UCOR
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Oak Ridge LLC

Safely Delivering the Department of Energy's Vision for the East Tennessee Technology Park Mission

DOE Workshop
Deposition Velocity Status

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Existing UCOR Analyses

- UCOR facilities at East Tennessee Technology Park (ETTP) and Oak Ridge National Laboratory (ORNL) use various plume models depending on when they were developed and by whom.
  - Some use MACCS or MACCS2 for dispersion evaluation. (~5 locations)
  - LLLW uses ingestion modeling (multiple locations)
  - Others use hand generated gaussian plume calculations. (~2 locations)
  - All use small (1- 3 years) meteorological data sets from an ORNL met tower.
  - Inconsistencies exist between facilities with respect to deposition velocity (DV) and surface roughness (SR).

Background

- Deposition Velocity (DV) is a Key Input to Atmospheric Transport and Dispersion (ATD) Models (including MACCS2)
- Office of Health Safety and Security (HSS) of the Department of Energy (DOE) Issued Guidance on DV in May 2011
- Overview for Unfiltered/Unmitigated Release
  - Historical value (including Oak Ridge site): DV = 1.0 cm/s
  - Option 1: New Default Value: DV = 0.1 cm/s
  - Option 2: Calculate site-specific DV values using GENII Version 2.10 (GENII2)
  - Option 3: Use more sophisticated code than MACCS2 for ATD analysis

