

Dioxin and Dibenzofuran Formation Following a Fire at a Plastic Storage Warehouse in Binghamton, New York in 1995

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ABSTRACT: We report a case study of a fire that occurred at a plastics storage facility in Binghamton, New York. ABS rigid plastic, polystyrene, sheets of foam packaging, polyethylene bottles, polyvinyl chloride (PVC) strapping tape, shrink wrap, bubble wrap, and wood were among the materials stored at the warehouse.

Dioxin and dibenzofuran levels were elevated in one industrial and 5 nearby residential soil samples as well as in one pooled soot sample (taken from soot deposited on nearby residential area plant leaves) in comparison to 3 control soil samples from Binghamton. This report documents the apparent formation of dioxins and dibenzofurans from the burning of chlorine containing plastics. Dibenzofurans made a larger contribution to the total dioxin toxic equivalents than did the dioxins.

Keywords: Polyvinyl chloride (PVC), dioxins, dibenzofurans, plastics fire, TEQ

INTRODUCTION: At 11:22 PM on June 29, 1995, the Binghamton (New York) Fire Department received a call reporting a plastics warehouse fire. Residents living adjacent to the warehouse were evacuated. The fire was completely extinguished by 3:30 pm the following day.¹

The warehouse, used as a storage facility for a variety of plastics for recycling, contained over 1,000,000 pounds of plastics, including Acrylonitrile-Butadiene-Styrene (ABS) rigid plastic, polystyrene, sheets of foam packaging, polyethylene bottles, polyvinyl chloride (PVC) strapping tape, shrink wrap, and bubble wrap, some of which are chlorine containing plastics that can produce dioxins and dibenzofurans when incinerated.¹

The formation and emission of polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) as by-products of the burning of plastics by controlled incineration and accidental fires has been reported by a number of authors.²⁻⁹

One of us (AS) was asked by the mayor of Binghamton to serve as a dioxin specialist and public health consultant for this incident and, as such, recommended environmental sampling and dioxin analyses to address community concerns about possible dioxin formation.

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METHODS: Soil sampling began in July 1995. A total of 10 dioxin analyses were performed. Five soil samples from nearby residences, one pooled soot sample (11 Hosta plant leaves) taken from a nearby residence, 3 control soil samples from other Binghamton neighborhoods, and one soil sample from the plastics warehouse site, were obtained and analyzed.

Samples were analyzed for PCDDs and PCDFs by the New York State Department of Health Dioxin Laboratory, under the supervision of Drs. Robert Smith and Patrick O'Keefe.

RESULTS: Table 1 shows the estimated amount and type of plastic material contained in the warehouse. At the time of the fire, it is estimated that 1 million pounds of plastic were stored in the warehouse, of which an unknown amount burned.

Congener-specific dioxin data for the 3 control soil samples, one soil sample from the warehouse site, 5 soil samples from 4 possible contaminated residences, and one soot sample are presented in Tables 2 and 3.¹ In this table, total dioxin toxic equivalents (TEQ) were calculated using one-half the detection limit and also using zero for non-detected congeners.

The TEQ of the soil from the warehouse site, 680 parts per trillion (ppt), is much higher than the mean TEQ of the control soil samples, 5 ppt (using one-half the detection limit for non-detects). The total measured PCDDs/Fs and calculated TEQ for the soot sample are 505,000 ppt and 14,000 ppt TEQ, respectively. The measured total PCDD/F for the soot is significantly higher than the 1300 to 3700 ng/kg range measured for the 5 residence soil samples. The soot sample, estimated to be 23 nanograms per square meter (ng/m²) TEQ, is just below the guideline of 25 ng/m² TEQ maximum for surfaces which the New York State Department of Health established for reentry into the Binghamton State Office Building after mixed PCB, dioxin, and dibenzofuran contamination. The Centers for Disease Control (CDC) has used a level of 1 part per billion (ppb) TCDD as a safety limit for soil.

DISCUSSION AND CONCLUSIONS: This case study reports finding PCDDs and PCDFs as apparent pyrolytic products in soil and soot near the plastics fire. In this incident dibenzofurans contributed more TEQ than did the dioxins.

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Table 1.
Estimated Contents of the Warehouse on June 29, 1995

Material	Pounds
Low density Polyethylene*	200,000
Styrenes*	200,000
Wood filled phenolics*	100,000
Polyvinyl chloride*	60,000
Fiberglass cloth*	10,000
Polycarbonate**	unspecified
ABS rigid plastic**	unspecified
Polypropylene**	unspecified
Noryl**	unspecified
Ristan**	unspecified
Total Amount of Plastic Stored*:	1,000,000 lbs.

* Based on Owner's Account

** Observed by a Broome County Employee the day before the fire

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Table 2. Soil Samples taken from Control Sites Away from the Warehouse Compared with the Warehouse Site in Binghamton, New York, 1995

