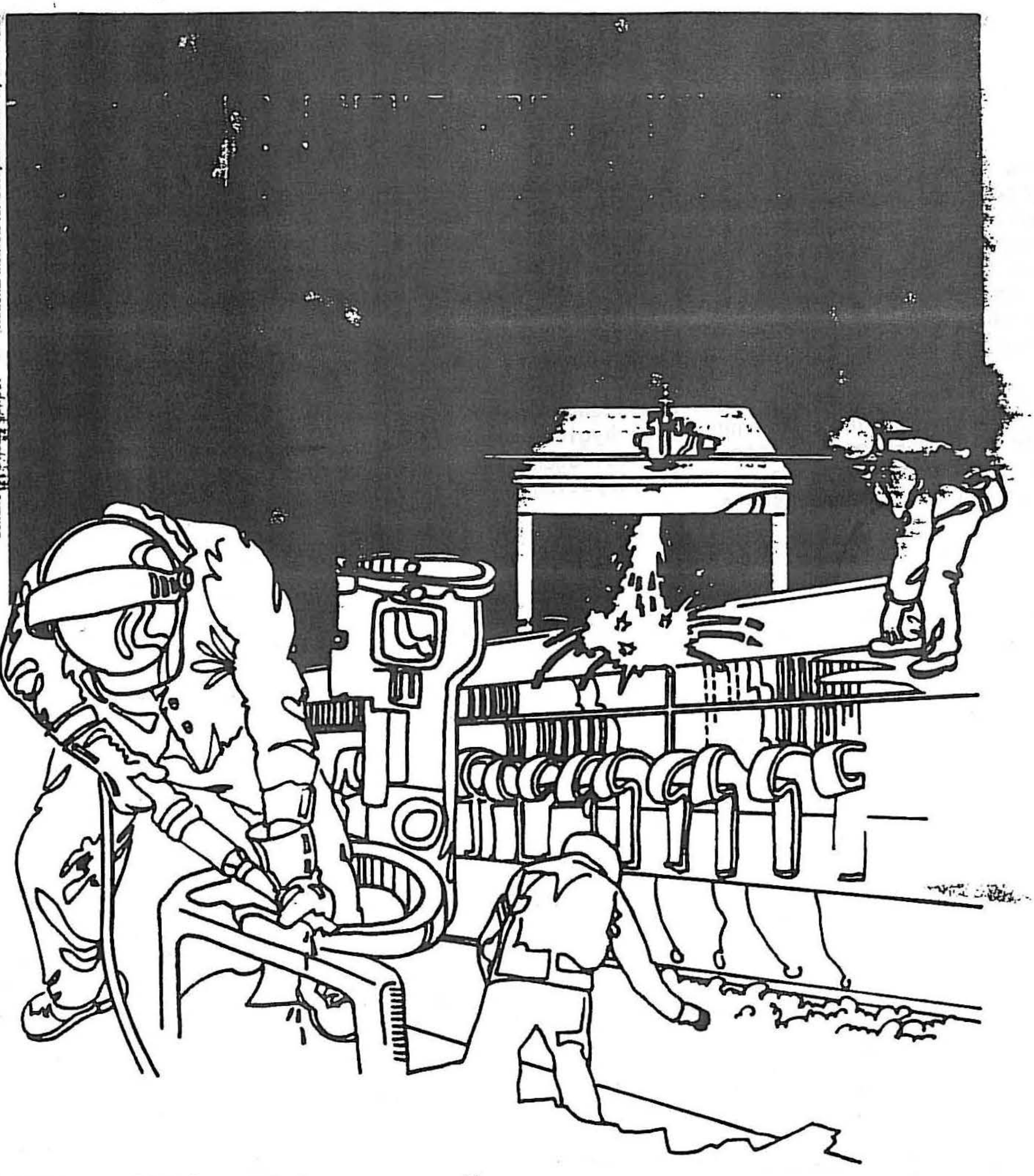
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



Health Hazard Evaluation Report

HETA 81-240-1031
METROPOLITAN SEWER DISTRICT
CINCINNATI, OHIO

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)ccupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which ıuthorizes the Secretary of Health and Human Services, following a written ·equest from any employer or authorized representative of employees, to letermine whether any substance normally found in the place of employment has otentially toxic effects in such concentrations as used or found.

'he Hazard Evaluations and Technical Assistance Branch also provides, upon equest, medical, nursing, and industrial hygiene technical and consultative ssistance (TA) to Federal, state, and local agencies; labor; industry and ther groups or individuals to control occupational health hazards and to revent related trauma and disease.

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HETA 81-240-1031
January 1981
Metropolitan Sewer District
Cincinnati, Ohio

NIOSH INVESTIGATOR:
Andrew D. Lucas, IH

I. SUMMARY

On March 11, 1981, the National Institute for Occupational Safety and Health (NIOSH) was requested by the Director, Metropolitan Sewer District of Greater Cincinnati to evaluate potential health hazards at the Mill Creek Wastewater Treatment Plant. The requestor was interested in characterizing potential exposures near the plant inlet and in airspaces of sewer mains upstream of the plant to provide for the safety of treatment plant workers and repair crews.