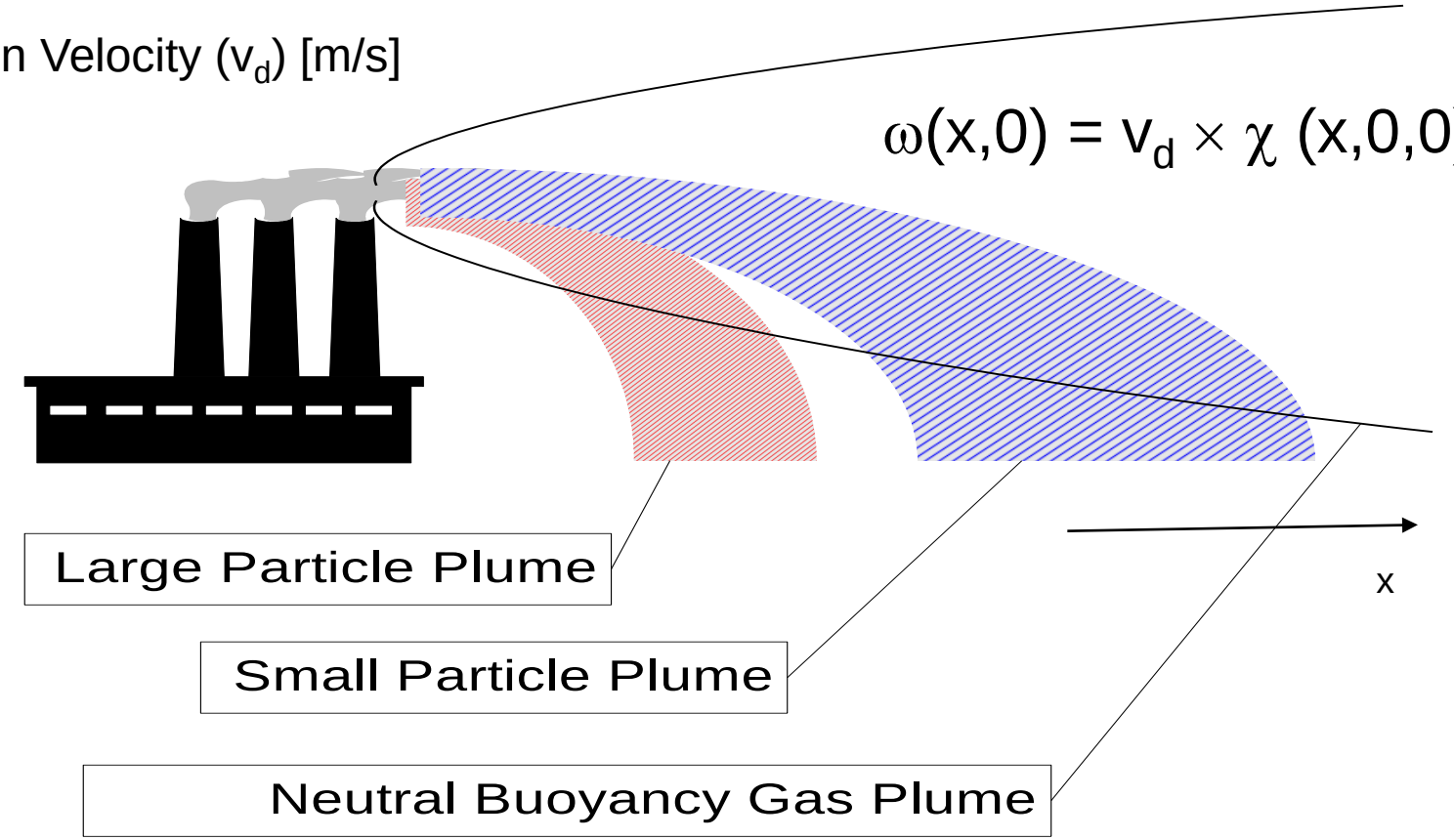
Deposition – General

Time-integrated Ground Flux (ω) [Ci/m^2]

Time-integrated Air Concentration at Ground (χ) [Ci-s/m^3]

Deposition Velocity (v_d) [m/s]

