

HETA 89-348-2295  
SNOMAX  
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## I. SUMMARY

In September 1989, the National Institute for Occupational Safety and Health (NIOSH) received a technical assistance request from the United States Forest Service to investigate potential respiratory health problems among workers involved in snowmaking operations using an ice nucleation product containing endotoxins, Snomax<sup>TM</sup>. In January 1990, NIOSH investigators conducted a medical survey at the Red River Ski Area, Red River, New Mexico. Industrial hygiene surveys, scheduled for this same time, were canceled due to the termination of snowmaking operations following heavy January snows. On July 27, 1990, an interim report was completed to provide preliminary results from the medical survey. In November 1990, industrial hygiene surveys were completed at Red River Ski Area early in the 1990/91 snowmaking season.

Industrial hygiene samples were collected over a 3-day period to assess occupational exposures to airborne dusts, viable Gram-negative bacteria, and endotoxins. The medical survey included the administration of a respiratory symptoms questionnaire to ski area workers.

Viable Pseudomonas syringae, the bacteria used in Snomax<sup>TM</sup>, were not identified in any of the air, snow, or water samples collected during this evaluation; although, other Gram-negative bacteria were identified in some samples. The biological activity of endotoxins is not dependent of the viability of Gram-negative bacteria. Endotoxins were detected in samples of snow, snowmaking water, and in airborne dust samples. Total, inhalable, and respirable dust samples were taken. The highest endotoxin concentrations were measured in direct snow plumes from snowmaking; concentrations ranged from below detectable levels to a high of 2600 endotoxin units per cubic meter of air (EU/m<sup>3</sup>). Personal exposures to endotoxins among workers directly involved in snowmaking ranged from 1 EU/m<sup>3</sup> to 92 EU/m<sup>3</sup>. The seven samples from these workers had a mean concentration of 20 EU/m<sup>3</sup> with a standard deviation of 33.1. At present, there are no established occupational exposure standards for endotoxins. The average personal endotoxin exposures measured during snowmaking did not exceed estimated threshold exposure limits derived from human exposure studies using endotoxin containing cotton dusts, 90 EU/m<sup>3</sup>. The personal exposure for one of the workers involved in snowmaking was high by comparison to this estimated exposure threshold. Some of the area endotoxin concentrations measured from stationary samples placed directly in the snow plume during snowmaking were substantially higher than the personal exposures and present the potential for higher exposures.

The symptoms frequently associated with endotoxin exposure (cough, fever, wheeze, shortness of breath, and chest tightness) were not significantly more prevalent among workers in the high exposure job categories. Although, the small numbers of workers in the high exposure category (8), involved in snowmaking, reduces the possibility of detecting occupational health problems related to snowmaking and endotoxin exposures.

On the basis of data obtained during this evaluation, workers at Red River Ski Area are exposed to endotoxins during snowmaking operations; however, mean exposures among workers in the high exposure category were below estimated human threshold levels based on existing human exposure response research. No significant respiratory health effects were identified among workers at this ski area using questionnaire studies.

Keywords: SIC 3585, Snowmaking, Endotoxins, Respiratory Symptoms, Gram- negative bacteria.

## II. INTRODUCTION

In September 1989, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health (NIOSH) received a technical assistance request from the United States Forest Service to investigate potential respiratory health problems among workers involved in snowmaking operations using an ice nucleation product, Snomax™. This snowmaking product, comprised of an endotoxin producing bacteria, was used in snowmaking operations at several commercial ski areas located on forest service lands. The Red River Ski Area, in Red River, New Mexico, was selected by the forest service as a study site. In January 1990, NIOSH investigators conducted a medical survey at the Red River Ski Area; a respiratory symptoms questionnaire was administered to ski area workers. Industrial hygiene surveys, scheduled for this same time, were canceled due to the termination of snowmaking operations following heavy January snows. On July 27, 1990, an interim report was completed to provide preliminary results from the medical survey. In November of 1990, industrial hygiene surveys were completed at Red River Ski Area early in the snowmaking season.

## III. BACKGROUND

Snomax™ is a material used in the production of artificial snow; it allows snow to form at slightly warmer temperatures than otherwise possible through its ice nucleation ability. Snomax™ is a freeze-dried preparation of the natural, Gram-negative bacteria Pseudomonas syringae grown in large fermenters, freeze-dried, and then sterilized by radiation.<sup>(1)</sup> Snomax™ (in pellet form) is mixed with water from a local pond to form a slurry. This slurry is then pumped through hoses to both portable and stationary snow guns. The Snomax™ slurry is aerosolized through snow guns positioned about the snow skiing area to accomplish snowmaking.

Snowmaking is a seasonal activity normally starting in early to mid-November and continuing until January or February depending on natural snowfall. Snowmaking operations are done at Red River Ski Area only during the night; no snow is made when skiers are present, as the snowmaking equipment can not run simultaneously with the ski lifts. The number of nights Snomax™ is used during the snowmaking season is variable depending on ambient temperatures and snow conditions. Snomax™ is used more frequently early in the snow season, during the months of November and December, to establish a good snow base. Ski area employees exposed directly to snowmaking (or Snomax™) would include workers in the snowmaking, slope maintenance, maintenance, and mountain manager job categories. Employees in other job categories do not normally have direct contact with snowmaking or Snomax™ in concentrated form.

