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EMPIRE-DETROIT STEEL DIVISION
MANSFIELD, OHIO

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I. SUMMARY

On January 10, 1986, the National Institute for Occupational Safety and Health (NIOSH) received a request from the United Steel Workers of America (USWA), Local 169, to conduct a Health Hazard Evaluation (HHE) in the Cold Rolling Mill at Empire-Detroit Steel Division, Mansfield, Ohio. NIOSH was asked to determine whether vapors generated by the rolling mills presented a health hazard to the workers in this area. Another concern was whether overhead crane operators might have exposures to acids accumulating in the crane areas of the rolling mill from an adjacent pickling operation in addition to vapors from the mills.

The specific area of concern in this request involved the five-stand cold reduction tandem mill and the cold reduction reversing mill. The mills perform gauge reductions on coils of steel and also perform some finishing operations. About 40 employees worked in this area over three shifts at the time of this investigation.

NIOSH investigators had conducted a previous HHE in September of 1982 in the Hot Strip Mill of this facility, but the investigation did not involve the Cold Rolling Department. For the current study an initial walk-through survey was conducted on March 27, 1986, with the follow-up industrial hygiene survey conducted November 19-21, 1986. During the initial survey bulk samples of the coolants, both as obtained from the supplier and as emulsions used on the mills were collected for laboratory analyses to identify potential contaminants that may be released from the process. Breathing zone exposures and area air monitoring was conducted on both the second shift (3p.m.-11p.m.) and the day shift (7a.m.-3p.m.) during the follow-up survey.

Laboratory analyses of the bulk samples for potential contaminants released when the coolants were heated disclosed a large number of hydrocarbons with a pattern similar to a kerosene fraction. Area sampling conducted for kerosene and oil mist revealed minimal airborne concentrations. Kerosene levels ranged from non-detectable (N.D.) to 6.1 mg/M^3. Oil mist concentrations ranged from N.D. to 0.3 mg/m^3. Potential decomposition products evaluated were acrolein (all samples N.D.), and formaldehyde (0.004 to 0.06 mg/m^3). Airborne concentrations of sulfuric acid were all N.D. and all but one of the samples for hydrochloric acid, which was 0.7 mg/m^3, were N.D.

Personal exposure monitoring for kerosene exposures ranged from N.D.to 6.7 mg/m^3. Exposure of crane operators to sulfuric and hydrochloric acid were all N.D.

Applicable evaluation criteria for the contaminants sampled are as follows: acrolein-OSHA 0.25 mg/m^3; formaldehyde-OSHA 3.7 mg/m^3, ACGIH 1.5 mg/m^3, NIOSH lowest feasible level; hydrochloric acid-OSHA 7 mg/m^3; oil mist-OSHA 5 mg/m^3; kerosene-NIOSH 100 mg/m^3; and sulfuric acid-OSHA 1 mg/m^3, NIOSH 1 mg/m^3.

Recommendations in Section VIII of the report address sampling for formaldehyde during heavier production schedules and periods of increased mist release from the mills to insure that exposures to this compound remain low, a ventilation assessment to determine if exhaust ventilation present on the mills is pulling all or the majority of its replacement air from surrounding contaminant sources, improved housekeeping, and elimination of food and beverage consumption at the work stations. A recommendation concerning the use of hearing protection in the cold rolling mill to comply with the designated high noise areas is also included.

Based upon the data collected during this HHE, the NIOSH investigators did not identify any chemical exposures representing a health hazard to the cold rolling mill workers. Low levels of formaldehyde were documented and periodic evaluation to assure that levels don't increase is recommended. Other recommendations relating to engineering controls, personal protective equipment, and housekeeping are presented in Section VIII of the report.

KEYWORDS: SIC 3312 (Blast Furnaces (Including Coke Ovens), Steel Works, and Rolling Mills), rolling oils, coolants, kerosene, formaldehyde, cold rolling mill.

II. INTRODUCTION

On January 10, 1986, the National Institute for Occupational Safety and Health (NIOSH) received a request to conduct a Health Hazard Evaluation (HHE) in the Cold Rolling Mill at Empire-Detroit Steel Division, Mansfield, Ohio. The request was submitted by the United Steel Workers of America (USWA) Local 169. The request concerned vapors generated by the rolling mills in the cold rolling mill and whether these vapors presented a health hazard to the workers in the area. An additional concern was whether overhead crane operators might be exposed to fugitive contaminants, specifically acids, accumulating in the crane areas of the rolling mill from an adjacent pickling operation.

III. BACKGROUND

A. Facility and Process Description:

1. Facility:

The Mansfield plant of the Empire-Detroit Steel Division, Cyclops Corporation, is engaged in steel production starting with steel scrap and various additives and ending with finished sheet steel. The area of concern in this HHE request involved the Cold Mill production area and specifically the five-stand cold reduction tandem mill and the cold reduction reversing mill. The two cold rolling mills occupy a high bay (49 foot ceiling) area between the continous pickling lines and the annealing operations. The bay area is approximately 500 feet long by 50 feet wide. The tandem mill was installed during the late 1950's and the reversing mill was added around 1960.

The coolant used on the rolling mills is recirculated from coolant reservoirs dedicated to the respective mills. The coolant systems filter, store, and recirculate coolant to the mills. Three coolant handling systems are present in the cold rolling mill area. One system serves mill stands one through four of the five-stand cold reduction tandem mill. A second system serves mill stand number five. The reversing mill has a smaller coolant handling system of its own.

Two overhead cranes move coils of steel to and from the rolling mills. The number 13 crane serves the reversing mill and the number 14 crane services the tandem mill.

2. Process:

Coils of steel come into the rolling mill staging area from the pickling lines west of the rolling mill area. Steel enters the five-stand tandem mill with gauges of .080-.250 inch and, under the extreme roll pressures applied by the mills is cold reduced into longer thinner sheets of steel with gauges of .011-.101 inches. The reversing mill also cold reduces the steel as well as tempering the steel. Lighter gauges are generally run on the tandem mill and heavier gauges on the reversing mill.

A coolant is applied to the coil steel from coolant nozzles aimed at the steel as it enters the rolls of each mill stand. A continous flow of coolant cascades over the sheet during mill operation. The action of the rolls on the mill, the movement of the steel coil, and the spray of the coolant from the coolant supply nozzles result in generation of a continous mist during mill operation. The gauge reduction being taken on the steel, the gauge of the feed stock, and the mill speeds affect the build up of heat in the mills and the amount of mist and vapors coming off of the mills.

