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ORIGINAL

Air Monitoring Investigation – SPF Installation in Residential Structures

July 16, 2009

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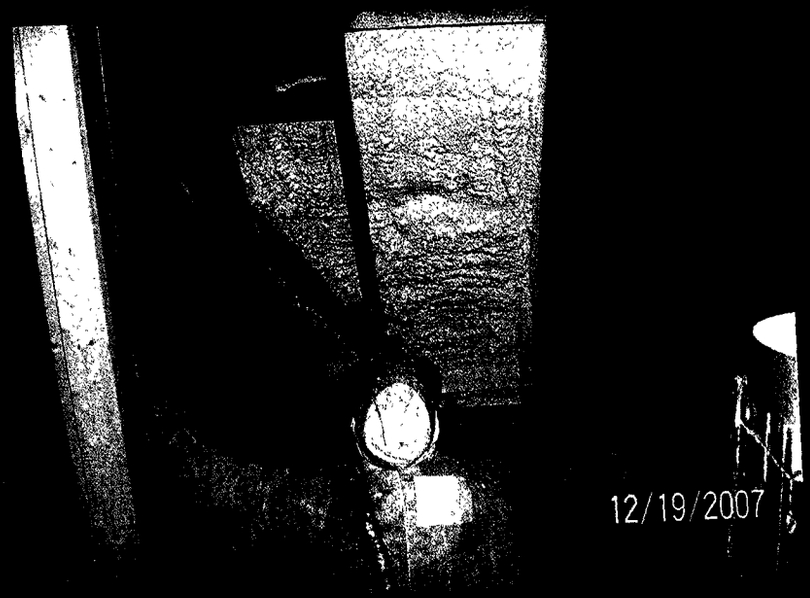

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Study Background

Purposes of Air Monitoring Study:

- Evaluate potential worker exposures during SPF application
- Evaluate potential migration of SPF compounds to adjoining floors
- Evaluate airborne concentrations with distance from applicator
- Evaluate airborne concentrations in truck trailer
- Evaluate rate of decline of airborne concentrations following the end of spraying
- Observe personal protective equipment use by SPF workers

Study Background

Five air monitoring surveys conducted:

- Pittsburgh, PA area 2007-08
- Four during summer months, one during winter
- Two during open cell foam applications in new town houses undergoing construction
- One during open cell foam application in single-family home undergoing renovation – different SPF formulation than others
- Two during closed cell foam applications in single-family homes undergoing renovation

Study Background

	Survey No. 1	Survey No. 2	Survey No. 3	Survey No. 4	Survey No. 5
SPF Type	Closed Cell (Formulation #1)	Closed Cell (Formulation #1)	Open Cell (Formulation #2)	Open Cell (Formulation #2)	Open Cell (Formulation #3)
Structure Type	Single-Family Home	Single-Family Home	Town House	Town House	Single-Family Home
Month Installed	August	December	June	August	July

Study Background

Five surveys conducted (cont.):

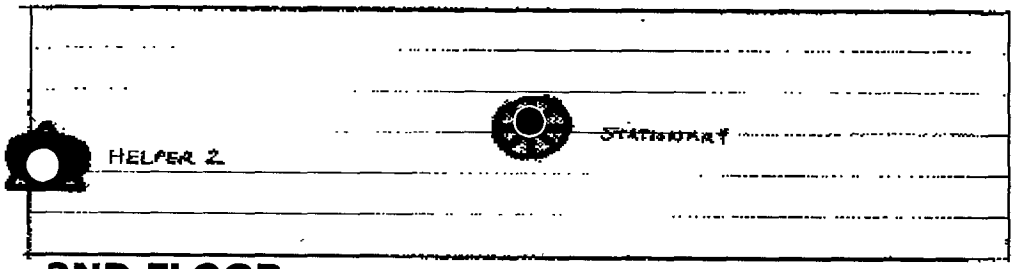
- Each structure two to four floors
- Each survey – SPF applied to perimeter wall, partial perimeter wall, and/or underside of roof deck
- Typically one or two windows and/or doors open somewhere in the structure
- Typical SPF crew – one applicator and one to two helpers. Applicators and helpers sometimes switched roles.

Study Summary

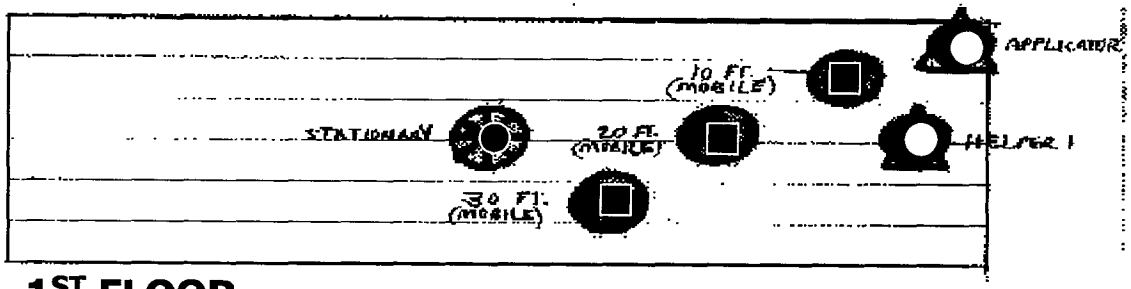
Each study included:

- personal air samples – short and long term
- stationary area samples on each floor – to evaluate potential migration of SPF compounds to adjoining floors
- mobile area samples to maintain prescribed distances from applicator
- post-spray samples on each floor
- area samples in truck trailer

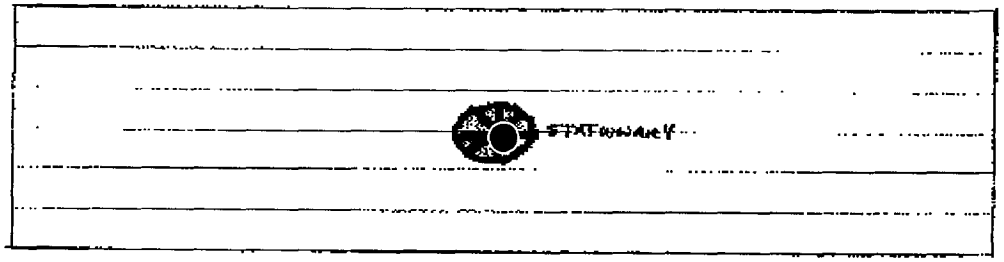
AIR SAMPLING PLAN SCHEMATIC



2ND FLOOR



1ST FLOOR



BASEMENT

Worker
■ Mobile
● Stationary

Study Summary

Analytes

- MDI and larger molecular weight oligomers of MDI
- Bayer Method 1.20.0
  - Spill proof impinger with toluene/1-(2-pyridyl)piperazine solution
  - Backed up with treated 13 mm glass fiber filter with 1-(2-pyridyl)piperazine and diethyl phthalate in Millipore Swinnex® cassette
  - Flow rate 1 liter per minute
  - Filter desorbed in field with acetonitrile/dimethylsulfoxide (90:10)
  - Analysis - HPLC with detection by UV or fluorescence

Study Summary

Analytes

- Amine catalysts
  (types/levels varied by formulation –
  2 to 5 per formulation, from <1% to about 5%)

- Bayer Method 2.10.3
  - XAD-2 tube
  - Flow rate 0.5 liters per minute
  - Analysis: GC-NPD (or GC-MS)

Study Summary

Analytes

- Blowing agent
  (HFC- 245fa or 1,1,1,3,3-pentafluoropropane)