Gram-negative bacteria, like those in the product Snomax, contain lipopolysaccharide substances within the cell wall referred to as endotoxins. The inhalation of endotoxins can induce a variety of biological responses including inflammatory, immunological, and hemodynamic activity. Illnesses possibly associated with endotoxin exposure include byssinosis, hypersensitivity pneumonitis, asthma, and humidifier fever.<sup>(2,3)</sup>

## IV. METHODS

Snomax™ is comprised of the Gram-negative, endotoxin producing bacteria P. syringae; consequently, the focus of this evaluation was directed towards evaluating exposures to Gram-negative bacteria, endotoxins, and related respiratory health effects among ski area workers. This study included both a medical questionnaire survey of workers and an industrial hygiene survey of bioaerosol exposures related to the use of P. Syringae during snowmaking.

## A. Medical

A list of all Red River employees from January 1, 1989 through the date of the medical survey (January 1990) was obtained from ski area management. Management did not have a current roster of employees; consequently, each department head at the ski area was asked to note the employees on the master list who had not worked during the present season. These individuals were removed from the list and the remaining were considered to be current employees. Some of the persons classified as current employees were not full-time employees and worked only an occasional weekend or during holiday periods. A medical questionnaire was administered to all available employees at Red River Ski Area over a four day period, January 28 to February 1, 1990. The questionnaire was designed to obtain information on each worker's age, race, gender, work history, smoking history, and prevalence of respiratory and systemic health symptoms. The questionnaire is attached as Appendix I.

## B. Industrial Hygiene

Industrial hygiene samples were taken to assess occupational exposures to airborne dusts, endotoxins, and Gram-negative bacteria generated during snowmaking operations using Snomax<sup>TM</sup>. These samples were collected during three separate nights of snowmaking with Snomax<sup>TM</sup>, November 13 to 15, 1990. Total, respirable and inhalable inlet samples were collected to measure particulate and endotoxin concentrations in air. Viable Gram-negative bacteria were measured in airborne total dusts, snow, and water samples. Table 1 provides detail on the industrial hygiene sampling methods used during this evaluation.

The filters from air samples for viable Gram-negative bacteria were plated directly onto MacConkey and EMB agars. Both of these media selectively inhibit Gram-positive bacteria. Bulk snow and water samples were tested by serial dilution plating on the same agars. Representative colonies were isolated, purified and tested using the Microlog system for environmental Gram-negative bacteria. This system uses 96-well tissue culture plates (by means of specific redox chemistry) to test the ability of each isolate to oxidize 95 different compounds. The pattern of utilization is compared with a database (containing over 434 species/groups) and identifications are done by a computer-based pattern recognition program. All isolates studied were compared with the pattern for Pseudomonas syringae using the Biolog system (Biolog, Inc. Hayward, CA).<sup>(9)</sup>

Both personal and area samples were collected to measure airborne concentrations of dust, endotoxins, and viable Gram-negative bacteria. Personal samples were collected by attaching a sampling pump to a worker and positioning the sampling inlet orifice in the breathing zone. All employees involved in the night snowmaking operations were sampled during the three shifts of snowmaking. Area samples were placed in sampling baskets positioned at various sampling stations during snowmaking; these sampling stations included:

1. Snomax<sup>TM</sup> mixing tank area
2. Ambient sampling stations in snow gun plume
3. Ambient area stations outside snow gun plume
4. Background station.

Bulk water and snow samples were also collected from various locations at the resort and analyzed for Gram-negative bacteria and endotoxins.

## V. EVALUATION CRITERIA

Evaluation criteria are used as guidelines to assess the potential health effects of occupational exposures to substances and conditions found in the work. These criteria consist of exposure levels for substances and conditions to which most workers can be exposed day after day for a working lifetime without adverse health effects. They are derived from industrial experience, from human and animal studies, and when possible, from a combination of these three. Several sources of environmental evaluation criteria exist and are commonly used by NIOSH investigators to assess occupational exposures. These include:

1. The United States Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL's);<sup>(10)</sup>
2. The American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV's);<sup>(11)</sup>
3. NIOSH Recommended Exposure Limits (REL's).<sup>(12)</sup>

At present, There are no OSHA, ACGIH, or NIOSH standards/criteria for P. syringae, Gram-negative bacteria, or the endotoxins produced from these bacteria. Consequently, the measurements taken during this evaluation are assessed by comparison to studies describing exposures and health consequences in other occupational settings.

## VI. RESULTS AND DISCUSSION

Viable Gram-negative bacteria were detected in the snow and water samples collected at Red River Ski Area, however, Pseudomonas syringae, the bacteria in Snomax<sup>TM</sup>, was not detected in any of these samples (Table 2). Gram-negative bacterial concentrations were highest in the concentrate tank slurry of Snomax<sup>TM</sup> and water,  $1.4 \times 10^5$  colony forming units per milliliter of water (CFU/ml). Concentrations of Gram-negative bacteria in the snow and snow gun water samples ranged from  $1.1 \times 10^3$  to  $5.5 \times 10^4$  CFU/ml. Gram-negative bacteria were detected in the pond water used for snowmaking ( $5.7 \times 10^2$  CFU/ml) suggesting one possible source of viable bacterial organisms. A background snow sample collected on National forest land west of Red River, New Mexico, contained Gram-negative bacteria at a concentration of  $6.0 \times 10^1$ . Table 2 lists the predominant species of bacteria identified in these samples.