The work stations for the mills are located at control panels along the east side of the tandem mill and the west side of the reversing mill. Workers generally stand back from the tandem mills during their operation except to make adjustments, check controls, and at the start and end of a coil pass through the mill.

B. Chemicals Used or Generated in the Process:

Chemical usage on the tandem mill and the reversing mill was very limited as it pertained to regular production. The only substances in general use were the coolant mixtures. The tandem mill used two coolants, a petroleum and animal fat blend mixed with water for mills one to four (Ironsides 369M*), and a petroleum distillate emulsion (Mill Clean LB*) on mill number five. Both coolants are primarily water (94% or greater) and no biocides or other modifying chemicals were reported to be added to the coolant. The company reports that the coolant is changed in both of these systems about once every four to five months.

The reversing mill uses an emulsion of water and a coolant containing heavy naphthenic petroleum distillates (Quakerol 6-100*). The emulsion is again primarily water (94% or greater) and the solution in the system is replaced every other week.

The coolant systems are monitored by an oil cellar attendant, which is staffed by workers in the maintenance department. Neither routine solvent use nor the presence of acid mist sources was observed within the cold rolling mill bay.

C. Engineering Controls and Personal Protective Equipment:

Side exhaust take-off hoods are present between the tandem mills on the side opposite the work stations. An exhaust hood is also located on the uptake side of the number five mill on the tandem mill operation above the winding reel. Exhaust hoods are located on the reversing mill to remove vapors and mists.

Personal protective equipment required in the cold rolling mill area included hard hats, safety glasses, and sound leather shoes. Respiratory protection was not required except for some clean-up operations.

D. Workforce:

The tandem mill and reversing mill are staffed by a workforce of 40. Job titles or classifications on the tandem mill were assistant roller, entry operator, first sticker, second sticker, recorder, utility man, #14 crane operator, stocker, tractor operator, and motor room operator. Job titles on the reversing mill were roller, assistant roller, utility man, helper(bander), #13 crane operator, and stocker. Table I presents a brief description for the job titles of workers wearing personal exposure monitors. The mill operated 20 shifts a week during the time of the NIOSH survey.

E. NIOSH Activities:

NIOSH investigators had conducted a HHE in September of 1982 in the Hot Strip Mill of this same Empire-Detroit facility. The investigation did not involve the Cold Rolling Department.(1) The final report for that evaluation was distributed in January 1984.

An initial walk-through survey was conducted at Empire-Detroit on March 27, 1986. This initial survey involved gathering background information addressing the union concerns, information about the process, materials used in the process, occupational health and safety programs and activities in the cold rolling mill, efforts by management to address the union's concerns, a review of occupational injury and illness data for the area of concern, and informal interviews with workers and union representatives working in the cold rolling mill. A walk-through of the rolling mill was also conducted along with supporting areas such as the coolant processing and recirculation equipment, the cranes, and process stageing areas. A determination of engineering controls present on the equipment and use of personal protective equipment was also conducted at that time.

Bulk samples of the coolants, both as obtained from the supplier and as emulsions used on the mills were collected for laboratory analyses to identify potential contaminants that may be released from the process. This data would be used subsequently in development of an industrial hygiene sampling protocol.

NIOSH investigators conducted a follow-up industrial hygiene survey November 19-21, 1986 in the cold rolling mill. Personal breathing zone exposure and area air monitoring were conducted on both the second shift (3p.m.-11p.m.) and the day shift (7a.m.-3p.m.). Area samples were collected at seven locations. Job titles of workers monitored for breathing zone exposures were: roller, assistant roller, first sticker, second sticker, bander, and crane operator.

Post-survey letters were sent to management and labor representatives April 9, 1986 and December 5, 1986. Bulk sample analytical results were reported by letter to the same representatives June 17, 1986. Raw laboratory data concerning the bulk sample analyses were provided to the company's industrial hygiene consultant at the request of the Manager of Industrial Relations for Empire-Detroit Steel Division. This data was provided without interpretation to management and labor representatives as well as the consultant July 30, 1986, since the bulk sample results had already been reported June 17, 1986.

IV. METHODS AND MATERIALS

A. Sampling Protocol:

The collection of bulk samples of the coolants used on the cold rolling mills permitted qualitative analyses of these substances for volatile organic compounds when heated, to provide some indication of potential contaminants released during operation of the mills. This was undertaken to identify selected contaminants for further personal exposure and area sampling during a follow-up survey. These results along with information gathered during the walk-through and consideration of the concerns and reported health effects presented in the request then identified potential contaminants for further evaluation.

The follow-up survey involved personal exposure sampling for the following contaminants among the indicated job titles: kerosene-first sticker, second sticker, roller, assistant roller, and bander; sulfuric and hydrochloric acids-crane operators. Area samples were collected for the following airborne contaminants: acrolein; formaldehyde; kerosene; sulfuric and hydrochloric acid mists; and oil mist samples as total particulate. Sampling was conducted during the first and second work shifts.

B. Sampling and Analytical Methods:

1. Qualitative Analyses of Heated Bulk Samples for Organics:

Eight bulk samples of rolling mill coolants were collected for analyses. The samples included undiluted and diluted coolants of each type currently in use. Analyses were limited to the undiluted coolants because the amount of water in the coolant solution, approaching almost 100 percent, presented problems with the analysis and the undiluted forms would identify contaminants released from a worst case situation-heating of the neat coolant material.

Portions of each bulk sample were heated using a tube furnace. Samples of one milliliter (mL) were initially heated at 60° Celsius (C), 140° Fahrenheit (F), and the effluent sampled with a charcoal tube. The oven temperature was subsequently increased to 100°C, 212°F, and a second charcoal tube collected in the effluent. A third charcoal tube sample was collected with new portions of the bulks being heated at 100°C. An attempt to determine if aldehydes were present in the effluent was undertaken by heating new portions of each bulk and heating these at 60°C and 100°C consecutively, sampling the effluents with ORBO-23* sorbent tubes. A total of five airborne effluent samples were collected for each bulk sample: three charcoal tubes and two ORBO-23* tubes.

The charcoal tubes were desorbed with one mL carbon disulfide. ORBO-23* tubes were desorbed with one mL toluene and put into an ultrasonic bath for 30 minutes. Charcoal tubes were screened by gas chromatography (GC) equipped with a flame ionization detector (FID) using a 30 meter DB-1 fused silica capillary column (splitless mode). ORBO-23* samples were screened by GC(FID) using a 30 meter DB-WAX fused silica capillary column (splitless mode). Representative samples were then analyzed by gas chromatography followed by mass spectroscopy (GC/MS).

