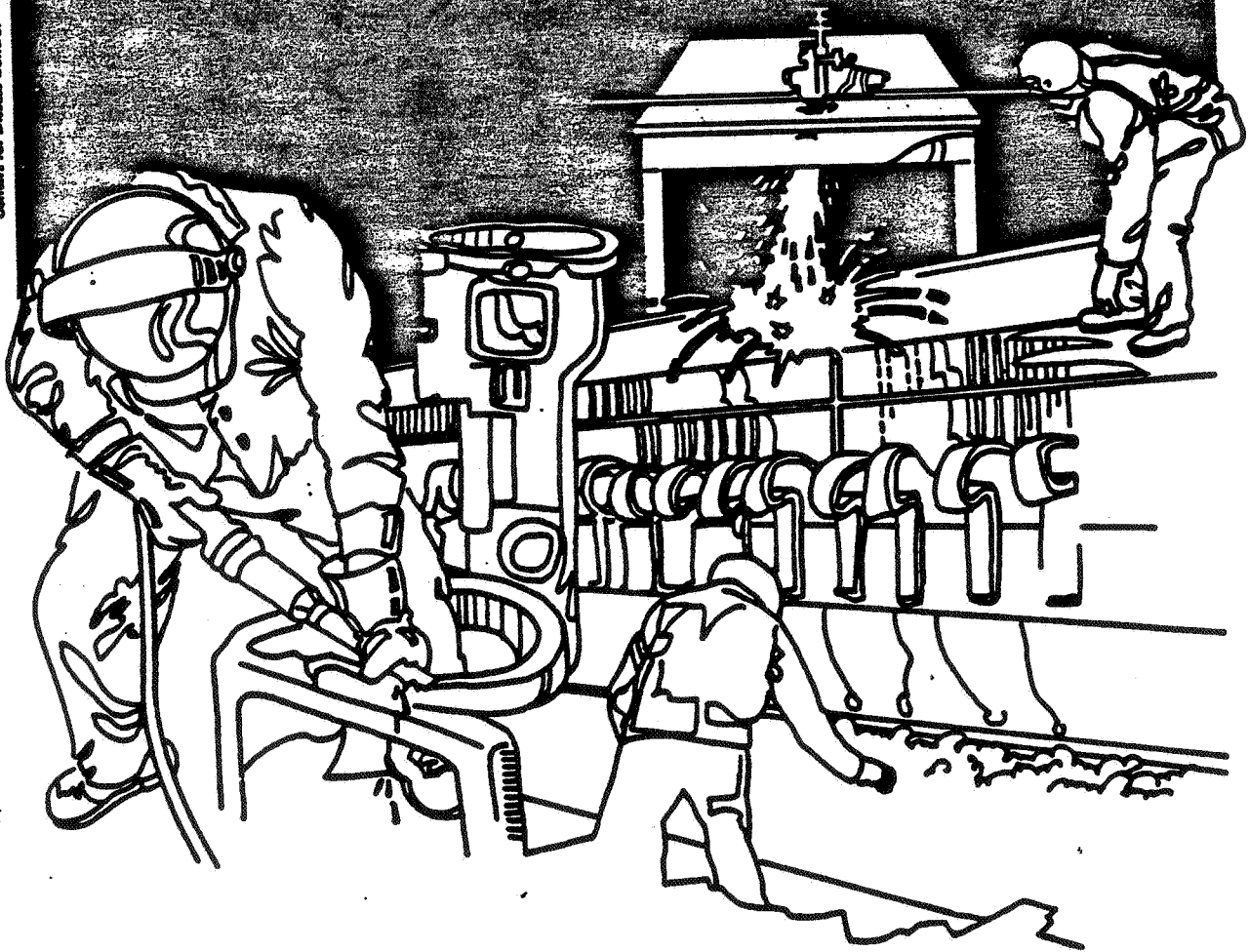


# NIOSH



## Health Hazard Evaluation Report

HETA 84-340-1606  
DENVER LAUNDRY AND DRY CLEANING  
DENVER, COLORADO

## 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.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

HETA 84-340-1606  
JULY 1985  
DENVER LAUNDRY AND DRY CLEANING  
DENVER, COLORADO

NIOSH INVESTIGATOR:  
Paul Pryor, CIH

## I. SUMMARY

In June 1984 the National Institute for Occupational Safety and Health (NIOSH) received a request to evaluate occupational health exposures to tetrachloroethylene (perchloroethylene - PERC) and noise at Denver Laundry and Dry Cleaning, Denver, Colorado.