Viable Gram-negative bacteria were detected in all 3 airborne samples taken on three separate nights of snowmaking (Table 3). Concentrations of bacteria ranged from 3.11 to 467 colony forming units per cubic meter of air (CFU/m<sup>3</sup>). The air sample collected during the first night of sampling (11/13/92) had the highest concentration of Gram-negative bacteria, 467 CFU/m<sup>3</sup>. Currently, there are no occupational exposure criteria to assess exposures to Gram-negative bacteria in air, however, these bacterial concentrations are lower than those commonly found in many agricultural workplaces.<sup>(13)</sup>

Endotoxin concentrations from bulk snow and water samples are presented in Table 4. The highest endotoxin concentration was detected in the bulk water sample from the Snomax<sup>TM</sup> concentrate tank,  $1.1 \times 10^7$  endotoxin units per milliliter of concentrate solution (EU/ml). This tank contained a concentrated mixture of Snomax<sup>TM</sup> and water; the concentrate from this tank is diluted with pond water and distributed to the snow guns for snowmaking. Samples collected from the water lines to the snow guns had a lower concentration of endotoxin with an average of approximately 40 EU/ml. The endotoxin concentration in 4 bulk snow samples collected during snowmaking ranged from 46.8 EU/ml to 92.5 EU/ml. Endotoxin was detected in the water from a local pond used as a source of snowmaking

water; the endotoxin concentration from this pond sample was 7.47 EU/ml. A background snow sample had an endotoxin concentration of 11.1 EU/ml.

Airborne dust samples, total, inhalable, and respirable, were below quantifiable levels in almost all samples analyzed gravimetrically; consequently, these results are not presented in tabular form in the report. The limit of quantification for these dust samples was approximately 0.01 milligrams of dust per sample. The majority of airborne particulate consisted of frozen water that melted shortly after collection.

Endotoxin was present at quantifiable levels in some of the total inhalable and respirable dust samples. Endotoxin concentrations in the area inhalable inlet samples are presented in Table 5. Endotoxin concentrations in the inhalable inlet samples ranged from below analytical detection limits (approximately 0.8 EU/m<sup>3</sup>) to a high of 2600 EU/m<sup>3</sup>. Concentrations were the highest in those samples placed directly in the snow plume. The inhalable dust samples collected within the snow plume on November 13 were higher on average than other sampling nights. This may have resulted from positioning some of the sampling stations very close, approximately 50 feet, to the snow guns during the first several hours of sampling; these sampling stations were repositioned to new locations within the snow plume but further from the snow guns due to snow accumulation on the sampling equipment. The average concentration of endotoxin measured in 12 inhalable inlet samples positioned at various locations directly in the snow plume was 357 EU/m<sup>3</sup> with a standard deviation of 748. The average concentration from the two inhalable inlet samples collected inside the maintenance area near the Snomax<sup>TM</sup> mixing was 5.1 EU/m<sup>3</sup>. The average endotoxin concentrations in the 3 general area samples collected outside the direct snow plume were consistent with background concentrations.

Endotoxins were detected in only one of the 11 respirable dust samples (Table 6). This sample was collected in the maintenance area near the bulk Snomax<sup>TM</sup> mixing tank. None of the respirable dust samples from the snow plume contained detectable endotoxins; this may be attributable to the large (nonrespirable) size of most frozen snow flakes containing the endotoxin particles.

Endotoxin concentrations were detected in 6 of the 12 total dust samples at concentrations ranging from ND to 0.77 EU/m<sup>3</sup> (Table 7). The endotoxin concentrations collected in the snow gun plume areas were not substantially different than those samples collected outside the plume. The endotoxin concentrations in the total dust samples were considerably lower than those collected using the inhalable inlet. This may be a result in sampling inlet orientation. Both sampling trains used an open-face inlet; however, the total dust sampling inlets were arranged in a downward position during sampling. The inhalable inlets were arranged in a horizontal position relative to the ground and direction of snow generation. A different brand of copolymer membrane filter was used for total dust sampling versus the inhalable and respirable dust sampling.

Personal exposures to endotoxins were measured on all workers involved in snowmaking operations on the nights of November 13 to 15, 1990. The job category of the workers sampled was snowmaking; workers in these job categories were all involved in snowmaking during the work shifts sampled. These workers would be classified in the high exposure categories having direct exposure to snowmaking operations. Workers in other job categories were unavailable for sampling since the industrial hygiene survey was done during the pre-season snowmaking operations and the ski resort was closed to skiing. Seven personal exposure measurements were collected over a three day period as indicated in Table 8. Exposures ranged from 1 EU/m<sup>3</sup> to a high of 92.9 EU/m<sup>3</sup>. The highest personal exposure was measured on a worker involved in positioning snowguns on the mountain; this worker also poured the Snomax<sup>TM</sup> into the concentrate tank during this snowmaking shift. These activities were similar to activities performed by other workers in the snowmaking job category. The seven workers involved in snowmaking operations over this three night period had a mean endotoxin exposure of 20 EU/m<sup>3</sup> with a standard deviation of 33.1. The personal endotoxin exposures were lower than some of the concentrations measured directly in the

snow plume at the area sampling stations. The resort workers engaged in snowmaking did not spend much time directly in the snow plume.

The inhalation of endotoxins can induce a variety of biological responses including inflammatory, immunological, and hemodynamic activity. The pulmonary macrophage is extremely sensitive to the effects of endotoxins and a primary target cell for endotoxin induced pulmonary injury following exposure. Exposures to endotoxins have been reported to cause acute fever, dyspnea, chest tightness, coughing, and decreases in pulmonary function. Illnesses possibly associated with endotoxin exposure include byssinosis, hypersensitivity pneumonitis, asthma, and humidifier fever.<sup>(2,3)</sup> There are no OSHA, ACGIH, or NIOSH standards/criteria for occupational airborne endotoxin exposure as noted earlier in this report. The scientific literature contains research describing human threshold exposure limits for endotoxins. The lowest endotoxin exposure level reported to cause adverse pulmonary response was measured in exposure studies among subjects sensitive to cotton dusts, 9 nanograms of elutriated endotoxin per cubic meter of air ( $\text{ng}/\text{m}^3$ );<sup>(14)</sup> this concentration is equivalent to approximately 90 EU/ $\text{m}^3$ . Threshold endotoxin exposures among healthy human subjects exposed to cotton dusts are reported by Rylander as approximately 1000 to 2000 EU/ $\text{m}^3$  for an across shift acute pulmonary response (decline in FEV<sub>1</sub>) and 5000 to 10,000 EU/ $\text{m}^3$  for fever.<sup>(3,15)</sup>

A questionnaire survey was completed to assess potential occupational health problems related to Snomax™ among resort employees.

