

Comparison of GXQ and MACCS2 Air Dispersion at WIPP

Principle Differences

- Wind Data
 - hourly vs joint frequency
- Receptor Location
 - shape of controlled area boundary
 - distance input vs approximate midpoint
- Dispersion Models
 - plume standard deviation
 - plume meander
 - cumulative distribution function

Wind Data for GXQ & MACCS

- Hourly data (MACCS)
 - list of hourly conditions
 - 7 stability classes, 130 wind speeds, 16 directions
- Joint frequency (GXQ)
 - table of wind speed, stability, direction
 - three cases used for WIPP data
 - 8 bin with classes A-F (20% smaller χ/Q')
 - 25 bin with classes A-F (base case)
 - 25 bin with classes A-G (doubles χ/Q')

Effect of Joint Frequency on GXQ Results

| Distance | WHB Ground Level | | | WHB X/Q' Ratios | |
|---|------------------|------------|------------|-----------------|-----------|
| | Original | 25-Bin A-F | 25-Bin A-G | Old / A-F | A-G / A-F |
| 100 m | 1.61E-02 | 1.97E-02 | 3.68E-02 | 0.82 | 1.87 |
| 285 m | 2.61E-03 | 3.25E-03 | 6.08E-03 | 0.80 | 1.87 |
| 285 square | 1.44E-03 | 2.03E-03 | 3.77E-03 | 0.71 | 1.86 |
| Circle / Square | 1.81 | 1.60 | 1.61 | na | na |
| Distance | WUS 7 m Stack | | | WUS X/Q' Ratios | |
| | Original | 25-Bin A-F | 25-Bin A-G | Old / A-F | A-G / A-F |
| 100 m | 9.77E-04 | 1.15E-03 | 1.15E-03 | 0.85 | 1.00 |
| 285 m | 1.12E-03 | 1.37E-03 | 1.17E-03 | 0.82 | 0.85 |
| 285 square | 6.45E-04 | 1.04E-03 | 1.04E-03 | 0.62 | 1.00 |
| Circle / Square | 1.74 | 1.32 | 1.13 | na | na |
| Above cases have no plume meander or ground deposition. | | | | | |

Receptor Location in GXQ

- List of distances in 16 directions
actual WIPP controlled area boundary
shown as “285 m, square” in later tables
- One distance for all 16 directions
shown as “285 m, circle” in later tables
- Minimum distance is 100 m

Receptor Location in MACCS

- Circles centered on release point
minimum distance is 50 m
- Average of 2 radial distances
radial distance increment > 100 m
- Need multiple MACCS runs
100 m receptor uses 50 m and 150 m
285 m receptor uses 235 m and 335 m
note: 150 m and 235 m within 100 m delta

Selecting MACCS χ/Q' Results

| Distance | Case 1 Best 100 m | Case 2 Convenient | Case 3 Best 285 m | Case 4 Extra Point | Selected for Base Case |
|--|------------------------------|------------------------------|------------------------------|-------------------------------|-----------------------------------|
| WHB Ground Level Release | | | | | |
| 100 m | 1.38E-02 | 1.82E-02 | na | na | 1.38E-02 |
| 285 m | 2.95E-03 | 2.76E-03 | 2.76E-03 | 2.76E-03 | 2.76E-03 |
| WUS 7 m Stack Release | | | | | |
| 100 m | 2.03E-03 | 1.64E-03 | na | na | 2.03E-03 |
| 285 m | 1.46E-03 | 1.46E-03 | 1.45E-03 | 1.45E-03 | 1.45E-03 |
| The base case means no plume meander (release duration is 3 minutes) and no ground deposition. MACCS uses the Tadmor-Gur representation of sigma Y and Z. | | | | | |

