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Dispersion Modeling Project

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DOE Workshop

Germantown, MD

SRNS- F3200-2012-00027

the Issue

- Direction was coming regarding deposition velocity (DV)
- Discovery – questioning meteorological data assumptions as specific calculation of DV being pursued (normalization, EPA vs. RG 1.23)
- Plan Development and Concurrence
- Plan Execution
- Potential Impacts

Executing the Plan

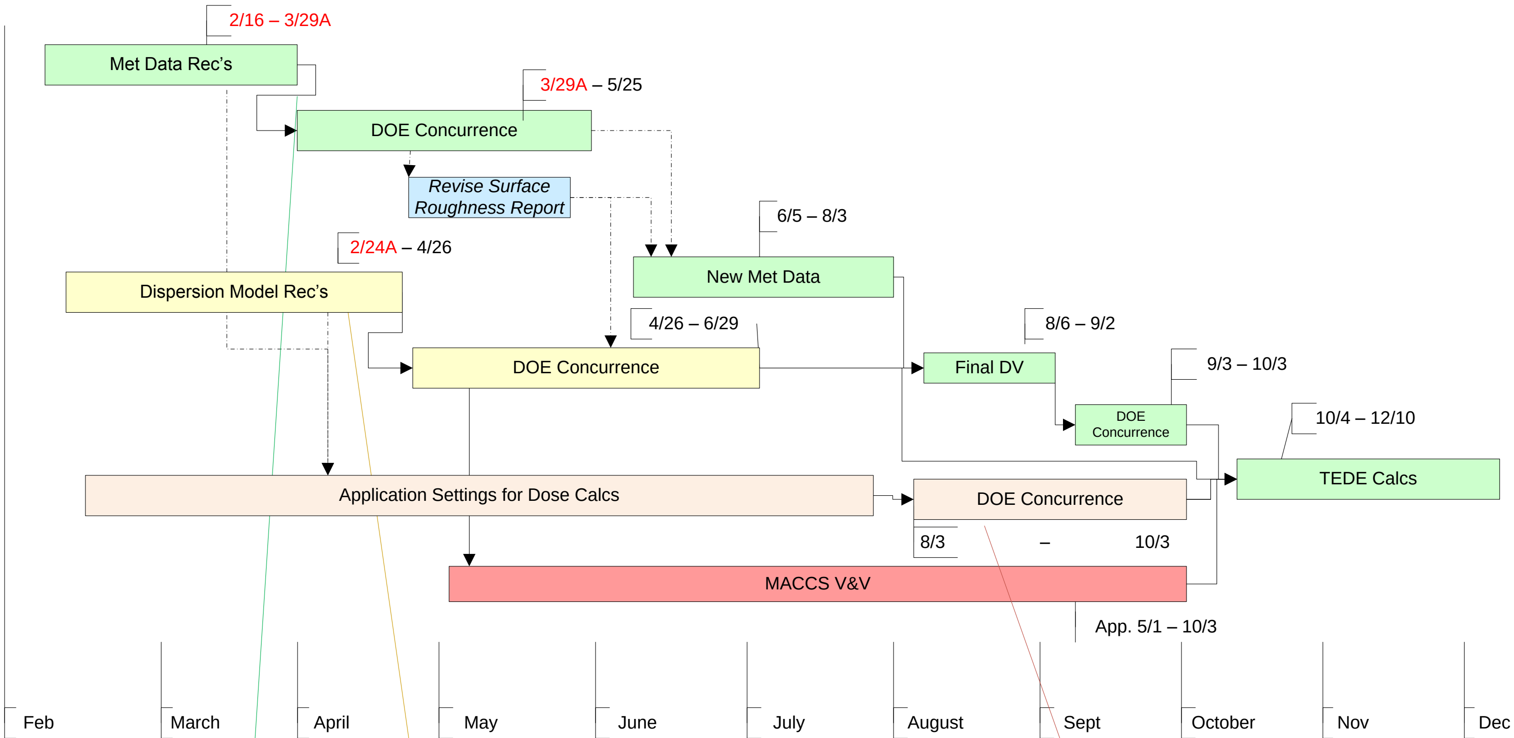
- HSS Bulletin regarding specification of "Deposition Velocity"
- Solicited external review of dispersion modeling as applied at SRS
  - Proper adjustment of site meteorological data for use in dispersion analysis
  - Surface roughness values and normalization of the met data for stability classification as input to MACCS
  - Best correlations governing plume dispersion.
  - DNFSB Letter to SRS Tritium
    - *Subsequent NNSA Letter of Direction*
- Developed plan and schedule
  - Submitted plan to DOE 11/17/2011
  - DOE concurrence received – plan execution commenced
- Regular interaction with DOE-SR, NNSA, and DNFSB site reps on project progress and planning
- Analytic and operational impacts anticipated (cost, schedule, operating limits, upgrades / modifications).
  - A number of facilities have current reported dose consequences that if increased could result in the need for additional or revised controls (including more restrictive material inventory limitations).
  - Some controls could go to SS, or from SS to SC
- Other considerations:
  - PISA process
  - Transportation analyses (OSAs; TSQs)