On July 19-20, 1984, a NIOSH investigator conducted an industrial hygiene survey at the facility. Two personal samples were collected to evaluate the OSHA Time Weighted Average (TWA) exposures to PERC. These results were 45 and 64 parts per million (ppm) and were less than the current OSHA TWA Standard of 100 ppm. Air sampling results for PERC did indicate overexposures when referencing the OSHA Ceiling Standard of 200 ppm. Ten samples were collected to evaluate the ceiling exposure criteria and these ranged from 68 to 597 ppm. Four of these results exceeded the OSHA Ceiling Standard of 200 ppm and nine exceeded the NIOSH ceiling criteria of 100 ppm. More recent evidence presented by the National Cancer Institute (NCI) and other pertinent data, indicate that PERC is a potential carcinogen. Based on this information NIOSH recommends that it is prudent to handle PERC in the workplace as if it were a human carcinogen, and therefore, exposures should be controlled to the Lowest Feasible Level (LFL).

Health complaints included irritation of the skin and occasional irritation of the eyes, nose and throat. It was also determined that the exhaust ventilation system located above each dry cleaning units door was operating efficiently. However, these local exhaust systems did not provide adequate coverage and/or removal of PERC from the operators breathing zone during the final dry cleaning process.

Five personal noise level measurements were taken during the survey, (range 81 to 89 dBA) and three of these exceeded the NIOSH recommended criteria of 85 dBA for an 8-hour TWA. Noise level measurements taken in areas thought to contribute to the highest exposures in the wash/dry area ranged from 84 to 93 dBA.

On the basis of the environmental data collected, NIOSH determined that a health hazard to tetrachloroethylene (perchloroethylene - PERC) did exist during the study period. It was also determined that a health hazard did exist from overexposures to noise. Recommendations to further assist in preventing PERC and noise exposures are included in this report.

Keywords: SIC 7216 (Laundry, Cleaning, and Garment Services - Dry Cleaning Pants) Dry cleaners, dryers, washers; tetrachloroethylene, perchloroethylene - PERC and noise.

## II. INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a request in June 1984 from a representative of Denver Laundry and Dry Cleaning Company, Denver, Colorado. The initial request was to determine if a health hazard from exposures to tetrachloroethylene (perchloroethylene - PERC) existed during the commercial laundry and dry cleaning process. A noise evaluation was also requested by the owner after the initial NIOSH walk through survey. An environmental survey was conducted on July 19 and 20, 1984. The results of this survey were given verbally to the requestor and the employees as they became available and formally presented in a letter on December 31, 1984.

## III. BACKGROUND

Denver Laundry and Dry Cleaning is a cleaning plant which supplies business, industrial plants, and institutions with a wholesale, high volume cleaning service in the Denver, Colorado area. There are approximately 45 full-time employees at the plant, with the majority of these performing specific duties (e.g., flat work iron operator, washer/dryer operators, towel folders, press assemblers, dry clean operators, clerical and maintenance personnel). The following information is a brief description of the basic dry cleaning process, jobs and health concerns NIOSH evaluated:

At present the dry cleaning operation at the Denver Laundry and Dry uses a Transfer Dry Cleaning process as compared to a Dry to Dry (closed system) dry cleaning process. The transfer system requires the garment to be cleaned in a washer/extractor unit and must be manually transferred to a separate dryer. In the dry to dry this process is performed in one machine.

There are two dry cleaning units (one large unit and one small unit) at the plant. The larger unit was used 6 to 8 times per day while the smaller unit was used an average of 4 times per day. The dry cleaning process was performed between 7 am and 1 pm and was typically performed by one operator. The following six steps were used during the dry cleaning process: (1) place the clothing in one of two cleaning machines, (2) allow approximately 30 minutes for cleaning (i.e., wash cycle, Perc dump, extracting and spinning), (3) remove the clothing from the machine, (4) place the clothing in a laundry cart, (5) transfer the cart to a reclaim tumbler and (6) place the clothing in the dryer. It is believed by the NIOSH investigator that the last four steps of this process were the major contributors to the overall PERC exposure to the operator.