$$\omega(x,0) = v_d \times \chi\,(x,0,0)$$

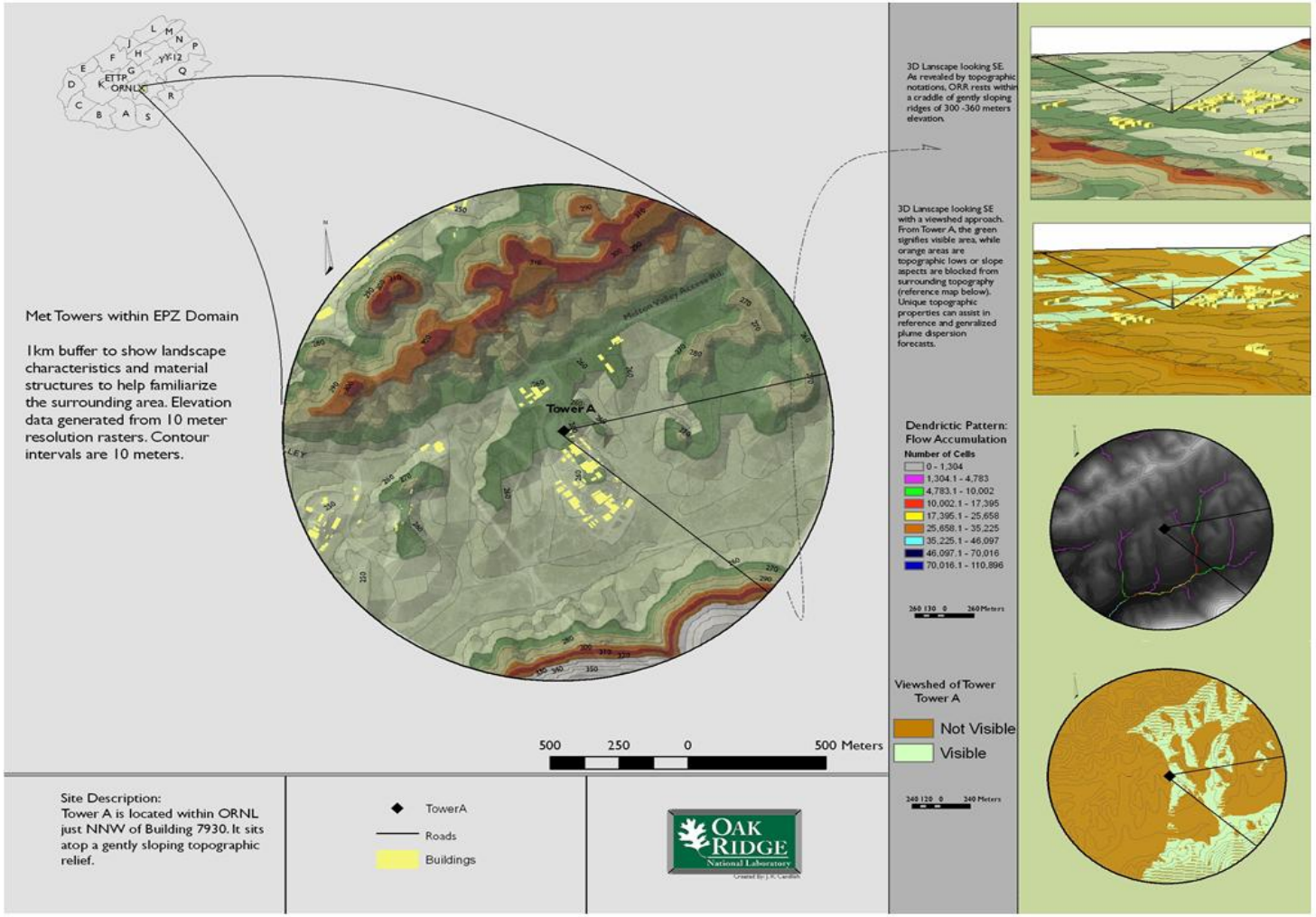


Path Forward (from 10/2011)