Selecting MACCS χ/Q' Results

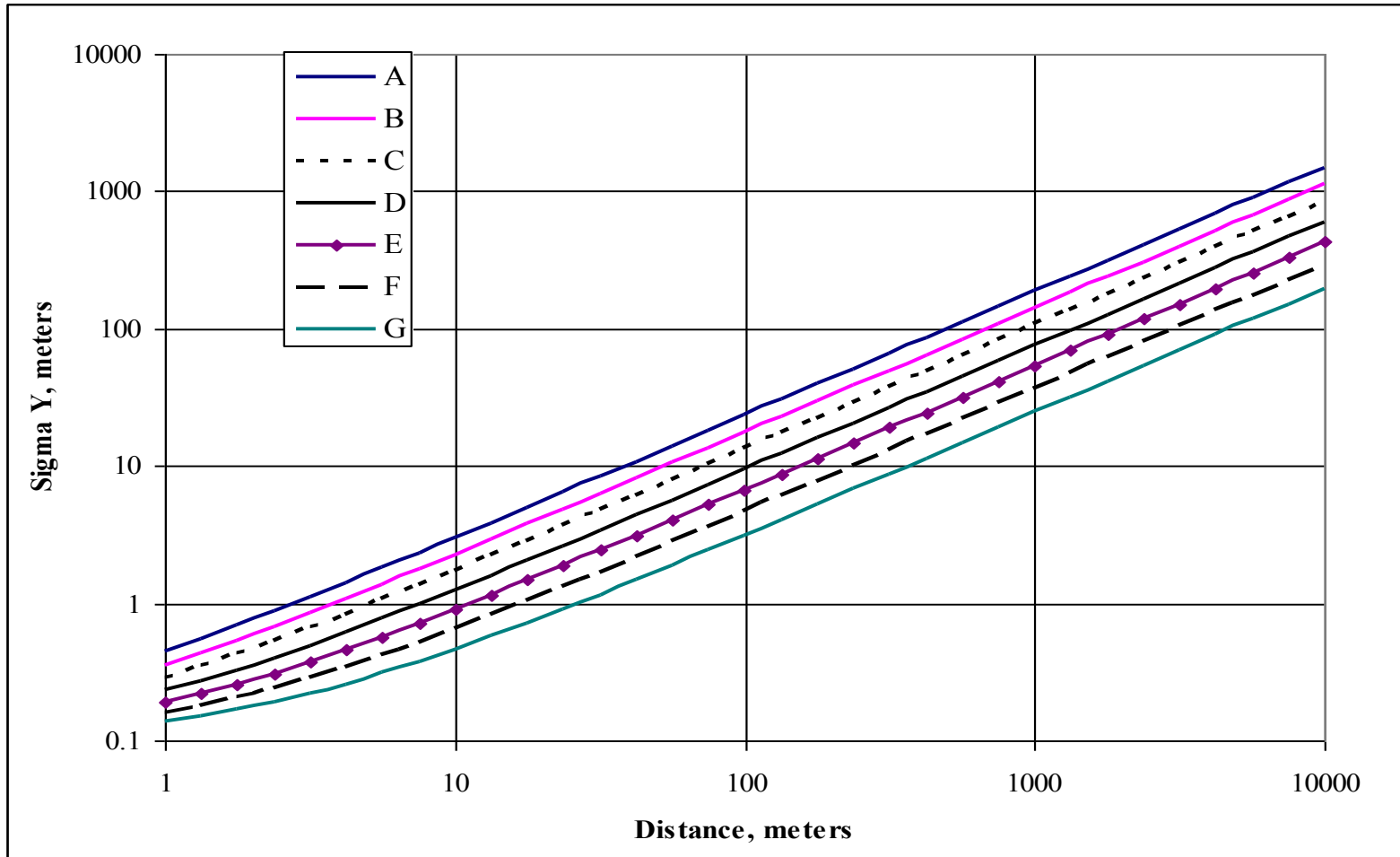
Including Ground Deposition

| Distance | Case 1 Best 100 m | Case 2 Convenient | Case 3 Best 285 m | Case 4 Extra Point | Selected for Base Case |
|--|------------------------------|------------------------------|------------------------------|-------------------------------|-----------------------------------|
| WHB Ground Level Release | | | | | |
| 100 m | 9.84E-03 | 1.53E-02 | na | na | 9.84E-03 |
| 285 m | 1.69E-03 | 1.69E-03 | 1.69E-03 | 1.58E-03 | 1.58E-03 |
| WUS 7 m Stack Release | | | | | |
| 100 m | 2.01E-03 | 1.62E-03 | na | na | 2.01E-03 |
| 285 m | 1.36E-03 | 1.35E-03 | 1.41E-03 | 1.35E-03 | 1.35E-03 |
| MACCS was run with a release duration of 3 minutes to eliminate plume meander. MACCS uses the Tadmor-Gur representation of sigma Y and Z. | | | | | |