Congener	Soil Samples parts per trillion (ppt)			
	Control 1	Control 2	Control 3	Plastics Warehouse
2,3,7,8-TCDD	ND(2.9)	ND(2.7)	ND(2.3)	38
Total TCDD	ND(2.9)	ND(2.7)	ND(2.3)	2191
1,2,3,7,8-PeCDD	ND(3)	ND(2.6)	ND(2.6)	112
Total PeCDD	ND(3)	ND(2.6)	ND(2.6)	1272
1,2,3,4,7,8-HxCDD	ND(5)	ND(4.4)	ND(4.4)	51
1,2,3,6,7,8-HxCDD	ND(4.6)	ND(4.1)	ND(4.1)	93
1,2,3,7,8,9-HxCDD	ND(4.2)	ND(3.7)	ND(3.7)	57
Total HxCDD	ND(4.6)	ND(4.1)	ND(4.1)	1360
1,2,3,4,6,7,9-HpCDD				
1,2,3,4,6,7,8-HpCDD	12	19	33	1016
Total HpCDD	22	35	58	1852
OCDD	100	220	420	5678
2,3,7,8-TCDF	ND(2.7)	ND(2.4)	ND(2.2)	990
Total TCDF	ND(2.7)	ND(2.4)	ND(2.2)	15270
2,3,4,7,8-PeCDF	ND(2.9)	ND(2.7)	ND(2.3)	680
1,2,3,7,8-PeCDF	ND(2.2)	ND(2.3)	ND(1.7)	338
Total PeCDF	6.5	ND(2.3)	ND(1.7)	5168
1,2,3,4,7,8-HxCDF	ND(2.6)	ND(2.2)	ND(2.3)	ND(12)
1,2,3,6,7,8-HxCDF	ND(2.7)	ND(2.3)	ND(2.3)	405
1,2,3,7,8,9-HxCDF	ND(3.2)	ND(2.5)	ND(2.7)	ND(14)
2,3,4,6,7,8-HxCDF	ND(3.2)	ND(2.6)	ND(2.7)	266
Total HxCDF	ND(2.6)	ND(2.2)	ND(2.3)	2088
1,2,3,4,6,7,8-HpCDF	7.6	5.8	7.8	1700
1,2,3,4,7,8,9-HpCDF	ND(5.9)	ND(4.1)	ND(5.4)	290
Total HpCDF	14	15	21	2615
OCDF	ND(12)	16	17	1644
TOTAL PCDDS	127	260	483	12500
TOTAL PCDFS	29	34	41	26500
TOTAL PCDD/Fs	156	294	524	39000
TOTAL TEQ ND=1/2DL*	5	4	5	680
TOTAL TEQ ND=0	0.3	0.5	0.8	680

* ND = 1/2DL means that for congeners that were not detected, a value of one half the detection limit was used.

ND = 0 means that for congeners that were not detected, a value of zero was used to calculate the TEQ.

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Table 3. Soil Samples taken from Various Sites Around the Plastics Warehouse in Binghamton, New York, 1995

Congener	Soil Samples parts per trillion (ppt)					Leaf Sample
	Residence A	Residence A(1)	Residence B	Residence C	Residence D	
2,3,7,8-TCDD	ND(2.4)	ND(2.5)	ND(2.5)	ND(2.7)	ND(2.7)	494
Total TCDD	ND(2.4)	ND(2.5)	ND(2.5)	ND(2.7)	ND(2.7)	24015
1,2,3,7,8-PeCDD	ND(2.9)	ND(2.9)	ND(2.5)	ND(3.3)	ND(3.2)	2364
Total PeCDD	ND(2.9)	ND(2.9)	ND(2.5)	ND(3.3)	ND(3.2)	19931
1,2,3,4,7,8,-HxCDD	4.3	4.1	ND(3.9)	2.9	ND(8.1)	1348
1,2,3,6,7,8-HxCDD	ND(4.4)	ND(4.9)	3.4	5.9	6.6	2105
1,2,3,7,8,9-HxCDD	ND(4)	2.5	3.1	2.6	6.9	1996
Total HxCDD	24	28	42	54	46	30102
1,2,3,4,6,7,9-HpCDD						
1,2,3,4,6,7,8-HpCDD	73	97	68	200	210	11265
Total HpCDD	148	185	120	680	340	20220
OCDD	940	1000	590	2100	2600	20779
2,3,7,8-TCDF	2.5	2.3	3.3	4.3	5.2	7907
Total TCDF	20	23	74	37	26	152140
2,3,4,7,8-PeCDF	ND(2.5)	6.6	40	ND(2.9)	ND(3.0)	15632
1,2,3,7,8,-PeCDF	ND(1.9)	ND(2.1)	5.4	3.7	ND(2.2)	8035
Total PeCDF	46	52	270	37	28	111941
1,2,3,4,7,8-HxCDF	1.6	2.4	6.2	4.2	7.7	ND(52)
1,2,3,6,7,8-HxCDF	1.5	2.3	6.5	4	9.7	13200
1,2,3,7,8,9-HxCDF	ND(3.1)	ND(3.1)	ND(2.2)	ND(3.9)	ND(5.8)	ND(59)
2,3,4,6,7,8-HxCDF	3.8	3.8	14	5.9	13	10619
Total HxCDF	47	54	150	49	110	52949
1,2,3,4,6,7,8-HpCDF	42	51	36	50	120	28685
1,2,3,4,7,8,9-HpCDF	ND(6.3)	ND(7.3)	ND(3.6)	ND(9.2)	ND(17)	9872
Total HpCDF	79	101	59	140	390	56478
OCDF	46	58	30	130	190	16660
TOTAL PCDDs	1115	1216	717	2837	2989	115048
TOTAL PCDFs	238	288	583	393	744	390200
TOTAL PCDD/Fs	1353	1504	1300	3230	3733	505248
TOTAL TEQ ND=1/2DL(2)	7	10	28	11	15	14152
TOTAL TEQ ND=0	4	8	26	8	11	14145

(1) Duplicate test from Residence A

(2) ND=1/2DL means that for congeners that were not detected, a value of one half the detection limit was used.

ND = 0 means that for congeners that were not detected, a value of zero was used to calculate the TEQ.