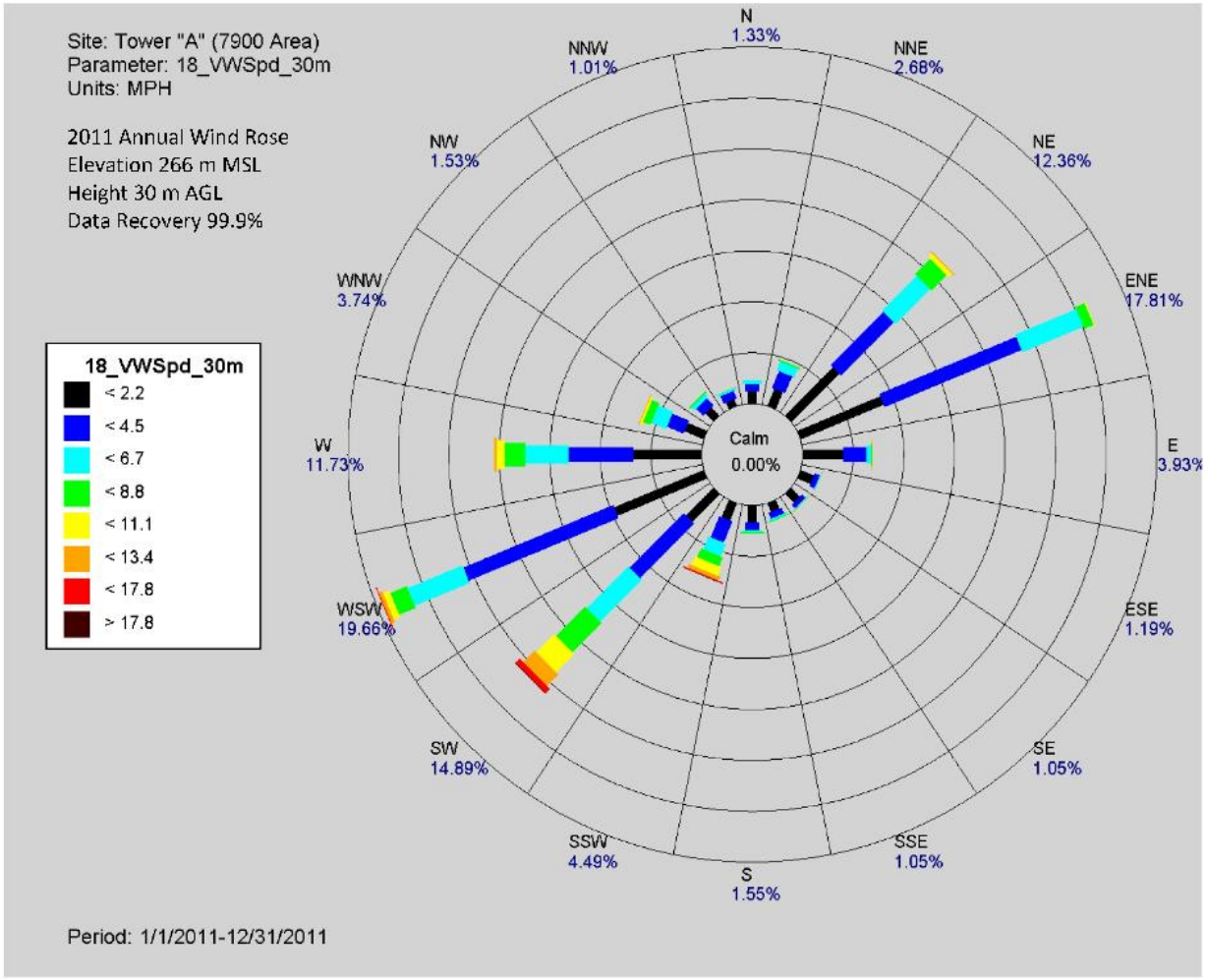
- **Resolve outstanding issues**
  - Appropriate Tower for Meteorological Data – Complete
  - Broader Meteorological Data Sets – Complete
  - Appropriate Surface Roughness Length – Draft
  - Particle Characteristics (AED, density) – Draft
- **Determine Impact of Possible New Meteorological Data and/or New Surface Roughness Length Input on MACCS2 Calculations – Complete**
- **Calculate, Document and Technically Review DV Calculations**
  - Contract for Vern Peterson for technical review of GENII2 DV calculations – Complete
  - Technical review of meteorological data processing – Complete
  - Finish SQA documents for GENII2 – Incomplete
  - GENII2 personnel training – (8 individuals)
  - V&V of GENII2 on UCOR computers and network - Complete
- **Calculate, Document and Technically Review GENII2 Calculations for DSA Annual Updates - Incomplete**

Oak Ridge Topography

ORNL Met Tower A



ORNL 2011 Wind Rose



Preliminary DV Results from GENII2

- **Surface Roughness Length of 40 cm (DV – 0.22 cm/s w/Y-12 data)**
- **ORNL**
  - DV = 0.30 cm/s for Tower M
  - DV = 0.28 cm/s for Tower A
  - DV = 0.25 cm/s for Tower C
  - DV = 0.22 cm/s for Tower B
- **ETTP**
  - DV = 0.27 cm/s for Tower L
  - DV = 0.22 cm/s for Tower K

Preliminary DV Results from GENII2

- **Surface Roughness Length of 70 cm (DV – 0.28 cm/s w/Y-12 data)**
- **ORNL**
  - DV = 0.36 cm/s for Tower M
  - DV = 0.35 cm/s for Tower A
  - DV = 0.31 cm/s for Tower C
  - DV = 0.27 cm/s for Tower B
- **ETTP**
  - DV = 0.33 cm/s for Tower L
  - DV = 0.28 cm/s for Tower K

UCOR Specific

Parametric Study Inputs

Parameters examined in this study are determined by the geographical and meteorological conditions of the location for which dose assessment is to be performed.

