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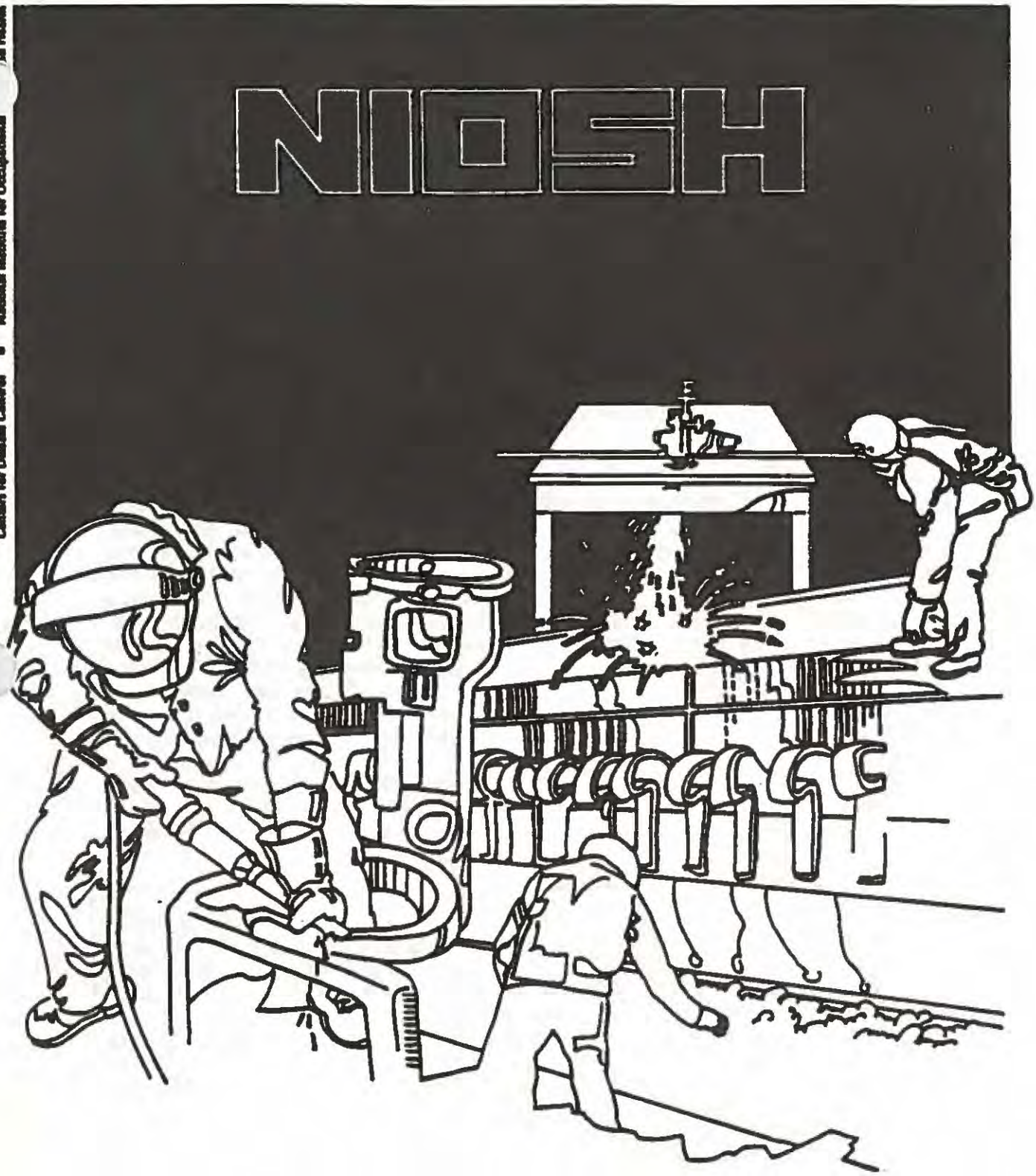

Health Hazard Evaluation Report

HETA 84-115-1493
MAINSTREET ENTERPRISES
LEBANON, INDIANA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 84-115-1493
JULY 1984
MAINSTREET ENTERPRISES
LEBANON, INDIANA

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I. SUMMARY

On January 31 to February 2, 1984, the National Institute for Occupational Safety and Health (NIOSH) conducted a field evaluation of a disposable respirator (3M 9910®) at Mainstreet Enterprises, Lebanon, Indiana. This survey was a follow-up to a completed study previously conducted by NIOSH (HETA 82-113-1374) at the facility in February 1982 and March 1983. As a result of the previous survey, NIOSH had concluded the primary airborne contaminant in the workplace was nuisance dust (airborne total particulate) and NIOSH recommended the use of respiratory protection at least during certain job operations.