2. Acrolein:

Acrolein samples were collected using ORBO-23* sorbent tubes at a sampling flow rate of 200 cubic centimeters (cc) per minute. The front and back sections were separated and analyzed by GC according to NIOSH Method 2501(2)with the following modifications.

Desorption Process:	30 minutes sonication in 2.0 mL of toluene.
Gas Chromatograph:	Hewlett-Packard Model 5711A equipped with a nitrogen-phosphorus detector.
Column:	6' x 1/4" glass column packed with 5% SP-2401 DB on 100/120 Supelcoport.
Oven Conditions:	Temperature programming from 90°C to 190°C at a rate of 32°C/minute.

The limit of detection (LOD) was 1 microgram/sample (ug/sample) for acrolein. The limit of quantitation (LOQ) was 5 ug/sample.

3. Formaldehyde:

Formaldehyde samples were collected using impingers containing a one percent sodium bisulfite solution at a flow rate of one liter per minute (LPM). The samples were analyzed for formaldehyde by visible spectroscopy according to NIOSH Method 3500(2). Sample volume was measured and a four mL aliquot taken for analysis. Color was developed by adding 0.1 mL of 1% chromotropic acid and six mL concentrated sulfuric acid to the samples.

The LOD for formaldehyde is estimated to be 0.2 ug/sample and the LOQ was 0.5 ug/sample.

4. Kerosene:

Kerosene samples were collected on standard charcoal tubes at a sampling flow rate of 200 cc/minute. The front and back sections of the samples were separated and analyzed by GC according to NIOSH Method 1550(2) with the following modifications.

Desorption Process:	30 minutes in 1.0 mL of carbon disulfide containing 1 microliter/milliter (uL/mL) of benzene as an internal standard.
Gas Chromatograph:	Hewlett Packard Model 5711A equipped with a FID.
Column:	30 meter (m) x 0.32 millimeter (mm) fused silica capillary column coated internally with 1.0 micron DB-5.

Oven Conditions: Temperature programming from 80°C to 200°C at a rate of 16°C/minute.

All sample peaks were quantitated against toluene and labeled kerosene, since the pure bulk samples were not representative of the air samples. The LOD was 0.1 milligrams/sample (mg/sample) for kerosene. The LOQ was 0.3 mg/sample. Values falling between these limits are semi-quantitative data and are denoted in the results section as trace quantities.

5. Sulfuric and Hydrochloric Acids:

Samples for sulfuric and hydrochloric acids were collected on washed silica gel sorbent tubes at a sampling flow rate of 200 cc/minute. The samples were analyzed for sulfate and chloride by ion chromatography according to NIOSH Method 7903.(2)

The front and back sections of the silica gel tubes were separately desorbed in 10 mL of eluent and heated in a boiling water bath for 10 minutes. The resulting solution was filtered through a 0.45 micron filter and an aliquot of each solution was analyzed via a Dionex ion chromatograph, utilizing a WISP 710B auto sampler. Liquid standards were prepared covering a range of 0.2 to 20 ug of analyte per mL.

The following ion chromatographic conditions were used:

Eluent:	0.003 Molar $NaHCO_3$/0.002 Molar Na_2CO_3.
Flow Rate:	2 mL/minute.
Detector Setting:	30 umho/centimeter (FS).
Column:	4 x 55 mm anion fast-run precolumn, 4 x 250 mm anion fast-run separator, Micro membrane suppressor.

The LOD and LOQ for sulfuric acid were 8 and 27 ug/sample, respectively. The LOD and LOQ for hydrochloric acid were 10 and 33 ug/sample, respectively.

6. Oil Mist:

Oil mist sampling was conducted by collecting air samples for mist on preweighed filters at a flow rate of 1.5 Lpm. The samples were submitted for gravimetric analysis, and the total weight gain interpreted as oil mist. This is a conservative approach since other particulate present in the rolling mill air would contribute to the total weight gain of the filter.

After equilibration, all filters were re-weighed on a Mettler AE 163 balance to obtain the post-weight on each filter. The differences between the initial and final weighings were then calculated. Results were reported in milligrams of particulate weight per filter.

V. EVALUATION CRITERIA

A. Environmental Criteria

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 workplace are: 1) NIOSH Recommended Exposure Limits (REL's), 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 REL's and ACGIH TLV's are lower than the corresponding OSHA standards. Both NIOSH REL's 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-REL's, by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing those levels found in this report, it should be noted that industry is required, by the Occupational Safety and Health Act of 1970, to meet those levels specified by OSHA standards.

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.

Table II presents the evaluation criteria used in this report.

VI. RESULTS

A. Bulk Coolant Samples:

The three bulk samples evaluated for contaminant generation were: Ironsides 369M*, used on mills one to four of the tandem mill; Mill Clean LB*, used on mill number five of the tandem mill; and Quakerol 6-100*, used on the reversing mill. The samples collected at the higher temperature of 100°C (212°F) were analyzed in preference to those obtained at the lower temperature of 60°C (140°F), since initial screening of these samples indicated that only low levels of contaminants were present on the lower temperature samples and that the chromatograms for all temperatures were similar. Figures 1 (Ironsides 369M*, Bulk Sample No. 5), 2 (Mill Clean LB*, Bulk Sample No. 4), and 3 (Quakerol 6-100*, Bulk Sample No. 6) present reconstructed ion chromatograms for the three coolants heated to 100°C. The characteristics of the coolants are consistent with their petroleum base: a majority of the components present were identified as aliphatic hydrocarbons. Formaldehyde, acetaldehyde, and possibly acrolein were identified as possible contaminants released from the heated bulk samples. Aliphatic hydrocarbons such as decane and undecane were the only compounds that could be specifically identified coming off of the samples. A decision to treat coolant exposures as similar to those of kerosene was based upon these results.

B. Area Sample Results:

1. Acrolein:

All area samples for acrolein were below the analytical limit of detection. This calculated out to an environmental limit of detection (ELOD) of less than about 0.08 mg/m^3. Acrolein results are presented by location in Table III.

2. Formaldehyde:

Area formaldehyde concentrations ranged from 0.003 up to 0.06 mg/m^3. Formaldehyde concentrations for the different area sample locations are presented in Table III.