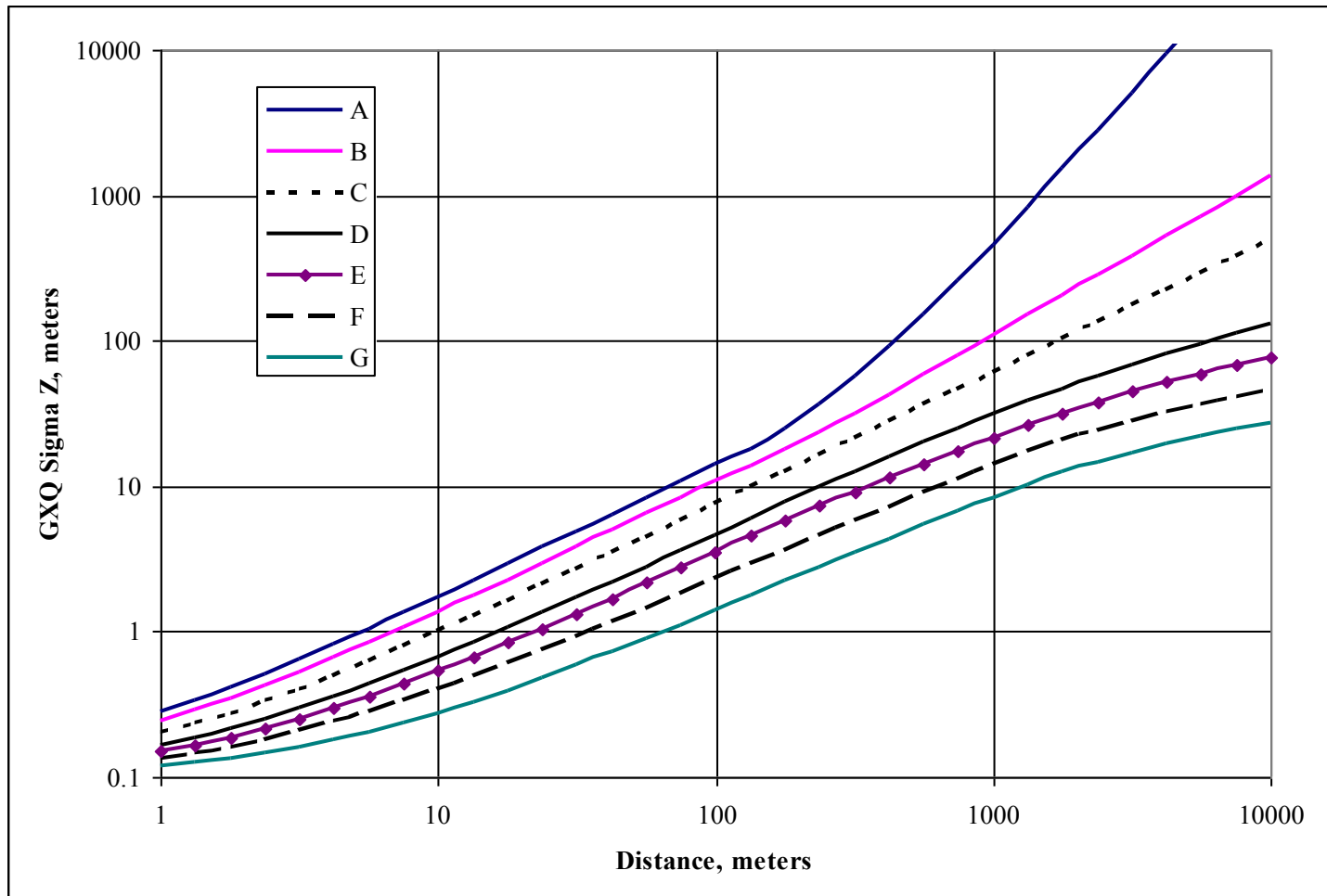
Dispersion Models – Sigma Z

- Horizontal standard deviations the same
- Vertical standard deviations different
 - GXQ uses Eimutis formula (defined to 0 m)
 - MACCS uses Tadmor-Gur formula (> 500 m)
- MACCS also run using Eimutis formula

