Air Dispersion Modelling for Surface Finishing Emissions Permitting

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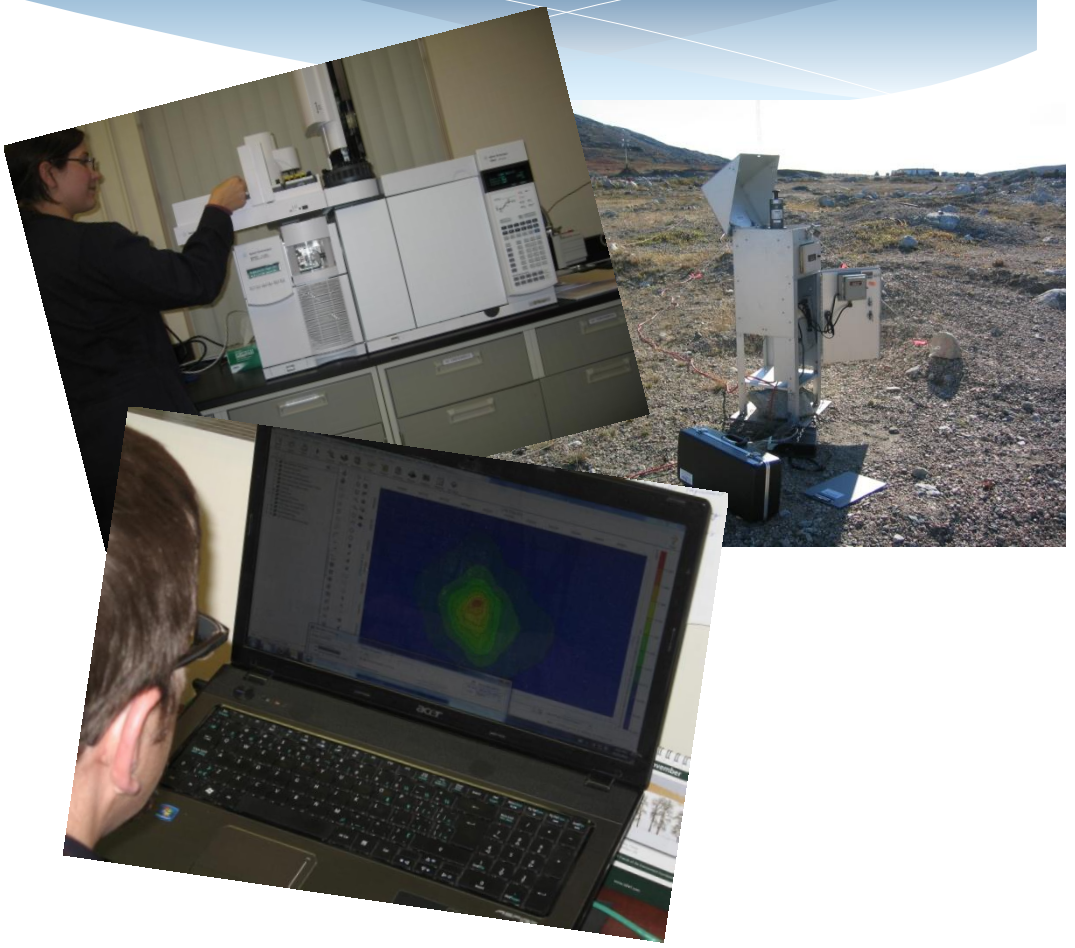
AirZOne

Comprehensive air quality Services

AirZOne, an employee-owned firm offering environmental services since 1979

- Ambient air quality (monitoring, modelling & permitting)
- Indoor air quality
- Occupational Hygiene & Safety
- Related laboratory analyses
- 30% to 40% of revenues from modelling and permitting



What are Permits?

* Legal permission to emit contaminants
* Operation of exhaust equipment

Air Emissions Permits for Surface Finishers in Canada

* Permits are provincial jurisdiction
* Rules and regulations vary province-to-province
* In parallel to Federal requirements

Why Permission Needed?

* S. 6 and s. 14 (EPA) prohibit against the discharge of contaminants into the natural environment that cause adverse effects
* However, s. 9 allows discharge where a permit is issued
* A permit is issued if the emissions do not cause significant adverse effects – i.e. *demonstrate compliance*
* Pollution (air and noise) can be controlled by controlling at the source, or using “dilution,” or both.