3. Kerosene:

   Airborne kerosene concentrations for the various area sample locations ranged from below detectable levels (ELOD of 1.8 mg/m^3) up to 6.1 mg/m^3. Area kerosene concentrations are presented by location in Table III.

4. Sulfuric and Hydochloric Acids:

   All samples for sulfuric and hydrocholoric acids, with one exception, were below the analytical limits of detection. This calculated out to less than (<) 0.1 mg/m^3 for sulfuric acid and < 0.2 mg/m^3 for hydrochloric acid. One sample for hydrochloric acid, in the tandem mill crane, had a concentration of 0.7 mg/m^3. This concentration should be considered a minimum value since the laboratory reported break-through and possible sample loss from this sample. The total hydrochloric acid concentration for this specific sample is still considered to be significantly less than 7 mg/m^3, the OSHA standard. The locations of sampling for these two acids are presented in Table III.

5. Oil Mist (Total Particulate):

   Airborne oil mist (total particulate) concentrations were negligible. Values ranged from no measureable weight gain on the filter up to 0.29 mg/m^3. This data is also presented in Table III.

C. Personal Exposure Sampling Results:

1. Kerosene:

   Worker exposures to kerosene ranged from below detectable levels (ELOD of 1.8 mg/m^3) up to 6.7 mg/m^3 for a full work shift. These results are presented in Table IV.

2. Sulfuric and Hydrochloric Acids:

   All worker exposures to sulfuric and hydrochloric acids were below detectable levels. Thus concentrations of these two acids would have to have been below the ELODs of 0.1 mg/m^3 and 0.2 mg/m^3, respectively, over the course of the work shift. Table V presents this data.

VII. DISCUSSION AND CONCLUSION

Health hazards were not identified for workers in the cold rolling mill for exposures to kerosene or sulfuric and hydrochloric acid. All personal exposure monitoring for these compounds documented exposure concentrations less than one tenth of the respective evaluation criteria. Area concentrations for acrolein and sulfuric acid were also below detectable levels.

The sulfuric acid ELOD for this sample set was 0.1 mg/m^3, below the estimated 0.2 mg/m^3 reported as a probable daily sulfuric acid exposure associated with an increased lung cancer risk among workers exposed to acid mists from steel pickling operations.(12) This (NIOSH) mortality study also demonstrated an excess lung cancer risk in workers exposed to acids other than sulfuric acid. Estimated exposure levels to acids other than sulfuric acid are not presented in the study. Adjustment for potential differences in smoking habits showed that increased smoking was unlikely to have entirely explained the increased risk. The current OSHA PEL for sulfuric acid is 1 mg/m^3.(7)

An area sample for hydrochloric acid in the tandem mill crane cab presented an area concentration approximately one tenth of the OSHA PEL of 7 mg/m^3. All other samples for hydrochloric acid were below the detection limit of 0.2 mg/m^3. One should note that the personal exposure for the crane operator in the tandem mill crane on the day this sample was collected was non-detectable. An absence of provisions for make-up air to the cold rolling mill necessitates dependence upon infiltration of supply air from surrounding areas including the adjacent continuous pickling line.

Formaldehyde is present in the rolling mill areas, however the levels observed during the shifts sampled were below a general threshold of irritation of 1.2 mg/m^3 (1 part per million (ppm)).(4,13) Symptoms of eye irritation and odor detection have been reported at levels down to 0.06 mg/m^3 (0.05 ppm).(13) These levels were well below the applicable OSHA and ACGIH evaluation criteria. The ACGIH classifies formaldehyde as a supect carcinogen.(3) NIOSH considers formaldehyde to be a human carcinogen and thus recommends that exposures be maintained to as low a level as feasible.(14)

Kerosene exposures were very low both for the personal exposure samples and for the area and process samples. This is most likely influenced by the substantial dilution of the coolant with water, by the presence of local exhaust ventilation, and in the case of worker exposures by the fact that many of the work stations do not require the worker to remain directly at the control panels during operation of the rolling mills. All kerosene concentrations measured during this investigation were well below one tenth of the NIOSH recommended exposure limit of 100 mg/m^3. This level is considered to be adequate to prevent adverse health effects associated with inhalation of kerosene vapor. Exposures to kerosene aerosols should always be minimized to prevent the possible accumulation of kerosene in the lungs which could result in pneumonitis.(5) Maintaining airborne concentrations below the NIOSH REL should also minimize the amount of aerosol present in the air. The odor threshold of kerosene is reported to be about 0.6 mg/m^3.(5)

Oil mist concentrations were evaluated as total particulate. Levels documented in the cold rolling mill were negligible. The highest particulate concentration was 0.29 mg/m^3 compared to the OSHA oil mist PEL of 5 mg/m^3.(7) This value should be considered a maximum value for oil mist since other airborne particulate released by the process may also be collected on the filter and constitute a portion of the total weight identified as oil mist.

Workers were permitted to smoke, eat, and consume beverages at their work stations and in the mill area. Workers also were observed to have numerous opportunities for skin contact with the coolant emulsion. This was observed both during coil handling and also during operation and handling of equipment around the mills. This presents additional routes of exposure of workers to the coolants.

VIII. RECOMMENDATIONS

Although airborne contaminants monitored during this HHE were well below the applicable evaluation criteria, periodic monitoring for the contaminant formaldehyde should be conducted during differing production levels to insure that these levels remain low.

Smoking, eating, and consumption of beverages at the mills should be discouraged since this allows for exposure of workers to substances used on the mills by the route of ingestion.

An increase in housekeeping measures may help reduce direct continous skin contact with the coolants when workers are not involved with working in the mills. Although dermatitis was not a main concern, continual skin contact with the coolants and especially the residues on surfaces may provide a potential for sporadic cases of dermatitis. Slippery work surfaces also present a safety hazard to those around the equipment. Workers are encouraged to report all cases of dermatitis to the company dispensary.

An evaluation of make-up air sources supplying replacement air to the exhaust hoods present on the mills should be undertaken to insure that contaminants from adjacent production areas are not being channeled into the cold rolling mill. Maintenance of the rolling mill under negative pressure in relation to surrounding plant areas may contribute to the concentration of contaminants in the area, especially under unfavorable weather or heavy production conditions.