A master employee list contained 267 names, of whom 147 were considered current ski area employees, although, the number of currently working employees was probably less. We completed 59 surveys, including 5/8 (62%) of eligible employees in the high exposure category, 18/45 (40%) in the low exposure category and 36/94 (38.3%) in the medium exposure category. The population was, in general, young and healthy. Although many symptoms were reported, these were frequently short lived, often related to a "cold", and not related to work.

Symptoms most frequently associated with endotoxin exposure (cough, fever, wheeze, shortness of breath, chest tightness) did not seem to be significantly more prevalent in the high or medium exposure group compared to the low exposure group (Table 9).

This symptom prevalence table is complicated since the medium exposure group is very physically active and is required to work outside in all types of weather. This might account for an increased prevalence of some symptoms in this group.

These survey data do not support a significant endotoxin exposure effect on the employees of this ski resort, although, there are some potential biases. We found a high employee turnover and could postulate that people with high exposures were leaving because of medical problems. This seems unlikely, however, as the turnover rate was similar in the low (51%), medium (43%), and high (43%) exposure categories. Another possibility is that the use of this product caused minor symptoms that were trivialized or attributed to something else, such as the weather or an upper respiratory tract infection.

In reality, the chance for exposure to endotoxin in our "medium exposure" category is probably negligible and both the medium and low exposure categories could be collapsed into one. If this were done, the low exposure category would exceed the high exposure category in the prevalence of all symptoms except fever.

Another problem is the small size of the "high exposure" group and the infrequent, seasonal use of Snomax™ at this resort. If only a small percentage of individuals are sensitive to inhaled endotoxin, we might not see a significant effect in this group of five nor a sensitization effect if workers had only occasional

intermittent exposures.

## VII. CONCLUSIONS

Workers at this ski resort are exposed to endotoxins during snowmaking operations with the ice nucleating product Snomax™. Viable Pseudomonas syringae, the bacteria used in Snomax™, were not identified in any of the air, snow or water samples collected during this evaluation; although other Gram-negative bacteria were identified in some samples. At present, there are no established occupational exposure standards or criteria for endotoxins. Average personal endotoxin exposures measured during snowmaking did not exceed the estimated threshold exposure limits derived from human exposure studies using endotoxin containing cotton dusts. One of the seven personal samples collected from workers involved in snowmaking (92 EU/m<sup>3</sup>) was high by comparison to the estimated threshold reported among sensitized workers exposed to cotton dusts containing endotoxins. This threshold is 90 EU/m<sup>3</sup>. Some of the endotoxin concentrations measured from area samples placed directly in the snow plume during snowmaking were substantially higher than the personal exposures and present the potential for higher exposures. Significant respiratory health effects were not identified among workers at this ski area using questionnaire studies. Although, the small numbers of workers in the high exposure category (8), involved in snowmaking, reduces the possibility of detecting any occupational health problems related to endotoxin exposures.

## VIII. RECOMMENDATIONS

1. Workers handling or mixing dry Snomax™ materials should use respiratory protection to prevent exposures to a concentrated endotoxin source. These respirators should be used as a part of a formal respiratory protection program including standard operating procedures for respirator use, training, fit testing, maintenance, and storage. The program should comply with the OSHA General Industry Occupational Safety and Health Standards, 29 CFR 1910.134.
2. Workers involved in snowmaking operations should minimize the time spent in direct snow plumes during snowmaking with Snomax™.

## IX. REFERENCES

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TABLE 1  
SNOMAX™  
Red River Ski Area  
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Industrial Hygiene Sampling Methods

Analyte	Sampler	Media	Sampling Rate	Sampling Time	Location <sup>1</sup>	Sample Analyses
Dusts and Endotoxins	Inspirable Inlet	Copolymer Membrane Filter (25 mm)	2.01 lpm	3 to 11 hours	P & A	1. Gravimetric <sup>(4,5)</sup> 2. Chromogenic Limulus Amebocyte Lysate (LAL) test for endotoxin <sup>(6)</sup>
	Respirable Cyclone (RD)	Copolymer Membrane Filter (37 mm)	1.7 lpm	2.5 to 7.5 hours	A	1. Gravimetric <sup>(4,7)</sup> 2. Chromogenic Limulus Amebocyte Lysate (LAL) test for endotoxin <sup>(6)</sup>
	Total dust cassette	Copolymer Membrane Filter (37 mm)	5-6 lpm	1.5 to 6 hours	A	1. Gravimetric <sup>(4,7)</sup> 2. LAL test <sup>(6)</sup>
	Total dust cassette (High volume)	Copolymer Membrane Filter (37 mm)	16-20 lpm	1.5 to 6 hours	A	1. Gravimetric <sup>(4,7)</sup> 2. LAL test <sup>(6)</sup> 3. Bacterial growth and enumeration (nutrient agar) <sup>(8)</sup>
Bulk endotoxins	Pyrogen Free Polypropylene container	—	—	—	A	1. LAL test on Snomax™, Snomax™ slurry, snow, or water <sup>(6)</sup>
Viable bacteria (bulk materials Snomax™, Snomax™ slurry, snow, and Facility water)	Sterile polypropylene container	—	—	—	A	1. Growth and enumeration on nutrient agar <sup>(8)</sup>

p - personal breathing zone samples; A - area samples

mm - millimeters

lpm - liters per minute

TABLE 2  
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Concentrations Of Viable Gram-Negative Bacteria in Bulk  
 Snow And Water Samples  
 Concentrations in CFU/ml