During the follow-up respirator field evaluation, 22 pairs of personal breathing-zone air samples were collected from workers for approximately 6 hours each to measure their exposure to total airborne particulate. One sample from each pair was collected from inside a respirator and an inside concentration (C_i) was calculated. The other sample was collected from outside the respirator in the worker's breathing-zone and an outside concentration (C_o) was calculated. The workplace protection factor (WPF) for each pair of samples was calculated by dividing C_o by C_i. For the 22 pairs of samples, C_o ranged from 2.6 to 101.6 milligrams per cubic meter (mg/m^3), C_i ranged from 0.2 to 10.7 mg/m^3, and WPF ranged from 1.6 to 143.2 (geometric mean - 17.9). The NIOSH assigned protection factor for this class of respirator is 5.0.

Eight area samples were collected to measure airborne particle size distribution. The aerodynamic mass median diameter for these 8 samples ranged from 6.0 to 26.2 x 10^{-6} meters (um).

Based on these results, NIOSH concluded that airborne concentrations of total particulate at Mainstreet Enterprises were high outside of the respirator (C_o), but that disposable respirators (3M 9910®) were effective in reducing this exposure for workers. Of particular concern were the documented high short-term levels of outside respirator exposure during the post-shift clean-up operations, which for one worker was calculated to be 101.5 mg/m^3. Recommendations to reduce exposure are contained in Section VII of this report.

KEYWORDS: SIC 3273 (Ready-Mixed Concrete), 3241 (Portland Cement), 8331 (Sheltered Workshops), Total Nuisance Dust, Disposable Respirators, Workplace Protection Factor.

II. INTRODUCTION

In November 1983, the National Institute for Occupational Safety and Health (NIOSH), in cooperation with Mainstreet Enterprises, planned to evaluate at the Lebanon, Indiana facility a proposed respiratory protection program which included disposable respirators. NIOSH had previously conducted a health hazard evaluation (HETA 82-113-1374) at this facility in February 1982 and March 1983 to evaluate the occurrence of several cases of benign breast tumors among female staff members. This study revealed the primary contaminant of exposure is concrete dust which is generated in the process of mixing and packaging a dry, powdered concrete mortar mix (Fix-Crete®).

Based on this previous evaluation, NIOSH determined that there was no evidence linking the occurrence of cases of benign breast tumors to exposure to chemicals used in the manufacturing process. However, because certain job tasks and areas were found to have high levels of total airborne particulate (concentrations ranging from 1.7 to 34.3 milligrams per cubic meter (mg/m^3), the NIOSH investigators recommended the implementation of engineering controls and the use of respiratory protection.

To determine the effectiveness in reducing total particulate exposure, NIOSH investigators conducted a field evaluation of a disposable respirator (3M 9910®) in February 1984 on workers in the Fix-Crete® operation. The 3M 9910® disposable respirator was selected for evaluation because it was believed to provide better protection than the non-NIOSH-certified respirator used by some workers before the evaluation and because the respirator was substantial enough to accommodate the sampling equipment.

III. BACKGROUND

Mainstreet Enterprises is a non-profit rehabilitation sheltered workshop and is part of Disabilities Services, Inc. serving Boone, Montgomery, and Clinton counties in Indiana. It began operations in 1971, and its main function is the occupational rehabilitation of physically and mentally handicapped individuals. The rehabilitees are usually referred from State hospitals or the Department of Mental Health.