The NIOSH investigators noted that the cold rolling mill is posted as a mandatory hearing protection area. While noise exposures were not evaluated, this area was acknowledged by the company to be a high noise area generally in excess of the permissible OSHA noise level of 90 dB(A) necessitating that all workers use hearing protection. Observation of the workers revealed that many did not wear the provided ear plugs or muffs, and among those that did examples of improper wear were common. Education efforts to improve worker acceptance and proper use of hearing protectors should be increased. Additionally the union should encourage its membership to responsibly use available hearing protection in order to conserve and protect their hearing. Participation in a comprehensive hearing conservation program and using hearing protection should be considered of equal importance by management and labor along with controlling chemical contaminant exposures, assuring proper operation of engineering controls, and using protective clothing or respiratory protection.

IX. REFERENCES

1. Stephenson RL, and Cherniak MG. NIOSH health hazard evaluation final report no. HETA 81-434-1404. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1984.

2. National Institute for Occupational Safety and Health. NIOSH manual of analytical methods. 3rd ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1984. (DHHS (NIOSH) publication no. 84-100).

3. American Conference of Governmental Industrial Hygienists. Threshold limit values and biological exposure indices for 1987-1988. Cincinnati, OH.: ACGIH, 1987.

4. National Institute for Occupational Safety and Health. Current intelligence bulletin 34–Formaldehyde: Evidence of carcinogenicity. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) publication no. 81-111).

5. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to refined petroleum solvents. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW publication no. (NIOSH) 77-192).

6. National Institute for Occupational Safety and Health. Criteria for a recommended standard: occupational exposure to sulfuric acid. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1974. (DHEW publication no. (NIOSH) 74-128).

7. National Institute for Occupational Safety and Health. The industrial environment: it's evaluation and control. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1973. (DHEW (NIOSH) publication no. 74-117).

8. National Institute for Occupational Safety and Health. NIOSH/OSHA pocket guide to chemical hazards. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) publication no. 78-210).

9. National Institute for Occupational Safety and Health. NIOSH/OSHA occupational health guidelines for chemical hazards. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1981. (DHHS (NIOSH) publication no. 81-123).

10. National Institute for Occupational Safety and Health. Occupational diseases: a guide to their recognition. Revised ed. Cincinnati, Ohio: National Institute for Occupational Safety and Health, 1977. (DHEW (NIOSH) publication no. 77-181).

11. Cullen MR, Balmes JR, Robins JM, and Smith GJ. Lipoid pneumonia caused by oil mist exposure from a steel rolling tandem mill. Am. J. of Industrial Med. 2:51-58, 1981.

12. Beaumont JJ, Leveton J, Knox K, et al. Lung cancer mortality in workers exposed to sulfuric acid mist and other acid mists. JNCI (in press).

13. National Research Council. Formaldehyde and other aldehydes. Washington D.C.: National Research Council, 1981.

14. National Institute for Occupational Safety and Health. Testimony of the National Institute for Occupational Safety and Health on the Occupational Safety and Health Administration proposed rule: occupational exposure to formaldehyde, 29 CFR 1910, Docket No. H-225A. Atlanta, Georgia: National Institute for Occupational Safety and Health, 1986.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, Publications Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. 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. United Steel Workers of America, Local 169
2. Empire-Detroit Steel Division, Mansfield, Ohio
3. NIOSH/Cinti. Region
4. OSHA, Region V

For the purpose of informing 40 "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

Job Titles and Descriptions

Empire-Detroit Steel Division
Mansfield, Ohio
HETA 86-125

JOB TITLE	PRIMARY FUNCTION
Tandem Mill:	
Roller	Operates a five-stand tandem cold rolling mill and auxilary equipment; processing coil products to obtain specified gauge, shape, surface, and physical properties
Assistant Roller	Assist the Roller in the operation of a five-stand tandem cold rolling mill
First Sticker	Assist the Roller by operating controls to obtain desired product specifications in rolling steel on a five-stand cold rolling mill
Second Sticker	Feed strip into mill stands as directed
Coil Bander	Band coiled steel produced on the tandem mill, and to apply protective materials if needed
Reversing Mill:	
Roller	Operates a four high reversing mill and auxilary equipment; processing coil products to obtain specified gauge, shape, surface, and physical properties
Assistant Roller	Assist the Roller in setting up and operating a four high reversing mill for cold reducing or temper passing strip steel

Table II
Evaluation Criteria and Health Effects Summary
Empire-Detroit Steel Division
Mansfield, Ohio
HETA 86-125

Health Effects[*]

Contaminant	Recommended Exposure Limit mg/m^3(ppm)[1]	Source[2]	OSHA Standard[3] mg/m^3(ppm)	Symptoms	Target Organs	Reference
Acrolein	0.25 (0.1)	ACGIH	0.25 (0.1)	Irritation of eyes, skin moucous membranes; abnormal pulmonary function; delayed pulmonary edema, chronic respiratory disease	Heart, eyes, skin, respiratory system	8
Formaldehyde	L.F.L.[4]	NIOSH	3.7 (3)	Dermatitis; mucous membrane irritation of the respiratory tract and eyes; cough, shortness of breath and pulmonary edema if inhaled in high concentrations	Respiratory system, eyes, skin. Animal carcinogen (nasal)	4
Hydrochloric Acid	7 (5) C[5]	ACGIH	7 (5) C	Inflammation of nose, throat, larynx; cough, burns throat, choking; burns eyes, skin; dermatitis	Respiratory system, skin, eyes	8
Kerosene	100	NIOSH	N.A.[6]	Skin irritation, dermatitis; inhalation high concentrations may cause headache,confusion, drowsiness, and coma; extensive lung damage if aspirated	Skin, lungs	5,9

continued

Table II (continued)

Evaluation Criteria and Health Effects Summary

Empire-Detroit Steel Division
Mansfield, Ohio
HETA 86-125

Contaminant	Recommended Exposure Limit mg/m^3(ppm)[1]	Source[2]	OSHA Standard[3] mg/m^3(ppm)	Health Effects[*] Symptoms	Target Organs	Reference
Oil Mist	5	ACGIH	5	Pulmonary effects are rare, possible irritation; lipoid pneumonia possible following aspiration; dermatitis from direct contact with liquid oil	Skin, lungs	10,11
Sulfuric Acid	1	NIOSH	1	Eye, nose, throat irritation; pulmonary edema, bronchial emphysema; conjunctivitis; stomatitis; dental erosion; tracheobronchitis; skin, eye burns dermatitis	Respiratory system, eyes, skin, teeth	8

*: Health Effects present symptoms which may result from acute and/or chronic exposure; the target organs; and the reference for this information.
1. mg/m^3 denotes concentration in milligrams per meter cubed of air; ppm presents the concentration in parts per million.
2. Sources of recommended exposure criteria are the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values, reference 3, and NIOSH recommended exposure limits, references 4,5,6.
3. OSHA General Industry Standards, 1910.1000, reference 7
4. L.F.L. denotes maintaining exposures at the Lowest Feasible Level.
5. C denotes Ceiling concentration which is not to be exceeded during a work shift.
6. N.A. denotes no applicable OSHA standard for kerosene.