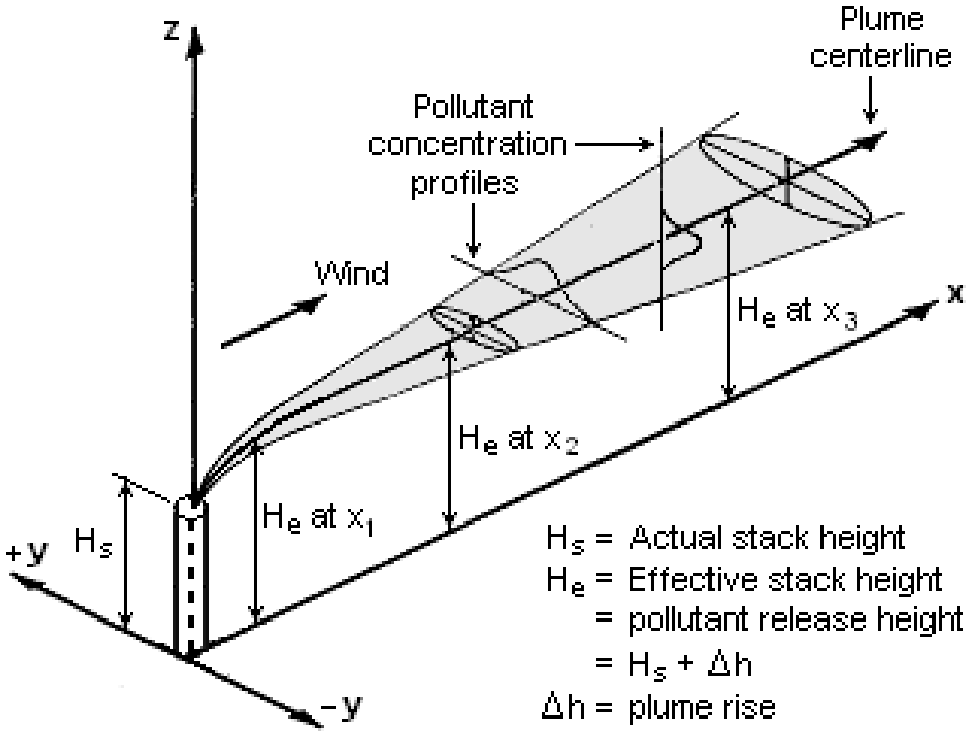
The Process

* Owner/operator needs to apply before (6-12 months?) constructing or altering anything
* Pre-application Consultation
* Application
* Public posting
* Decision
* Appeal?
* Permit issued

The Application Package

* Application form
* Proof of Legal Entity
* Air Impact Assessment (ESDM)
* Noise Impact Assessment form/report
* Costs
* Site diagrams
* Other supporting information – e.g., MSDSs

Impacts Assessments: Computer-based Dispersion Models



* A model is used that allows you to predict the dispersion of contaminants emitted from a process exhaust
* Used to determine "worst-case" impacts

Impact Assessment: Air

(1) Quantify worst-case emissions (estimate or measure)

(2) Use a dispersion model to predict impacts at and beyond the fence line

(3) Compare the maximum impacts against the air standards

(4) Produce Impact Assessment Report (ESDM)

Air Standards

15.1	71-36-3	Butanol, n-	-	920	-
16.	7440-43-9	Cadmium and Cadmium Compounds	-	0.025	-
17.	1305-62-0	Calcium Hydroxide	-	13.5	-
18.	1305-78-8	Calcium Oxide	-	10	-
19.	1333-86-4	Carbon Black	-	10	-
20.	630-08-0	Carbon Monoxide	-	-	6000 (half hour)
21.	REVOKED: O. Reg. 507/09, s. 35(2).				
22.	56-23-5	Carbon Tetrachloride	-	2.4	-
23.	7782-50-5	Chlorine	-	10	-
24.	10049-04-4	Chlorine Dioxide	-	2	-
24.1	75-00-3	Chloroethane	-	5,600	-
25.	67-66-3	[illegible]	-	[illegible]	-
Note: On July 1, 2016, Schedule 3 is amended by adding the following items:					
25.1	7440-47-3	Chromium Compounds (Hexavalent)	-	-	0.00014; annual
25.2	7440-47-3	Chromium and Chromium Compounds (Metallic, Divalent and Trivalent)	-	0.5	-
See: O. Reg. 282/11, ss. 16 (4), 20 (1).					
26.	7440-50-8	Copper	-	50	-
27.	1319-77-3	Cresols	-	75	-
28.	110-82-7	Cyclohexane	-	6,100	-

Where is compliance measured?

* Air:
  * Industrial facility – plant property line and beyond
  * Hospital, school – on-site receptors; property line and beyond
  * Multi-tenant building – boundary between tenants, neighbours air intakes/openable doors and windows; property line and beyond

* Noise:
  * Sensitive receptors (houses, daycare, schools, churches, etc..)

Models Available

* US EPA Models: SCREEN3, AERMOD
* Same structure - ASHRAE

But before you start modelling….