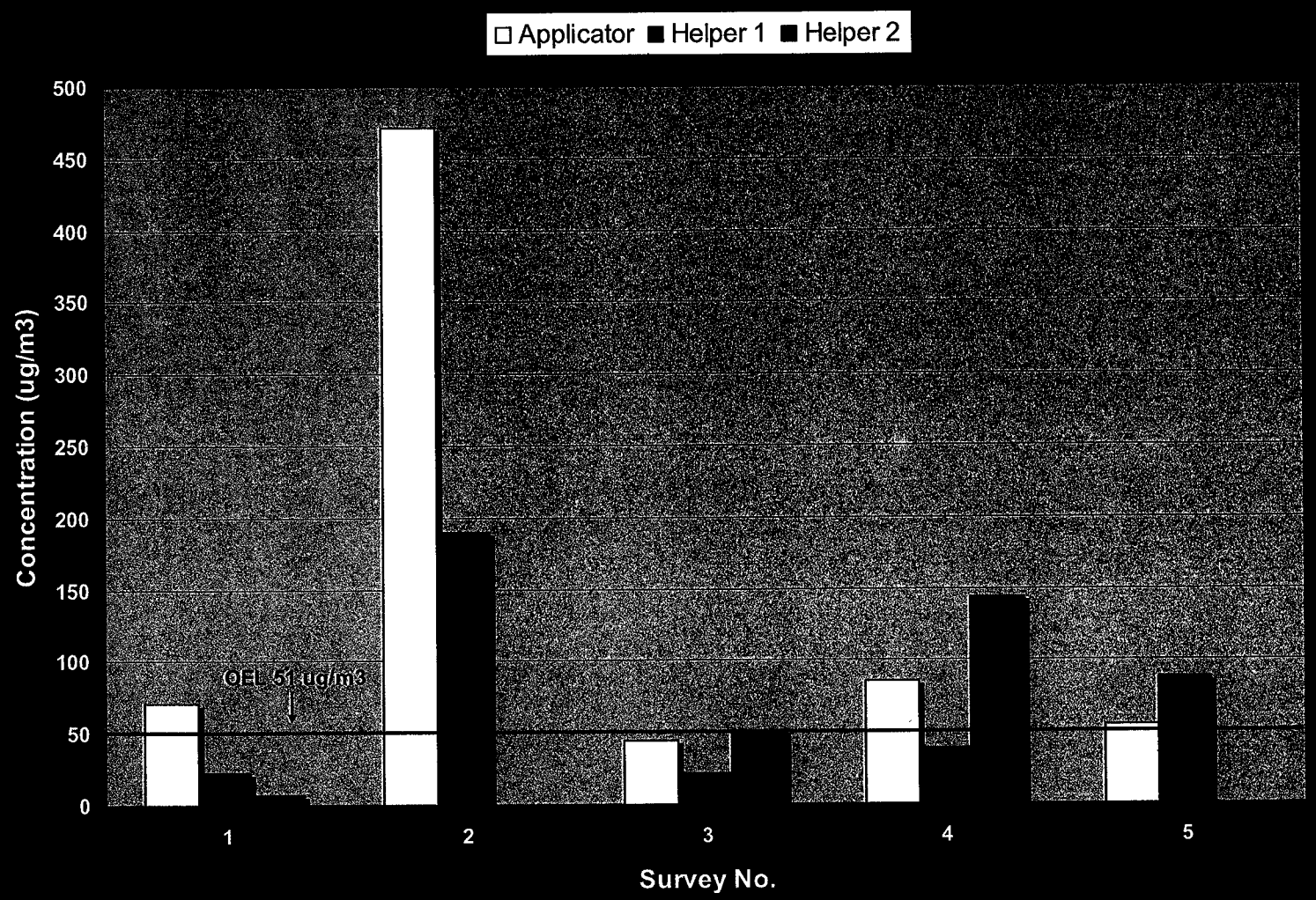
- NIOSH Method 2516 – modified
  - Two charcoal tubes in series
  - Flow rate 0.02 liters per minute
  - Analysis: GC-FID

Summary of Potential Health Effects of Overexposure

	Respiratory Tract	Eyes	Skin	Other
MDI	Irritation Sensitization	Irritation	Irritation Sensitization	
Amine Catalysts	Irritation Sensitization (few)	Irritation Hazy/Halo Vision	Irritation Sensitization (few)	
Blowing Agent	Irritation	Irritation	Irritation	CNS Effects Irregular Heartbeat

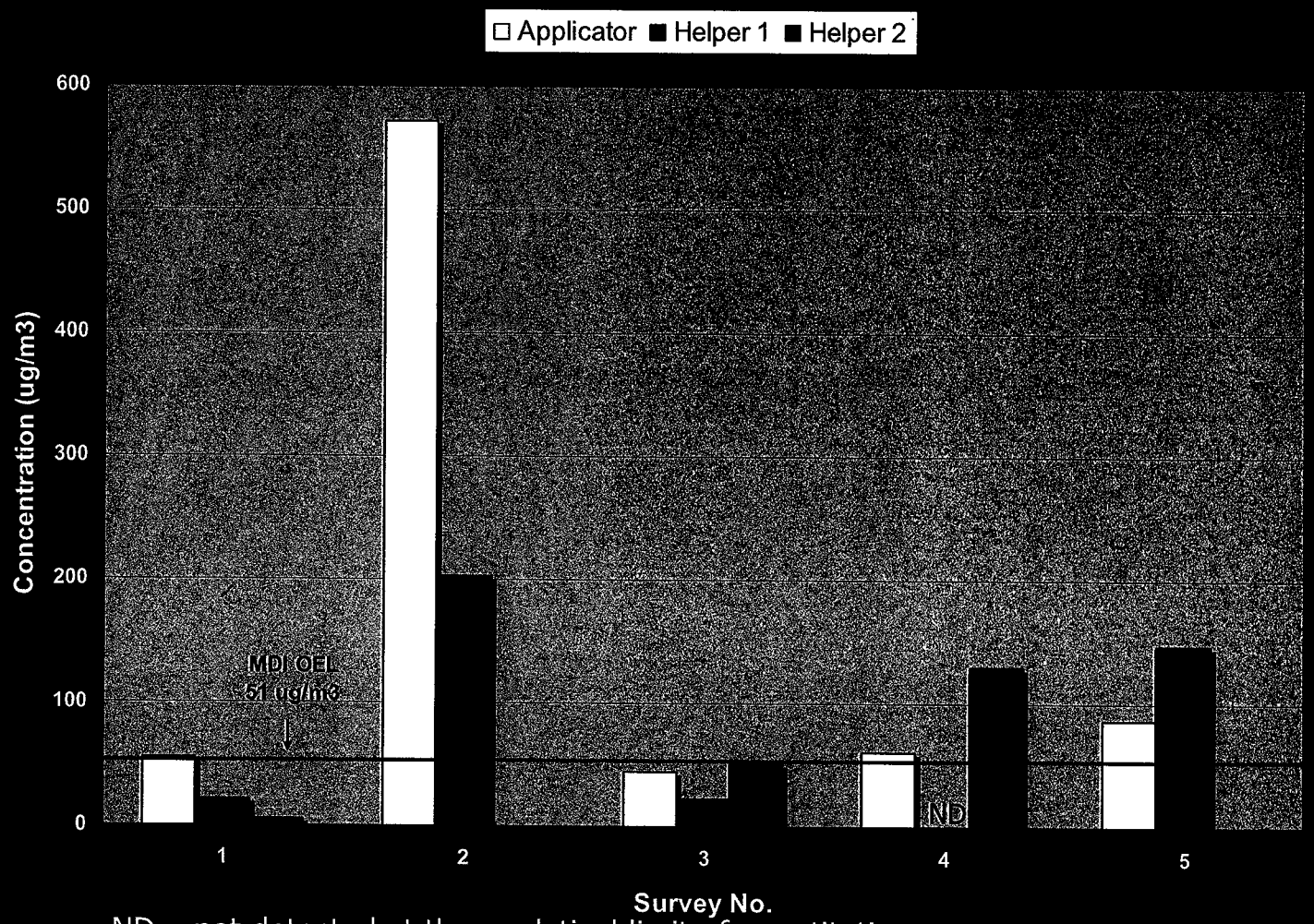
PERSONAL SAMPLE RESULTS

Airborne MDI Concentrations - Applicator and Helpers



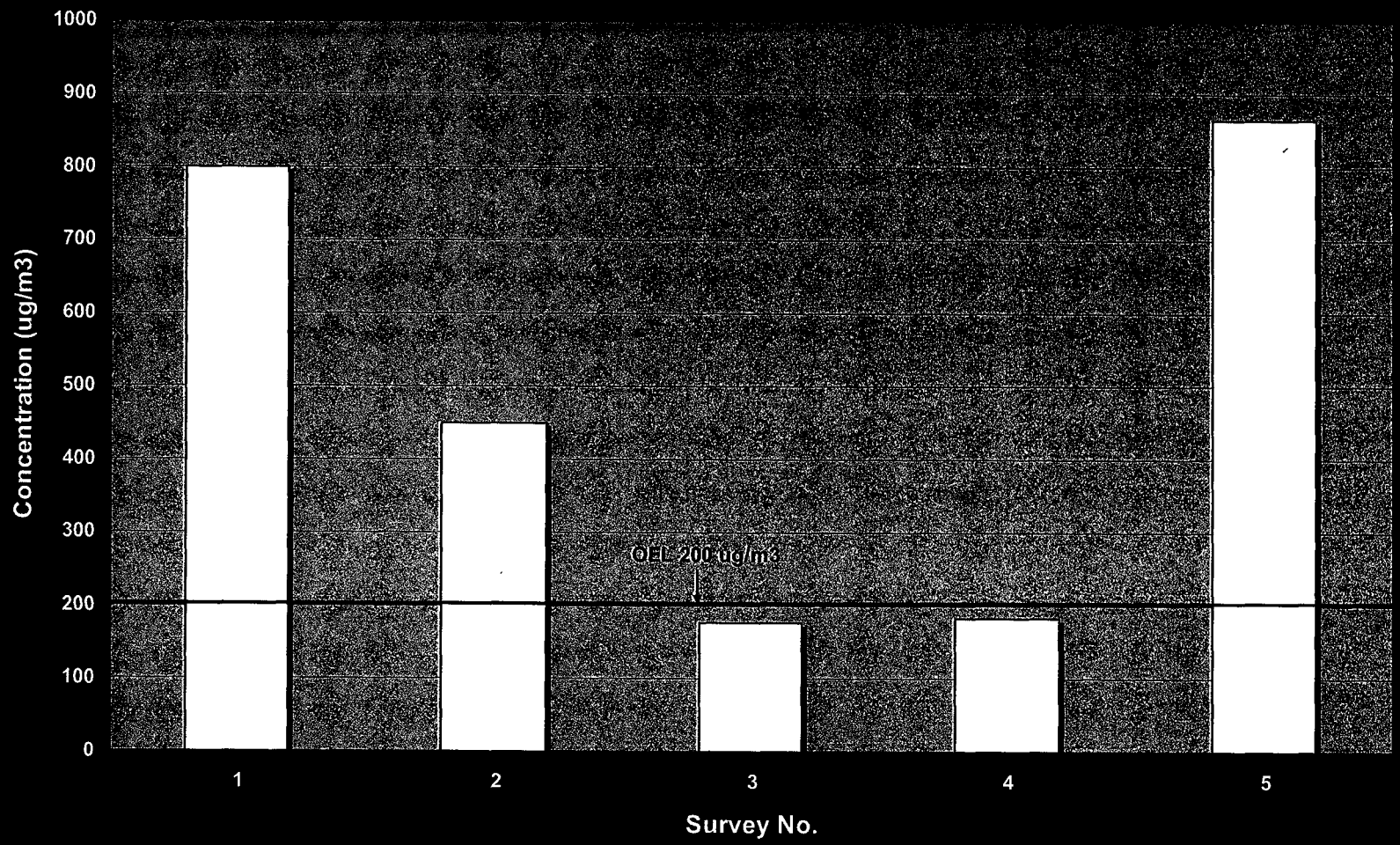
For Survey Nos. 2, 4, and 5, Helper conducted some amount of spraying.
Survey Nos. 1 and 2 are closed cell; Survey Nos. 3-5 are open cell