On March 25 and 26; and June 15, 17 and 23, 1981, a NIOSH industrial hygiene survey team conducted air sampling at the treatment plant and in sewer airspaces in the highly industrialized Mill Creek Valley. Direct reading instruments were used to determine gross levels of organic vapors. Air samples collected on charcoal tubes were used to qualitate and quantitate those vapors.

Results of the sampling showed that one sewer airspace contained potentially explosive concentrations of hexane (greater than 100% of the lower explosive limit) and that two contained levels of contaminants in air which were immediately dangerous to life or health (IDLH): ammonia levels of 808 mg/M^3 (IDLH - 350) and hexane levels of at least 39,600 mg/M^3 (IDLH 18,000). Numerous contaminants were identified at the bar screen area of the treatment plant. They included toluene, xylene, aliphatic naphtha, perchloroethylene, chlorobenzene, o-chlorotoluene, dichlorobenzene and trichlorobenzene. In all, 12 different contaminants were identified in the various sampling areas: Trichlorobenzene (range non-detectable to 1267 mg/M^3); ammonia (808 mg/M^3, OSHA PEL 35 mg/M^3); dichlorobenzene (range ND to 7.5 mg/M^3, OSHA PEL 300 or 450 mg/M^3), o-chlorotoluene (range ND to 5.8 mg/M^3, ACGIH TLV 250 mg/M^3); chlorobenzene (range ND to 7.8 mg/M^3, OSHA PEL 350 mg/M^3); perchloroethylene (range ND to 8.5 mg/M^3, OSHA PEL 680 mg/M^3; NIOSH recommends lowest feasible level, a suspect carcinogen); 1,1,1 trichloroethylene (range ND to 20 mg/M^3, OSHA PEL 1900 mg/M^3), aromatic naphtha (range ND to 630 mg/M^3); aliphatic naphtha (range ND to 152 mg/M^3, NIOSH recommended TWA 350 mg/M^3); xylene (range ND to 62 mg/M^3, OSHA PEL 435 mg/M^3); toluene (range ND to 286 mg/M^3, NIOSH recommended TWA 375 mg/M^3); and hexane (range ND to 39,600 mg/M^3, NIOSH recommended TWA 360 mg/M^3).

Based on the environmental measurements made during this investigation NIOSH concluded that a danger to public safety and workers existed due to the presence of high concentrations of hexane found in a sewer airspace. At least two sewer airspaces were determined to have levels of vapors which were immediately dangerous to the life or health of workers who might enter those areas. Numerous organic vapors were detected in the bar screen area of the wastewater treatment plant. Specific recommendations to protect the health and safety of sewer workers, including the use of supplied air escape-type respirators, the use of appropriate air testing equipment before entry into sewers, and a rigorous worker education program are contained in Section VIII of this report.

KEYWORDS: SIC 4952 (Sewerage Workers) SIC 4950 (Sanitary Services) explosive gases, hexane, toluene, xylene, aliphatic naphtha, aromatic naphtha, 1,1,1 trichloroethylene, perchloroethylene, chlorobenzene, o-chlorotoluene, dichlorobenzene, trichlorobenzene, ammonia.

.II. INTRODUCTION/BACKGROUND

On March 11, 1981, the National Institute for Occupational Safety and Health received a request for technical assistance in evaluating potential health hazards at the Mill Creek Wastewater Treatment Plant in Cincinnati, Ohio. The requestor was concerned about potential worker exposures to organic vapors near the inlet to the plant. In addition, the requestor was interested in characterizing the potential exposures which might be encountered by Metropolitan Sewer District repair crews entering sewer mains upstream of the wastewater treatment plant.

NIOSH personnel met with representatives of the Metropolitan Sewer Department (MSD) on March 13 and 24, to discuss procedures for the survey and to take a walkaround survey of the plant. Discussions with management concerned the nature and occurrence of potential exposures, routine and non-routine maintenance and operational activities, and the use of personal protective equipment. Discussions with employees included the above topics. In addition, the employees were able to provide more specific information regarding the time and nature of the odors which they observed could change periodically and without warning. Workers in the plant noted the periodic occurrence of a "blue haze" near the comminution chamber which was associated with irritation of the eyes and nose. Workers also reported that high levels of unknown vapors periodically forced the evacuation of the bar screen area of the plant. Sewer maintenance workers observed that certain sewer lines were often filled with odors and vapors which, at times, forced them to leave the sewer lines for relief.

:I. PROCESS DESCRIPTION

The original Mill Creek Wastewater Treatment Plant which provided for primary treatment of wastewater with chlorination, separate sludge digestion, vacuum filtration, and incineration was completed in 1959. The plant was expanded in 1978 to provide for secondary treatment using activated sludge, and is designed to produce an effluent containing not more than 23 mg/l of bio-chemical oxygen demand, 30 mg/l of suspended solids and 10mg/l of total Kjeldahl nitrogen. The complex covers 76 acres. Figure 1 is a schematic flow chart of the facility.

The hydraulic design of the plant is based on a dry weather flow of 120 million gallons per day with facilities for handling a maximum of 360 million gallons per day of combined wastewater and storm flow. It has a service area of approximately 133 square miles and serves over a half million persons. The wastewater and industrial wastes received at the Mill Creek plant are from the highly industrialized Mill Creek Valley.