* Use of conservative dispersion modelling factors

Table 3-1: Conservative Dispersion Factors (1 hour averaging time period)

Distance (m)	Urban Dispersion Factor ($\mu g/m^3$ per g/s emission)	Rural Dispersion Factor ($\mu g/m^3$ per g/s emission)
20	8700	10000
40	6300	8100
60	4600	5900
80	3400	5100
100	2600	4500
150	1400	3500
200	900	2800
250	600	2300
300	450	1900
350	350	1700
400	300	1500

SCREEN3

```
16:50:30¶
 ··***··SCREEN3·MODEL·RUN···***¶
 ··***·VERSION·DATED·96043·***¶
¶
 ·NOx·-·E-16MILL-1.1·-·capped·and·ST·d'wash·····························
¶
 ·SIMPLE·TERRAIN·INPUTS:¶
 ····SOURCE·TYPE·····=·····POINT¶
 ····EMISSION·RATE·(G/S)····=·····.455098····¶
 ····STACK·HEIGHT·(M)·····=·····3.5100¶
 ····STK·INSIDE·DIAM·(M)····=·····5.0000¶
 ····STK·EXIT·VELOCITY·(M/S)=·····.7800¶
 ····STK·GAS·EXIT·TEMP·(K)··=····323.0000¶
 ····AMBIENT·AIR·TEMP·(K)···=····305.0000¶
 ····RECEPTOR·HEIGHT·(M)····=·····.0000¶
 ····URBAN/RURAL·OPTION·····=·····URBAN¶
 ····BUILDING·HEIGHT·(M)····=····16.9200¶
 ····MIN·HORIZ·BLDG·DIM·(M)·=····120.0000¶
 ····MAX·HORIZ·BLDG·DIM·(M)·=····483.0000¶
¶
 ·THE·REGULATORY·(DEFAULT)·MIXING·HEIGHT·OPTION·WAS·SELECTED.¶
 ·THE·REGULATORY·(DEFAULT)·ANEMOMETER·HEIGHT·OF·10.0·METERS·WAS·ENTERED.¶
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* Usually confined to single, “simple” sources