Noise levels were also elevated. Noise is a potential problem during maintenance processes and the washing and drying operation performed in the washroom. Two maintenance operators work throughout the plant performing general duties. Some of these activities require the operators to work in high noise areas (i.e., in excess of 85 to 95 dBA). Other employees who operate the industrial washers and dryers were also exposed to excessive noise. This noise was primarily generated from bearings in the tumble dry machines.

The employee performing the dry cleaning operation was provided and did wear a NIOSH/MSHA approved organic type respirator; however, no other personal protective clothing was worn by this person. No other personal protective clothing was worn by the other employees at the plant.

#### IV. ENVIRONMENTAL DESIGN AND METHODS

A variety of sampling techniques were used to evaluate the suspected contaminants at the plant. Personal samples were taken on the employees in each of the processes evaluated. The following is a description of the sampling techniques used:

##### A. Perchloroethylene - PERC

PERC samples were collected by drawing air through a charcoal tube for approximately 8 hours at 50, 100 and 200 cubic centimeters (cc) per minute. The samples were analyzed using gas chromatography according to NIOSH Method S-335 with modifications. The limit of analytical detection was 0.02 milligrams per sample (mg/sample).

##### B. Noise

Five personal noise level measurements were taken using Metrosonic noise dosimeters which register on a memory cell the dose or noise level received during the exposure period. The data can then be displayed as a read-out (hard copy) for each minute at the end of the exposure period. The read-out also described, at the end of the sampling period, the accumulated exposure for each hour which was described as the average noise exposure for each hour evaluated.

Noise levels and sound pressure levels were also evaluated using a Bruel & Kjoer @ (B&K) Precision Sound Level Meter equipped with an octave band analyzer.

#### V. EVALUATION CRITERIA AND TOXICOLOGY

##### A. Environmental

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).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are

absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the work place are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienists<sup>o</sup> (ACGIH) Threshold Limit Values (TLV<sup>o</sup>s), and 3) the U.S. Department of Labor (OSHA) occupational health standards. Often, the NIOSH recommendations and ACGIH TLV<sup>o</sup>s are lower than the corresponding OSHA standards. Both NIOSH recommendations and ACGIH TLV<sup>o</sup>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 solely 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 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. The current criteria and/or standards for perchloroethylene and noise are as follows:

1. Tetrachloroethylene (Perchloroethylene -PERC)

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Environmental Exposure Limits  
for PERC in Parts Per Million (ppm)

NIOSH	LFL	
ACGIH	50	(TWA)
	200	(STEL)
OSHA	100	(TWA)
	200	(C)

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ppm = parts contaminant per million parts of air.  
TWA = Time Weighted Average.  
STEL = Short Term Exposure Limit.  
C = Ceiling value which should never be exceeded.

LFL = Lowest Feasible Level. More recent studies as described in Current Intelligence Bulletin 20 (1978) have shown carcinogenesis in mice (but not rats). Prudence dictates that exposures be minimized and incidental exposures be prevented as far as possible.

2. NOISE

OSHA's existing standard for occupational exposure to noise (29 CFR 1910.95) specifies a maximum permissible noise exposure level of 90 dBA for a duration of 8 hours, with higher levels allowed for shorter durations. OSHA Time-weighted average noise limits as a function of exposure duration are shown below:

Duration of Exposure (hours/day)	Sound Level, dBA	
	NIOSH	OSHA
16	80	---
8	85	90
4	90	95
2	95	100
1	100	105
1/2	105	110
1/4	110	115*
1/8	115*	---
	---	140 dB**

\* No exposure to continuous noise above 115 dBA.

\*\* No exposure to impact or impulse noise above 140 dB peak sound pressure level (SPL).

NOTE: NIOSH, in its Criteria for a Recommended Standard, proposed a limit of 5 dB less than the OSHA standard (i.e., 85 dBA).

