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The Impact of a Building Implosion on Airborne Particulate Matter in an Urban Community

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ABSTRACT

In response to community concerns, the air quality impact of imploding a 22-story building in east Baltimore, MD, was studied. Time- and space-resolved concentrations of indoor and outdoor particulate matter (PM) (nominally 0.5–10 μm) were measured using a portable nephelometer at seven and four locations, respectively. PM_{10} levels varied in time and space; there was no measurable effect observed upwind of the implosion. The downwind peak PM_{10} levels varied with distance (54,000–589 $\mu g/m^3$) exceeding pre-implosion levels for sites 100 and 1130 m 3000- and 20-fold, respectively. Estimated outdoor 24-hr integrated mass concentrations varied from 15 to 72 $\mu g/m^3$. The implosion did not result in the U.S. Environmental Protection Agency (EPA) National Ambient Air Quality Standard (NAAQS) for PM_{10} being exceeded. X-ray fluorescence analysis indicated that the elemental composition was dominated by crustal elements: calcium (57%), silicon (23%), aluminum (7.6%), and iron (6.1%). Lead was above background but at a low level (0.17 $\mu g/m^3$). Peak PM_{10} concentrations were short-lived; most sites returned to background within 15 min. No increase in indoor PM_{10} was observed even at the most proximate 250 m location. These results demonstrate that a building implosion can have a severe but short-lived impact on community air quality. Effective protection is offered by being indoors or upwind.

IMPLICATIONS

This study provides some of the first data of its kind characterizing the impact of a building implosion on community PM_{10} air quality. Although the data are limited (size and chemical composition), they provide a basis for assessing the public health threat and means of protection. Extremely high transient outdoor PM_{10} levels were observed downwind and in the immediate vicinity of the implosion; however, EPA's 24-hr NAAQS PM_{10} standard was not exceeded. Indoor locations were protective. Therefore, public health can be protected by discouraging spectator attendance, limiting spectators to upwind locations, and staying indoors with doors and windows closed.

INTRODUCTION

Building implosions are an increasingly common occurrence in cities across the United States. In 2000 alone, one major building demolition contractor imploded 23 high-rise public housing apartment buildings.[1] The increase in building demolition by implosion is the result of an initiative by the Department of Housing and Urban Development (HUD) to replace high-population-density residential high-rises in urban environments with restructured low-level community-type residences.[2]

Building demolition can be accomplished through either implosion or mechanical means (e.g., wrecking ball and excavator). The characteristics of dust emissions and community exposure will differ greatly between the two methods, although this difference has not been specifically characterized. Whereas the dust plume resulting from an implosion will be immediate, intense, and short-lived, affording opportunity for planning to minimize community impact (e.g., residents can be advised to vacate during the implosion and clean settled dust after the implosion), a mechanical demolition occurs over weeks or months, generating lower-level emissions but over a longer time, making planning to minimize exposure less practical.[3]

Demolition by implosion is conducted by using nitroglycerine-based dynamite to strategically destroy load-bearing structures, allowing the building to collapse onto itself. Depending on the timing and location of charges, implosion contractors are able to predetermine the direction of the collapse and subsequent debris pile.[3] (The demolition that is the subject of this paper was conducted by collapsing a high-rise on top of adjacent smaller buildings, thereby achieving multiple building demolitions from a single implosion.) For economic purposes and to minimize the emission of hazardous chemicals during demolition or debris removal, recyclable (e.g., plumbing and ventilation) and hazardous materials (e.g., asbestos and lead [Pb]), respectively, are removed before the implosion.[4] Asbestos removal is federally regulated under the National Emission Standards for Hazardous Air Pollutants (NESHAP, 40 CFR Part 61, Subpart M). Depending

on proximity, adjacent buildings may be draped with a heavy-gauge plastic or woven vinyl to prevent damage from flying debris. Such a precaution likely has a secondary benefit of reducing dust infiltration. Emissions and exposure also can be affected by meteorology. Specific criteria are site-and contractor-dependent; however, in general, light precipitation with winds in the direction of sparse population is desirable. Post-implosion settled dust control strategies include suppression with water and vacuum street cleaners.[4]

Despite these precautions, the potential for human exposure to air contaminants from urban building implosions is great because of a combination of high population density, the enormous particulate matter (PM) emission rate, and the resulting high PM concentrations. The exposure potential is further exacerbated by the spectacle of the event and media promotion that brings community residents outdoors and to the site, swelling the exposed population. In addition to the short-term exposure concern associated with the airborne PM at the time of the implosion, there is the potential for longer-term exposure to PM that settles across the community and then is available to be resuspended and inhaled or ingested after hand-to-mouth contact. The work of Lioy et al.[5] provides some insights as to the hazard posed by this latter exposure scenario. The focus of the current study relates to the former scenario—exposure to inhalable PM during a building implosion.