Sample Number	Sample Type	Sampling Location	Concentration (CFU/ml)	Predominant Bacteria
1	Water	Water Line to Snow Gun	9.5 x 10 <sup>3</sup>	<u>Pseudomonas fluorescens</u> <u>Agrobacterium radiobacter</u>
2	Water	Concentrate tank slurry	1.4 x 10 <sup>5</sup>	<u>Yersinia intermedia</u> <u>Serratia fonticola</u>
3	Water	Water line to snow gun	1.1 x 10 <sup>3</sup>	<u>Pseudomonas fluorescens</u> <u>Clavibacter michiganense</u>
7	Snow	Snow gun plume	5.5 x 10 <sup>4</sup>	<u>Moraxella bovis</u>
8	Snow	Snow gun plume	1.5 x 10 <sup>4</sup>	<u>Agrobacterium radiobacter</u>
11	Snow	Snow gun plume	2.4 x 10 <sup>3</sup>	<u>Alcaligenese falicalis</u>
12	Water	Pond used as water source for snow making	5.7 x 10 <sup>2</sup>	<u>Pseudomonas fluorescens</u> <u>Buttiaxiella agrestis</u>
13	Snow	Background snow sample	6.0 x 10 <sup>1</sup>	<u>Moraxella athantae</u> <u>Klebsiella terrigena</u>

CFU/ml - Colony forming units per milliliter of sample.

TABLE 3  
SNOMAX™  
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Airborne Concentrations Of Viable Gram-Negative Bacteria  
Concentrations in CFU/m<sup>3</sup>

SAMPLE NUMBER	SAMPLING DATE	JOB	SAMPLING TIME	CONCENTRATION EU/m <sup>3</sup>
1	NOV 13	IN SNOW PLUME	210	467
2	NOV 14	IN SNOW PLUME	322	3.11
3	NOV 15	IN SNOW PLUME	310	13.3

CFU/m<sup>3</sup> - Colony forming units per cubic meter of air.

TABLE 4  
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Table 4  
 Endotoxin Concentrations In Bulk Snow and Water Samples  
 Concentrations in EU/ml

Sample	Sample Type	Sampling Location	Endotoxin Concentration (EU/ml)
1	Water	Water line to snow gun	53.2
2	Water	Concentrate tank slurry	1.1 x 10 <sup>7</sup>
4	Water	Water line to snow gun	26.9
7	Snow	Snow gun plume	64.4
8	Snow	Snow gun plume	92.5
9	Snow	Snow gun plume	51.2
11	Snow	Snow gun plume	46.8
12	Water	Pond used as a water source for snow making	7.47
13	Snow	Background snow sample	11.12

EU/ml - Endotoxin units per milliliter of sample

TABLE 5  
 SNOMAX™  
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 Airborne Endotoxin Concentrations  
 Area Samples Collected Using An Inhalable Sampling Inlet  
 Concentrations in EU/m<sup>3</sup>

SAMPLE NUMBER	SAMPLING DATE	AREA	SAMPLING TIME	CONCENTRATION EU/m <sup>3</sup>
19344	NOV 13	IN SNOW PLUME	217	720
19332	NOV 13	IN SNOW PLUME	210	595
19335	NOV 13	IN SNOW PLUME	210	2600
19322	NOV 13	IN SNOW PLUME	179	127
19353	NOV 14	IN SNOW PLUME	386	6.61
19351	NOV 14	IN SNOW PLUME	322	209
19348	NOV 14	IN SNOW PLUME	322	0.699
19336	NOV 14	IN SNOW PLUME	322	27.8
19347	NOV 15	IN SNOW PLUME	301	ND
19339	NOV 15	IN SNOW PLUME	310	ND
19341	NOV 15	IN SNOW PLUME	310	ND
19329	NOV 15	IN SNOW PLUME	310	0.039
19317	NOV 13	MIX TANK	453	8.22
19345	NOV 14	MIX TANK	444	1.97
19316	NOV 13	GENERAL AREA	367	ND
19350	NOV 13	GENERAL AREA	317	1.02
19357	NOV 14	GENERAL AREA	385	ND
19311	NOV 13	BACKGROUND	342	ND
19310	NOV 14	BACKGROUND	430	0.465

EU/m<sup>3</sup> - Endotoxin units per cubic meter of air.

ND - Below analytical detection limit, approximately 0.8 EU/m<sup>3</sup> depending on the volume of air sampled.

TABLE 6  
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Red River Ski Area  
HETA 89-348

Airborne Endotoxin Concentrations From Area  
Respirable Dust Samples  
Concentrations in EU/m<sup>3</sup>

SAMPLE NUMBER	SAMPLING DATE	AREA	SAMPLING TIME	CONCENTRATION EU/m <sup>3</sup>
19213	NOV 13	IN SNOW PLUME	217	ND
19211	NOV 13	IN SNOW PLUME	179	ND
19223	NOV 14	IN SNOW PLUME	386	ND
19207	NOV 14	IN SNOW PLUME	322	ND
19221	NOV 15	IN SNOW PLUME	301	ND
19214	NOV 15	IN SNOW PLUME	310	ND
19225	NOV 13	MIX TANK	453	ND
19224	NOV 14	MIX TANK	444	2.517
19212	NOV 13	GENERAL AREA	367	ND
19222	NOV 13	GENERAL AREA	317	ND
19218	NOV 14	GENERAL AREA	385	ND
19204	NOV 13	BACKGROUND	342	ND
19206	NOV 14	BACKGROUND	430	ND

EU/m<sup>3</sup> - Endotoxin units per cubic meter of air

ND - Below analytical detection limit, approximately 0.08 EU/m<sup>3</sup> depending on the volume of air sampled.