B. Toxicology

1. PERC

Exposure to PERC is irritating to the eyes, nose and throat and can cause central nervous system depression which may show up as headache, dizziness, impaired memory, confusion, fatigue, drowsiness, or irritability. It can also cause loss of appetite, nausea, or vomiting. Excessive exposures can cause liver and kidney injury. Skin exposure can lead to a dermatitis. PERC is stored in body fat and only slowly eliminated (biologic half-life has been estimated at 3 or 6 days). This means that if the 40 hours exposure per week is exceeded (as with overtime or extra days), it will be necessary to decrease exposure levels to prevent toxic effects.

Animal studies have shown PERC to cause liver cancers in mice, but failed to show carcinogenesis in rats. Fetotoxicity and teratogenicity have been shown in rats and mice. Because of the carcinogenesis in mice, NIOSH considers it prudent to treat PERCH as a possible human carcinogen, and, therefore, to reduce exposure as much as possible for those necessarily exposed to it, and prevent exposure for others who have no need to be exposed (such as employees and customers of stores around dry cleaning establishments).

## 2. NOISE

Noise, commonly defined as unwanted sound, covers the frequency range of sound which is implicated in harmful effects (4000-6000 Hz). Noise can be classified into many different types, including wide-band noise, narrowband noise, and impulse noise. To describe the spectrum of a noise, the audible frequency range is usually divided into eight frequency bands, each one-octave wide, and sound pressure level (SPL) measurements are made in each band using a special sound level meter. A wide-band noise can be found in the weaving room of a textile mill and in jet aircraft operations.

Exposure to high levels of noise may cause temporary and/or permanent hearing loss. The extent of damage depends primarily upon the intensity of the noise and the duration of the exposure. There is abundant epidemiological and laboratory evidence that protracted noise exposure above 90 decibels (dBA) causes hearing loss in a portion of the exposed population.

When workers are exposed to sound levels exceeding the OSHA standard, feasible engineering or administrative controls must be implemented to reduce levels to permissible limits. OSHA has recently issued a hearing conservation amendment to its noise standard. The amendment states that for workers exposed at or above a TWA of 85 dB, noise exposure monitoring, employee education, and audiometric testing will be required. Review of audiograms have to be made by an audiologist, orolaryngologist or a qualified physician. Employees also must be notified of monitoring results within 21 days. Employee records must be kept by the employer for up to five years after termination of employment. Finally, for those employees exposed to noise levels exceeding 90 dBA for eight hours and/or where audiometric testing results indicate a hearing loss, ear protection must be worn.

Exposure to intense noise causes hearing losses which may be temporary, permanent, or a combination of the two. These impairments are reflected by elevated thresholds of audibility for discrete frequency sounds, with the increase in dB required to hear such sounds being used as a measure of the loss.

Temporary hearing losses, also called auditory fatigue, represent threshold losses which are recoverable after a period of time away from the noise. Such losses may occur after only a few minutes of exposure to intense noise. With prolonged and repeated exposures (months or years) to the same noise level, there may be only partial recovery of the threshold losses, the residual loss being indicative of a developing permanent hearing impairment.

Temporary hearing impairment has been extensively studied in relation to various conditions of noise exposure. Typical industrial noise exposures produce the largest temporary hearing losses at test frequencies of 4,000 and 6,000 Hertz (Hz).

The actual pattern of loss depends upon the spectrum of the noise itself. The greatest portion of the loss occurs within the first two hours of exposure. Recovery from such losses is greatest within one or two hours after exposure.



The amount of temporary hearing loss from a given amount of noise varies considerably from individual to individual. For example losses at a given frequency due to noise intensities of 100 dBA may range from 0 to more than 30 dBA.

Low frequency noise, below 300 Hz, must be considerably more intense than middle or high frequency noise to produce significant threshold losses.

Considerably fewer temporary hearing losses result from intermittent than from continuous noise exposure, even though the total amount of noise exposure is the same in both instances.

Physiologic reactions to a noise of sudden onset represent a typical startle pattern. There is a rise in blood pressure, an increase in sweating, an increase in heart rate, changes in breathing, and sharp contractions of the muscles over the whole body. These changes are often regarded as an emergency reaction of the body, increasing the effectiveness of any muscular exertion which may be required. However, desirable in emergencies, these changes are not desirable for long periods since they could interfere with other necessary activities. Fortunately, these physiologic reactions subside with repeated presentations of the noise.