Airborne MDI Oligomer Concentrations - Applicator and Helpers

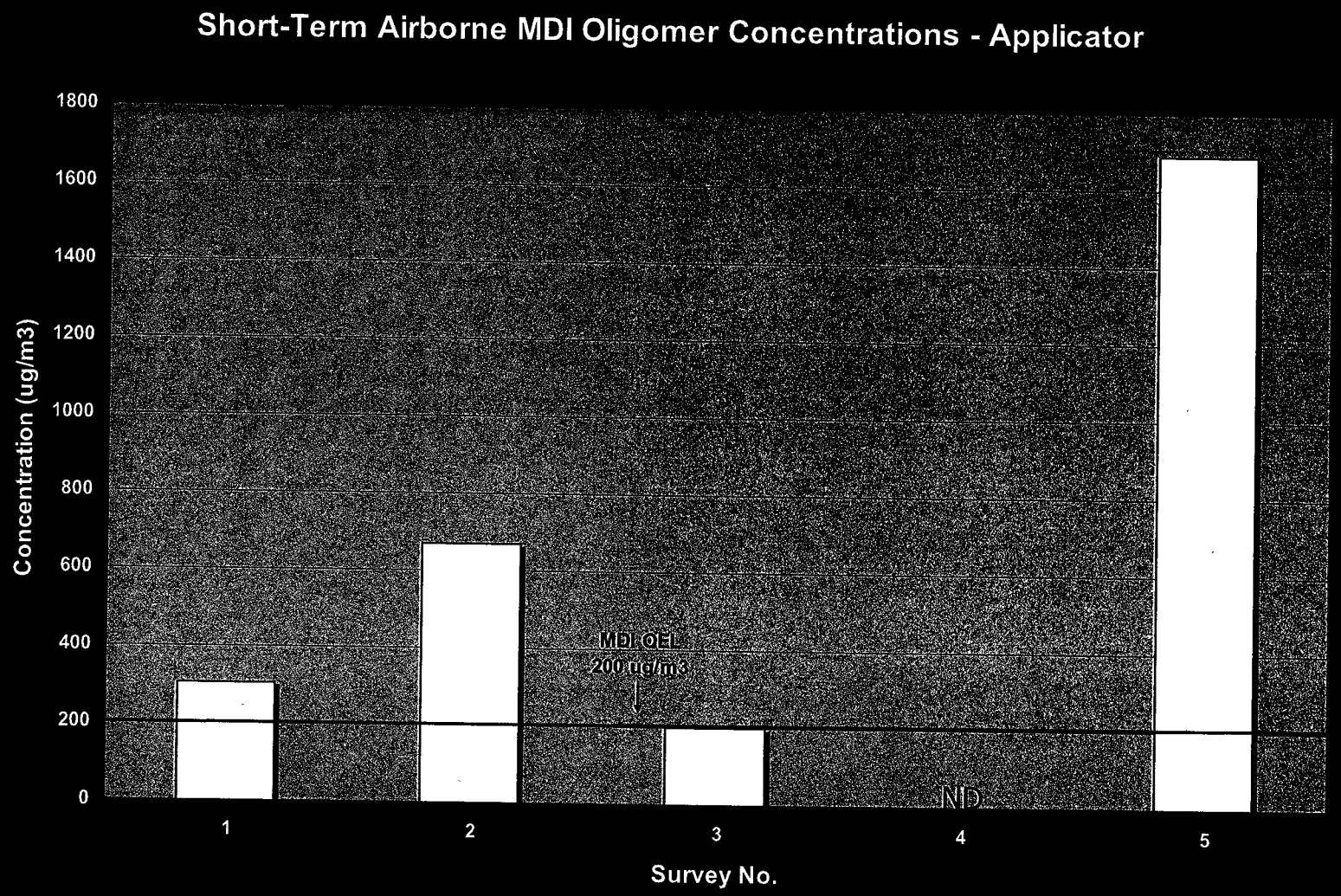


ND – not detected at the analytical limit of quantitation.
For Survey Nos. 2, 4, and 5, Helper conducted some amount of spraying.
Survey Nos. 1 and 2 are closed cell; Survey Nos. 3-5 are open cell