Therefore, there is a strong public health rationale for investigating urban PM exposure associated with building implosions. First, such exposures have not been previously reported. Second, urban communities are already at risk for air pollution-related morbidity, including asthma.[6–8] Lastly, there is strong and growing evidence of PM's adverse respiratory effects. Prezant et al.[9] recently reported upper respiratory effects, including increased bronchial responsiveness and cough, among firefighters exposed to the intense smoke and dust from the collapse of the World Trade Center. It has also been shown that individuals who are elderly or compromised by cardiovascular disease are at increased risk when PM levels are elevated.[10,11] The health threat from the implosion was further heightened because of its close proximity to a large hospital, placing susceptible individuals (e.g., immune-compromised, cardiopulmonary disease) at increased risk.[12,13]

Despite the potential of exposure and public health threat, little has been done to assess the airborne particle hazard associated with building implosions. The extent of the hazard will depend on a number of factors, including mass concentration, size distribution, and composition. The current study relies on the measurement of nominal PM_{10} by nephelometry. This methodology is advantageous in providing portable and time-resolved PM measurements; however, it is limited to a single size fraction and no composition information is provided. It is likely that a significant hazard would also stem from inspirable particles (i.e., 10–100 μm) generated from such an event. Lioy et al.[5] identified a number of toxic organic and inorganic components by particle size for three settled dust samples collected several days after the September 11, 2001, attack on the World Trade Center. This study highlights the significance of inspirable particles in the settled dust PM fraction (>98% of total particle mass), although such a sample has limited relevance to the actual airborne PM at the time of collapse because of the preferential settling of larger-sized particles.

The lack of information regarding the dust generated from a building implosion heightened the surrounding community's health concerns and formed the rationale and basis for the study design. Outreach activities were directed at informing the community of possible exposure risks before the implosion and of the results of this investigation after the implosion. Accordingly, this study was designed both to address the general research gap as well as to respond to community concerns by assessing PM_{10} concentrations over time and space related to a building implosion.

METHODS

Site Description

This study involved the implosion of a 22-story residential apartment building located on the 400 block of Washington Boulevard in east Baltimore, MD. The implosion occurred at 10:00 a.m. on Saturday, August 19, 2000. Figure 1 presents a diagram of the implosion site showing the location of the imploded building, the surrounding residential communities, as well as all monitoring locations used to assess the implosion's air quality effect. The building was centrally located in an area surrounded by residential communities and small businesses. According to the 2002 census, ~12,000 people live within the 13 census blocks in the vicinity around and downwind of the implosion (shown in Figure 1).[14] The Johns Hopkins Hospital is located two to three blocks north of the implosion site.

A square block surrounding the implosion site (275 × 129 m) was fenced off and guarded by police and city officials on the morning of the implosion. A large number of individuals witnessed the event from the fence perimeter. Public access was restricted preceding the implosion as well as for ~30 min following the event.

Sampling Strategy

PM_{10} was measured at four indoor and seven outdoor locations surrounding the implosion site, as described in

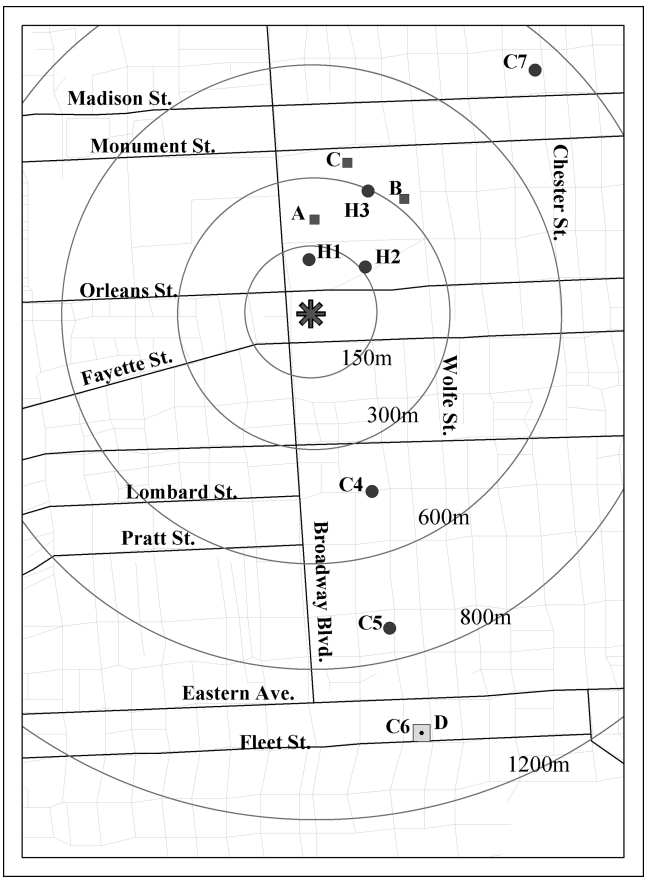


Figure 1. Site map showing the location of the seven outdoor and four indoor sampling sites. Outdoor and indoor sites are shown with circles and squares, respectively. Indoor and outdoor sampling was conducted at site C6/D.