Deposition Velocity could also be impacted by the particle size and density (which was not examined in this study). The HSS safety bulletin recommends 2-4 µm.

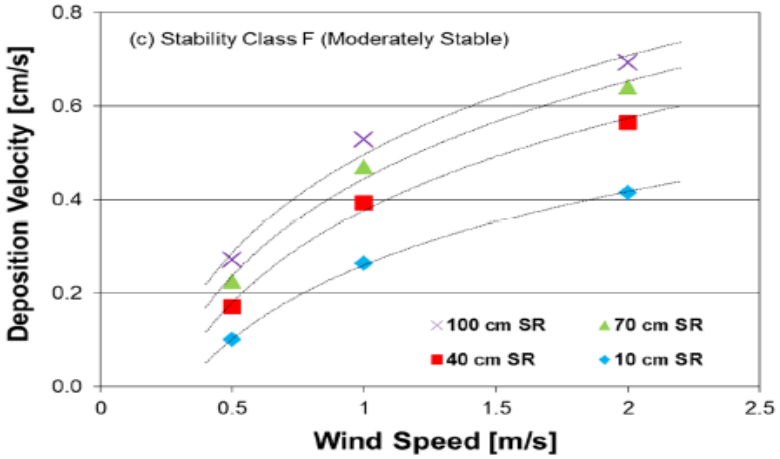
Input #	Parameter (units)	Value
1	Wind Speed (m/s)	0.5, 1.0, 2.0
2	Stability Class	D (neutrally stable), E (slightly stable), F (moderately stable)
3	Surface Roughness Length (m)	0.1, 0.4, 0.7, 1.0

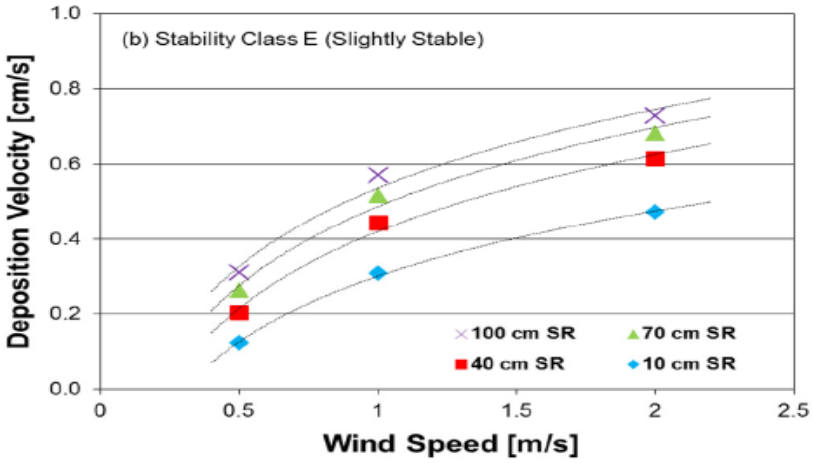
Parametric Study Results

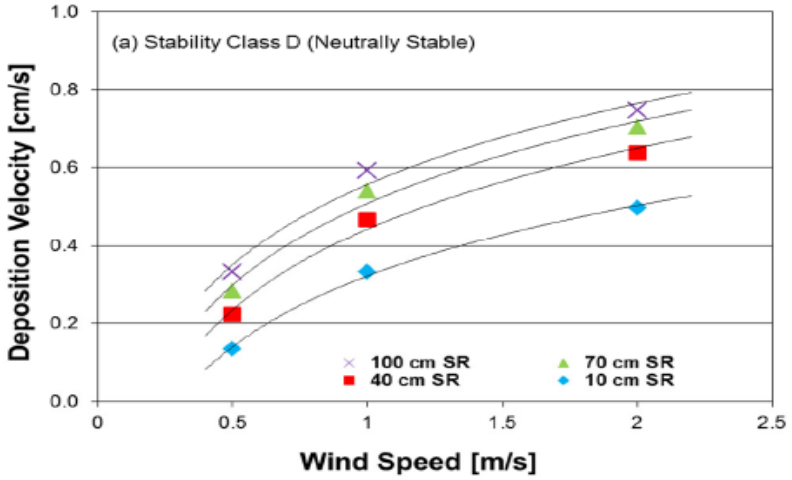
DV is observed to **increase slightly** with respect to **stability class**