Short-Term Airborne MDI Concentrations - Applicator

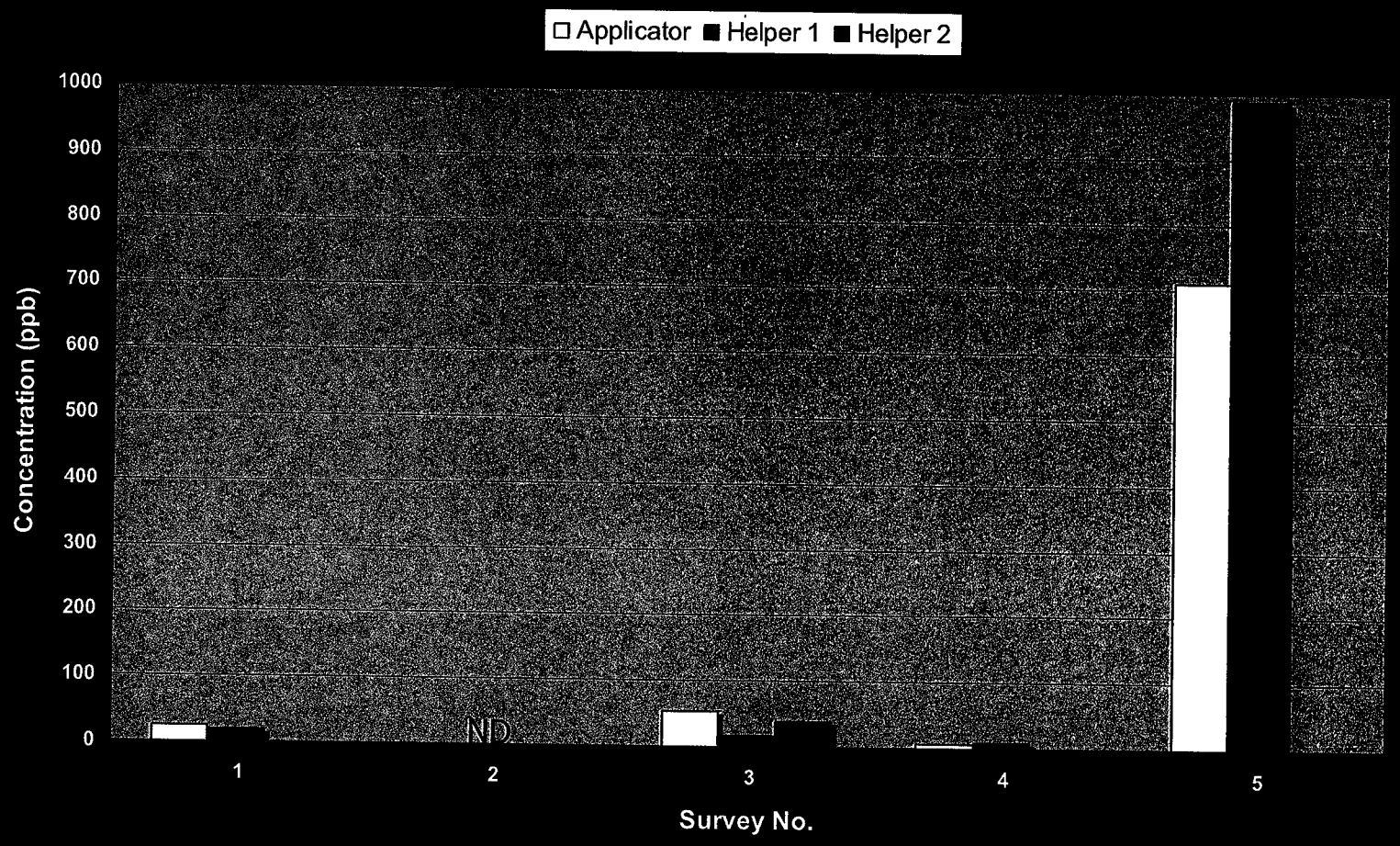


Survey Nos. 1 and 2 are closed cell; Survey Nos. 3-5 are open cell

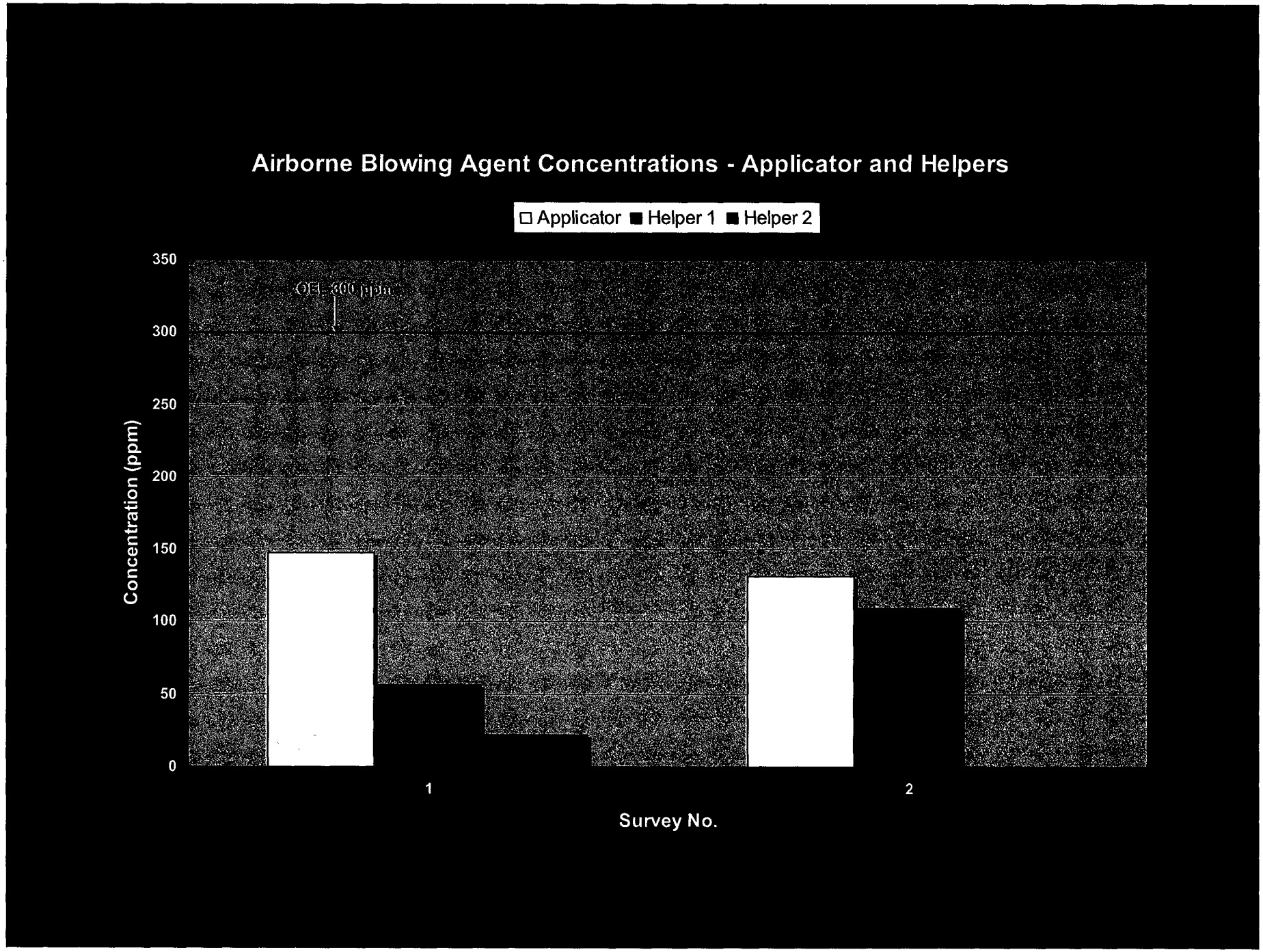


ND – not detected at the analytical limit of quantitation.
Survey Nos. 1 and 2 are closed cell; Survey Nos. 3-5 are open cell

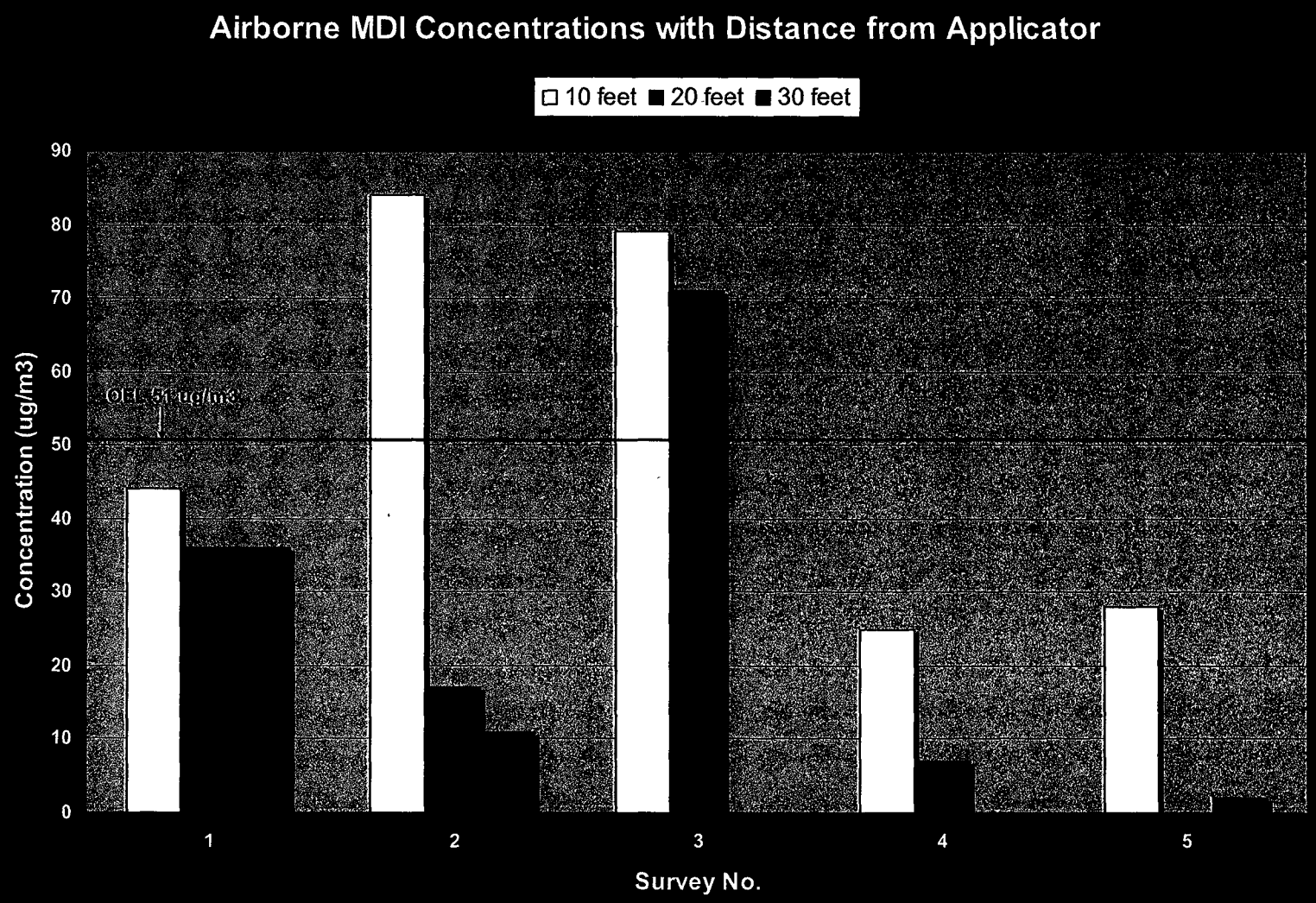
Total Airborne Amine Catalyst Concentrations - Applicator and Helpers