Table IV

Personal Exposure Sampling Results for Kerosene

Empire-Detroit Steel Division
Mansfield Ohio
November 1986
HETA 86-125

Location and Date	Job Title	Sample Duration in Minutes	Concentration in mg/m^3*
Tandem Mill			
11/19/1986,	First Sticker	450	Trace
	Second Sticker	448	4.7
	Roller	452	4.6
	Assistant Roller	453	6.7
Reversing Mill			
11/19/1986	Roller	433	N.D.
	Assistant Roller	433	Trace
Tandem Mill			
11/20/1986	Second Sticker	108**	Trace
	Second Sticker	219**	Trace
	Roller	437	4.9
	Assistant Roller	436	Trace
	Bander	432	4.8
Reversing Mill			
11/20/1986	Roller	302	N.D.
	Assistant Roller	423	Trace
Environmental Limit of Detection:			1.8
Evaluation Criteria in mg/m^3***			100

*: Concentration is given in milligrams per meter cubed of air (mg/m^3). All exposure concentrations are calculated as time weighted averages over the period sampled. Trace denotes that the contaminant was present in the sample but was below the Limit of Quantitation. N.D. denotes that the specific contaminant was Non-Detectable in the particular sample.

**: These two workers split the shift on 11/20/1986, thus these two samples represent one worker°s job for the shift. No First Sticker was assigned on the Tandem Mill 11/20/1986.

***:NIOSH Recommended Exposure Limit for kerosene. See reference 5.

Table V

Sampling Results for Crane Operator Exposures to Sulfuric and Hydrochloric Acids

Empire-Detroit Steel Division
Mansfield, Ohio
November 1986
HETA 86-125

Location	Date	Sample Duration** in minutes	Concentration in mg/m^3*	
			H_2SO_4	HCl
Reversing Mill Crane #13	11/19/1986	423	N.D.	N.D.
Tandem Mill Crane #14	11/19/1986	364	N.D.	N.D.
Reversing Mill Crane #13	11/20/1986	447	N.D.	N.D.
Tandem Mill Crane #14	11/20/1986	388	N.D.	N.D.
Environmental Limit of Detection:			0.1	0.2

*: Concentration is given in milligrams per meter cubed of air (mg/m^3) for sulfuric acid (H_2SO_4) and hydrochloric acid (HCl). N.D. denotes that concentrations of these contaminants in these samples were Non-Detectable.

**: Concentrations are calculated as Time Weighted Averages over the sample period.

Table III

Area Sampling Results for Airborne Concentrations of
Acrolein, Formaldehyde, Kerosene, Sulfuric Acid, Hydrochloric Acid,
and Oil Mist in the Cold Rolling Mill

Empire-Detroit Steel Division
Mansfield, Ohio
November 1986
HETA 86-125

Sample Location*	Date	Sampling Duration (Minutes)	Contaminant Concentration in (mg/m^3**)					
			Acrolein	Formaldehyde	Kerosene	Sulfuric Acid	Hydrochloric Acid	Oil Mist
Tandem Mill Loc#1	11/19	327	N.D.	0.03	Trace	-	-	0.16
Tandem Mill Loc#2	11/19	349	N.D.	0.03	Trace	-	-	0.06
Tandem Mill Loc#3	11/19	335	N.D.	0.01	6.1	-	-	0.14
Tandem Mill Loc#4	11/19	340	N.D.	0.005	N.D.	-	-	0.04
Tandem Mill Crane	11/19	347	N.D.	0.04	-	N.D.	0.7	0.29
Reverse Mill Loc#6	11/19	298	N.D.	0.02	N.D.	-	-	-
Reverse Mill Crane	11/19	290	N.D.	0.05	Trace	N.D.	N.D.	-
Tandem Mill Loc#1	11/20	389	N.D.	0.01	5.3	-	-	0.28
Tandem Mill Loc#2	11/20	381	N.D.	0.004	5.4	-	-	0.24
Tandem Mill Loc#3	11/20	394	N.D.	0.01	Trace	-	-	0.05
Tandem Mill Loc#4	11/20	403	N.D.	0.003	N.D.	-	-	0.02
Tandem Mill Crane	11/20	381	N.D.	0.04	-	N.D.	N.D.	N.D.

continued

Table III (continued)

Area Sampling Results for Airborne Concentrations of Acrolein, Formaldehyde, Kerosene, Sulfuric Acid, Hydrochloric Acid, and Oil Mist in the Cold Rolling Mill

Empire-Detroit Steel Division
Mansfield, Ohio
November 1986
HETA 86-125

Sample Location*	Date (Minutes)	Sampling Duration	Contaminant Concentration in (mg/m^3**)					
			Acrolein	Formaldehyde	Kerosene	Sulfuric Acid	Hydrochloric Acid	Oil Mist
Reverse Mill Loc#6	11/20	429	N.D.	0.02	Trace	-	-	-
Reverse Mill Crane	11/20	438	N.D.	0.06	Trace	N.D.	N.D.	-
Environmental Limit of Detection+:			0.08	-	1.8	0.1	0.2	-
Evaluation Criteria in mg/m^3++:		OSHA	0.25	3.7	-	1	7	5
		NIOSH	-	L.F.L.	100	1	-	-
		ACGIH	0.25	1.5	-	1	7	5