* Not much less work than a “simple” implementation of AERMOD

AERMOD

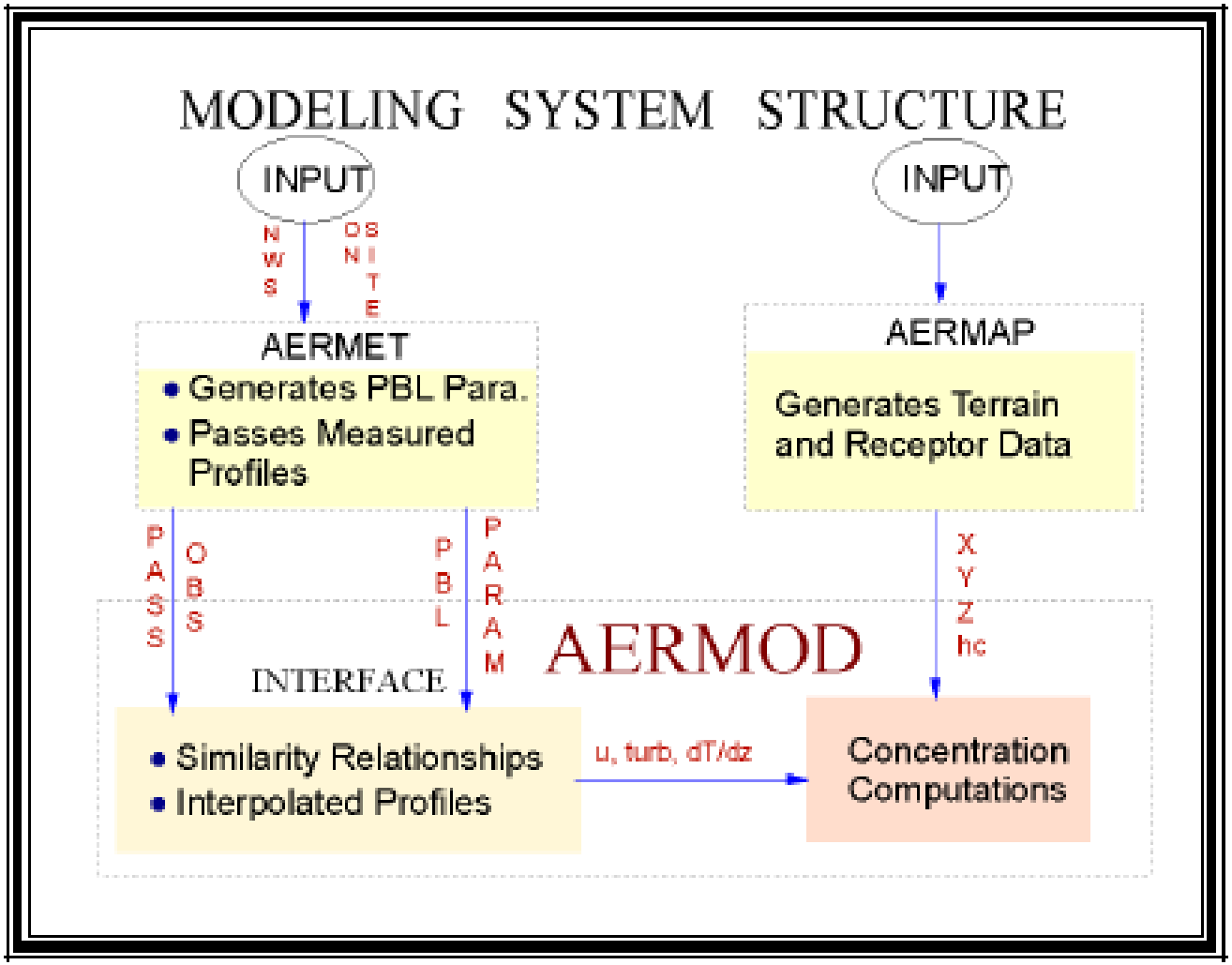
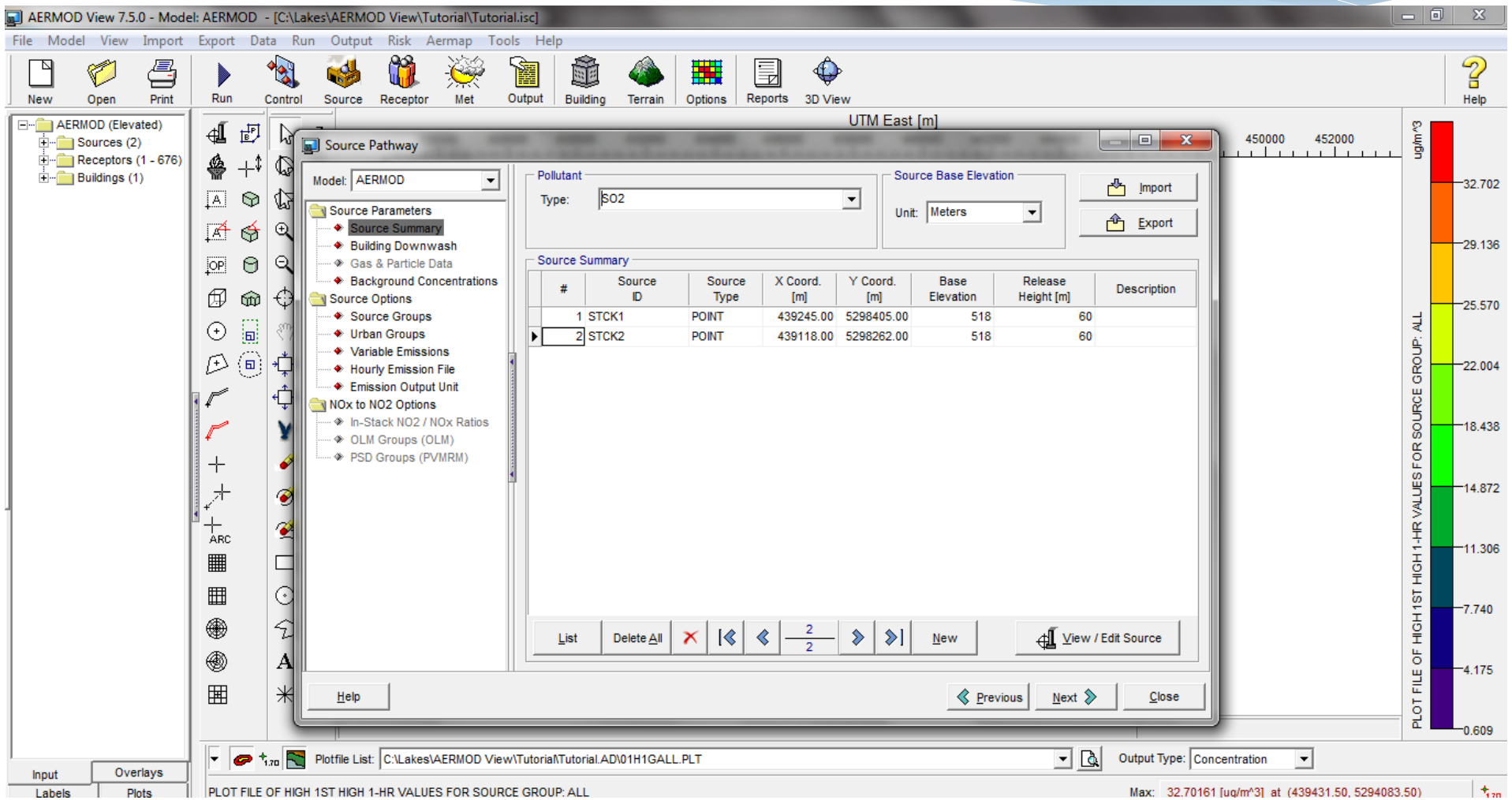


Figure 2: Data flow in the AERMOD modeling system

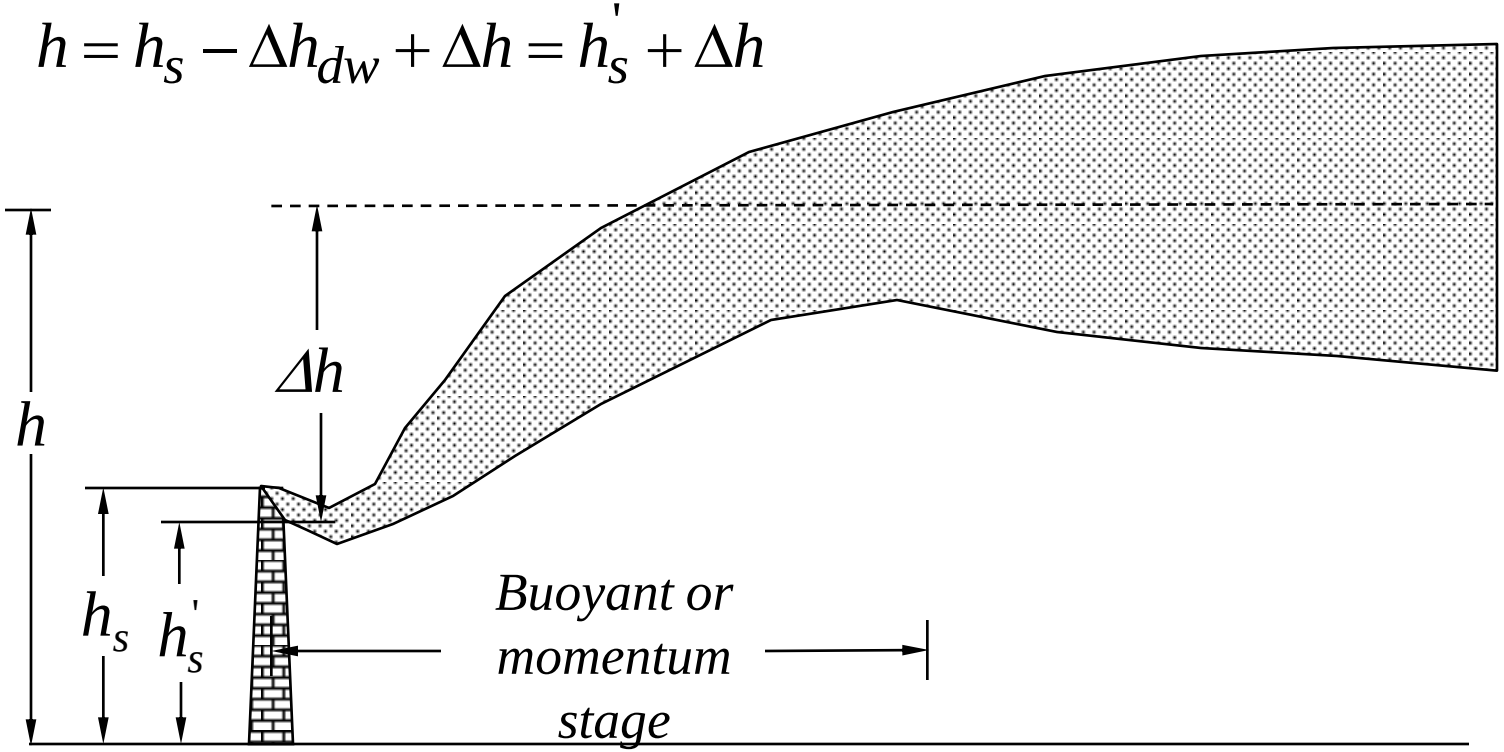
US EPA, 2004

AERMOD


AERMOD View 7.5.0 - Model: AERMOD - [C:\Lakes\AERMOD View\Tutorial\Tutorial.isc]
File Model View Import Export Data Run Output Risk Aermap Tools Help
New Open Print Run Control Source Receptor Met Output Building Terrain Options Reports 3D View Help
AERMOD (Elevated)
Sources (2)
Receptors (1 - 676)
Buildings (1)
UTM East [m]
450000
452000
Source Pathway
Model: AERMOD
Source Parameters
Source Summary
Building Downwash
Gas & Particle Data