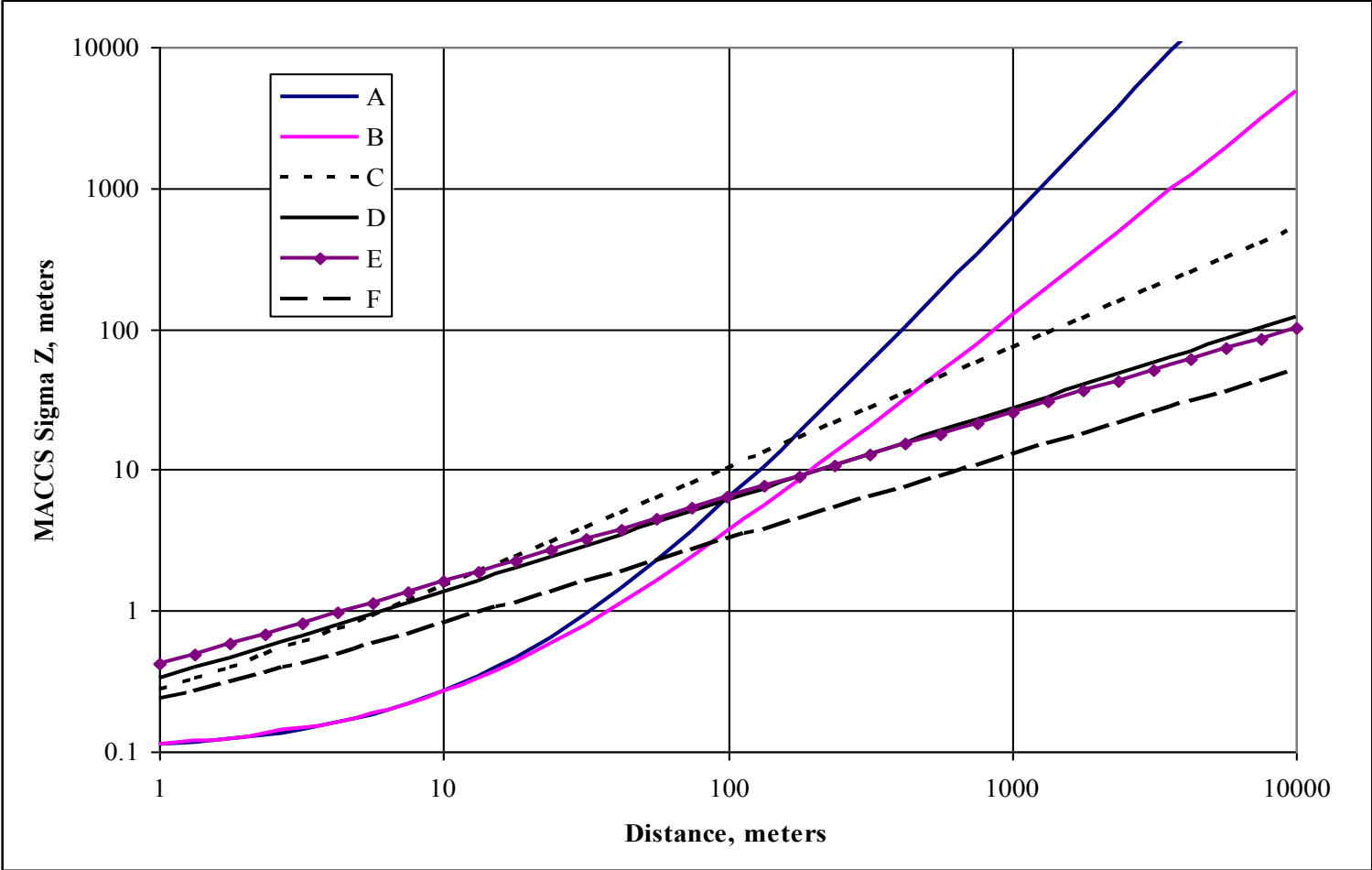
Sigma Y - Horizontal



Sigma Z – GXQ (Eimutis)