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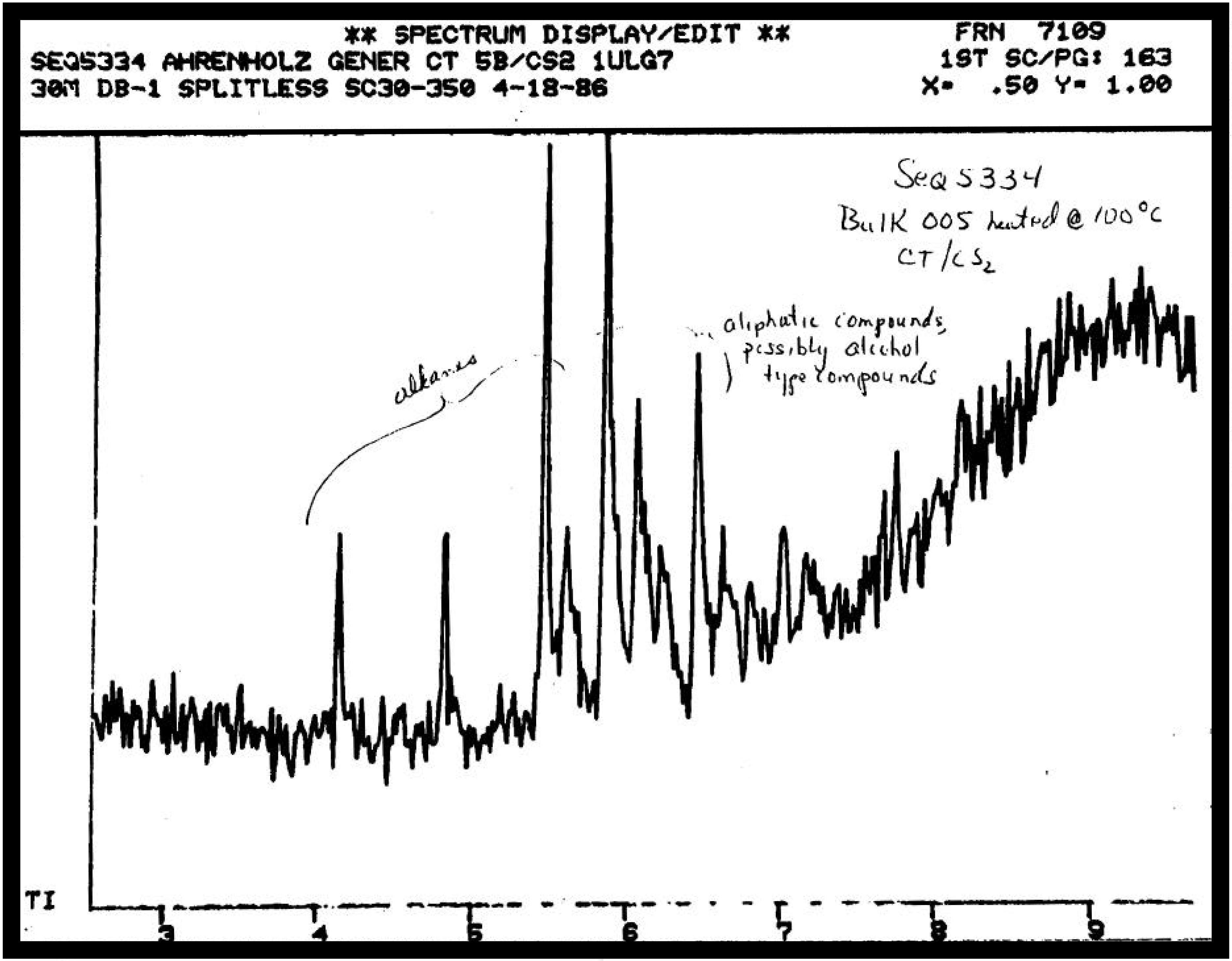
* Location Key: Location (Loc#1)-Backside of control panel between mills 1 and 2.
Loc#2-Top of control panel, operator°s station between mills 2 and 3.
Loc#3-Take-off end of mill, Assistant Roller station, railing by gate.
Loc#4-Tandem Mill basement, mixing tanks across from the oil bench.
Tandem Mill Crane-Crane No. 14, operator°s booth.
Loc#6-Reversing Mill, take-off end, railing next to take-up coil.
Reverse Mill Crane-Crane No. 13, operator°s booth.

** mg/m^3: All concentrations are given in milligrams per meter cubed of air (mg/m^3). Trace denotes that the contaminant was detectable in the sample but below the analytical limit of quantitation; N.D. denotes that the contaminant was not detected in the sample (below the analytical limits of detection).

\+ Calculated Environmental Limit of Detection: A calculated environmental limit of detection for the specific contaminant based on the smallest sample volume.

++ Evaluation Criteria: OSHA-Occupational Safety and Health Administration Permissible Exposure Limits (PELs).
NIOSH-National Institute for Occupational Safety and Health Recommended Exposure Limits (RELs). L.F.L. denotes Lowest Feasible Limit for potential occupational carcinogen. See reference no. 4.
ACGIH-American Conference of Governmental Industrial Hygienists Threshold Limit Value (TLVé).
\- denotes no applicable evaluation criteria listed by indicated source.