Sewage is conducted to the plant through a combination sewage and stormflow system. The conducting system has regulators throughout the system to provide diversion of flow when it reaches an unacceptably high level. Since the system is a combined one, the potential exposures to vapors from industrial effluent are more likely to occur during dry periods when the industrial flow is not diluted by other ruins. Sewer maintenance crews, however, may incur the risk of inundation during storms. Due to the size of the system, this risk of inundation may exist even though rain may be occuring in a remote part of the system.

IV. METHODS

On March 25 and 26, 1981 air samples were collected for a continuous 24 hour period (three consecutive sets of 8 hr. samples) at three areas in the Mill Creek Wastewater Treatment Plant: (1) The bar screen area, where the sewage flow initially enters the plant and passes through bars set 2" apart on a continuous conveyor to screen out materials which could foul later treatment processes (2) The grit building, which houses the grit chambers, comminutors and chlorination equipment. Here, raw wastewater is distributed through the grit chambers at a reduced velocity which allows the gritty material such as sand, cinders, etc., to settle to the bottom of the tank. Comminutors then shred the coarse solids in the wastewater flow. (3) The primary settling tanks where primary (raw) sludge is allowed to settle out before the settled wastewater is passed to aeration tanks for further treatment. Fourteen air samples for organic vapors were collected on charcoal tubes in these areas by means of portable pumps calibrated at 50 cc/min. In addition, an H-Nu photoionization detector, which detects organic vapors through an ionization process, had been modified to record on a strip chart and was deployed in the bar screen area to record real-time fluctuations in the organic vapor levels in that area. The strip chart was equipped with a trip switch to activate a sampling pump to collect samples for qualitative analysis if levels of organic vapors above 200 ppm were detected by the photoionizer. Eleven air samples for hexachlorocyclopentadiene were collected on porous polymer tubes using portable battery operated pumps calibrated at 1 or 1.5 lpm. Hexachlorocyclopentadiene was suspected as a possible causative agent for the "blue haze". The above samples were analyzed qualitatively by gas chromatography and gas chromatography/mass spectrometry.

Air sampling was also conducted by NIOSH on June 15, 17 and 23 at the Mill Creek Plant and selected sewer mains located in the Mill Creek Valley upstream of the plant. On these days, samples were collected on charcoal tubes with portable pumps calibrated at 200cc/min and 1 lpm. These samples were collected in tandem so that the higher flow samples (A) could be used for qualitative analysis by gas chromatography and gas chromatography/mass spectometry, while the lower flow samples (B) were used for quantitative analysis. Each A charcoal tube was desorbed with 1 mL carbon disulfide, screened by gas chromatography (Flame Ionization Detector), then analyzed by GC/MS. 25 meter methyl silicone fused silica capillary columns were used for these analyses. Two different gas chromatographs were used for the quantitative analyses. The charcoal samples were desorbed with 1 mL carbon disulfide containing hexadecane as an internal standard. All single components (chlorinated compounds, toluene, xylene, hexane) were quantitated using an internal standard method on a HP5840A gas chromatograph equipped with a 25 meter methyl silicone fused silica capillary column (splitless mode). Naphtha mixtures were quantitated on a HP5710A gas chromatograph equipped with a packed 10 ft., 20% SP2100 glass column. Total area (the sum of all peak areas within the naphtha standards) was used for quantitation.

Area air samples were also collected for ammonia by using impingers containing 0.1N H_2SO_4 with portable pumps calibrated at 1 lpm. Ammonia samples were analyzed according to NIOSH method No. P&CAM 205. Additional sampling was conducted by MSD sewer crews on June 4 and July 2 to attempt to identify a gas of transient origin which was not manifest on the days of the NIOSH survey. Area air samples in the sewer mains were collected in the air space of the mains by lowering the sampling pumps with ropes and suspending them above the sewage flow.

A J&W SSP Supersensitive Organic Vapor Monitor was used to conduct spot sampling for potentially explosive concentrations of vapors in the sewer mains. The survey for combustible gases was conducted at street level by placing the monitor near the sewer covers.

V. EVALUATION CRITERIA

The sources of criteria used to assess concentrations of air contaminants were 1) Recommended Threshold Limit Values (TLV's) and their supporting documentation as set forth by the American Conference of Governmental Industrial Hygienists (ACGIH) 1980; 2) Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910), July, 1980; 3) NIOSH Recommendations for Occupational Health Standards. These standards/criteria are summarized in Table 1. In instances where these standards/criteria vary, the most recent or most restrictive criterion should be used for comparison to actual measured levels. This practice ensures maximum protection in the workplace.

VI. RESULTS

A. Air Sampling March 25 and 26 at the Mill Creek Wastewater Treatment Plant

The results of the air sampling conducted with the photoionization detector on March 25 in the bar screen area are depicted in Figure 2. Tne detector was deployed from 1200-1630 hours. As the strip chart indicates, the air levels of volatile organic hydrocarbons varied greatly and ranged as high as 128 parts per million (ppm) at 1245. The relative humidity in the bar screen area was measured with a psychrometer and ranged from 85% to 95%. It is possible that the high levels of water vapor in the air may have reduced the sensitivity of the instrument as evidenced by the lack of response towards the end of the sampling period.