Recommendations & Unit Dose Calculation Schedule

Dispersion Modeling Project

April 25, 2012

For discussion purposes only



Report 1:
Met Data Recommendations:
1. Normalize per EPA 454
2. Use 180 cm surface roughness for normalization
3. Use 5 year average of 95% dose
5. Use displacement height x

Report 2:
Dispersion Modeling Recommendations:
1. Use MACCS version 2.6
- includes option for RG 1.145 dispersion model vice power law
-Use look-up tables for Dispersion coefficients
(Briggs for elevated releases, E-K for ground level releases)
2. Use X/Q from 1189 for CW, or Use area specific surface roughness
3. Parametric Deposition Velocity for particulates
4. Tritium Deposition Velocity
5. Confirm MACCS SQA bulletins addressed

Report 3:
Dose Calc Application / MACCS Settings
1. time basis for plume meander (180 sec)
2. use area source for releases (vice point)
3. use DCF parameter criteria
4. time average vs. plume meander
5. default resuspension
6. distance to site boundary

Measured Conditions

MACCs

Wind data as a function of x, y and z; Measurement at 61m elevation on a site with any roughness other than 3 cm.

OK to directly enter the stability class curves?

Translation via curves - Pasquill curves (which are prairie grass / 3 cm based)

Time Dependent [Wind Speed, x] & [Stability Class as a function of (y, z)]

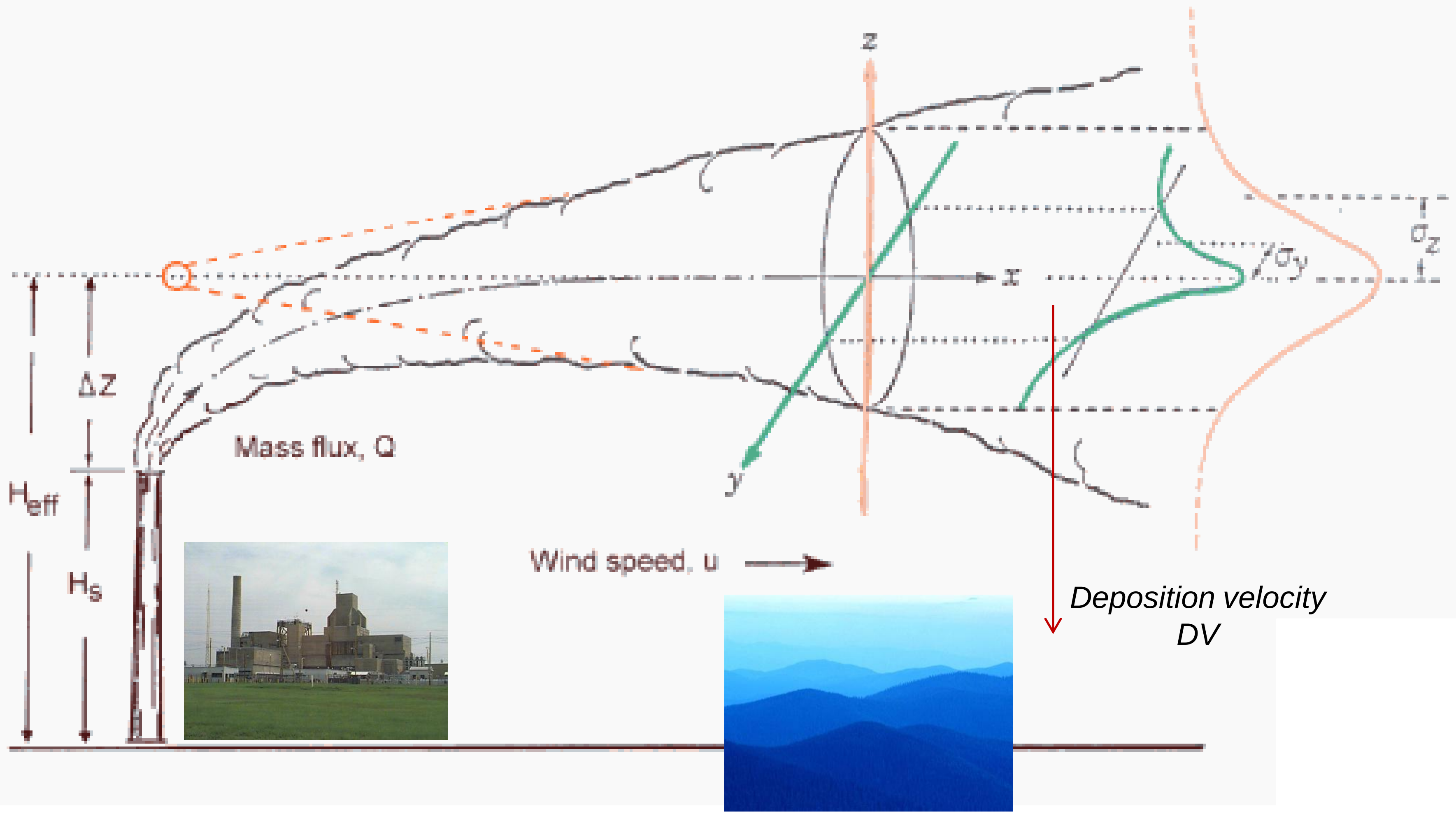
Translation via curves

Input / MACCs Output

Given a stability class, translates to y & z dispersion values [without correction assumes 3 cm.]