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             ** SPECTRUM DISPLAY/EDIT **                    FRN  7109
SEQ5334 AHRENHOLZ GENER CT 5B/CS2 1ULG7                  1ST SC/PG: 163
30M DB-1 SPLITLESS SC30-350 4-18-86                     X=  .50 Y= 1.00
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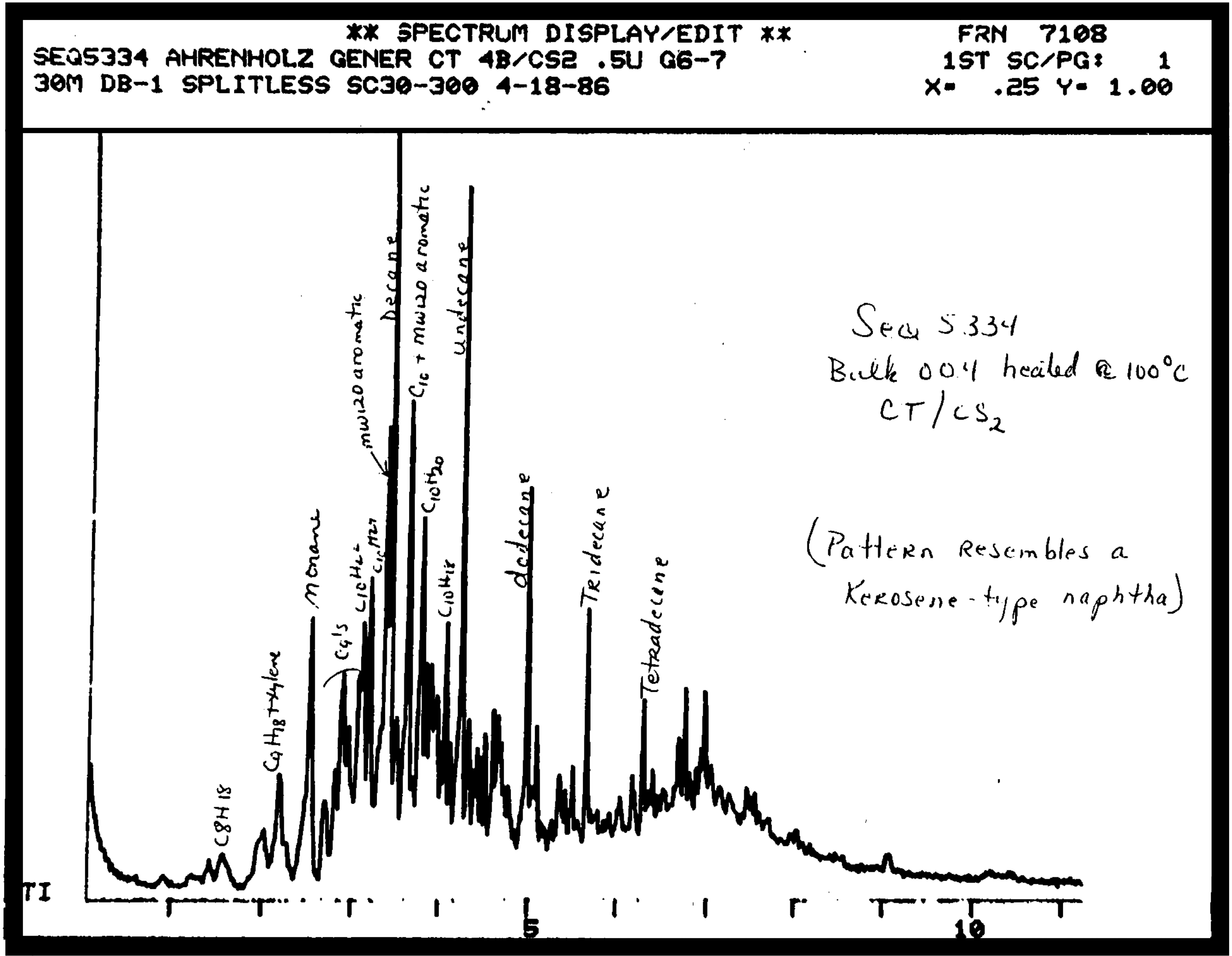
Seq 5334

Bulk 005 heated @ 100°C

CT/CS_2

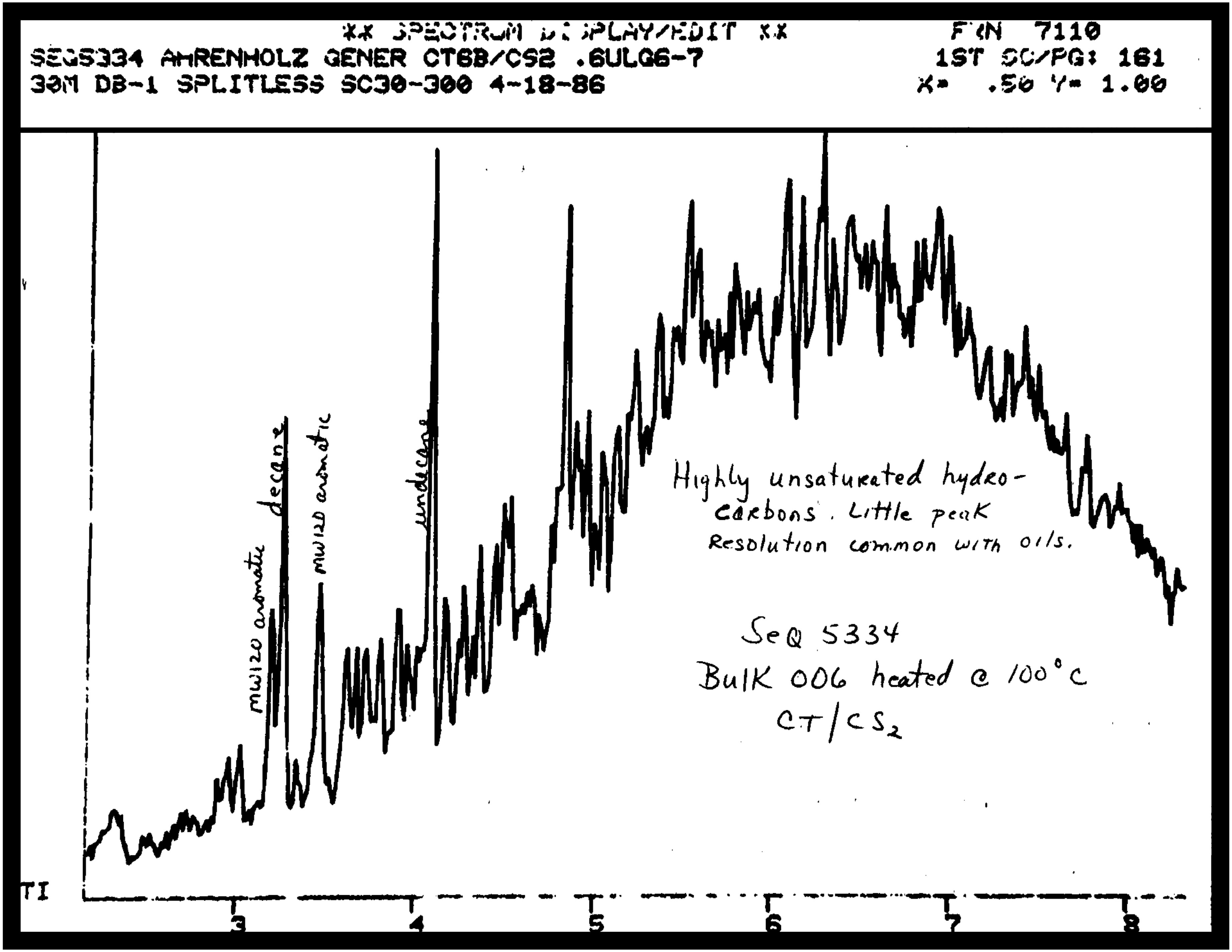
FIGURE 1



Seq 5334
Bulk 004 heated @ 100°C
CT/CS_2

(Pattern Resembles a Kerosene-type naphtha)

FIGURE 2



Highly unsaturated hydrocarbons. Little peak Resolution common with oils.

SeQ 5334
BulK 006 heated @ 100°C
CT/CS$_2$

FIGURE 3
Quakerol 6-100^R