Background Concentrations
Source Options
Source Groups
Urban Groups
Variable Emissions
Hourly Emission File
Emission Output Unit
NOx to NO2 Options
In-Stack NO2 / NOx Ratios
OLM Groups (OLM)
PSD Groups (PVMRM)
Pollutant
Type: SO2
Source Base Elevation
Unit: Meters
Import
Export
Source Summary
| Source ID | Source Type | X Coord. [m] | Y Coord. [m] | Base Elevation | Release Height [m] | Description
1 STCK1 POINT 439245.00 5298405.00 518 60
2 STCK2 POINT 439118.00 5298262.00 518 60
List Delete All 2 2 New View / Edit Source
Help Previous Next Close
ug/m^3
32.702
29.136
25.570
22.004
18.438
14.872
11.306
7.740
4.175
0.609
PLOT FILE OF HIGH 1ST HIGH 1-HR VALUES FOR SOURCE GROUP: ALL
Plotfile List: C:\Lakes\AERMOD View\Tutorial\Tutorial.AD\01H1GALL.PLT
Output Type: Concentration
Input Overlays Labels Plots
PLOT FILE OF HIGH 1ST HIGH 1-HR VALUES FOR SOURCE GROUP: ALL
Max: 32.70161 [ug/m^3] at (439431.50, 5294083.50)

AERMOD: source information

$$h = h_s - \Delta h_{dw} + \Delta h = h_s^{'} + \Delta h$$

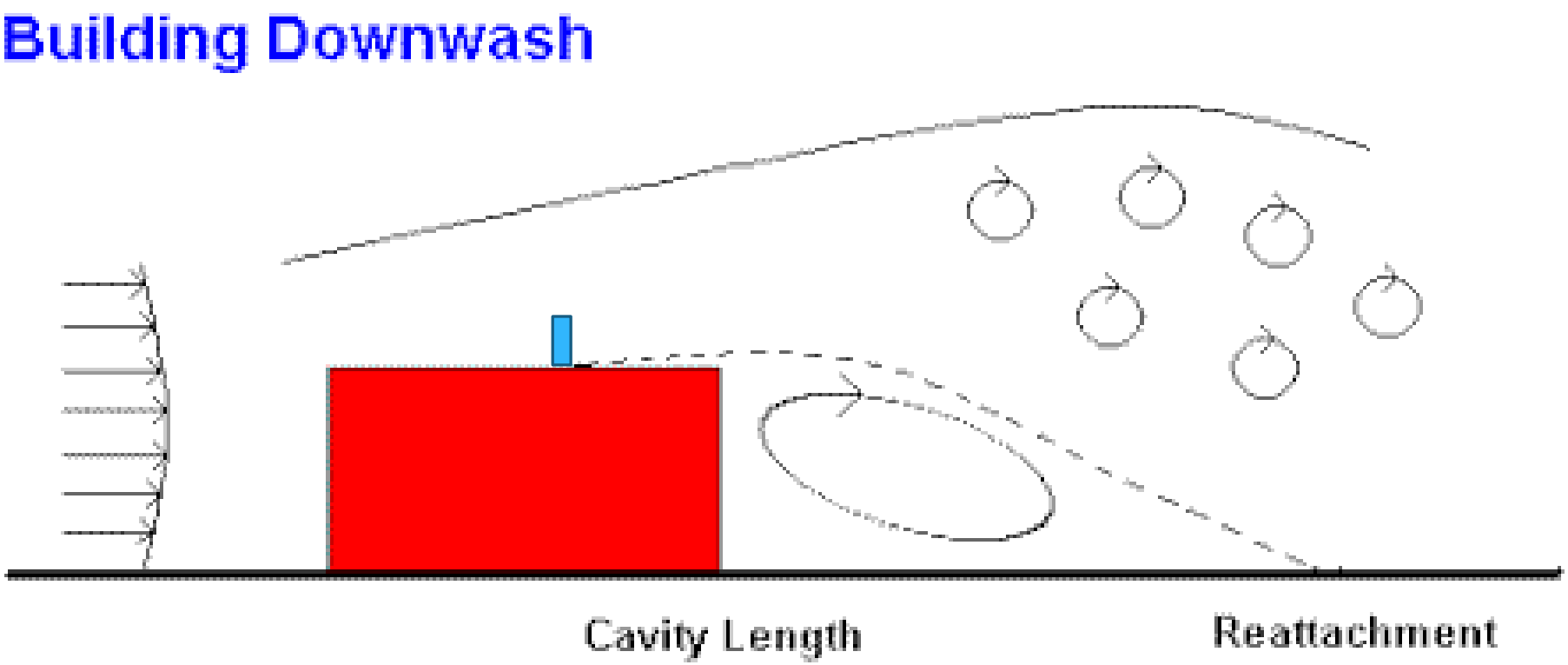


AERMOD: where are your receptors?

AERMOD: meteorological data

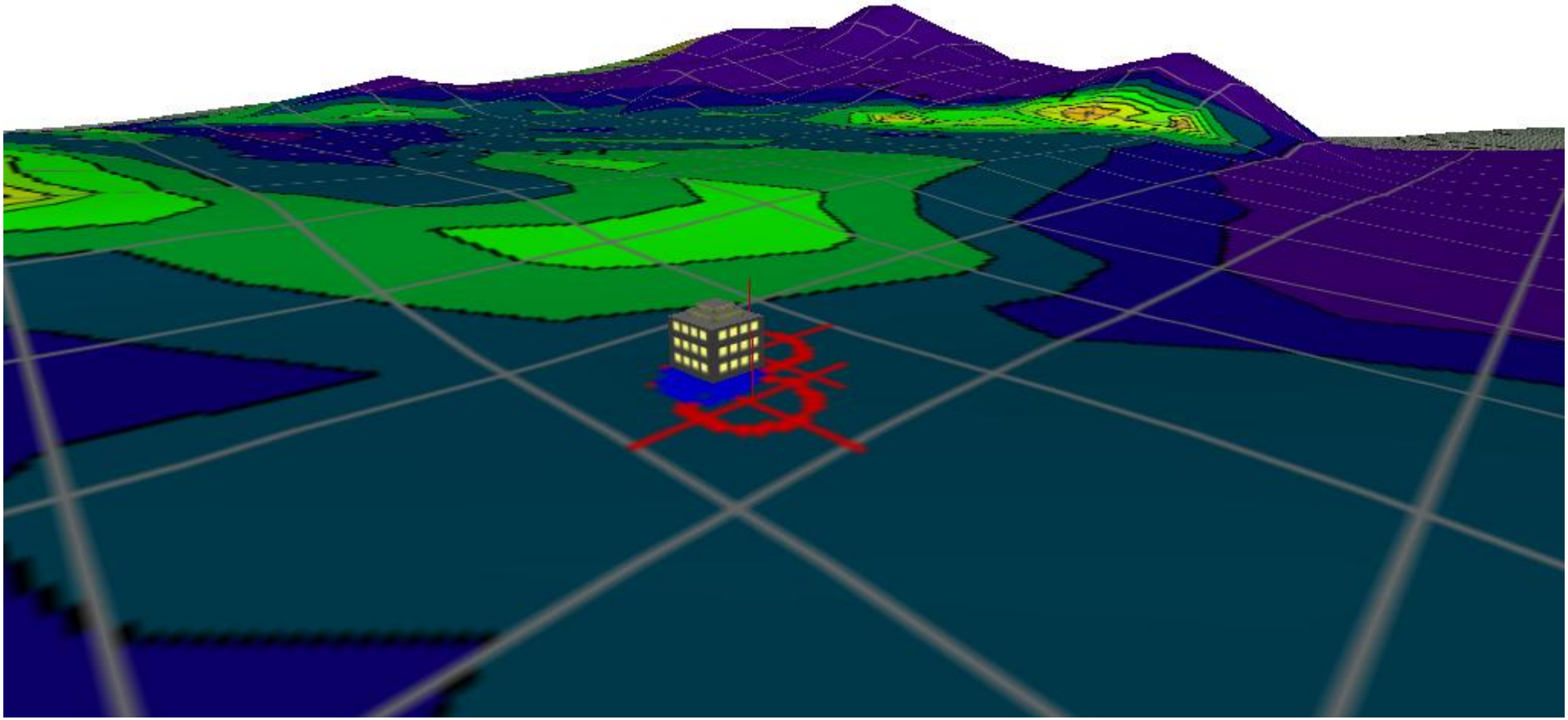
* Surface weather data
* Upper air data
* Airports (usually)
* MOE default datasets

AERMOD: building size/shape



AERMOD: building size/shape

AERMOD: surrounding terrain



AERMOD


ug/m^3