DV is observed to **increase moderately** with respect to **surface roughness**

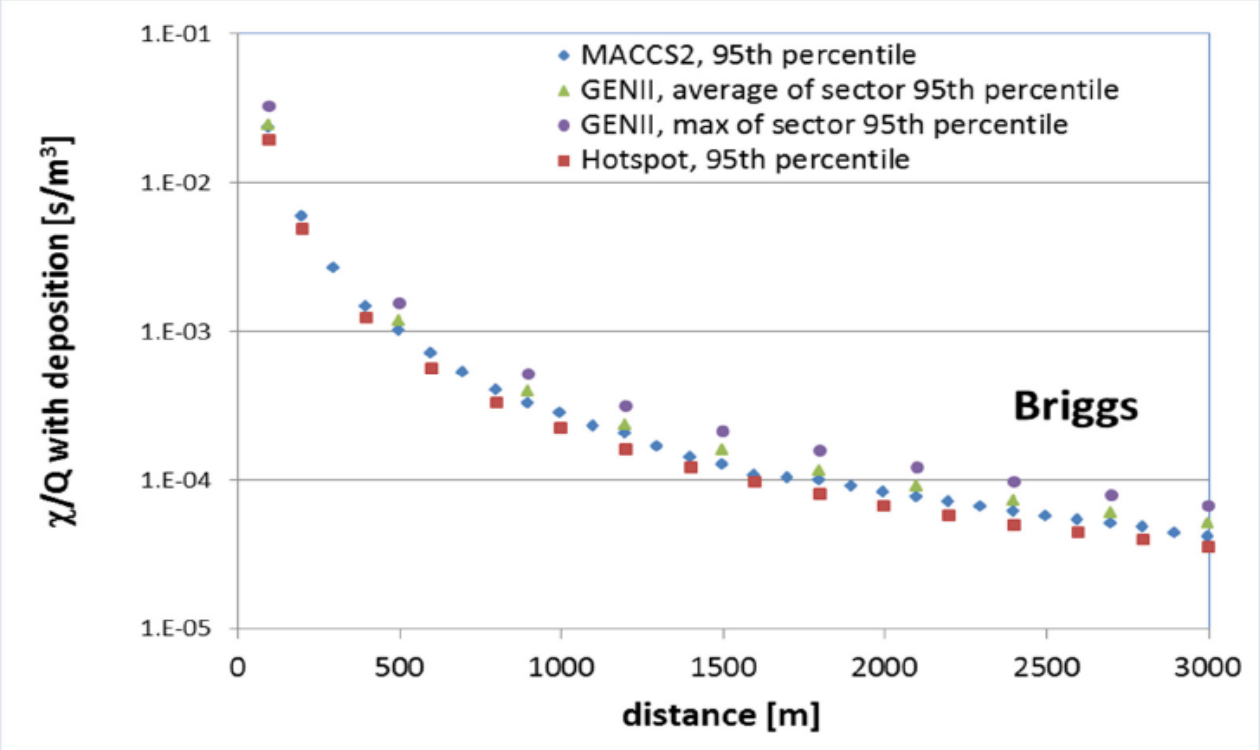
DV is observed to **increase greatly** with respect to **wind speed**







Comparison of MACCS2, GENII and Hotspot



Briggs dispersion coefficients and 3 cm surface roughness were used to compare 3 software suites. Doses calculated using hotspot were converted to χ/Q values.