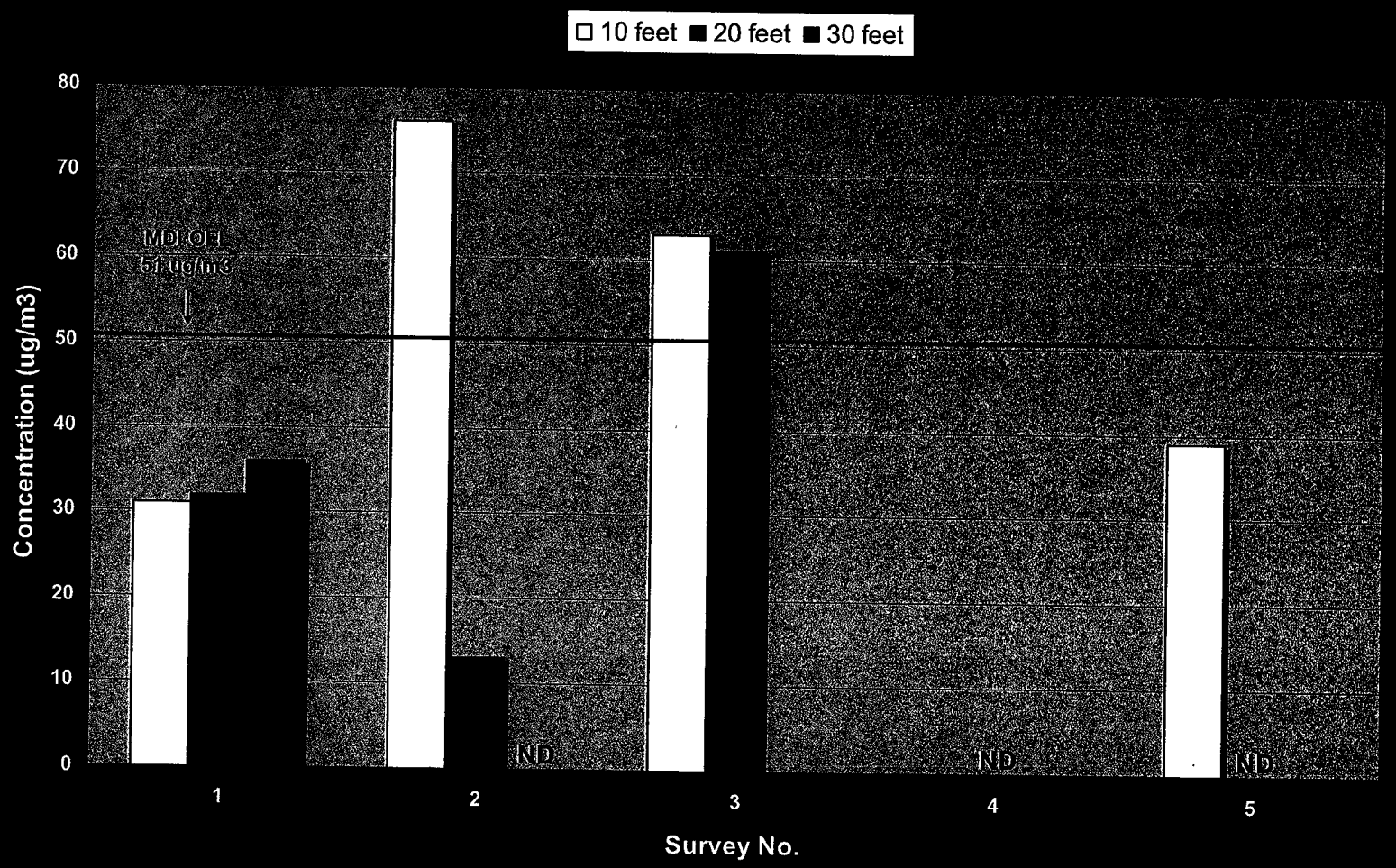
ND – not detected at the analytical limit of quantitation.
Survey Nos. 1 and 2 are closed cell; Survey Nos. 3, 4, and 5 are open cell


Airborne Blowing Agent Concentrations - Applicator and Helpers
Applicator
Helper 1
Helper 2
OEL 300 ppm
Concentration (ppm)
350
300
250
200
150
100
50
0
1
2
Survey No.