For performance on a task to remain un-impaired by noise, man must exert greater effort than would be necessary under quiet conditions. When measures of energy expenditure--for example, oxygen consumption and heart rate--are made during the early stages of work under noisy conditions, they show variations which are indicative of increased effort. Measurements in later stages under continued exposure, however, show responses return to their normal level.

## VI. RESULTS AND DISCUSSION

Employee exposures to PERC and noise were evaluated by NIOSH. The following are the results of NIOSH's study.

### 1. PERC

PERC samples indicated overexposures to the OSHA Standard and the NIOSH criteria (refer to Table 1). Two personal samples were collected to evaluate the OSHA-TWA exposure (range 45 to 64 ppm). Both were less than the OSHA Standard of 100 ppm. Ten additional samples were collected to evaluate the 15-minute ceiling exposures (range 68 to 597 ppm). Four of these exceeded the OSHA Standard of 200 ppm and nine of these samples exceeded the NIOSH 15-minute ceiling criteria of 100 ppm.

### 2. NOISE

Five personal noise samples were taken to evaluate the exposures to the equipment operators and towel folders working in the wash and dry area. An additional ten noise measurements were taken in the shop using a hand held dosimeter. Three of the personal samples exceeded the current NIOSH noise criteria of 85 dBA for an 8-hour TWA and these were found on the equipment operators (range 85 to 89 dBA). Refer to Table 2.

The area noise level measurements ranged from 84 to 93 dBA. The locations with the highest noise levels (85 to 93 dBA) were the wash and dryer areas.

#### VII. CONCLUSIONS

It was concluded that a health hazard did exist to the dry cleaning operator from exposures to PERC. It was also determined that the local exhaust ventilation systems on the dry cleaning machines were operating effectively during the unloading operation. The elevated PERC exposures to the operator, therefore, are considered to be occurring during the clothing transfer process after the clothes have been dry-cleaned. That is, when the operator removes the clothing from the dry cleaning machine, the residual PERC on these materials must be sufficient to exceed both the TWA and the Ceiling levels.

It was also concluded that a potential health hazard existed from excessive noise levels in the washing and drying operations evaluated in the washroom department. The elevated noise levels in this area were thought to be caused by the ball bearings in the dryers.

#### VIII. RECOMMENDATIONS

In view of the findings of NIOSH's environmental study, as well as personal communications with individuals at the Denver Laundry and Dry Cleaning, Denver, Colorado, the following recommendations are made to assist in providing a better work environment for the concerned employees:

##### A. PERC

1. If possible, replace the present transfer system to a dry to dry, closed system for the dry cleaning process.
2. If the two current machines continue to be used, the overall exposure could be reduced by moving the existing dry cleaning machines and the reclaiming units closer together. This will allow the operator to place the clothing from the dry cleaning machine, directly into the reclaiming unit, and totally eliminate the need for the cart.
3. Remove clothing from each machine at approximately the same time, therefore, both loads could be placed into the dryer at once and reduce the overall exposure time an additional 25 to 50 percent.
4. Personal protective clothing is essential in protecting employees from continuous or occasional exposures to chemicals. Therefore, the following is considered good work practices for normal working conditions as well as clean-up and maintenance operations when working with PERC:
  - a. Respirators are necessary when the exposures to a chemical exceed either standards or evaluation criteria. Respirators should not be considered a primary control and should only be used in lieu of more permanent controls such as engineering controls, chemical substitution, etc. Respirators can be used

in a useful manner for such activities as nonroutine maintenance or repair activities and emergencies. For the chemical evaluated at your facility, a NIOSH/MSHA approved organic vapor gas cartridge with a high efficiency pre-filter should be used as necessary. If respirators are to be used routinely to prevent overexposures, a complete program on selection, maintenance, and fit testing that meets OSHA requirements under 1910.134 should be established.

- b. Each employee who comes in contact with PERC should wear protective clothing. This should include impervious gloves and an apron or smock that will protect against skin exposure to the arms, chest, and neck area. The recommended impervious material/garments for preventing PERC exposures on the skin is nitrile, polyvinyl alcohol, polyurethane, and VITON (rated as good). Butyl, natural rubber, neoprene, and polyvinyl chloride materials are considered non-acceptable, i.e., breakthrough testing for PERC occurs in less than one hour.
  - c. Other protective clothing should include protective goggles and a cap to protect the scalp from chemical irritation.
5. In the event PERC should come in contact with skin, immediately wash with water. If PERC should come in contact with eyes, wash eyes repeatedly for 15 minutes with fresh water.