Surface Roughness

- **The surrounding terrain differs amongst the facilities.**
  - For MEGA at ORNL, it is surrounded closely by dense hardwood forest with various office structures and other buildings on the release path to the site boundary.
  - For K-25 at ETTP, the distance is much shorter to the site boundary. It is more park-like with broader landscaped grass areas, parking lots, some buildings and trees.
- **Evaluated values using three guides**
  - MACCS2 Training Module from EFCOG 2005
  - EPA's AERSURFACE User's Guide
  - NUREG/CR-4691, Table 2.3

NUREG/CR-4691

- For ORNL, forested landscape = 20 – 200 cm
- FOR ETTP, Tall Grass/countryside = 10 – 30 cm

DSA Impact

- **Mega DSA evaluates 9 Haz Cat 2 and 3 Haz Cat 3 facilities.**
- **Facilities provide storage of solid waste.**
- **Estimated revised consequences challenge offsite and onsite Evaluation Guidelines.**
- **Calculated consequences can be reduced by:**
  - Better definition of inventory.
  - Credit/partial credit of containers as passive design features.
  - Improved release modeling.

DV Impact

Fire Event (Full Facility Pool Fire) with Y-12, MACCS 95%, with deposition (ICRP-68/72)
Event assumed to involve entire facility inventory (in drums) with 25% of inventory in drums subject to lid ejection remaining 75% burn in a confined manner
All containers except 7822K staging from Tank W-1A and 7826 from retrival are assumed to be filled with contaminated combustible solids

Bldg No	Description	Waste Type	Max Inventory (TQ-2 SOF)	ST (TQ)	Offsite (m)	Initial Dose_On (rem)	Initial Dose_Off Vdep 0.3 and SR 40 (rem)	Initial Dose_Off Vdep 0.3 (rem)	Initial Dose_Off Vdep 0.3 and SR 40 (rem)
7572	Bulter bldg	TRU/fissile	70	9.04E-02	1900	3.08E+03	1.39E+01	5.17E+01	4.79E+01
7574	Bulter bldg	TRU/fissile	70	9.04E-02	1900	3.08E+03	1.39E+01	5.17E+01	4.79E+01
7822K	Open pad	SLLW & Tank W-1a	3.5	4.52E-03	189	1.54E+02	7.45E+01	1.56E+02	1.09E+02
7823	HS bldg	RCRA/TRU	1	1.29E-03	1497	4.41E+01	2.13E-01	1.16E+00	1.04E+00
7823B/C/D		TRU & SSLW	1	1.29E-03	1473	4.41E+01	2.67E-01	1.32E+00	1.17E+00
7823E/CT8-7800		TRU & SSLW	1	1.29E-03	1473	4.41E+01	2.67E-01	1.32E+00	1.17E+00
7826	UG bunker	TRU & SSLW	11.3	1.46E-02	1526	4.98E+02	2.41E+00	1.31E+01	1.18E+01
7827 (per well)	Wells	SLLW & spent fuels	22	2.84E-02	1519	9.69E+02	4.68E+00	2.55E+01	2.29E+01
7834	UG bunker	TRU & SSLW	82.1	1.06E-01	1507	3.62E+03	1.75E+01	9.50E+01	8.55E+01
7855	HS bunker	TRU & SSLW	39.9	5.16E-02	1497	1.76E+03	8.49E+00	4.62E+01	4.16E+01
7860A	Rubb Tent	TRU & SSLW	10	1.29E-02	1582	4.41E+02	1.98E+00	1.16E+01	1.04E+01
7879	Building	TRU & SSLW	46	5.94E-02	1497	2.03E+03	9.79E+00	5.33E+01	4.79E+01
7883	HS bunker	TRU & SSLW	30	3.88E-02	1551	1.32E+03	5.94E+00	3.47E+01	3.13E+01
Trench 13	Open pad	SLLW	0	0.00E+00	1473	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Staging									
7572+7574	Staging		9	1.16E-02	1900	3.97E+02	1.78E+00	6.64E+00	6.15E+00
7822K	TRU Staging		1.02	1.32E-03	189	4.49E+01	2.17E+01	4.55E+01	3.17E+01
7822K	Other Staging	Tank W-1A (Soil)	1	6.00E-05	189	2.05E+00	9.89E-01	2.07E+00	1.44E+00
7823B/C/D	Staging		1	1.29E-03	1473	4.41E+01	2.67E-01	1.32E+00	1.17E+00
7823E/CT8-7800	Staging		1	1.29E-03	1473	4.41E+01	2.67E-01	1.32E+00	1.17E+00
7823+7826+7834+7879	Staging		9	1.16E-02	1497	3.97E+02	1.92E+00	1.04E+01	9.38E+00
7827	Staging		22	2.84E-02	1519	9.69E+02	4.68E+00	2.55E+01	2.29E+01
7855	Staging		20	2.58E-02	1497	8.81E+02	4.26E+00	2.32E+01	2.08E+01
7860A	Staging		5	6.46E-03	1582	2.20E+02	9.90E-01	5.79E+00	5.21E+00
7883	Staging		5	6.46E-03	1551	2.20E+02	9.90E-01	5.79E+00	5.21E+00
Retrival									
7826	Outside Bunker	Plutonium metal	23	5.75E-03	1526	1.96E+02	9.47E-01	5.15E+00	4.64E+00