The 14 charcoal tubes collected for qualitative analysis of organic compounds in the bar screen, grit building and primary settling tank areas over a 24 hr. period on March 25 and 26 demonstrated similar peak patterns on the gas chromatograms. Mass spectral analysis to identify major compounds indicated the presence of toluene, chlorobenzene, chlorotoluene, xylene, di and trichlorobenzenes, 1,1,1 trichloroethane, styrene, and numerous C_7-C_{12} alkanes. A copy of the reconstructed chromatogram from the mass spectral analyses of a sample obtained in the bar screen area on March 25 from 1645-2224 with all identified peaks labeled is depicted in Figure 3. The complexity of this chromatogram demonstrates the highly diverse nature of the substances which may be encountered in the treatment plant. The results of these samples were used to plan followup sampling strategies.

The 11 porous polymer tube air samples collected on March 25 and 26 in the same areas as the above samples were analyzed for the presence of hexachlorocyclopentadiene. A standard of hexachlorocyclopentadiene was used as a spike for comparison to the sample chromatograms. This sample peak eluted on the tailing side of a much larger peak. Because of the interference of other peaks, it was not possible to identify and quantitate this peak. Due to the interferences present, hexachlorocyclopentadiene could not be definitely identified nor quantitated. If it is present, it is less than 200 nanograms per tube. Sample P3, which was collected in the comminution chamber on March 24 from 1325-1423 was also analyzed by gas chromatography and mass spectrometry to identify the major peaks present and is reproduced in Figure 4. Major peaks included toluene, chlorobenzene, decane, undecane, trimethylbenzene, methyl ethyl benzene, methyl styrene, dichlorobenzene, terpene, aromatic hydrocarbons such as tetramethylbenzenes or dimethyl ethyl benzenes, trichlorobenzene, numerous alkanes and methyl napthalene. These results were also incorporated into followup sampling strategies.

B. Air Sampling Conducted on June 15, 17 and 23 at the Mill Creek Wastewater Treatment Plant and Sewer Mains in the Mill Creek Valley

The quantitative results of the 12 B type charcoal tube air samples for organic compounds collected at the Mill Creek Wastewater Treatment Plant and in sewer main airspaces in the Mill Creek Valley on June 15, 17 and 23 are contained in Table 2. Eleven major compounds were identified and quantitated. The reconstructed gas chromatograms for each of the 12 A samples which were used to target quantitative analysis, with all major peaks identified, are contained in Appendix I. The most common substances found on the samples were toluene, xylene, perchloroethylene, and some type of complex naphtha mixture. These naphtha mixtures varied greatly from sample to sample, some containing mostly aliphatics (anywhere from C_8 all the way up to the C_{16} range with smaller amounts of aromatics), others containing only higher aromatics (trimethyl-, tetramethyl-, pentamethyl benzenes, etc.) and very few aliphatics. Several of the samples also contained one or more of the following chlorinated compounds: 1,1,1 trichloroethane, chlorobenzene, o-chlorotoluene, dichlorobenzenes (1-2 isomers), and trichlorobenzenes (usually 2 isomers, the 1,2,4 isomer predominant). Hexane was found only on the 3A and 3B pair.

Several of the charcoal samples (both A and B) were wet; i.e., this indicates that either very high amounts of solvents or water vapor were collected on the tube which could have affected the adsorptive capacity of the charcoal. Backup B sections were analyzed separately for the higher concentrated samples. Samples 3B, 5B, 7B and 8B appeared to have substantial amounts of solvents on the backup sections which indicates the possibility of breakthrough. The results for these samples, therefore, should be considered minimum values.

If the naphtha mixture found on the sample contained mainly aliphatics (alkanes, cycloalkanes, alkenes or other olefins), a mineral spirits bulk was used as a standard to estimate the total amount of naphtha on the tube. If the naphtha mixture contained mainly higher aromatics (trimethyl-, tetramethyl-, pentamethyl benzenes, etc.), an aromatic naphtha bulk was used as the standard. Any naphtha values reported must be considered as approximations, since the components found in the individual samples varied considerably and were not exactly the same as those in the naphtha bulks used as standards.

One air sample for ammonia was collected from 1008-1034 on June 23 at sampling site 8. The results indicated an airspace concentration of 808 mg/M^3.

C. Air Sampling Conducted by MSD on June 4 and July 2

Results of 2 B type charcoal tube air samples for organic vapors collected by MSD in sewer main airspaces on June 4 and July 2 are contained in Table 2. The reconstructed gas chromatograms from the 2 A type charcoal tube samples used to quantitate these samples are contained in Appendix I.