58.4
50.0
30.0
10.0
9.0
5.0
3.0
1.0
0.9
OT FILE OF HIGH 1ST HIGH 24-HR VALUES FOR SOURCE GROUP: ALL

ASHRAE

ASHRAE

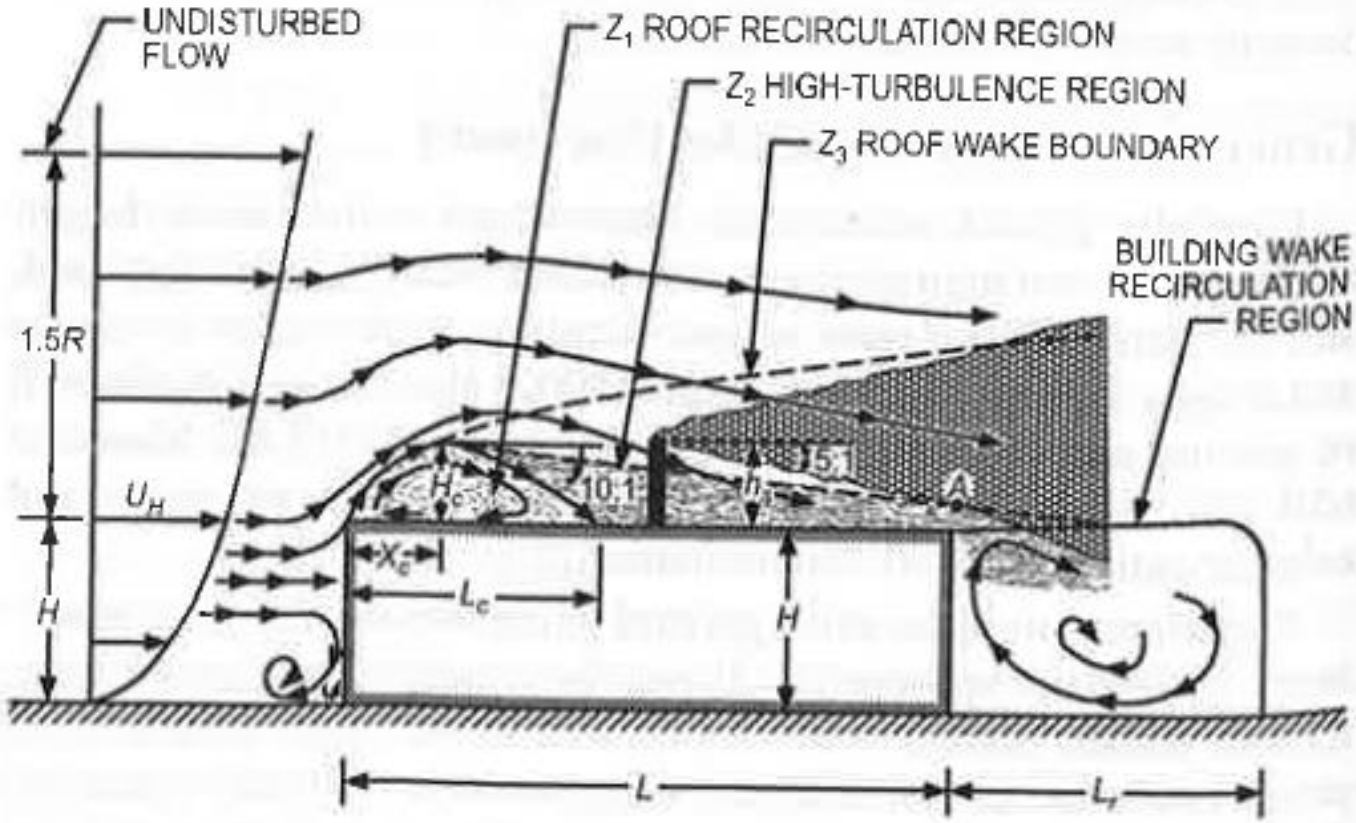


Fig. 6 Design Procedure for Required Stack Height to Avoid Contamination
(Wilson 1979)

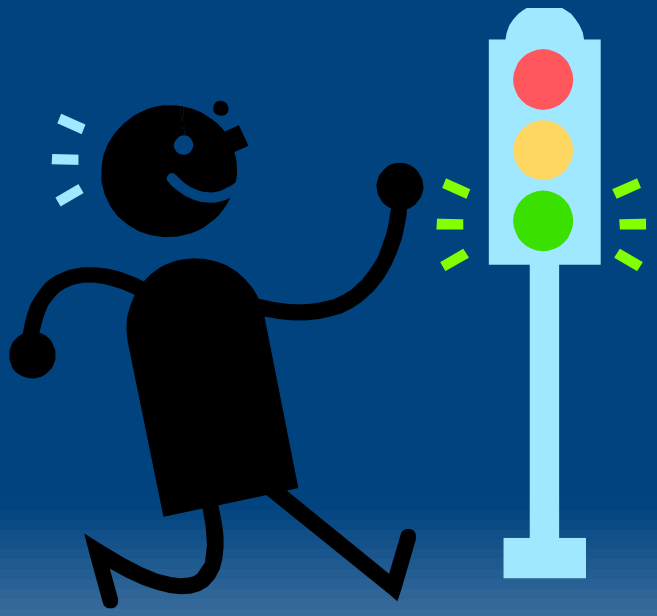
ASHRAE, 2011

General Assessment Approach

* Start with simplest (cheapest) methods first to try to show compliance.
* If those don’t work then (progressively) refine methods until you can.
* If you still can’t (after maximizing refinement) then you may have to consider controls/mitigation

The End

Thank You!



Questions/Discussion?

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