TABLE 7  
 SNOMAX™  
 Red River Ski Area  
 HETA 89-348

Airborne Endotoxin Concentrations From Area Total Dust Samples  
 Concentrations in EU/m<sup>3</sup>

SAMPLE NUMBER	SAMPLING DATE	AREA	SAMPLING TIME UNITS	FLOW RATE UNITS	CONCENTRATION EU/m <sup>3</sup>
19242	NOV 13	IN SNOW PLUME	355	16.7	0.287
19239	NOV 13	IN SNOW PLUME	179	6.7	ND
19251	NOV 14	IN SNOW PLUME	386	5.0	ND
19247	NOV 14	IN SNOW PLUME	386	16.7	0.109
19246	NOV 14	IN SNOW PLUME	322	6.7	ND
19252	NOV 14	IN SNOW PLUME	95	20.5	0.770
19241	NOV 15	IN SNOW PLUME	301	5.0	ND
19248	NOV 15	IN SNOW PLUME	301	16.7	ND
19236	NOV 15	IN SNOW PLUME	310	6.7	0.481
19243	NOV 15	IN SNOW PLUME	310	20.5	0.157
19234	NOV 13	GENERAL AREA	367	20.5	0.598
19244	NOV 13	GENERAL AREA	317	6.7	ND

EU/m<sup>3</sup> - Endotoxin units per cubic meter of air.

ND - Below analytical detection limit, approximately 0.05 or lower depending on the volume of air sampled.

TABLE 8  
 SNOMAX™  
 Red River Ski Area  
 HETA 89-348

Personal Exposures To Airborne Endotoxins  
 Samples Collected Using An Inhalable Sampling Inlet  
 Concentrations in EU/m<sup>3</sup>

SAMPLE NUMBER	SAMPLING DATE	JOB	SAMPLING TIME	CONCENTRATION EU/m <sup>3</sup>
19312	NOV 13	SNOWMAKING	664	92.9
19319	NOV 13	SNOWMAKING	655	4.66
19334	NOV 14	SNOWMAKING	663	2.22
19343	NOV 14	SNOWMAKING	693	2.85
19324	NOV 15	SNOWMAKING	247	24.1
19321	NOV 15	SNOWMAKING	650	1.00
19337	NOV 15	SNOWMAKING	626	12.5

EU/m<sup>3</sup> - Endotoxin units per cubic meter of air.

TABLE 9  
 SNOMAX™  
 Red River Ski Area  
 HETA 89-348

Symptoms Prevalence Table  
 Subjects With Symptoms By Exposure Category

Symptoms	High (n=5)	Medium (n=36)	Low (n=18)
Fevers	2 (40%)	2 (6%)	2 (11%)
Cough	1 (20%)	18 (50%)	5 (28%)
Wheeze	0	4 (11%)	1 (6%)
Chest Tightness	0	2 (6%)	0
Short of Breath	0	8 (22%)	1 (6%)
Coryza	0	23 (64%)	12 (67%)
Nausea	0	5 (14%)	0
Fatigue	0	5 (14%)	4 (22%)
Anorexia	0	0	1 (6%)
Numbness	0	4 (11%)	1 (6%)
Myalgias	0	7 (19%)	2 (6%)
Weight Loss	0	1 (3%)	0

APPENDIX I  
MEDICAL QUESTIONNAIRE

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
PUBLIC HEALTH SERVICE, CENTERS FOR DISEASE CONTROL  
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH  
MORGANTOWN, WEST VIRGINIA  
MHETA 89-348

I, \_\_\_\_\_, voluntarily agree to participate in this Health Hazard Evaluation conducted by the National Institute for Occupational Safety and Health (NIOSH). I understand that I will be asked some questions about my work history, health and use of tobacco. I have the right to ask questions of NIOSH and am free to terminate my consent and discontinue participation at any time without prejudice to myself.

Every effort will be made to safeguard the confidentiality of information collected in this survey, in accordance with the Privacy Act of 1974. The information will be used for statistical purposes and will not be disclosed in a manner which will identify me as an individual, except with my written permission or as required by law to protect me and others.

I understand that other than emergency treatment, medical care is not provided. If I am injured as a result of negligence of a NIOSH employee, I may be able to obtain compensation under the Federal Tort Claims Act (28 USC 1346(b)).

All questions concerning my participation in this study have been answered to satisfaction. Further inquiries may be directed to Dr. David Mannino, Mining Hazard Evaluation and Technical Assistance Program, NIOSH, 944 Chestnut Ridge Road, Morgantown, WV 26505, Telephone: (304) 291-4223). I have received a copy of this form.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Investigator: \_\_\_\_\_

MHETA 89-348

QUESTIONNAIRE

I. PERSONAL HISTORY

SUBJECT IDENTIFICATION NO.:

1    2    3

DATE:

\_\_\_\_\_

NAME (LAST-FIRST-MID INIT.)

\_\_\_\_\_

ADDRESS:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

TELEPHONE:

( ) - - \_\_\_\_\_

DATE OF BIRTH: (Month - Day - Year)

4 5 - 6 7 - 8 9

- 1 = WHITE            4 = HISPANIC
- 2 = BLACK           5 = ASIAN
- 3 = AMERICAN NATIVE

RACE: \_\_\_\_\_  
10

- 1 = MALE
- 2 = FEMALE

SEX: \_\_\_\_\_  
11

HEIGHT (INCHES):

12    13

WEIGHT (POUNDS):

14    15    16

II. OCCUPATIONAL HISTORY

WHEN DID YOU BEGIN WORKING AT RED RIVER SKI AREA? (MONTH - YEAR) 17 18, 19 19 20

WHAT IS YOUR REGULAR SHIFT?