D. Combustible Gas Meter Survey Results

A combustible gas meter survey was conducted at each of the 12 sampling sites visited by the NIOSH survey team (sites 1B-12B in Table 2), while the charcoal tube samples were taken. With the exception of one sampling site (3B) no significant levels of combustible gases were detected. When the sampling pumps were deployed at sewer A at 11:55 there were no detectable levels of combustible gases. However, as the pumps were lowered into the sewer airspace a strong solvent odor became noticeable. The combustible gas meter began to register significant levels of combustible gases and quickly rose to 100% of the lower explosive limit (LEL) by 12:05. An immediate survey of sewer lines in the vicinity was conducted. The results of this survey and sewer locations are depicted in Figure 5. At sewer B airspace located behind a chemical company a level of 8% of the lower explosive limit was detected. The other sewers in the vicinity demonstrated no levels above 1% of the LEL. At 12:24, sewer A remained at 90% of the LEL. The MSD sewer maintenance crew which was accompanying the NIOSH survey team followed their protocol for such emergencies and notified the Norwood Fire Department of the imminent danger. The Norwood Fire Department responded immediately. At the time of their arrival, the levels of combustible gases had dropped to 10-15% of the LEL. Analysis of charcoal tube 3B taken during this time period indicated the presence of high levels of hexane, and low levels of other solvents. The quantitative results of this sample, which are contained in Table 2, should be taken as minimum values due to the breakthrough which occured on the sampling media.

VII. DISCUSSION

A. Mill Creek Wastewater Treatment Plant

The results of air sampling at the Mill Creek Wastewater Treatment Plant indicate that workers entering the bar screen area for routine observation and maintenance activities may be exposed to a myriad of chemicals. Aliphatic naphtha levels were detected at about 1/3 of the NIOSH recommended levels. It is important to note that the levels reported are concentrations which have been averaged over a duration of several hours. As the strip chart which is reproduced in Figure 2 indicates, the levels of contaminants can vary greatly. Workers in the plant reported that vapor levels in the bar screen area and comminution chambers can change rapidly and without warning. Employees entering the bar screen area should have appropriate respiratory protection (see recommendations) to ensure safety in a rapidly changing environment which is known to contain numerous chemical contaminants.

Air levels of contaminants in the area of the primary settling tanks (sampling site 2B) were substantially lower than those obtained in the bar screen area. This, presumably, is due to the dilution of vapors which is to be expected in an unenclosed zone.

The presence or absence of hexachlorocyclopentadiene could not be determined due to the many interfering compounds present on the air samples which were obtained in the plant. If it was present, it was less than 200 ng per sample. Recent communications with employees of the plant indicate that the episodes of "blue haze" have ceased.

B. Sewer Mains and Sewer Maintenance Repair Crews

Air sampling in sewer airspaces revealed several areas which represent potentially severe health risks to those who enter these environments. Airspace samples collected at sampling site 8B (Mid-City Industrial Park Rd.; 0.3 miles N of Mitchell Ave.) determined ammonia concentrations of 808 mg/M^3. The ACGIH TLV for ammonia is 18 mg/M^3. An air level of 350 mg/M^3 of ammonia is considered by NIOSH to be immediately dangerous to life or health. Trichlorobenzene concentrations at this same site were determined to be a minimum of 1267 mg/M^3. Although there are no standards for trichlorobenzene, the OSHA PEL for similar chlorinated benzene compounds are as follows: chlorobenzene 350 mg/M^3; o-dichlorobenzene 300 mg/M^3; p-dichlorobenzene 450 mg/M^3. The trichlorobenzene level measured at this site was significantly higher than the standards for similar compounds.

Air sampling conducted at site 3B (500 yds. SW of the point where Lester Rd. deadends into I-71) discovered an atmosphere which was greater than 100% of the LEL. This represents not only a potential health hazard, but also a public safety threat. Qualitative analysis of air samples collected at the same time as the combustible gas meter survey indicate that hexane was the primary component of the explosive mixture. Quantitative analysis of air samples obtained at the same time indicated a minimum concentration of 1446 mg/M^3 of hexane. There was, however, considerable overloading and corresponding breakthrough on these samples. Since the LEL of hexane is 1.1% of the atmosphere, it is more reasonable to conclude that the concentration of hexane was greater than 11,000 ppm (39,600 mg/M^3). NIOSH considers hexane to be immediately dangerous to life or health at concentrations of 5,000 ppm. A recent (1980) episode of a sewer explosion in Louisville, Ky., which was attributed to the presence of hexane in the sewer system, caused more than $40 million in damage and is a graphic demonstration of the public safety hazard which these vapors create.[1]

Sewer airspace concentrations at sampling site 5B (1701 Dana Street) revealed aromatic naphtha levels at a minimum concentration of 630 mg/M^3. While no standards/criteria exist for aromatic naphthas, the NIOSH recommended criteria for aliphatic naphtha is 350 mg/M^3. Since aromatic naphthas generally contain compounds which are more injurious to health than aliphatic naphthas, it seems reasonable to recommend that air levels of aromatic naphthas should not exceed those criteria which exist for aliphatic naphthas.

The results of the sewer airspace sampling which was conducted revealed several areas which represent immediate danger to life and health, in addition to, in at least one case, a public safety hazard. Numerous minor contaminants were identified, and it is reasonable to expect that the levels of these other contaminants might be higher or lower upstream or downstream of the sites where these samples were taken. Moreover, as the results of the combustible gas meter survey demonstrated, the concentrations of gases may fluctuate rapidly and without warning.

