An Analysis of Worst Case Meteorological Days Versus Poor Dispersion Days During Emergency Episodes

David R. Maxwell, Indiana State Board of Health
Air Pollution Control Division, Indianapolis, Indiana 46206

Abstract

An analysis is made to distinguish "worst case" meteorological days from poor dispersion days. The characteristics of each condition are evaluated and their contribution to poor air quality and Emergency Episodes described. Pollutant notification levels for the State of Indiana and Air Stagnation Advisory Criteria used by the National Weather Service are listed.

There are two distinctly different meteorological conditions which may produce such poor air quality in a particular area that the National Ambient Air Quality Standards (NAAQS) may be exceeded. These conditions are classified as "worst case" meteorological days or poor dispersion days. A "worst case" meteorological day can be defined as a given day in which the meteorological conditions are such that high air pollutant concentrations occur over regions downwind from a point source or several sources of pollution. The poor air quality is usually confined to a small region in the path of looping or fumigation (inversion breakup) plumes, with the latter resulting in extremely high concentrations lasting from only a few minutes to less than an hour, unless an onshore sea breeze condition exists which could prolong the problem for several hours. Areas outside of the plume path may experience excellent dispersion while the NAAQS may be exceeded for the small territory within the plume path.

Poor dispersion days occur when the atmosphere is very stable and large temperature inversions prevail. These conditions are associated with a quasi-stationary high pressure system manifested by a very stable temperature profile, light winds, weak vertical motion, and no precipitation. When these meteorological conditions are expected to continue for at least 36 hours, the nearest National Weather Service Forecast Office may issue an Air Stagnation Advisory (ASA) for the affected region. The ASA is a special bulletin used to warn the general public that stagnant atmospheric conditions are expected which could cause increased concentrations of air pollutants near the ground. An ASA checklist (Table 3) is used by Weather Service forecasters to help determine whether an ASA should be issued for a specific region. Poor dispersion days imply that the regional air quality is poor, although no NAAQS may be exceeded. Pollutant notification levels for Indiana are included in Table 2.

"Worst case" days are characterized by nearly constant wind direction with wind speeds usually ranging from 8 to 12 knots, atmospheric stability classifications changing from unstable during daylight hours to slightly unstable at night, mixing heights in excess of 1500 meters, generally fair skies with scattered high clouds, very good visibility, and a heavily concentrated looping plume during the strongest

TABLE 1. *Characteristics of "Worst Case" Meteorological Day Versus Poor Dispersion Day.*

Meteorological Parameter	"Worst Case" Day	Poor Dispersion Day
Wind direction	Nearly constant all day	Variable
Wind speed	8-12 knots	Light; sometimes calm, always less than 5 knots
Average mixing height	Greater than 1,500 meters	Below 500 meters
Temperature profile	Superadiabatic lapse rate	Strong inversion
Characteristic plume	Looping	Fanning
Atmospheric stability	Unstable	Very stable
Cloud cover	Usually scattered high clouds	Usually clear
Visibility	Very good, 10-20 miles	1-4 miles; obscurations due to smoke, fog and/or haze)

periods of vertical mixing. Poor dispersion days usually occur during the summer and autumn months in the midwest when temperature inversions and stagnant air associated with slow moving synoptic scale high pressure systems engulf the central portion of the United States and dominate the weather pattern for a week at a time. "Worst case" days are most frequent during the spring and early summer when the atmosphere is relatively unstable and daylight hours longer. Table 1 lists the meteorological parameters and characteristic features of both poor dispersion and "worst case" days.

The frequencies at which "worst case" and poor dispersion days occur vary from year to year at each of the National Weather Service stations in the midwest. Poor dispersion days are largely dependent on a synoptic scale mass of stagnant air that covers a large portion of the country and the transport of ozone and other pollutants that are carried along with this system.

TABLE 2. *Pollutant Notification Levels for Indiana.*

Pollutant	Alert	Warning
Particulate APC 12R	3.0 COH (24-hour average)	6.0 COH (24-hour average)
Particulate Proposed APC 12	Same	5.0 COH (24-hour average)
SO_2 APC 12R	0.30 ppm (24-hour average)	0.60 ppm (24-hour average)
SO_2 Proposed APC 12	0.30 ppm (4-hour average)	0.35 ppm (4-hour average)
NO_2 APC 12R	1. 0.60 ppm (1-hour average) or 2. 0.15 ppm (24-hour average)	1. 1.20 ppm (1-hour average) or 2. 0.30 ppm (24-hour average)
NO_x Proposed APC 12	Same	Same
O_x APC 12R	0.10 ppm (1-hour average)	0.40 ppm (1-hour average)
O_3 Proposed APC 12	Same	Same
CO APC 12R	15 ppm (8-hour average)	30 ppm (8-hour average)
CO Proposed APC 12	Same	Same

For all Proposed APC 12 warning pollutant levels the meteorological conditions must be such that pollutant concentrations can be expected to remain at the above level for twelve (12) or more hours or increase. An Air Pollution Emergency will be called for both APC 12R and for Proposed APC 12 when a warning level for the respective regulations, has been exceeded and (1) the concentrations of the pollutant(s) are continuing to increase or, (2) the Technical Secretary of the Air Pollution Control Board determines that conditions will continue to increase because of meteorological or other factors.

TABLE 3. *ASA Check Sheet (From the National Weather Service)*

Morning Winds	>10 K	STOP
	$\leqq 10$K	−1
	$\leqq$ 8K	+1
	$\leqq$ 6K	+2
Afternoon and Early Tonight Winds	>11 K	STOP
	$\leqq 11$K	−1
	$\leqq$ 8K	+1
	$\leqq$ 6K	+2
Morning Mixing Heights	>1500m	STOP
	$\leqq 1500$m >750m	−1
	$\leqq$ 750m >500	0
	$\leqq$ 500m	+1
Afternoon Ventilation Factor	>8000 m^2/s	STOP
	$\leqq 8000$m^2/s >6000m^2/s	−2
	$\leqq 6000$m^2/s >4000m^2/s	0
	$\leqq 4000$m^2/s	+1

Both "worst case" and poor dispersion days have distinguishing characteristics, however, both may result in violations of national air quality standards and make breathing more difficult and hazardous for the people in affected areas. "Worst case" days, although more severe for the limited territory that is affected, are less disturbing to the environment than the wide-ranging poor dispersion days that are associated with periods of air stagnation which may last for a week or more.

DECISION (Based on algebraic sum of weighted parameters)
Yes (ASA called) +3, +2
Marginal Yes +1
Marginal No 0
No for negative values and "stop"

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