Sigma Z – MACCS (Tadmor-Gur)



Comparison with Same Sigma Z (Eimutis)

| Distance | WHB Ground Level | | | WUS 7-meter Stack | | |
|------------|------------------|----------|-------|-------------------|----------|-------|
| | GXQ | MACCS | Ratio | GXQ | MACCS | Ratio |
| 100 m | 1.97E-02 | 1.98E-02 | 1.01 | 1.15E-03 | 1.16E-03 | 1.01 |
| 285 m | 3.25E-03 | 3.17E-03 | 0.98 | 1.37E-03 | 1.40E-03 | 1.02 |
| 285 square | 2.03E-03 | na | na | 1.04E-03 | na | na |

- The units for χ/Q' are seconds per cubic meter, s/m³.
- The base case has no plume meander or ground deposition. GXQ uses the hourly based joint frequency with no class G. MACCS uses the Eimutis sigma Z.
- The “Ratio” columns show the MACCS χ/Q' divided by the GXQ χ/Q' .

Dispersion Models – Plume Meander

- **GXQ follows NRC Reg Guide 1.145**
 - depends on wind speed, stability, release duration
 - not used for stacks
- **MACCS uses release duration function**
 - time base a user input
 - meander factor same for all stability classes
 - applied to stack and ground-level releases

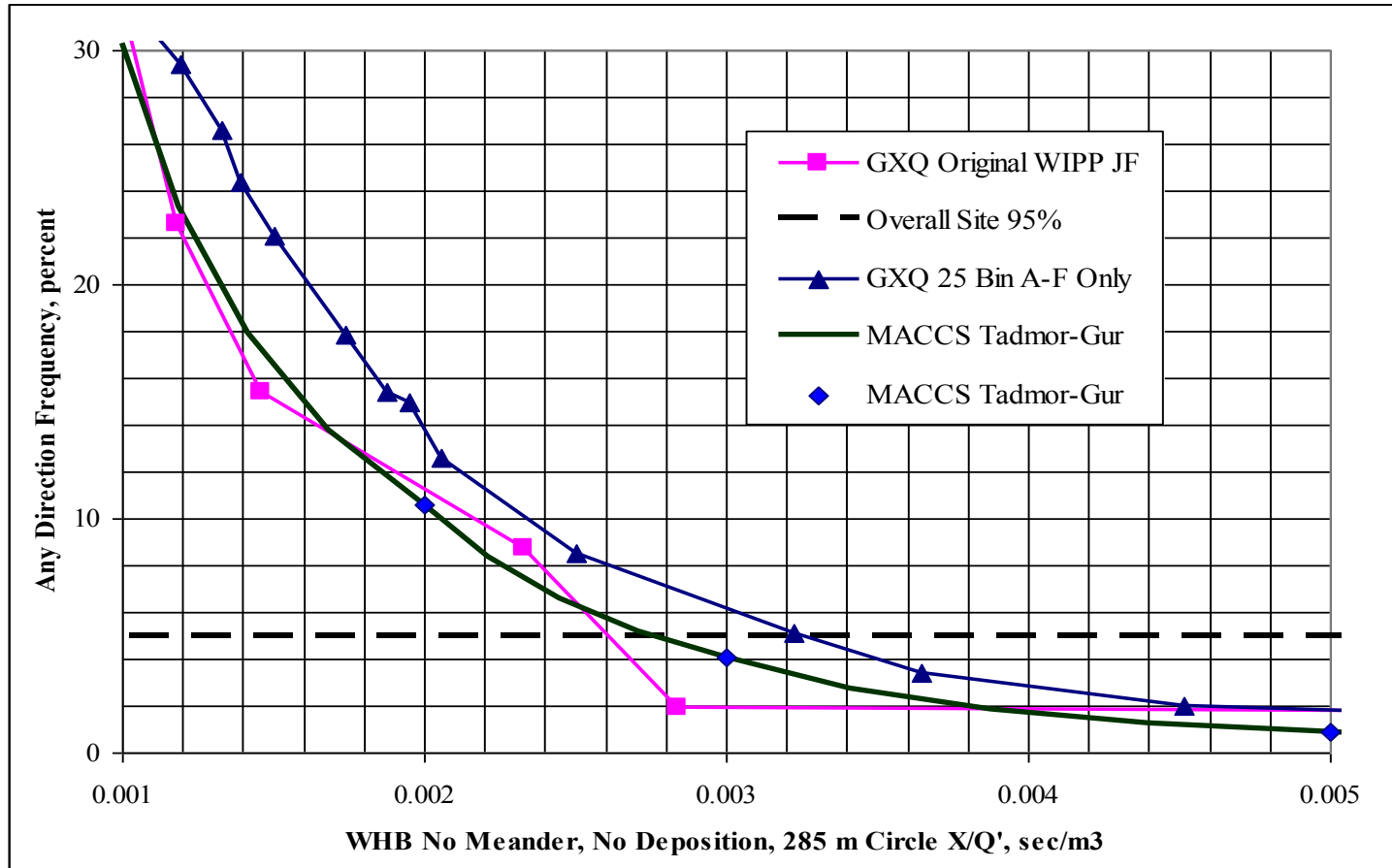
Comparison of Plume Meander with 2 hour Release Duration