Table 1. Two sets of outdoor sites were selected. The first set was oriented to assess the impact of the implosion on the nearby hospital buildings, while the second set was designed to assess community exposures. The community air sampling locations were selected based on meteorological conditions on the morning of the implosion, distance, and direction from the implosion center. Wind speed and direction were measured using a Davis Meteorological station (Davis Instruments Corp.) located on the roof of a two-story row home northeast of the implosion (site C7). Three sites were selected downwind (southeast) of the implosion site (C4, C5, and C6), and a fourth site (C7) was located 780 m upwind to measure background PM_{10} levels. The four community monitoring sites were located at distances ranging from 475 to 1130 m from the implosion center.

The second type of outdoor sampling location was focused on the nearby Johns Hopkins Hospital and was determined independent of wind direction (H1, H2, and H3). All three sites were within 300 m of the implosion. The hospital sampling locations were selected because of its close proximity to the implosion and because of particular concern over the threat that the implosion plume might have on vulnerable hospital patients (e.g., respiratory, cardiac, and immune disease). Monitoring was initiated 2 hr before the implosion and continued for 2 hr after the implosion. All outdoor air-monitoring locations were at ground level, with the exception of sites C7, H1, and H3, which were located at heights of 2, 3, and 10 stories, respectively. All samples were collected ~1 m above floor or ground level.

Table 1. Sampling locations relative to the imploded building.

Location ID	Description	Distance (m)	Direction
	Indoor		
A[a]	Hospital: cardiac suite 7th-floor patient room (ICU)	250	North (adjacent to restricted area)
B[a]	Hospital: 8th-floor AIDS patient room	335	North (adjacent to restricted area)
C[a]	Hospital: oncology 3rd-floor patient room	390	North (adjacent to restricted area)
D[b]	Community: row home	1130	Southeast (downwind)
	Outdoor		
H1	Hospital: 3rd-floor patio of Weinberg Cancer Center	100	North (adjacent to restricted area)
H2	Hospital: ground-level court yard patio	160	North (adjacent to restricted area)
H3	Hospital: 10th-floor balcony	300	North (adjacent to restricted area)
C4	Community: corner of residential side streets	475	Southeast (downwind)
C5	Community: corner of residential side streets	825	Southeast (downwind)
C6	Community: ground-level patio of row home	1130	Southeast (downwind)
C7	Community: upwind control site, rooftop of 2-story row home	780	Northeast (upwind)

[a]HVAC system is single-pass nonrecirculating (100% outside air) with 99% filtration efficiency ($\geq$1 μm). The only modification to the HVAC system on the day of the implosion was the addition of a 30% efficient prefilter to prevent excessive dust loading on air filters; [b]Windows and doors were closed. On-demand central air conditioning was operational and included a standard household particle filter.

Four indoor locations were monitored, including three hospital sites (A, B, and C) and one community row home (D). The community row home was located 1130 m downwind of the implosion and was the same location as outdoor site C6. This indoor site was occupied by an adult during the time of monitoring. The home's windows and doors were all closed to minimize particle intrusion, and the central air conditioner was operational. All three hospital locations were patient rooms, as described in Table 1. As a precaution to intrusion of implosion-related particles, 30% prefilters were added to the hospital's existing 99% particle filtration (1 μm) HVAC system. The indoor air-monitoring sites within the hospital were also sampled for biological airborne contaminants such as bacteria and fungi. Methods and results of this monitoring are presented elsewhere.[14]

Airborne Particle Monitoring

A portable direct-reading nephelometer with data logging capability (MIE pDR1000, ThermoAndersen) was used to measure indoor and outdoor PM_{10} concentrations. The instrument incorporates a pulsed, high-output, near-infrared light-emitting diode source (880 nm). The intensity of the light scattered over the forward angle inside the inlet by the particles passing through the sensing chamber is linearly proportional to the airborne PM_{10} concentration. The instrument's optical configuration produces response to particles in the size range of 0.1–10 μm, although empirical evidence suggests that there is a differential response such that particles in the size range of 0.3–2 μm are more efficiently detected relative to the size fraction from 2 to 10 μm.[15–20] The MIE pDR-1000 samples air passively and has a measurement range of 1–400,000 $\mu g/m^3$. A characteristic advantage of PM measurement by nephelometry is its linear response over this wide concentration range.[21] Instruments were factory-calibrated within 1 yr using SAE Fine (ISO Fine) test dust (Powder Technology, Inc.) characterized as having a mass median diameter of 2–3 μm, a geometric standard deviation of 2.5, a bulk density of 2.60–2.65 g/cm^3, and a refractive index of 1.54.