While air sampling is suggested before entry into sewer lines, an initial indication of "safe" air levels will not ensure that they will remain so. Therefore, it is of utmost importance that sewer maintenance crews which enter such potentially dangerous environments be equipped with personal protective equipment which will ensure safe emergency egress. Large 20-30 minute supplied air respirators are, in most cases, too bulky and heavy for routine troubleshooting entries into sewers. However, there are currently several types of NIOSH approved emergency escape supplied air respirators which weigh about five pounds, are refillable, relatively inexpensive, and can be easily carried. This type of respirator could be used to supplement cartridge organic vapor type respirators which have been recommended to MSD for their sewer repair crews. In addition, they could provide emergency protection against non-organic vapors (for example, ammonia, hydrogen sulfide, hydrogen cyanide, carbon monoxide) and sudden entry into oxygen deprived environments. An example of such an emergency escape respirator is provided in Appendix 2.

VIII. RECOMMENDATIONS

Recommendations made in this report are intended to supplement, not supersede, those recommendations which were made in HETA 81-207, Metropolitan Sewer District Cincinnati, Ohio, August 1981. Those recommendations are contained in Appendix 3.

A. Mill Creek Wastewater Treatment Plant

1. Before entering the bar screen area in the MCWTP for routine maintenance or operational activities, the air should be tested with rugged, portable, direct reading instruments such as explosimeters and oxygen detectors. Workers entering this area should be equipped with NIOSH approved full- or half-face chemical cartridge respirators. In addition, those employees should be provided with emergency escape respirator devices of the type discussed in Section VII of this report. This will ensure safety should the air concentrations of contaminants undergo a rapid change.

2. When conducting major maintenance activities in the bar screen area which will require the presence of workers for sustained periods of time (for example, the two day cleanup of the tar spill which accumulated on the bar screens and impelled immediate and continuous maintenance activity to prevent a major diversion of sewer flow into the Mill Creek and Ohio River) forced-air ventilation should be used to provide a fresh source of supply and dilution air in the bar screen area.

3. If a jet exhaust venturi blower (air horn) is used to ventilate the bar screen area, the intake should be placed in an area which is free of air contaminants and remote from automobile or diesel exhaust emissions which may be given off by the air compressor or support vehicles for the air compressor.

B. Sewer Airspaces

1. Workers entering sewer airspaces should test the air for gross contamination with portable direct reading instruments for explosivity and oxygen sufficiency. If high levels of organic vapors, explosive or oxygen deficient atmospheres are detected, the sewer should be ventilated before entry.

2. Workers entering sewers for routine maintenance or troubleshooting activities should be equipped with NIOSH approved full- or half-face chemical cartridge respirators. In addition, to ensure safety in an environment which may change rapidly and without warning, the workers should also be equipped with the lightweight, emergency escape respirators which can provide a continuous 5 minute supply of fresh air. These respirators can provide a margin of safety when the air contaminants are not organic in nature, or when there is a lack of oxygen.

3. MSD should investigate the feasibility of using two-way radio communication to maintain contact (when visual contact is not possible) with workers engaged in troubleshooting activities in areas known to contain hazardous gases or vapors.

4. During major repairs and reconstruction in the sewer system those companies which are located upstream of the repair site and are major contributors to the flow should be contacted to determine the nature of their effluent and discuss procedures to control any hazardous chemicals or vapors which may be present in their flow.

5. MSD should institute a rigorous worker education and training program to outline safe entry procedures and demonstrate the use of recommended instrumentation and protective equipment. The importance of proper usage of equipment and strict adherence to safety rules must be stressed in the educational program.

6. Workers using air hammers to make repairs in sewers should have appropriate hearing protection provided by MSD.

X. AUTHORSHIP AND ACKNOWLEDGEMENTS

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standard Development and Technology Transfer, 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 the NIOSH Publications Office at the Cincinnati address.

Copies of the report have been sent to:

1. City Health Commissioner
2. Superintendent, Metropolitan Sewer District
3. Director, Metropolitan Sewer District
4. NIOSH, Region V
5. OSHA, Region V