- 1 = DAY
- 2 = EVENING
- 3 = NIGHTS
- 4 = ROTATING

21

HOW MANY HOURS PER WEEK DO YOU USUALLY WORK AT YOUR PRESENT JOB? 22

- 1 = 0-20
- 2 = 20-40
- 3 = >40

HOW MANY MONTHS PER YEAR DO YOU WORK AT RED RIVER SKI AREA? 22A 22B

HOW MANY YEARS HAVE YOU WORKED AT RED RIVER SKI AREA? 22C 22D

PLEASE LIST ALL JOBS YOU HAVE HAD AT RED RIVER SKI AREA AND THE DATES YOU BEGAN AND ENDED EACH JOB. START WITH YOUR CURRENT POSITION AND GO BACKWARDS IN TIME.

A. CURRENT JOB TITLE: \_\_\_\_\_ 23 24

DATE BEGAN AND ENDED FROM: 25 26, 19 27 28

TO: PRESENT.

B. OTHER JOB TITLE: \_\_\_\_\_ 29 30

DATE BEGAN AND ENDED FROM: 31 32, 19 33 34

TO: 35 36, 19 37 38

C. OTHER JOB TITLE: \_\_\_\_\_ 39 40

DATE BEGAN AND ENDED FROM: 41 42, 19 43 44

TO: 45 46, 19 47 48

D. OTHER JOB TITLE: \_\_\_\_\_ 49 50

DATE BEGAN AND ENDED FROM: 51 52, 19 53 54

TO: 55 56, 19 57 58

DO YOU WEAR A MASK OR RESPIRATOR IN YOUR WORK? \_\_\_\_\_  
 1 = YES      2 = NO      59

WHAT OTHER JOBS HAVE YOU HAD (BESIDES EMPLOYMENT AT RED RIVER SKI AREA)?  
 BEGIN WITH MOST RECENT AND WORK BACKWARDS.

A.	INDUSTRY AND JOB TITLE	_____	60	61	62
	# OF YEARS		63	64	
B.	INDUSTRY AND JOB TITLE	_____	65	66	67
	# OF YEARS		68	69	
C.	INDUSTRY AND JOB TITLE	_____	70	71	72
	# OF YEARS		73	74	
D.	INDUSTRY AND JOB TITLE	_____	75	76	77
	# OF YEARS		78	79	

HAVE YOU EVER HAD TO LEAVE A JOB BECAUSE OF RESPIRATORY PROBLEMS?  
 1 = YES      2 = NO

III. PERSONAL EXPOSURE

**A. SMOKING**

**HAVE YOU EVER SMOKED CIGARETTES?**

1 = YES

0 = NO

IF NO SKIP TO B.

\_\_\_\_\_

81

IF YES,

**a) DO YOU SMOKE CIGARETTES NOW?**

1 = YES

0 = NO

\_\_\_\_\_

82

**b) WHAT IS THE TOTAL NUMBER OF YEARS YOU SMOKED?**

\_\_\_\_\_

83

\_\_\_\_\_

84

**c) WHAT IS THE AVERAGE NUMBER OF CIGARETTES YOU SMOKED PER DAY?**

\_\_\_\_\_

85

\_\_\_\_\_

86

**B. DO YOU KEEP OR COME IN CLOSE CONTACT WITH ANY ANIMALS?**

(e.g. dog, cat, mouse, goat)

1 = YES

0 = NO

\_\_\_\_\_

87

a. \_\_\_\_\_  
(TYPE OF ANIMAL)                      NUMBER

b. \_\_\_\_\_  
(TYPE OF ANIMAL)                      NUMBER

c. \_\_\_\_\_  
(TYPE OF ANIMAL)                      NUMBER

IX. SYMPTOMS

PLEASE FOLLOW DIRECTIONS CAREFULLY AND PROVIDE YOUR BEST ESTIMATE WHENEVER NUMBERS ARE REQUESTED?

WHILE EMPLOYED AT RED RIVER SKI AREA HAVE YOU HAD ANY OF THE FOLLOWING SYMPTOMS?

1. STUFFY, RUNNY NOSE AND/OR WATERY EYES:

1 = YES    0 = NO  
(IF NO GO TO QUESTION 2)

88

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THE SYMPTOMS?

89    90    19    91    92

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

93

- 1 = EVERYDAY = ALL THE TIME
- 2 = SOMETIME EVERY WEEK = FREQUENTLY
- 3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
- 4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

94

- 1 = MORNING                    2 = AFTERNOON                    3 = EVENING
- 4 = NIGHT                      5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

1 = YES    0 = NO

95

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

2. CHILLS AND/OR FEVER (ONLY REPORT EPISODES WITHOUT RUNNY NOSE OR SORE THROAT!?)

1 = YES    0 = NO  
(IF NO GO TO QUESTION 3)

96

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS?

97    98    19    99    100

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

101

- 1 = EVERYDAY = ALL THE TIME
- 2 = SOMETIME EVERY WEEK = FREQUENTLY
- 3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
- 4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

102

- 1 = MORNING            2 = AFTERNOON            3 = EVENING
- 4 = NIGHT             5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

- 1 = YES    0 = NO

103

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

3. NAUSEA/VOMITING:

- 1 = YES    0 = NO
- (IF NO GO TO QUESTION 4)

104

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THE SYMPTOMS?