The instrument was operated using a rechargeable battery and programmed to record PM_{10} levels every 10 sec. Before monitoring, all the nephelometers were zeroed against a HEPA filter according to manufacturer's instructions. The "zero value" was checked after the completion of sampling to assess any drift during monitoring.

In addition to the nephelometry measurements, integrated PM_{10} sampling was conducted at two sites. At the upwind "background" site C7, PM_{10} was monitored for 24 hr before and after the implosion with a 37 °C tapered element oscillating microbalance (TEOM Series 1400a Ambient Particulate Monitor, Rupprecht & Patashnick). At site H1, integrated PM_{10} sampling was conducted in duplicate using a 10 L/min 10-μm Harvard Impactor (HI, AirDiagnostics, Inc.) loaded with a 37-mm Teflo filter (Gelman Sciences). Sampling was conducted from 1 hr before to 2 hr after the implosion. Sample flow was calibrated immediately before the start of sampling and checked at the end of sampling with a BIOS DryCal DC-2 (BIOS International Corp.) flow meter. A single field blank was collected by loading the filter into the HI and removing it. Gravimetric analysis was conducted according to 40CFR50 Appendix L using a Mettler T5 microbalance. Before analysis, filters were placed in Petri dishes and stored for 24 hr in a weighing room equipped with temperature and humidity control. The filter from the HI was analyzed for trace elemental composition by X-ray fluorescence (XRF) according to U.S. Environmental Protection Agency (EPA) method IO-3.3[22] (Chester LabNet) using a Kevex EDX 770 energy-dispersive X-ray spectrometer.

RESULTS

Meteorology on the morning of the implosion was characterized by a clear sky, light winds, an ambient temperature of 21.6 °C, and a relative humidity of 65%. The wind direction was from the northwest at 1.8 m/sec with a peak velocity of 4.9 m/sec occurring within 30 min postimplosion.

The outdoor pre- and post-implosion PM_{10} concentrations are summarized in Table 2 and presented graphically in Figure 2. Mean background levels at all outdoor sites for 2 hr before the implosion ranged from 13 to 29 $\mu g/m^3$ and were statistically indistinguishable (by t test assuming unequal variances, $p > 0.05$). A dramatic postimplosion increase in PM_{10} was observed at the two ground-level hospital sites (H1 and H2) as well as at the downwind community sites (C4, C5, and C6). At these locations, peak PM_{10} levels ranged from 54,000 to 589 $\mu g/m^3$, exceeding background levels by as much as 3000-fold. The time interval from implosion to peak varied with distance from 1 to 7 min, whereas the time to background ranged from 7 to 40 min. As expected, sites nearest to the implosion center showed a more dramatic and earlier peak relative to sites further away from the implosion. Site H2 was an exception because of its somewhat protected location within a hospital courtyard. The plume's dispersion and dilution is evidenced by the decreasing peak PM concentrations as the distance from the implosion increases. The velocity of the plume was estimated by distance from the implosion site and time to peak for the three downwind sites (C4, C5, and C6) as 2.6 m/sec. The estimated plume velocity is within the range of the measured wind speed, that is, 1.8–4.9 m/sec. Site

Table 2. Summary of outdoor PM concentrations before and after implosion by sample location.

Air Sampling Location ID	H1	H2	H3	C4	C5	C6	C7
Distance from implosion (m)	100	160	300	475	825	1130	780
Direction relative to implosion	North	Northeast	Northeast	Southeast	Southeast	Southeast	Northeast
Background concentration ($\mu g/m^3$)[a] and standard deviation[b]	17 (12)	20 (16)	21 (17)	18 (11)	13 (12)	29 (5)	27 (6)
Peak concentration ($\mu g/m^3$)	54,000	605	36	5686	1578	589	42
Time to peak concentration (min)	1.3	5.3	No effect	2.75	5.2	7	No effect
Average concentration over peak	1524	185	No effect	420	528	98	No effect
Duration of peak (min)	40	14	No effect	38	7	12	No effect
Estimated 24-hr TWA[c]	72	17	No effect	29	18	15	No effect

[a]Determined by the preimplosion 2-hr time-weighted average; [b]In parentheses; [c]The MIE-derived portion of this estimate is adjusted by a factor of 1.37 to account for its apparent underestimation of the actual dust mass concentration relative to integrated sampling/gravimetric determination.