| Distance | WHB Ground Level | | | WUS 7-meter Stack | | |
|---|------------------|----------|-------|-------------------|----------|-------|
| | GXQ | MACCS | Ratio | GXQ | MACCS | Ratio |
| 100 m | 4.90E-03 | 7.83E-03 | 1.60 | 1.15E-03 | 4.71E-04 | 0.41 |
| 285 m | 8.10E-04 | 1.27E-03 | 1.57 | 1.37E-03 | 5.52E-04 | 0.40 |
| 285 square | 7.29E-04 | na | na | 1.04E-03 | na | na |
| Notes: <ul style="list-style-type: none"> •The units for χ/Q' are seconds per cubic meter, s/m³. •Ground deposition is not included. MACCS uses the Eimutis formula for sigma Z. The release duration in the MACCS runs is 2 hours. GXQ uses the NRC Regulatory Guide Plume Meander. •The “Ratio” columns show the MACCS χ/Q' divided by the GXQ χ/Q'. | | | | | | |

Dispersion Models – 95th Percentile Calc

- **Cumulative Probability Distribution (CPD)**
very similar curves using different methods
- **GXQ**
CPD based on calculated χ/Q'
linear interpolation to find 95th percentile
- **MACCS**
CPD based on binned χ/Q' (5 per decade)
log-log interpolation to find 95th percentile

CPD for 285 m Circles



Additional Comparisons

Table 16. Original γ/Q' Reported in the WIPP Comparison

| Description of Case | WHB 100 m | WHB 285 m | WUS 100 m | WUS 285 m |
|---------------------------|-----------|-----------|-----------|-----------|
| WIPP "Current GXQ X/Q" | 3.79E-03 | 3.36E-04 | 5.86E-04 | 2.44E-04 |
| WIPP "GXQ X/Q No Meander" | 9.92E-03 | 7.05E-04 | 1.02E-03 | 5.38E-04 |
| WIPP "MACCS2 X/Q" | 9.84E-03 | 1.69E-03 | 2.01E-03 | 1.41E-03 |
| GXQ – 8 Bin A-F, Circle | 9.92E-03 | 1.23E-03 | 1.02E-03 | 9.91E-04 |
| GXQ – 25 Bin A-F, Square | 1.02E-02 | 4.23E-04 | 1.14E-03 | 9.56E-04 |
| GXQ – 25 Bin A-F, Circle | 1.02E-02 | 1.30E-03 | 1.14E-03 | 1.30E-03 |
| MACCS – Eimutis Sigma Z | 1.14E-02 | 1.41E-03 | 1.16E-03 | 1.31E-03 |

Notes:

- All the cases include ground deposition at 1 cm/s.
- The WIPP GXQ cases use the rectangular boundary for the 285 m location as well as the original joint frequency file with 8 wind speed groups. The first row includes Regulatory Guide 1.145 plume meander while the other GXQ rows do not include this.
- The two MACCS cases shown above use a release duration of 3 minutes to eliminate plume meander.