Seven supervisory staff members are currently employed to oversee the rehabilitee's activities. These activities include the production and packaging of Fix-Crete® from several ingredients including Portland cement, iron powder, gypsum, sodium and ammonium chloride, and a detergent. A mechanical hopper is used to mix these powdered ingredients, and as many as a dozen rehabilitees may be involved in the process. The staff members take turns supervising this particular activity. The Fix-Crete® process is the only one in the facility where chemicals are handled.

The process was started on a small scale in 1971. After November 1976, when Mainstreet Enterprises moved to its present location, production of Fix-Crete® was increased. A maximum of just over 3000 pounds of Fix-Crete® can be produced in several batches during any workday. Some 30 other rehabilitees work in a separate area sorting and packing books, fitting metal components, and doing other light assembly work. This work does not involve any direct exposure to or contact with chemicals.

IV. EVALUATION DESIGN AND METHODS

During the field evaluation conducted on January 31 to February 2, 1984, a total of 52 personal breathing-zone air samples were collected from personnel in the Fix-Crete® process area. These 52 samples were taken in pairs, for a total of 26 pairs collected from 7 different workers and 2 NIOSH industrial hygienists. Each sample pair for an individual consisted of one sample collected inside the worker's probed 3M 9910® disposable respirator and one breathing-zone lapel sample. All air samples were collected during the six-hour workshift using pre-weighed polyvinyl chloride (PVC) filters at a flowrate of 2.0 liters per minute (lpm). The samples were turned off during lunch and rest breaks. The filter media were post-weighed and, for each pair of samples, total particulate air concentrations were calculated for the inside (C_i) and outside (C_o) respirator environment. For each pair of concentrations, a work-place protection factor (WPF) was calculated by dividing C_o by C_i. WPF has been defined[1] by NIOSH as a measure of the actual protection provided by a respirator only when the respirator is properly worn and used during normal work activities.

A total of 8 area samples for particle size distribution were collected at a flowrate of 2.0 lpm in 3 locations of the Fix-Crete® work area using six-stage Marple® impaction samplers. The 3 sample locations were: 1) in the distant corner of the large Fix-Crete® mixing room, 2) next to a small mixing machine, and 3) on the Fix-Crete® packaging table. For the 8 area samples, 3 were collected in location 1, 3 were collected in location 2, and 2 were collected in location 3.

V. EVALUATION CRITERIA

Environmental Criteria and Toxicological Effects

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is, however, important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

The primary sources of environmental evaluation criteria for the workplace are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLV's), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV's usually are based on more recent information than are the OSHA standards. The OSHA standards also may be required to take into account the feasibility of controlling exposures in various industries where the agents are used; the NIOSH-recommended standards, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet only those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8-to-10 hour workday. Some substances have recommended short-term exposure limits or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Particulates and Respirable Dusts

In contrast to fibrogenic dusts which, when inhaled in excessive amounts, cause scar tissue to be formed in the lungs, so-called "nuisance" dusts are stated to have little adverse effect on lungs and do not produce significant organic disease or toxic effects when exposures are kept under reasonable control. The "nuisance" dusts have

also been called (biologically) "inert" dusts, but the latter term is inappropriate to the extent that there is no dust which does not evoke some cellular response in the lung when inhaled in sufficient amount. However, the lung tissue reaction caused by inhalation of "nuisance dusts" has the following characteristics: 1) the architecture of the air spaces remains intact, 2) collagen (scar tissue) is not formed to a significant extent; and 3) the tissue reaction is potentially reversible.

Excessive concentrations of dusts in the workroom air may seriously reduce visibility, may cause irritation of the eyes, ears, and nasal passages or cause injury to the skin or mucous membranes by chemical or mechanical action per se or by the rigorous skin cleansing procedures necessary for their removal.

Respirable dusts, called such due to their size characteristics and ability to be inhaled, include particulates with more restrictive size range parameters than total nuisance dusts. In general, particulates between 0.5 and about 5 microns in size are deposited in the alveoli and respiratory bronchioles and some types of dust of such sizes can cause pulmonary fibrosis. Most of the particles five microns and larger are collected in the upper respiratory passages. Like nuisance dusts, the overall effects of respirable particulates are dependent on their site of deposition and on their toxic and antigenic properties.