DISTANCE FROM APPLICATOR RESULTS

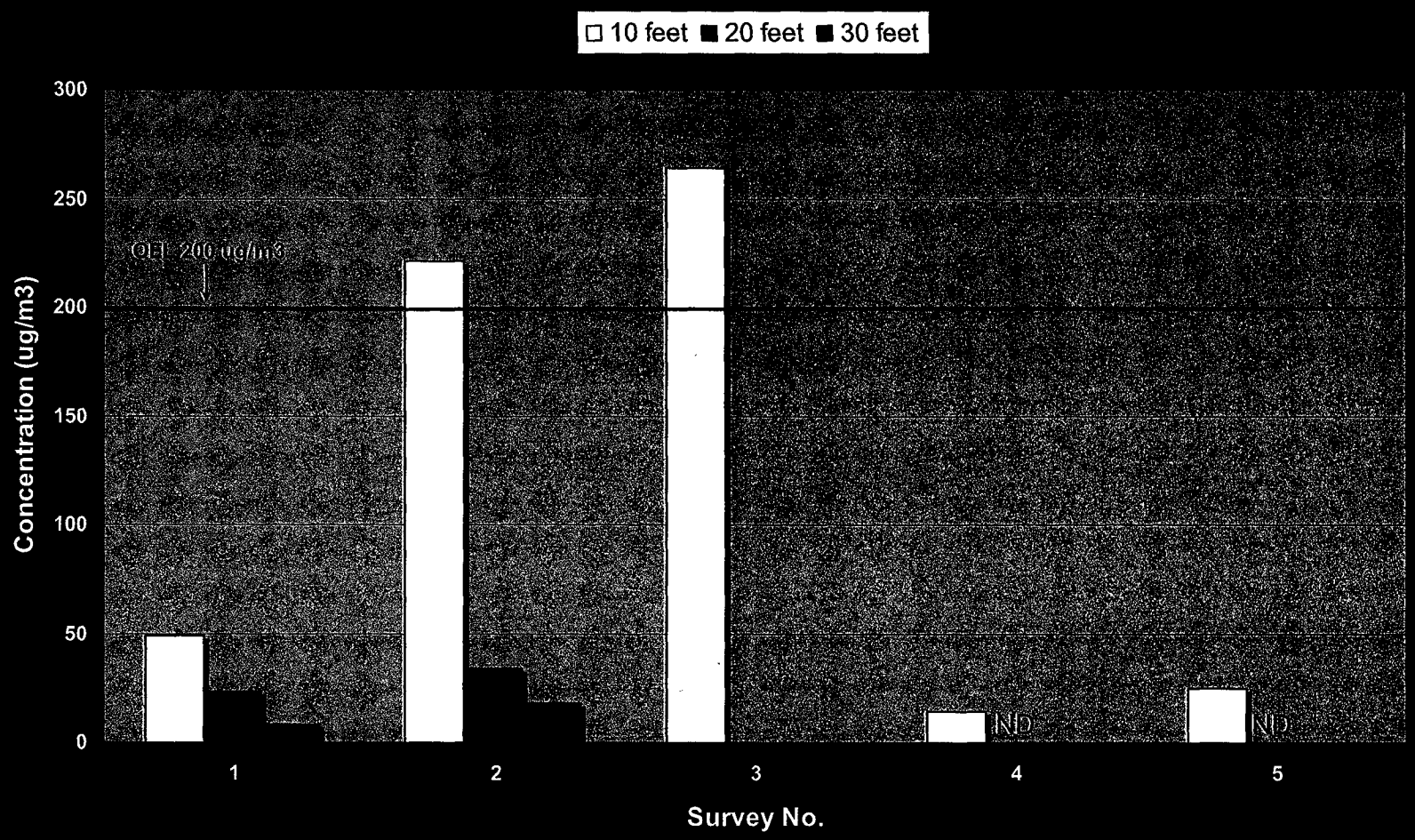


Survey Nos. 1 and 2 are closed cell; Survey Nos. 3-5 are open cell



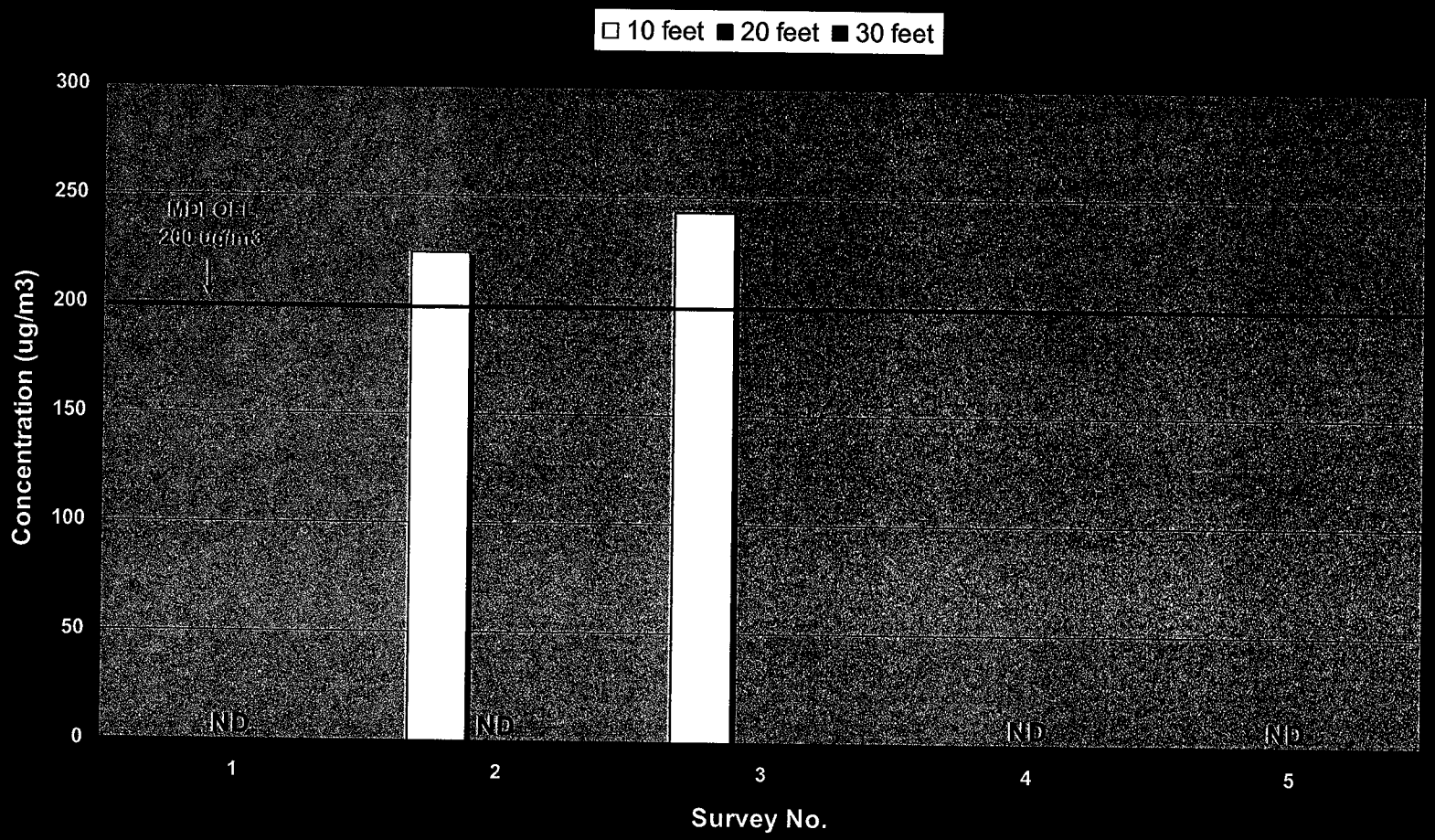
ND – not detected at the analytical limit of quantitation.
Survey Nos. 1 and 2 are closed cell; Survey Nos. 3-5 are open cell

Short-Term Airborne MDI Concentrations with Distance from Applicator



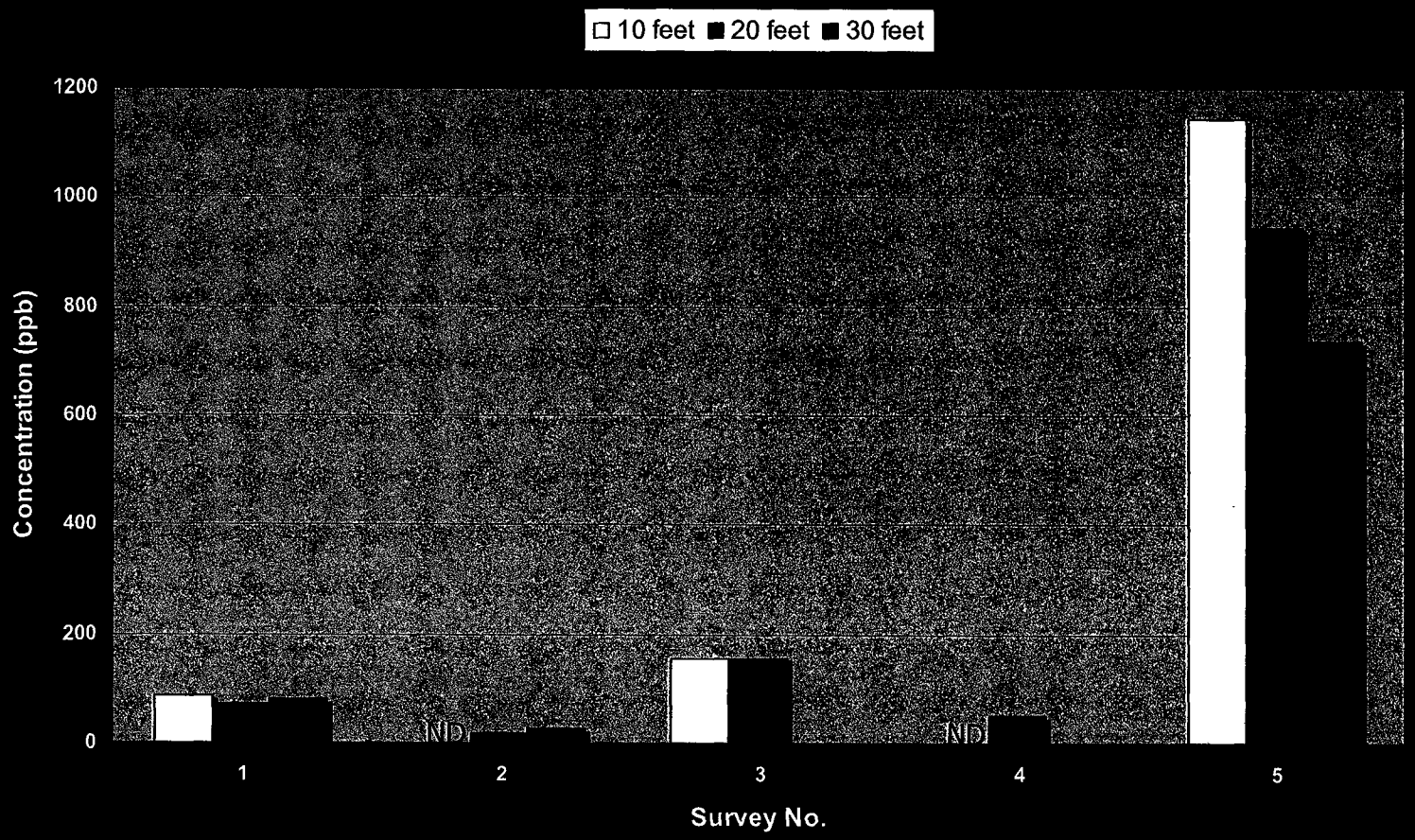
ND – not detected at the analytical limit of quantitation.
Survey Nos. 1 and 2 are closed cell; Survey Nos. 3-5 are open cell

Short-Term Airborne MDI Oligomer Concentrations with Distance from Applicator



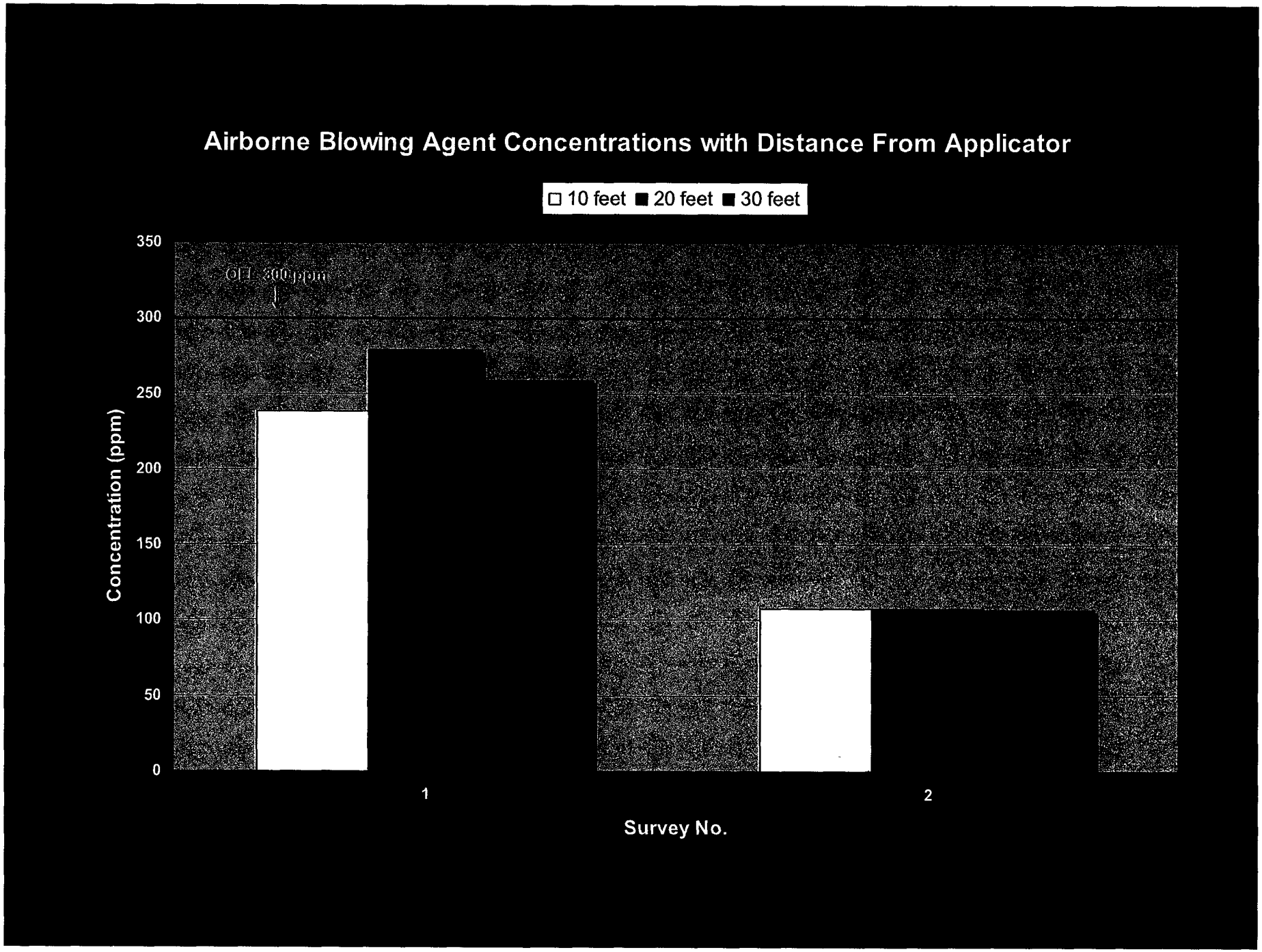
ND – not detected at the analytical limit of quantitation.
Survey Nos. 1 and 2 are closed cell; Survey Nos. 3-5 are open cell