H3, the hospital 300-m 10th-floor location, and site C7, the upwind 780 m control site, registered no discernable PM increase.

In contrast to the dramatic implosion effect observed for outdoor PM levels, no discernable effect was observed for any of the indoor locations, as shown in Figure 3. Although PM levels varied between locations, there was little change in variability or distribution values from before to after the implosion (see Table 3). Based on temporal association, there is some indication that the community row home (site D) indoor peak of 68 $\mu g/m^3$ might have been attributed to the implosion. This peak occurred 9 min after the implosion (10:09:24) and 2 min after the peak concentration (589 $\mu g/m^3$) corresponding to this same outdoor location. However, because this peak was transient (occurring over a single 10-sec interval) and within the range of recorded values during the 1-hr post-implosion period, this peak is as likely to have resulted from an indoor activity event.

Side-by-side integrated PM_{10} sampling at outdoor site H1 yielded mass concentrations of 547 and 542 $\mu g/m^3$, giving a mean of 545 $\mu g/m^3$ (CV = 0.65%). Over the same sampling interval, the nephelometer at the same location recorded a time weighted average (TWA) concentration of 398 $\mu g/m^3$, suggesting that the nephelometer was reading 73% of the gravimetric mass concentration.

An estimate of the outdoor integrated 24-hr average concentration on the day of the implosion was derived from the implosion peak along with background PM_{10} mass concentrations measured during the balance of the

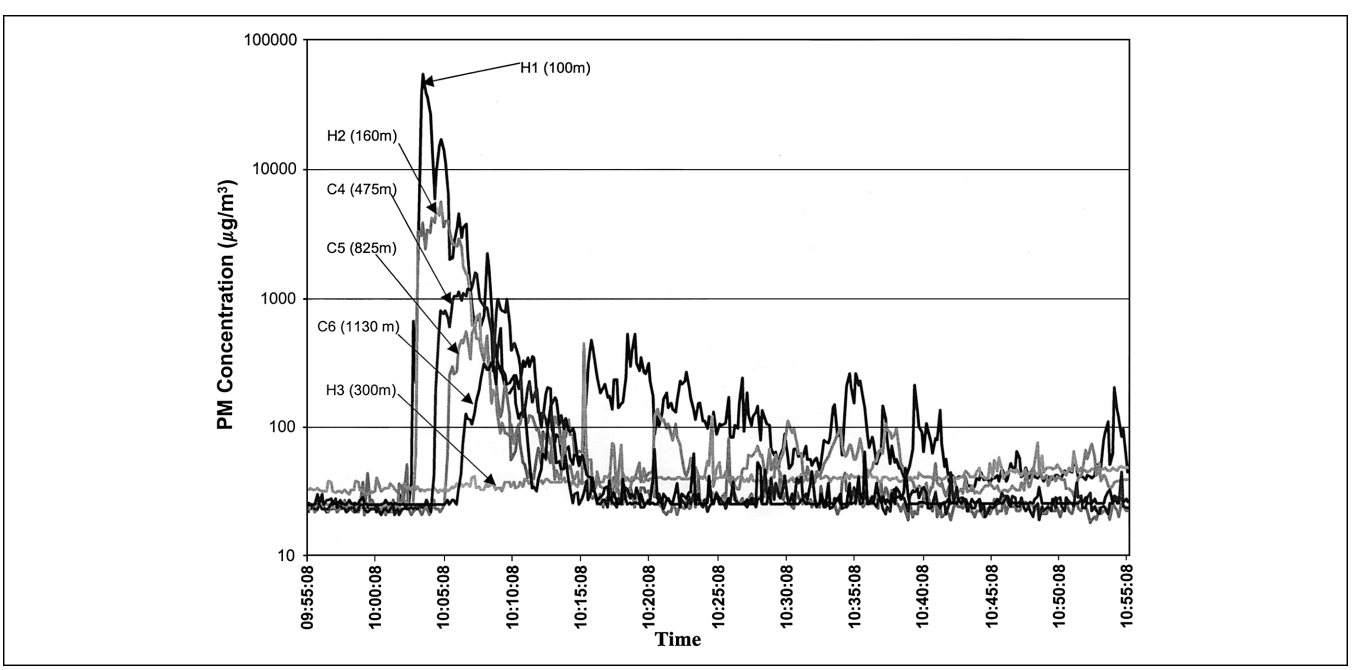


Figure 2. Outdoor PM_{10} concentration profiles. Site H3 was located on the 10th floor of the hospital.

