evaporation)

H11 Resuspension

H12 Radionuclide Ingrowth and Decay

H13 Temporally and Spatially Variant Mesoscale Processes

a) Urban heat island

b) Canopies

c) Complex terrain (land) effects (mountain-valley wind reversals, anabatic winds, katabatic winds)

d) Complex terrain (land-water) effects (seabreeze airflow trajectory reversals, Thermally Induced Boundary Layer definition, seabreeze fumigation, landbreeze fumigation)

e) Thunderstorm outflow

f) Temporally variant winds

g) High velocity wind phenomena (tornado, hurricane, microburst)

## Part I: Model Input Requirements

Identify all applicable model input parameters from those listed below.

I1 Radio(chemical) and Weapon Release Parameters

a) Release rate (Continuous, time dependent, instantaneous)

b) Release container characteristics (Vapor temperature, tank diameter, tank height, tank temperature, tank pressure, nozzle diameter, pipe length)

c) Jet release (Initial size, shape, and concentration profile at end of jet affected zone)

d) Release dimensions (Point, line, area)

e) Release elevation (Ground, roof, stack)

I2 Meteorological Parameters

a) Wind speed and wind direction (Single point, single tower/multiple point, multiple towers)

b) Temperature (Single point, single tower/multiple point, multiple towers)

c) Dew point temperature (Single point, single tower/multiple point, multiple towers)

d) Precipitation (Single point, single tower/multiple point, multiple towers)

e) Turbulence typing parameters (Temperature difference, sigma theta, sigma phi, Monin-Obukhov length, roughness length, cloud cover, incoming solar radiation, user-specified)

f) Four-dimensional meteorological fields from prognostic model

## Part J: Model Output Capabilities

Identify all applicable model output capabilities from those listed below.

J1 Hazard Zone

J2 Graphic Contours and resolution

J3 Concentration versus time plots

J4 Tabular at fixed downwind locations

J5 Health effects (toxicity indices [e.g., ERPG's, PAG's], potential fatalities, cancers, other adverse effects)

J6 Number of people affected, calculated at what resolution (block, block group, county)

J7 Graphic contours of probability of exceeding concentration

J8 F-N probability distribution curves

J9 Commercial off-the-shelf (COTS) Geographic Information System (GIS) used

J10 Other (Describe)

J11 Accuracy of output, calculated in terms of percentages of population impacted more than predicted at one, two, and three standard deviations in urban and rural areas

## Part K: Model Usage Considerations

Identify all applicable information regarding model usage from the characteristics listed below.

K1 Ease of Model Use

a) Training required to run the model

1) Background (years of education)

2) Training time needed on the model to be able to exercise all model capabilities

b) Training required to continue development of the model

1) Background (years of education)

2) Training time needed on the model to be able to exercise all model capabilities

K2 Time to process from notification of release (including data acquisition) to production of product listed above, listed for platforms for which the program is already compiled

K3 Ease of use of output, evaluated as the time needed to train a college graduate in the use of the output (e.g., one week, one day, one hour)

Appendix T contains points of contact for other models not covered by the completed questionnaires.

## 2.2 Extract Tables

As previously mentioned, a key objective of this directory is to facilitate interagency and intraagency coordination. In order to accomplish this objective, 18 extract tables are included in this directory (Appendices B thru S). These tables focus on particular model attributes and are intended to aid in selecting models of interest for a particular application.

For example, if an agency wanted to augment its existing model with chemical health consequences criteria, it could research the topic, develop algorithms, write the appropriate code from the algorithms, develop a beta version of the code, validate the code, and verify the model results with field data. Embedded within this effort would also be the development of extensive documentation and quality assurance procedures to establish computer surety. All of these processes are highly labor intensive. This directory provides another option that the agency can choose; that is to identify if other public domain codes have already accomplished most of this work and to subsequently acquire applicable code subroutines to be integrated into its model.

Use of the extract tables shortens the time it takes to identify what are the appropriate candidate codes. The agency should first access the Chemical Health Consequences Extract Table (Appendix L) which will establish which of the chemical codes contained in the directory has this algorithm. After establishing these candidate codes, the agency can use the Model Acquisition Extract Table (Appendix B) to determine the custodians and appropriate points-of-contact. Lastly, this list of candidate models can be further shortened by using the Model Pedigree and Quality Extract Table (Appendix C) to identify which candidate codes are more advanced and better documented. After completing this research, contact can be made with the model custodians to obtain more comprehensive and possibly more recent model information.