#### B. NOISE

There was enough information presented to the NIOSH investigator regarding potential noise problems in the areas surveyed at the plant to warrant the following recommendations:

1. Replacement and/or general maintenance (e.g., cleaning, oiling, greasing, etc.) of the bearings in the rotating portion of the dryers should be performed as soon as possible.
2. Noise monitoring should be performed periodically in the washroom department and for maintenance operations. This is especially necessary during maintenance operations where high noise levels are thought to exist. This will identify areas which even for short periods should require hearing protection. All areas determined to be high noise areas should be posted accordingly.
3. To insure that full personal protection is being provided during those periods of high noise exposures, the Environmental Protection Agency's Noise Reduction Ratings (NRR) should be applied when selecting hearing protection. Each protective device (ear plugs or muffs) has a NRR rating which, for that particular type and model, describes what percent of noise attenuation may be obtained.
4. Implement an educational program to instruct new employees on the hazards of chemical and noise exposures. Special attention should be placed on PERC dry cleaning operations and short term maintenance operations where high noise levels are known to exist.

IX. REFERENCES

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**X. AUTHORSHIP AND ACKNOWLEDGMENTS**

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NIOSH is thankful to the employees at Denver Laundry and Dry Cleaning Company for their cooperation and assistance with this Health Hazard Evaluation. The information gathered from this study will not only assist in maintaining the health and safety of those persons working here, but also other facilities that perform similar operations.

**XI. DISTRIBUTION AND AVAILABILITY**

Copies of this report are currently available upon request from NIOSH, Division of Standard Development and Technology Transfer, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days the report will be available through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office, at the Cincinnati address.

Copies of this report have been sent to:

1. Denver Laundry and Dry Cleaning, Denver, Colorado
2. U.S. Department of Labor/OSHA - Region VIII
3. NIOSH - Region VIII
4. Colorado Department of Health
5. State Designated Agency

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

TABLE I

Breathing Zone Perchloroethylene  
TWA and Ceiling Air Concentrations

Denver Laundry and Dry Cleaning Co.  
Denver, Colorado

November, 1984

Job/Sample Description	Sampling Time (minutes)	PPM Perchloroethylene
Dry cleaner - 1	330	64
Dry cleaner - 3	330	45
Dry cleaner - 5A	15	68
Dry cleaner - 5B	15	147
Dry cleaner - 5C	15	545
Dry cleaner - 5D	15	186
Dry cleaner - 5E	15	486
Dry cleaner - 8A	15	597
Dry cleaner - 8B	15	560
Dry cleaner - 8C	15	162
Dry cleaner - 8D	15	180
Dry cleaner - 8E	15	130

EVALUATION CRITERIA

SOURCE	PPM
NIOSH	LFL 100 Ceiling
OSHA	100 TWA 200 Ceiling

LABORATORY LIMIT OF DETECTION 0.02 mg/sample

mg = milligrams  
TWA = Time Weighted Average  
PPM = Parts Per Million  
C = Ceiling

LFL = Lowest Feasible Limit. More recent studies as described in NIOSH's Current Intelligence Bulletin 20 (1978) have shown perchloroethylene to produce carcinogenesis in mice (but not in rats). Presence dictates that exposures be minimized and incidental exposures be prevented as much as possible.

Table 2

Personal Noise Dosimeter Levels  
 Denver Laundry and Dry Cleaning CO.  
 Denver, Colorado

November 1984

<u>Job/Task Description</u>	<u>Sampling Time (hours)</u>	<u>8-hour TWA Noise (dBA)</u>
Equipment Operator	8	89
Equipment Operator	8	86
Tumbler/Folder Operator	8	81
Tumbler/Folder Operator	8	83
Maintenance Operator	8	85
<hr/>		
EVALUATION CRITERIA	NIOSH 8-hour TWA	85 dBA
	OSHA 8-hour TWA	90 dBA
	OSHA 8-hour TWA*	85 dBA

\* OSHA Revised Hearing Conservation Regulation requires employers to institute a hearing protection program if TWA noise levels exceed 85 dBA.