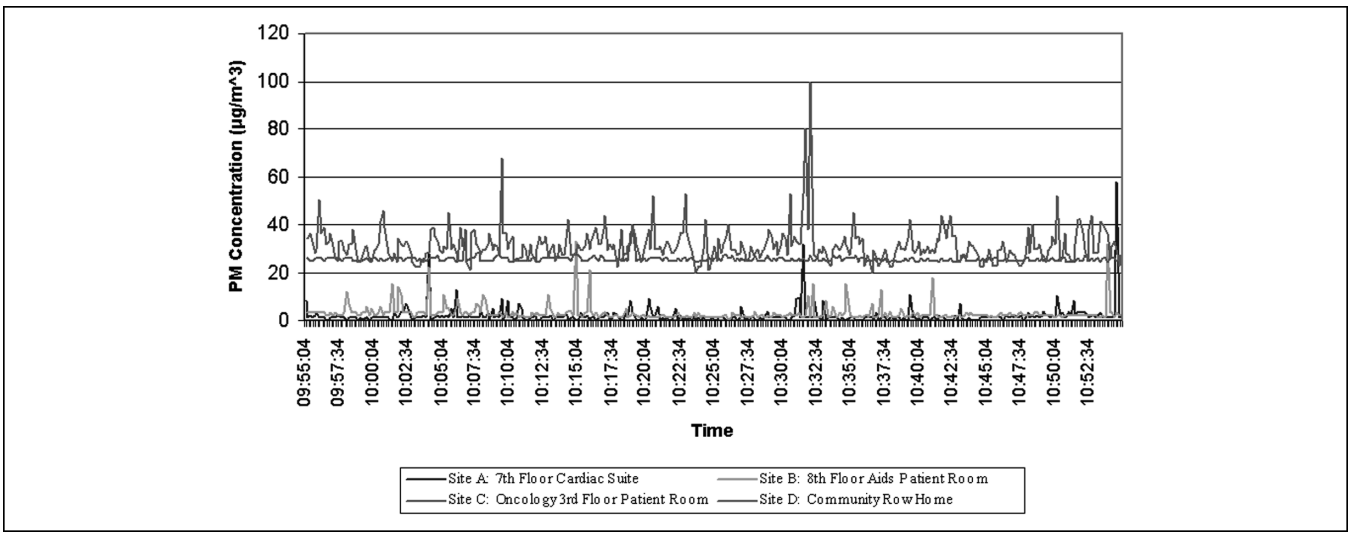


Figure 3. Indoor postimplosion PM_{10} concentration profiles.

24-hr period. Background time-weighted mass concentrations of 13.1 and 15.2 $\mu g/m^3$ were recorded by a 37 °C TEOM at site C7 during the nominal 10 and 13 hr before and after peak levels associated with the implosion. Estimates range from 14.9 to 71.9 $\mu g/m^3$ (see Table 2) with the maximum concentration at the most proximate site, H1. At this location, the implosion had a clear and substantial impact on the 24-hr TWA concentration, exceeding the upwind TEOM-measured 24-hr TWA concentration (17 $\mu g/m^3$) by a factor of 4.2.

XRF analysis of the PM_{10}-integrated sample yielded 27 elements above the limit of detection. The field blank showed elevated levels of barium (Ba), tin (Sn), and chlorine (Cl). The total elemental mass concentration was 141 $\mu g/m^3$, representing 26% of the gravimetric mass with the bulk of the elemental mass (96%) comprised of elements associated with crustal and building materials, including calcium (Ca) (57%), silicon (Si) (23%), aluminum (Al) (7.6%), iron (Fe) (6.1%), potassium (K) (2.1%), titanium (Ti) (0.38%), and manganese (Mn) (0.31%). Pb was measured at a concentration of 0.17 $\mu g/m^3$.

DISCUSSION

The current case study demonstrates the dramatic impact of a building implosion on community air quality. Outdoor PM levels nearby or downwind were observed to increase 3000- to 8-fold depending on distance from the implosion. These results indicate that the implosion had a significant effect on short-term ambient PM concentration at distances as great as 1130 m downwind. In the upwind direction, however, a sampling site as near as 300 m (site H3) from the implosion did not detect any measurable increase in ambient PM. Although PM concentration levels increased dramatically, the increases were of relatively short duration. In all cases, PM levels returned to background within 40 min postimplosion, while at four of the six outdoor monitoring sites, PM concentration returned to background in 15 min. Resolution of the PM concentration peaks was a function of wind speed. At the time of the implosion, a wind speed of 1.8 m/sec (with a maximum velocity of 4.9 m/sec) was recorded. The calculated plume speed (2.5 m/sec) was consistent with the observed wind velocity.

Table 3. Comparison of indoor PM_{10} concentration ($\mu g/m^3$) from before to after implosion.