105    106    107    108    109

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

109

- 1 = EVERYDAY = ALL THE TIME
- 2 = SOMETIME EVERY WEEK = FREQUENTLY
- 3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
- 4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

110

- 1 = MORNING            2 = AFTERNOON            3 = EVENING
- 4 = NIGHT             5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

- 1 = YES    0 = NO

111

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

4. COUGH:

- 1 = YES    0 = NO
- (IF NO GO TO QUESTION 5)

112

DO YOU COUGH UP MUCOUS WHEN YOU COUGH?

- 1 = YES    0 = NO

113

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THE SYMPTOMS?

114    115    116    117    118

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

118

- 1 = EVERYDAY = ALL THE TIME
- 2 = SOMETIME EVERY WEEK = FREQUENTLY
- 3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
- 4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

119

- 1 = MORNING                      2 = AFTERNOON                      3 = EVENING
- 4 = NIGHT                              5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

- 1 = YES      0 = NO

120

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

5. FATIGUE:

- 1 = YES      0 = NO
- (IF NO GO TO QUESTION 6)

121

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THE SYMPTOMS?

122    123    19    124    125

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

126

- 1 = EVERYDAY = ALL THE TIME
- 2 = SOMETIME EVERY WEEK = FREQUENTLY
- 3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
- 4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

127

- 1 = MORNING                      2 = AFTERNOON                      3 = EVENING
- 4 = NIGHT                              5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

- 1 = YES      0 = NO

128

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

6. WHEEZING BREATHING:

129

1 = YES 0 = NO  
(IF NO GO TO QUESTION 7)

A. WHEN DID YOU FIRST NOTICE THE  
OCCURRENCE OF THESE SYMPTOMS?

130 131 19 132 133

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

134

- 1 = EVERYDAY = ALL THE TIME
- 2 = SOMETIME EVERY WEEK = FREQUENTLY
- 3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
- 4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

135

- 1 = MORNING            2 = AFTERNOON            3 = EVENING
- 4 = NIGHT            5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

1 = YES 0 = NO

136

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

7. SHORTNESS OF BREATH:

137

1 = YES 0 = NO  
(IF NO GO TO QUESTION 8)

A. WHEN DID YOU FIRST NOTICE THE  
OCCURRENCE OF THESE SYMPTOMS?

138 139 19 140 141

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

142

- 1 = EVERYDAY = ALL THE TIME
- 2 = SOMETIME EVERY WEEK = FREQUENTLY
- 3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
- 4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

143

- 1 = MORNING            2 = AFTERNOON            3 = EVENING
- 4 = NIGHT            5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

1 = YES 0 = NO

144

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

8. CHEST TIGHTNESS:

145

1 = YES 0 = NO  
(IF NO GO TO QUESTION 9)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS?

146 147 19 148 149

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

150

- 1 = EVERYDAY = ALL THE TIME
- 2 = SOMETIME EVERY WEEK = FREQUENTLY
- 3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
- 4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

151

- 1 = MORNING            2 = AFTERNOON            3 = EVENING
- 4 = NIGHT            5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

1 = YES 0 = NO

152

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

9. LOSS OF APPETITE:

153

1 = YES 0 = NO  
(IF NO GO TO QUESTION 10)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS?

154 155 19 156 157

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

158

- 1 = EVERYDAY = ALL THE TIME
- 2 = SOMETIME EVERY WEEK = FREQUENTLY
- 3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY
- 4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

159

- 1 = MORNING            2 = AFTERNOON            3 = EVENING
- 4 = NIGHT            5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

1 = YES 0 = NO

160

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

10. NUMBNESS IN THE FACE AND ARMS:

161

1 = YES    0 = NO  
(IF NO GO TO QUESTION 11)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS?

                 , 19                    
162    163            164    165

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

166

- 1 = EVERYDAY = ALL THE TIME  
2 = SOMETIME EVERY WEEK = FREQUENTLY  
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY  
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

167

- 1 = MORNING            2 = AFTERNOON            3 = EVENING  
4 = NIGHT              5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

1 = YES    0 = NO

168

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

11. MYALGIAS (SENSE OF ACHING ALL OVER):

169

1 = YES    0 = NO  
(IF NO GO TO QUESTION 12)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THESE SYMPTOMS?

                 , 19                    
170    171            172    173

B. HOW OFTEN DO THESE SYMPTOMS OCCUR?

174

- 1 = EVERYDAY = ALL THE TIME  
2 = SOMETIME EVERY WEEK = FREQUENTLY  
3 = EVERY ONCE IN A WHILE = SOMETIMES = OCCASIONALLY  
4 = ONCE OR TWICE PER YEAR = RARELY

C. WHAT TIME OF DAY DO THE SYMPTOMS GENERALLY BEGIN?

175

- 1 = MORNING            2 = AFTERNOON            3 = EVENING  
4 = NIGHT              5 = UNRELATED TO TIME OF DAY

D. DID YOU SEE A DOCTOR BECAUSE OF THESE SYMPTOMS?

1 = YES 0 = NO

176

IF "YES" WHAT WAS (WERE) HIS DIAGNOSIS?

---

12. UNEXPLAINED WEIGHT LOSS:

177

1 = YES 0 = NO

(IF NO GO TO QUESTION 13)

A. WHEN DID YOU FIRST NOTICE THE OCCURRENCE OF THE SYMPTOMS?

178 179 19 180 181

B. HOW MUCH WEIGHT DID YOU LOSE?

182

183

C. DID YOU SEE A DOCTOR BECAUSE OF THIS WEIGHT LOSS?

184

1 = YES 0 = NO

WHAT WAS HIS DIAGNOSIS?

---