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

XI. REFERENCES

1. New York Times, February 14, 1981.

TABLE 1

EVALUATION CRITERIA[1]
METROPOLITAN SEWER DISTRICT
CINCINNATI, OHIO
HETA 81-240

	OSHA PEL (mg/M3)	NIOSH RECOMMENDED TWA (mg/M3)	ACGIH TLV (mg/M3)	IDLH LEVEL+	HEALTH EFFECTS
Hexane (n-Hexane)	1,800	360 1,800 ceiling (15 min)	360 180*	18,000	Attacks nervous system, skin, eyes, respiratory system and lungs. Causes light-headedness, nausea, headaches, periphenal nerve damage.
Toluene	750 1,125 acceptable ceiling 1,875 max peak (10 min)	375 750 ceiling (10 min)	375	7,500	Attacks CNS liver, kidneys and skin. Induces fatigue weakness, euphoria and confusion.
Xylene	435 870 ceiling (10 min)	435	435	43,500	Depresses CNS. Irritates eyes and skin Toxic to GT tract, blood, liver and kidneys. Causes dizziness excitement, drowsiness, nausea.
Aliphatic Naphtha (mineral spirits or stoddard solvents)	2,900	350 1,800 ceiling (15 min)	575 525*	29,500	CNS depressant. Irritates eyes, nos and throat.
Aromatic Naphtha (aromatic hydrocarbons (excluding benzene)	--	--	--	--	Irritating to skin and lungs. Some aromatics may cause cancer.
1,1,1-Trichloroethane	1,900	1,900 ceiling (15 min)	1,900	5,430	Depresses the CNS. Irritating to eyes and nose. Induces headaches and lassitude. Defats skin.
Perchloroethylene	680 1,360 acceptable ceiling 2,040 peak (5 min)	low level attainable as it is a suspect carcinogen	670 335*	3,400	Toxic to liver and kidneys. Irritating to eyes and upper respiratory system. Depresses CNS. Suspect carcinogen.

TABLE 1 (CONTINUED)

EVALUATION CRITERIA
METROPOLITAN SEWER DISTRICT
CINCINNATI, OHIO
HETA 81-240

	OSHA PEL (mg/M3)	NIOSH RECOMMENDED TWA (mg/M3)	ACGIH TLV (mg/M3)	IDLH LEVEL+	HEALTH EFFECTS
Chlorobenzene	350	--	350	--	Depresses CNS. Irritates eyes, nose, respiratory system and skin. Toxic to liver.
O-Chlorotoluene			250		Irritates skin and eyes. Depresses central nervous system.
Dichlorobenzene	300 (o-dichlorobenzene) 450 (p-dichlorobenzene)	--	300 (o-dichlorobenzene) 450 (p-dichlorobenzene)	10,200	Toxic to liver and kidneys. Irritates eyes and skin.
Trichlorobenzene	--	--	--	--	Toxic by ingestion and inhalation. Currently undergoing testing for carcinogenesis.
Ammonia	35	35 ceiling (5 min)	18	350	Severe irritant of eyes, respiratory system and lungs. May cause burning and tearing of eyes, coughing and chest pain.

1 all values expressed in mg/M^3

* ACGIH notice of intended change for 1981

+ IDLH - immediately dangerous to life or health

TABLE 2

SOLVENT CONCENTRATIONS IN mg/M^3
METROPOLITAN SEWER DISTRICT
CINCINNATI, OHIO
HETA 81-240

LOCATION	DATE	TIME	VOLUME (1)	HEXANE	TOLUENE	XYLENE	ALIPHATIC NAPHTHA	AROMATIC NAPHTHA	TCE	PCE	CHLORO-BENZENE	O-CHLORO-TOLUENE	DCB	TCB
1B - MCWTP: bar screen area	6-15-81	1044-1556	62	--	8.1	5.2	152	--	--	19	7.8	5.8	7.5	19.5
2B - MCWTP: primary settling tanks	6-15-81	1053-1552	57	--	0.2	0.2	--	BLD	--	0.2	0.2	BLD	0.2	0.4
3B - Sewer Airspace: 500 yds SW of the point where Lester Rd deadends intoI-71	6-15-81	1155-1453	33	1446L+*	1.5	4.3	89.5	--	--	5.2	--	--	--	--
4B - Sewer Airspace:intersection of Seymour Ave. and Carthage Ct.	6-15-81	1419-1522	12	--	7.5	1.7	--	--	--	BLD	5.8	0.8	--	--
5B - Sewer Airspace: 1701 Dana St.	6-17-81	0937-1616	75	--	0.9L+	62L+	--	630L+	--	8.5L+	--	--	--	--
6B - Sewer Airspace: 4700 Paddock Rd.	6-17-81	1010-1605	68	--	0.3	1.3	--	66	--	--	--	--	--	--
7B - Sewer Airspace: 630 Glendale-Milford Rd	6-17-81	1036-1535	59	--	12	0.5	64	--	20L+	3.4	--	--	--	--
8B - Sewer Airspace: Mid-City Industrial Park Rd., 0.3 miles N of Mitchell Ave	6-23-81	1017-1426	48	--	--	--	--	--	--	--	--	--	--	1267L+
9B - Sewer Airspace: inter-section of Spring Grove Ave. and Kings Run Dr.	6-23-81	1052-1421	37	--	2.2	8.7	97	--	--	3.3	0.5	--	--	41

TABLE 2 (CONTINUED)

SOLVENT CONCENTRATIONS IN mg/M^3
METROPOLITAN SEWER DISTRICT
CINCINNATI, OHIO
HETA 81-240

LOCATION	DATE	TIME	VOLUME (1)	HEXANE	TOLUENE	XYLENE	ALIPHATIC NAPHTHA	AROMATIC NAPHTHA	TCE	PCE	CHLORO-BENZENE	O-CHLORO-TOLUENE	DCB	TCB
10B - Sewer Airspace: Kings Run Dr., 300 yds E of Spring Grove Ave.	6-23-81	1104-1417	37	--	0.3	0.8	71	--	2.2	2.7	--	--	--	--
11B - Sewer Airspace: 4900 Este Road	6-23-81	1118-1412	34	--	4.4	5.6	70	--	--	--	3.5	--	--	--
12B - Sewer Airspace: interceptor chamber on Bloody Run sewer main 0.2 miles W of I-75	6-23-81	1200-1347	21	--	1.9	4.2	--	9.9	--	1.4	--	--	--	--
13B - Sewer Airspace: 1365 Tennessee	6-04-81	1450-1500	0.8	--	21	7.8	--	--	--	--	--	--	--	--
14B - Sewer Airspace: Intersection of South and Evans Streets	7-02-81	1405-1425	5.2	--	286	57	--	--	--	--	--	--	--	--