Location	Interval	25th Percentile	Mean	Median	75th Percentile	95th Percentile	Maximum	Standard Deviation	Interquartile Range
H1	Pre	1	1.9	1	1	6	40	4.1	0
	Post	1	1.8	1	2	7	58	4.1	1
H2	Pre	3	5.5	4	5	15	118	7.7	2
	Post	1	2.9	2	3	7.9	33	3.7	2
H3	Pre	24	25	25	26	26	84	3.6	2
	Post	25	26	25	26	27	38	1.5	1
H4	Pre	29	33	32	36	45	65	6.6	7
	Post	27	31	30	34	44	100	7.7	6.8

The composition of the plume was investigated with respect to mold spores and elemental composition. As described in Srinivasan et al.,[23] the implosion was associated with a >6 and 10-fold increase in outdoor total fungal and *Aspergillis* spore counts at the 100- and 200-m locations, respectively. The elemental composition of the implosion plume was evaluated based on an integrated PM_{10} sample. Of the 545 $\mu g/m^3$ measured, seven crustal elements accounted for 96 and 26% of the elemental and total mass concentrations, respectively. The total mass contribution rises to 39%, assuming that the seven elements were present as their common oxides (Al_2O_3, K_2O, CaO, TiO_2, Mn_2O_7, and Fe_2O_3). In comparison, Davis et al.[24] reported that these same elements accounted for 28% of the total ambient PM_{10} mass measured in Boston, MA. Brook et al.[25] reported a similar mean soil contribution of 28% across multiple Canadian locations (n = 19) and years (1986–1993). These comparative results suggest that the implosion plume was enriched with the crustal elements. For ambient background PM, the source of these oxides is primarily the Earth's crust. However, in this case, the source primarily included the imploded building in addition to the soil resuspended by the force of the building collapse. The more likely inorganic compounds related to this source would be those associated with building material, such as Alite (tricalcium silicate), Belite (dicalcium silicate), and Celite (tetracalcium aluminoferrite).

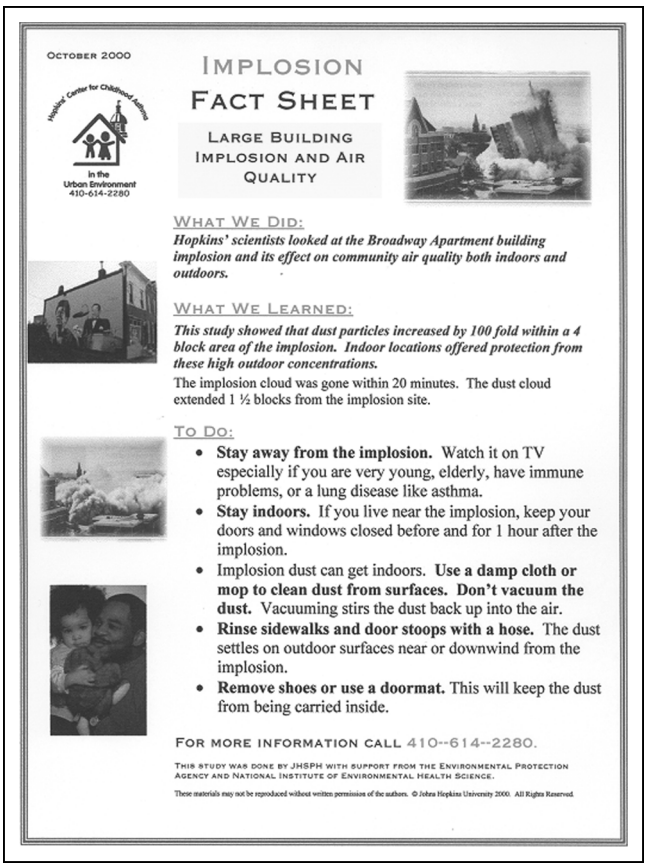
The measured Pb concentration of 0.17 $\mu g/m^3$ is an order of magnitude higher than background levels of 0.01 $\mu g/m^3$ indicated by the quarterly average reported by EPA's Aerometric Information Retrieval System (AIRS), suggesting that the implosion plume may have been a source for airborne Pb.[26] However, this level is still well below the National Ambient Air Quality quarterly standard of 1.5 $\mu g/m^3$.

Based on a single PM_{10} collocated sample, the nephelometer recorded a mass concentration 73% of the HI filter-based measurement. The underestimation of filter-based mass concentration determination contrasts with previous studies indicating a 56[15] and 400%[20] overestimation of the nephelometer relative to integrated $PM_{2.5}$ and PM_{10} sampling, respectively. The inconsistency of the current study with these previous reports may be attributable to the specific characteristics of the implosion plume such as particle density, index of refraction, and sampling characteristics at high particle concentrations.