Adjustment can be made to give dispersion appropriate to actual surface roughness

Geometry of a Gaussian Plume



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Basic Dose Consequence

- **How much material**
- **What energy to lead to release (fire, explosion, spill, spray leak, etc.)**
- **How much material affected (damage ratio, e.g. 5 of 20 drums, 1 tank, etc.)**
- **Nature of material when released (airborne release fraction and respirable fraction)**

- **Receptor TEDE = $ST/t_r \bullet X/Q \bullet (BR \bullet t_e) \bullet IDCF$**

- **X/Q, the downwind dilution factor from atmospheric dispersion**
  - A function of terrain, wind speed, obstacles, temperature, particle size and density
  - Obstacles put in term "surface roughness"
  - Behaves like $\approx 1/(h/h_{base})^{0.2}$
  - the higher the surface roughness, the lower the dose at a given distance

the Changes

• Analysis Aspect	Considerations for change
• HSS Bulletin for deposition velocity	1.0 cm/s not good unless specifically justified *(w/dependence on surface roughness, particle size and density, wind speed, stability class)*
• Site specific Deposition velocity dependent on particle size, stability class, surface roughness	Questioned the assumptions in historic met data sets that provide stability class distribution input for dose calculations
• Stability class reflects data collection and other assumptions	Original establishment of Pasquill classification; EPA adjustment, NRC usage
• Stability class cast in terms of various correlations of test data	Briggs, Tadmor-Gur, E-K
• Surface roughness – means of measure, account for the effect on input AND output data	Land-use looks ups, direct turbulence via bi-vanes, direct turbulence via sonic anemometry, Delta-T SR variation with distance
• DOE Guides and Standards	DOE STD 3009, STD 5506, STD 3010, Accident Analysis guidance
• NRC and EPA guidance	RG 1.145, EPA 454

Receptor TEDE = $ST/t_r \bullet X/Q \bullet (BR \bullet t_e) \bullet IDCF$

Term	Dependencies
ST (source term)	MAR ● DR ● ARF ● RF● LPF
MAR (material at risk)	“bounding” inventory; scenario specific
t_r (release duration)	scenario specific
DR (damage ratio)	scenario specific, STD 5506
ARF (airborne release fraction)	STD 3010 ranges
RF (respirable fraction)	STD 3010 considerations; particle distribution, density, agglomeration
LPF (leak path factor)	1.0
X/Q (dilution factor)	Surface roughness, wind speed, stability class, deposition velocity, plume meander time basis, STD 1189 for collocated worker
BR (breathing rate)	3.3E-4 m^3/sec
t_e (exposure duration)	STD 3009 considerations (2 hour, 8 hour, physics)
IDCF (inhalation dose conversion factor)	Particle size dependence w/ICRP *(e.g. 1 μm, 5 μm, 10 μm)*

Deposition Velocity Initial Parametric Range for SRS

- Stability classes D, E, & F
- Wind speeds 0.5 m/s, 1 m/s, 1.5 m/s, & 2 m/s
- Particle sizes 1 micron, 5 micron, & 10 micron
- Particle densities 1 g/cc, 3 g/cc, & 5 g/cc
- Surface roughnesses 3 cm, 30 cm, 100 cm, & 200 cm

Potential Calculational Impact

Parameter	OLD	*Preliminary* NEW	Change
Stability	E	F	
Wind Speed	1.7 m/s	1.3 m/s	
Surface Roughness	100 cm	160 cm	
Deposition Velocity (particulates)	1 cm/s	0.7 cm/s	
4 km Dose	2.6E-3 Rem/Ci	6.0E-3 Rem/Ci	~2 – 2½ X increase
10 km Dose	6E-4 Rem/Ci	1.3E-3 Rem/Ci	

- *1 Ci Pu-239 ground release*
- *180 second release duration*
- *180 sec time basis*
- *No plume meander correction*

Next Actions, June – December 2012

- Finalize Met Data
- Finalize DV for particulate
  - Value for Tritium recommended 0.0 cm/sec
- Develop recommendations for other MACCS2 settings
  - Various default values, Area source, etc.
- DOE concurrence on all recommendations
- Run unit dose calculations
- Plan for facility specific DSA revision and implementation