Total Airborne Amine Catalyst Concentrations with Distance from Applicator



ND – not detected at the analytical limit of quantitation

Survey Nos. 1 and 2 are closed cell; Survey Nos. 3, 4, and 5 are open cell


Airborne Blowing Agent Concentrations with Distance From Applicator
10 feet
20 feet
30 feet
OEL 300 ppm
Concentration (ppm)
350
300
250
200
150
100
50
0
1
2
Survey No.

Migration of Airborne SPF Compounds

Survey No.	Degree of Migration Observed			
	MDI	MDI Oligomers	Amine Catalysts	Blowing Agent
1	*Slight Migration to Lower Floors.* <5% of concentration on floor sprayed	*Moderate Migration to Lower Floors.* <45% of concentration on floor sprayed	None	*Slight Migration to Lower Floors.*** <10% of concentration on floor sprayed
2	*Slight Migration to Lower Floors.* <20% of concentration on floor sprayed	None	None	*Moderate Migration to Lower Floors.* <60% of concentration on floor sprayed
3	None	None	None	NA
4	None	None	None	NA
5	None	None	*Slight Migration to Lower Floors.* <1% of concentration on floor sprayed	NA

Where migration was observed, levels were not in excess of the OELs on those floors.

** Post-spray results from attic indicated upward migration from 2nd floor.

Truck Trailer Results

Survey No.	Airborne SPF Compounds Identified in Truck Trailer			
	MDI	MDI Oligomers	Amine Catalysts	Blowing Agent
1	no	no	yes (11 ppb)	yes (1 ppm)
2	no	no	no	yes (31 ppm)
3	Yes (13 ug/m^3)	Yes (1 ug/m^3)	Yes (73 ppb)	na
4	no	no	no	na
5	no	no	no	na

Where identified, levels were well below the OELs.

POST-SPRAY SAMPLE RESULTS

POST-SPRAY SAMPLE RESULTS

MDI

62 non-detect
Two samples - 5 ug/m^3
(from two different surveys)

MDI Oligomers

All non-detect (64 samples)