Initial Condition Impact

Application of ICs						
IC	Affect on Event	Reduction	Dose_On (rem)	Dose_Off (rem)	Dose_Off Vdep 0.3 (rem)	Dose_Off Vdep 0.3 & SR 40 (rem)
Grading, slope, etc.	Becomes combustible exposure fire		5.97E+02	2.68E+00	1.00E+01	9.26E+00
Grading, slope, etc.	Becomes combustible exposure fire		5.97E+02	2.68E+00	1.00E+01	9.26E+00
Cask	Greatly reduces release (DR=0.01)	1.00E-02	1.54E+00	7.45E-01	1.56E+00	1.09E+00
Cask	Greatly reduces release (DR=0.01)	1.00E-02	4.41E-01	2.13E-03	1.16E-02	1.04E-02
Cask	Greatly reduces release (DR=0.01)	1.00E-02	4.41E-01	2.67E-03	1.32E-02	1.17E-02
Cask	Greatly reduces release (DR=0.01)	1.00E-02	4.41E-01	2.67E-03	1.32E-02	1.17E-02
UG Bunker walls	Becomes combustible exposure fire		9.63E+01	4.65E-01	2.53E+00	2.24E+00
Elevated well plat.	Becomes combustible exposure fire with DR of 0.01	1.00E-02	1.88E+00	9.06E-03	4.93E-02	4.36E-02
UG Bunker walls	Becomes combustible exposure fire		7.00E+02	3.38E+00	1.84E+01	1.63E+01
Vault	Greatly reduces release (DR=0.1)	1.00E-01	1.76E+02	8.49E-01	4.62E+00	4.09E+00
Cask	Greatly reduces release (DR=0.01)	1.00E-02	4.41E+00	1.98E-02	1.16E-01	1.04E-01
Grading, slope, etc.	Becomes combustible exposure fire		3.92E+02	1.89E+00	1.03E+01	9.27E+00
Vault	Greatly reduces release (DR=0.1)	1.00E-01	1.32E+02	5.94E-01	3.47E+00	3.13E+00

Path Forward

- Deposition velocities were calculated from GENII2 output for meteorological datasets and selected surface roughness.
- Up to date datasets (2001-2010) were provided by ORNL for various Oak Ridge met towers.
  - Broader data ranges than previously used.
  - Improved data QA.
- Parametric calculations are being performed for met datasets using variations in surface roughness.
  - Demonstrates conservatism in the analysis.
  - Creates consistency between facilities.
- Awaiting approval of GENII2 (ver. 2.10.1) as a DOE toolbox code (June 2012).