Although a limited number of indoor sites were assessed, no implosion-related increase in PM concentration was detected even when an increase was observed with the associated outdoor site. There is a combination of particle, building, and ventilation characteristics that determine the efficiency of outdoor particle penetration indoors, as recently summarized by Riley et al.[27] Size is the primary particle determinant for particle penetration. For urban PM in the size range of PM_{10}, Riley et al. predict an indoor proportion of outdoor particles in the range of 0.38–0.80. This proportion drops substantially for an office-building scenario (assumes 40 and 80% ASHRAE filters) to 0.17 and 0.55, respectively. The absence of any observed PM_{10} penetration within the hospital buildings where an implosion-related increase in outdoor concentrations was observed (H1 and H2) is attributed to the hospital HVAC system operating at 99% filtration efficiency or to the short residence time of the dust plume. The absence of any observed PM_{10} penetration at the 1130 m downwind residence (D) despite the 20-fold increase in outdoor PM_{10} is attributed to precautions, including closing doors and windows and the relatively small (589 $\mu g/m^3$) and short-lived (12 min) plume. Howard-Reed et al.[28] recently demonstrated the significance of window opening on air-exchange rate and therefore the penetration of outdoor particles indoors. It is likely that without the precaution of closing windows, indoor PM_{10} levels would have been comparable to outdoor levels. Therefore, these data indicate that an efficient particle filtration system and closing doors and windows provided indoor protection against the dust plume likely dominated by relatively large particles generated from a building implosion for a hospital and a residence, respectively. These findings are in contrast to studies demonstrating that residential buildings are relatively ineffective as a barrier to PM penetration. Both Ozkaynak et al.[29] and Thatcher and Layton[30] estimated a PM_{10} penetration factor of near unity. A more recent study by Vette et al.[31] estimated penetration efficiency for $PM_{2.5}$ in a range of 0.6–0.8. In Finnish day care centers, Partti-Pellinen et al.[32] found that indoor PM levels averaged 25% of outdoors during times of high outdoor levels.

Based on the results of this study, and in consultation with the Community Advisory Board, we developed a community advisory alert for a second implosion that was to occur 9 months later. This advisory included the recommendations given in Figure 4.

The current study tells part of the story about the impact of a building implosion on the air quality in an urban community by providing time- and space-resolved PM_{10} assessment. As shown by Lioy et al.[5] from settled dust samples after the collapse of the World Trade Center, PM in the inspirable size range 10–100 μm is also generated from a building collapse, posing an exposure and health threat not characterized in the current study.


October 2000

IMPLOSION FACT SHEET

LARGE BUILDING IMPLOSION AND AIR QUALITY

Johns Hopkins Center for Childhood Asthma in the Urban Environment 410-614-2280

WHAT WE DID:

Hopkins' scientists looked at the Broadway Apartment building implosion and its effect on community air quality both indoors and outdoors.

WHAT WE LEARNED:

This study showed that dust particles increased by 100 fold within a 4 block area of the implosion. Indoor locations offered protection from these high outdoor concentrations.

The implosion cloud was gone within 20 minutes. The dust cloud extended 1 ½ blocks from the implosion site.

TO DO:

- **Stay away from the implosion.** Watch it on TV especially if you are very young, elderly, have immune problems, or a lung disease like asthma.
- **Stay indoors.** If you live near the implosion, keep your doors and windows closed before and for 1 hour after the implosion.
- Implosion dust can get indoors. **Use a damp cloth or mop to clean dust from surfaces. Don't vacuum the dust.** Vacuuming stirs the dust back up into the air.
- **Rinse sidewalks and door stoops with a hose.** The dust settles on outdoor surfaces near or downwind from the implosion.
- **Remove shoes or use a doormat.** This will keep the dust from being carried inside.

FOR MORE INFORMATION CALL 410--614--2280.

THIS STUDY WAS DONE BY JHSPH WITH SUPPORT FROM THE ENVIRONMENTAL PROTECTION AGENCY AND NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCE.

Figure 4. Implosion Fact Sheet used to inform community residents of exposure and health risks associated with a building implosion.

The air quality effects of such events are likely to be building- and meteorology-specific so that generalizability is limited; however, these data form the basis for additional study and model development. With respect to PM_{10}, the current study's findings as to the magnitude, duration, and composition of the building implosion dust plume suggest that there is little risk to healthy adults. There are no established health-based standards for transient high-level PM as occurs with a building implosion. However, even though it is not directly relevant, it is of interest to note that estimated community PM_{10} levels on the day of the implosion did not exceed the National Ambient Air Quality Standard (NAAQS) for PM_{10} of 150 $\mu g/m^3$ even at the most proximate outdoor site. However, there are very limited data regarding the health effects of short-term transient PM spikes on susceptible individuals. Therefore, individuals that are immune-compromised or have underlying respiratory disease may be at increased risk. Risk can be avoided or minimized by staying away from such events, being positioned upwind, or staying indoors.

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