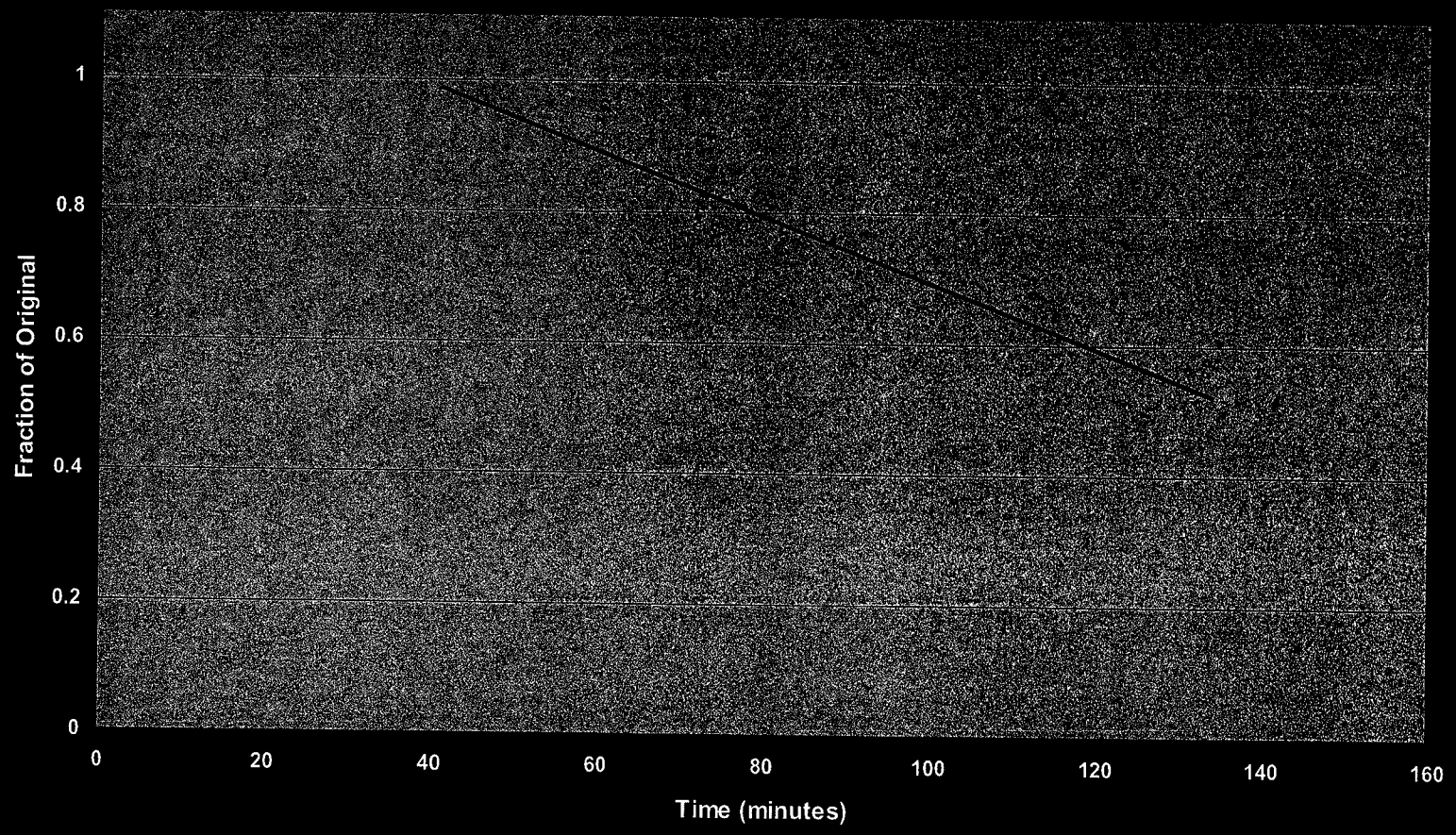
Amine Catalysts

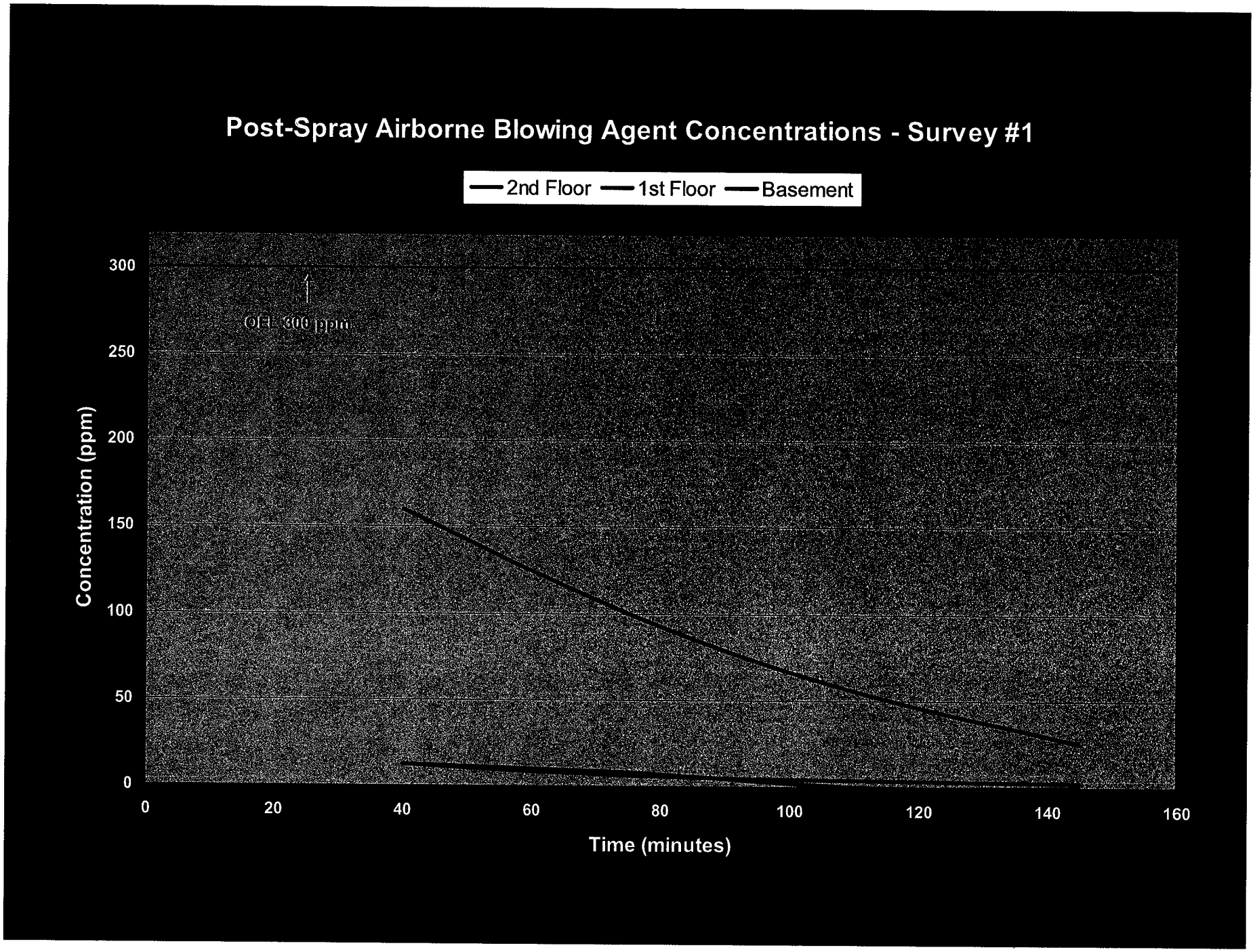
Identified in Survey #5 only

Blowing Agent

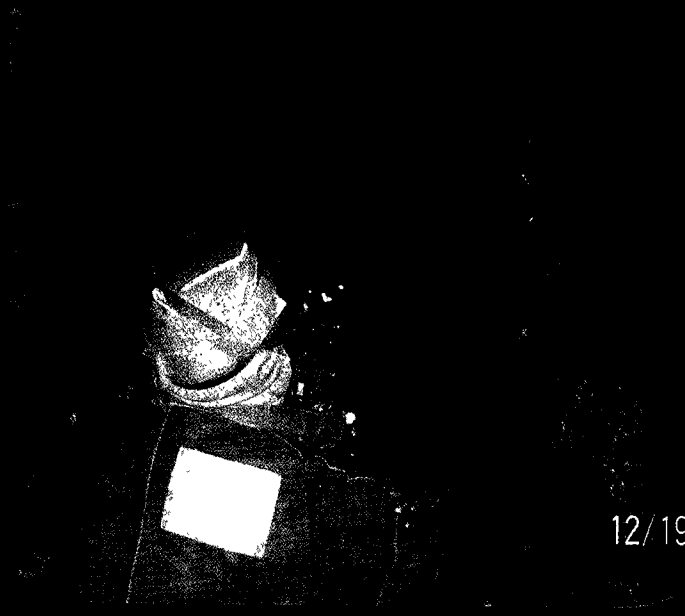
Identified in Survey #1

Post-Spray Relative Airborne Amine Catalyst Concentrations - Survey #5




Post-Spray Airborne Blowing Agent Concentrations - Survey #1
2nd Floor
1st Floor
Basement
OEL 300 ppm
Concentration (ppm)
300
250
200
150
100
50
0
0
20
40
60
80
100
120
140
160
Time (minutes)

PERSONAL PROTECTIVE EQUIPMENT



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PPE - APPLICATORS

Category of PPE	Types of PPE Observed
Respirator	Hood-type supplied air respirator
	Full-face supplied air respirator
	Half-face air purifying respirator (APR) with combination organic vapor/particulate cartridges
Eye Protection	Safety glasses with side shields (where full-face or hood-type respirators were not used)
Gloves	Fabric gloves
	Coated fabric gloves
Clothing	Disposable coveralls (Kleenguard®, Komfortguard®, Tyvek®)
	Disposable jacket (Komfortguard®)
	Street clothes only
Other	Fabric head/neck covering
	Disposable overboots
	Make-shift faceshield (overhead transparency material attached to head covering)

PPE - HELPERS

Category of PPE	Types of PPE Observed
Respirator	Half-face APR with combination organic vapor/particulate cartridges Half-face APR with organic vapor cartridges
Eye Protection	Safety glasses with side shields None
Gloves	Disposable nitrile gloves None
Clothing	Disposable coveralls (Komfortguard®) Street clothes only (short or long-sleeve shirts, pants or shorts, athletic shoes or boots)
Other	Disposable overboots Make-shift faceshield (overhead transparency material attached to a hardhat)

SUMMARY OF FINDINGS

- Airborne concentrations of MDI exceeded the 8-hour and short-term OELs for applicators for the majority of the surveys.

  Airborne concentrations of MDI exceeded the 8-hour OELs for helpers only when they conducted some amount of spraying during the work shift.

  Similar results were seen for MDI oligomers (when comparing against the MDI OEL).

- Airborne concentrations of blowing agent did not exceed the OEL for applicators or helpers.

- Airborne amine catalysts were identified for applicators and helpers. Variable concentrations - likely due to the different types and levels of catalysts in the SPF formulations, and differences in the specifics of the application/job site.

SUMMARY OF FINDINGS

- Airborne concentrations of MDI exceeded the 8-hour and short-term OELs at distances up to 20 feet from the applicator in some surveys.

  Similar results were seen for MDI oligomers (when comparing against the MDI OEL).

  The MDI concentrations generally displayed a decrease with distance.

- Airborne amine catalysts were identified at up to 30 feet from the applicator in some surveys.

  The concentrations generally did not display a particular trend with distance from the applicator.

SUMMARY OF FINDINGS

- Airborne blowing agent was identified at up to 30 feet from the applicator in both closed cell surveys, however the levels were not in excess of the OEL.

  The concentrations remained largely unchanged with distance from the applicator.

- Migration of airborne MDI, MDI oligomers, and amine catalysts to lower floors was observed in some surveys, however airborne concentrations were not in excess of the OELs on those floors where identified.

- Some upward and/or downward migration of blowing agent was observed in both closed cell surveys, however airborne concentrations were not in excess of the OEL on those floors where identified.

SUMMARY OF FINDINGS

- With two exceptions, airborne MDI was not detected in any post-spray sample, beginning as soon as 15 minutes following the completion of spraying.

  Where identified, the levels were an order of magnitude lower than the 8-hour OEL.

  Airborne MDI oligomers were not detected in any post-spray samples.

- Airborne blowing agent was identified in post-spray samples; concentrations generally declined with time, but blowing agent was still present in the final samples that were collected approximately 2.5 hours following the end of spraying.

  None of the samples exceeded the 8-hour OEL, however.

SUMMARY OF FINDINGS

- Airborne amine catalysts were identified in post-spray samples in only one of the five surveys; concentrations generally declined with time, but catalysts were still present in the final samples that were collected approximately 2.5 hours following the end of spraying.

  The types and levels of amine catalysts in the SPF formulation applied during this survey were different than the other surveys. Also, largest amount of foam applied per area.

- Low airborne concentrations of MDI, MDI oligomers, amine catalysts, and/or blowing agent were identified in the truck trailer in some surveys.

RECOMMENDATIONS

- Respiratory protection is required not only for the applicator, but also for helpers working on the same floor as the applicator.
- The following respiratory protection is recommended for both applicators and helpers.
  - A full-face or hood-type supplied air respirator operated in positive pressure or continuous flow mode.

RECOMMENDATIONS

- Respiratory protection is also recommended....
  - during trimming of SPF, which may release amine catalysts into the air,
  - during other post-spray activities in the area where sprayed to protect against residual airborne SPF compounds.
- The recommended full-face or hood-type supplied air respirators should provide adequate respiratory protection for most application environments, and should also protect the eyes from aerosols and vapors, particularly amine catalyst vapors, some of which can induce hazy/halo vision.

RECOMMENDATIONS

- For protection against accidental sprays of reacting foam, as well as contact with aerosols, the applicator should also wear...
  - a disposable coverall (e.g., Tyvek®, Kleenguard®) with attached hood; see-through materials provide less of a barrier
  - disposable boot covers
  - fabric gloves that are fully coated (front and back) in materials such as nitrile, neoprene, or butyl. The fabric component can provide some degree of thermal resistance, while the coating should prevent the reacting foam from penetrating to the skin
- Helpers working on the same floor as the applicator should wear the same personal protective clothing - boot covers may not be necessary.

RECOMMENDATIONS

- The equipment in the truck trailer, particularly the connection points, should regularly be checked and tightened/secured if necessary.

  Also, leaks should be promptly cleaned up. These measures should help reduce truck trailer airborne concentrations.

RECOMMENDATIONS

- Following installation of SPF, the structure should be ventilated, either by…
  - opening windows and/or doors on opposite sides of the structure, or
  - by placing fans in windows and/or doors to introduce air at one side of the structure and exhaust it at the other

Objective is to enhance the air exchange rate to flush the airborne SPF compounds from the space.

The amount of time that ventilation should be conducted will vary depending on the SPF formulation, size of the space, quantity of SPF installed, ventilation rate, air mixing, etc.