By weight, the primary constituent of Fix-Crete® is Portland cement. Toxicologically, ACGIH considers Portland cement to be a nuisance dust. Listed below are the evaluation criteria for nuisance dust (total particulate).

	NIOSH	ACGIH	OSHA
8-Hour TWA Exposure Limit	--	10 mg/m^3	15 mg/m^3

VI. RESULTS

A total of 26 pairs of total particulate air samples were collected during the January 31 to February 2, 1984 study for the 6-hour workshift. Nineteen pairs of samples were collected on 7 workers and 4 pairs were collected on 2 industrial hygienists. The remaining 3 pairs of samples were collected on 3 workers during a short (15-20 minute), post-shift, dry-sweeping clean-up operation.

For the 19 pairs of samples from the 7 workers (Table I), the outside respirator concentration (C_o) ranged from 2.6 to 52.6 mg/m^3 and the inside respirator concentration (C_i) ranged from 0.2 to 7.5 mg/m^3. The ACGIH environmental exposure limit for total particulates is 10 mg/m^3. The corresponding workplace protection factor (WPF = C_o/C_i) for these 19 pairs of samples ranged from 1.6 to 143.2 (geometric mean - 17.9). For the 4 pairs of samples from the 2 industrial hygienists, C_o ranged from 4.0 to 7.6 mg/m^3, C_i ranged from 0.3 to 1.1 mg/m^3, and WPF ranged from 4.2 to 23.1 (geometric mean - 9.5). For the 3 pairs of samples collected during the clean-up operation, C_o ranged from 44.4 to 101.6 mg/m^3, C_i ranged from 2.7 to 10.7 mg/m^3, and WPF ranged from 5.9 to 16.8 (geometric mean - 8.5).

For the 3 area particle size samples (Table II) collected in location 1 (distant corner of room), the aerodynamic mass median diameter (AMMD) of the particles ranged from 7.3 to 8.9 x 10^{-6} meters (um). For the 3 samples collected in location 2 (near small mixer) the AMMD ranged from 6.0 to 10.4 um. For the 2 samples collected in location 3 (packaging table), the AMMD ranged from 15.3 to 26.2 um.

VII. DISCUSSION AND RECOMMENDATIONS

High levels of total airborne particulate exposure were documented during the 3 day survey. In fact, of the 22 outside respirator sample concentrations (C_o) collected from the 7 employees, 17 (77%) exceeded the ACGIH 10 mg/m^3 exposure limit for total particulates. However, of the 19 sample concentrations collected from inside (C_i) the respirator for the 6-hour workshift, none exceeded this exposure limit. Of the 3 inside respirator sample concentrations collected from workers during the short clean-up operation, one (10.71 mg/m^3) exceeded the ACGIH 10 mg/m^3 exposure limit for nuisance dust.

From the respirator evaluation data, the 3M 9910® disposable respirator appears to be effective in reducing worker exposure to total airborne particulate. For the 19 full-shift samples collected from workers, the geometric mean WPF was 17.9. That is, the airborne level of total particulate exposure for workers was reduced by a mean factor of 17.9. This mean WPF exceeds the NIOSH assigned protection factor of 5.0 for disposable respirators. However, the high levels of outside respirator particulate concentration emphasize the need for improved engineering controls (ventilation) and work practices. In this regard, a team of NIOSH engineers has agreed to evaluate the Fix-Crete® mixing and bagging operation and to provide recommendations for engineering controls. Also, during the post-shift clean-up operation, a high efficiency particulate (HEPA) filter vacuum system should be used to reduce total particulate exposure.

An optional dust control strategy would consist of a combination of good work practices (detailed in HETA 82-113-1374), engineering controls, and protective equipment, including respirators. When the former 2 elements of the strategy have been satisfactorily implemented, respiratory protection might not be required or might be required only during high exposure operations such as the post-shift clean-up.

