

### Ranking Formula Handout

This handout shows an example of how the proposed ranking equation works (OAR 340-245-0040). It also shows some of the testing of hypothetical facility risk and demographics scores that the Oregon Department of Environmental Quality (DEQ) and the Oregon Health Authority (OHA) used to determine that 75 percent weight on risk and 25 percent weight on demographics was the best to propose to the Cleaner Air Oregon (CAO) Rules Advisory Committee (RAC).

The overall objective of a tiered approach to implementation is to address the highest risk facilities first. Consistent with this objective, it is important that the ranking formula not give high scores to facilities with low risk based solely on demographics factors, which could happen if risk and demographics factors were given equal weight (note that facilities N and O have the same score with equal weighting in the right two columns). Effective weighting would allow the demographics factors to influence the ranking of medium and high risk facilities, but not give high scores to low risk facilities regardless of demographics. The proposed weighting of 75 percent risk and 25 percent demographics attempts to achieve this objective.

For actual ranking and implementation, facility-specific data will be used from the emissions inventory for the risk part of the equation and low income, minority, children under 5, and population from the American Community Survey for the demographics factor. All terms in the equation will be converted to percentiles relative to all facilities being ranked.

Ranking equation:

$$Score = Risk^{0.75} \times \left( \frac{low\ income + minority + children < 5 + population}{4} \right)^{0.25}$$

Example (Facility D):

$$Score = 0.4^{0.75} \times \left( \frac{0.5 + 0.7 + 0.4 + 0.8}{4} \right)^{0.25} = 0.4^{0.75} \times 0.6^{0.25} = 0.503 \times 0.88 = 0.44$$

Facility	Risk Percentile	Demographics Percentile	Weight Risk 0.75		Weight Demographics 0.25		Weight Risk 0.8		Weight Demographics 0.2		Weight Risk 0.6		Weight Demographics 0.4		Weight Risk 0.5		Weight Demographics 0.5	
			Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank		
A	0.1	0.7	0.16	15	0.15	15	0.22	14	0.26	14								
B	0.2	0.6	0.26	12	0.25	12	0.31	12	0.35	11								
C	0.3	0.7	0.37	11	0.36	11	0.42	10	0.46	9								
D	0.4	0.6	0.44	10	0.43	10	0.47	9	0.49	6								
E	0.5	0.5	0.50	9	0.50	9	0.50	7	0.50	5								
F	0.6	0.4	0.54	7	0.55	7	0.51	6	0.49	6								
G	0.7	0.4	0.61	5	0.63	5	0.56	4	0.53	4								
H	0.8	0.3	0.63	3	0.66	4	0.54	5	0.49	8								
I	0.9	0.2	0.62	4	0.67	3	0.49	8	0.42	10								
J	0.1	0.2	0.12	16	0.11	16	0.13	16	0.14	16								
K	0.2	0.2	0.20	13	0.20	13	0.20	15	0.20	15								
L	0.5	0.8	0.56	6	0.55	8	0.60	3	0.63	3								
M	0.9	0.5	0.78	1	0.80	1	0.71	2	0.67	2								
N	0.9	0.1	0.52	8	0.58	6	0.37	11	0.30	12								
O	0.1	0.9	0.17	14	0.16	14	0.24	13	0.30	12								
P	0.8	0.7	0.77	2	0.78	2	0.76	1	0.75	1								

Proposed Weighting

### Alternatives to using exponents in the ranking equation

Three approaches were considered for ranking: 1) multiplication with exponential weighting (from page 1) 2) multiplication of the risk and demographic terms with simple weighting using multiplication and 3) addition of the risk and demographic terms.

When adding the two factors, weighting can be applied by multiplying each term by the appropriate weight. Note that when multiplying the two terms, simple weighting using multiplication is problematic because it does not effectively allocate the weight because of the distributive property of multiplication (as in option 2 below). For example, facilities N and O have the same ranking using equation 2.

1.  $Score = Risk^{0.75} \times \left( \frac{low\ income + minority + children < 5 + population}{4} \right)^{0.25}$
2.  $Score = (0.75 * Risk) * \left( 0.25 * \frac{low\ income + minority + > 5 + population}{4} \right)$
3.  $Score = (0.75 * Risk) + \left( 0.25 * \frac{low\ income + minority + > 5 + population}{4} \right)$

The following table compares rankings based on these three different scoring methods

Facility	Risk Percentile	Demographics Percentile	Equation 1 Score	Equation 1 Rank	Equation 2 Score	Equation 2 Rank	Equation 3 Score	Equation 3 Rank
A	0.1	0.7	0.16	15	0.013125	14	0.25	14
B	0.2	0.6	0.26	12	0.0225	11	0.3	12
C	0.3	0.7	0.37	11	0.039375	9	0.4	11
D	0.4	0.6	0.44	10	0.045	6 (tie)	0.45	10
E	0.5	0.5	0.5	9	0.046875	5	0.5	9
F	0.6	0.4	0.54	7	0.045	6 (tie)	0.55	8
G	0.7	0.4	0.61	5	0.0525	4	0.625	6
H	0.8	0.3	0.63	3	0.045	6 (tie)	0.675	5
I	0.9	0.2	0.62	4	0.03375	10	0.725	3
J	0.1	0.2	0.12	16	0.00375	16	0.125	16
K	0.2	0.2	0.2	13	0.0075	15	0.2	15
L	0.5	0.8	0.56	6	0.075	3	0.575	7
M	0.9	0.5	0.78	1	0.084375	2	0.8	1
N	0.9	0.1	0.52	8	0.016875	12 (tie)	0.7	4
O	0.1	0.9	0.17	14	0.016875	12 (tie)	0.3	13
P	0.8	0.7	0.77	2	0.105	1	0.775	2