VIII. REFERENCES

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1. Mainstreet Enterprises
2. NIOSH, Region V
3. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

Total Particulate Concentrations and Workplace Protection Factor
For Personal Samples

Mainstreet Enterprises
Lebanon, Indiana
HETA 84-115

January 31 - February 2, 1984

b Classification	Sample Duration	Total Particulate Concentration (mg/m^3) Outside Respirator (C_o)	Inside Respirator (C_i)	Workplace Protection Factor ($WPF = C_o/C_i$)
Worker	Day 1 (January 31)			
#1	9:40-10:57, 12:25-14:35	23.02	1.93	11.93
#2	10:15-10:55, 12:04-14:58	10.93	0.26	42.04
#3	9:30-10:56, 12:07-15:08	11.86	7.48	1.59
#4	9:10-10:55, 12:13-14:54	39.87	1.17	34.08
#5	9:45-10:55, 12:09-15:03	2.60	0.33	7.88
#6	10:00-10:58, 12:06-14:55	8.35	0.37	22.57
dustrial Hygienist				
#1	9:35-10:55, 12:17-15:06	3.96	0.90	4.40
Worker	Day 2 (February 1)			
#1	8:57-10:30, 10:45-11:00 12:09-14:35	27.42	4.07	6.74
#2	9:42-10:30, 10:45-11:00 12:12-13:30, 13:50-15:28	18.39	0.50	36.78
#3	9:10-10:30, 10:45-11:00 12:12-13:30, 13:50-15:26	23.29	0.69	33.75
#4	9:12-10:30, 10:45-11:00 12:15-13:17	52.58	1.06	49.60

Continued

TABLE I

Continued

Job Classification	Sample Duration	Total Particulate Concentration (mg/m^3) Outside Respirator (C_o)	Inside Respirator (C_i)	Workplace Protection Factor (WPF = C_o/C_i)
Worker	Day 2 (February 1)			
#5	9:24-10:30, 10:45-11:00 12:07-13:30, 13:50-14:52	3.47	0.29	11.97
#6	8:59-10:30, 10:45-11:00 12:10-13:30, 13:50-14:27	11.55	2.38	4.85
#7	9:20-10:30, 10:45-11:00 12:05-13:30, 13:50-15:24	15.81	0.44	35.93
Industrial Hygienist				
#1	10:05-10:30, 10:45-11:00 12:16-13:30, 13:50-14:35	4.59	1.10	4.17
#2	12:20-13:30, 13:50-14:10	7.61	0.33	23.06
Worker	Day 3 (February 2)			
#2	9:35-10:33, 10:51-12:00 12:28-13:35, 14:03-14:55	37.64	0.51	73.80
#3	9:11-10:32, 10:51-11:58 12:27-13:33, 14:00-15:04	15.86	1.52	8.26
#4	9:09-10:31, 10:51-11:55 12:30-13:36, 13:56-14:42	44.40	0.31	143.23
#5	9:26-10:33, 10:51-11:55 12:31-13:32, 14:02-14:48	6.26	1.41	4.44
#6	9:24-10:33, 10:51-11:58 12:27-13:33, 14:04-14:58	11.72	1.25	9.38
#7	9:18-10:32, 10:51-11:59 12:33-13:35, 14:00-14:33	8.88	0.21	42.29

TABLE I

Continued

ɔb Classification	Sample Duration	Total Particulate Concentration (mg/m^3) Outside Respirator (C_o)	Inside Respirator (C_i)	Workplace Protection Factor ($WPF = C_o/C_i$)
ıort-term Clean-up				
#2	14:56-15:15	101.58	6.05	16.79
#3	15:03-15:16	63.57	10.71	5.94
#6	14:59-15:16	44.41	2.65	16.76

TABLE II

Particle Size Distribution and Total Particulate Concentration
for Area Samples

Mainstreet Enterprises
Lebanon, Indiana
HETA 84-115

Sample Location	Day	Sample Duration	Aerodynamic Mass Median Diameter (AMMD) x 10^{-6} meters (um)	Total Particulate Concentration (mg/m^3)
1	January 31	12:15-14:23	8.78	3.63
	February 1	9:19-10:30	7.33	3.55
	February 2	9:47-10:37	7.83	4.0
2	January 31	12:16-13:57	5.97	1.9
	February 1	9:18-10:29	10.05	3.26
	February 2	9:46-10:39	10.35	5.61
3	February 1	9:59-10:32	15.30	10.44
	February 2	12:15-13:36	26.24	23.0

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