TCE - 1,1,1 Trichloroethylene
PCE - Perchloroethylene
DCB - Dichlorobenzene
TCB - Trichlorobenzene

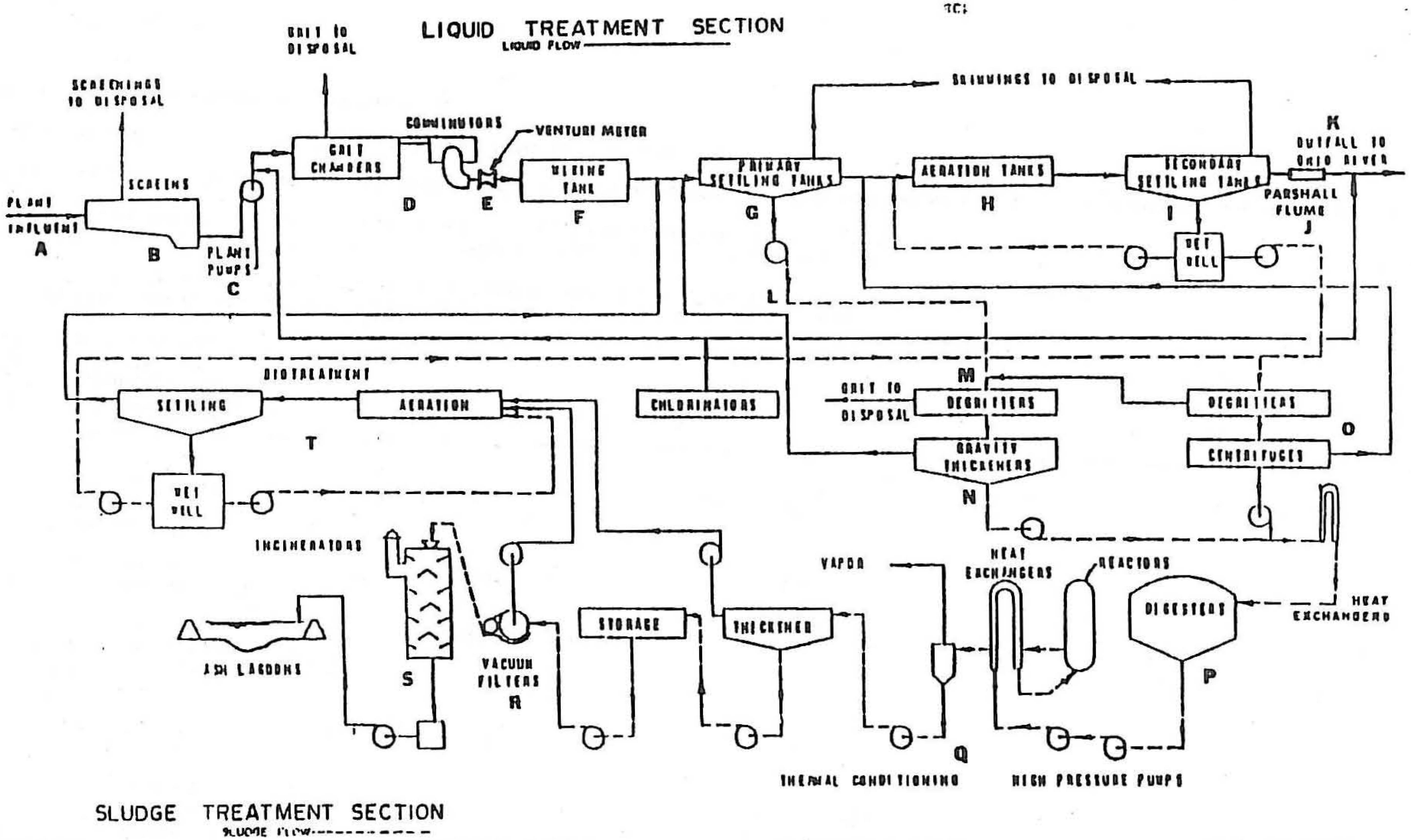
-- indicates compound was not identified as present in the parallel bulk air sample by GC/MS and, therefore, not quantitated in the corresponding lower volume sample.

+L - Large amount found in backup section indicates possible overload or breakthrough of this compound on this sample. Values should be considered as minimum amounts present.

*indicates combustible gas meter survey site determined levels above the LEL. Therefore hexane levels reached a minimum peak of 39,600 mg/M^3.

BLD - indicates that the substance was below the limit of detection.

MCWTP - Mill Creek Wastewater Treatment Plant

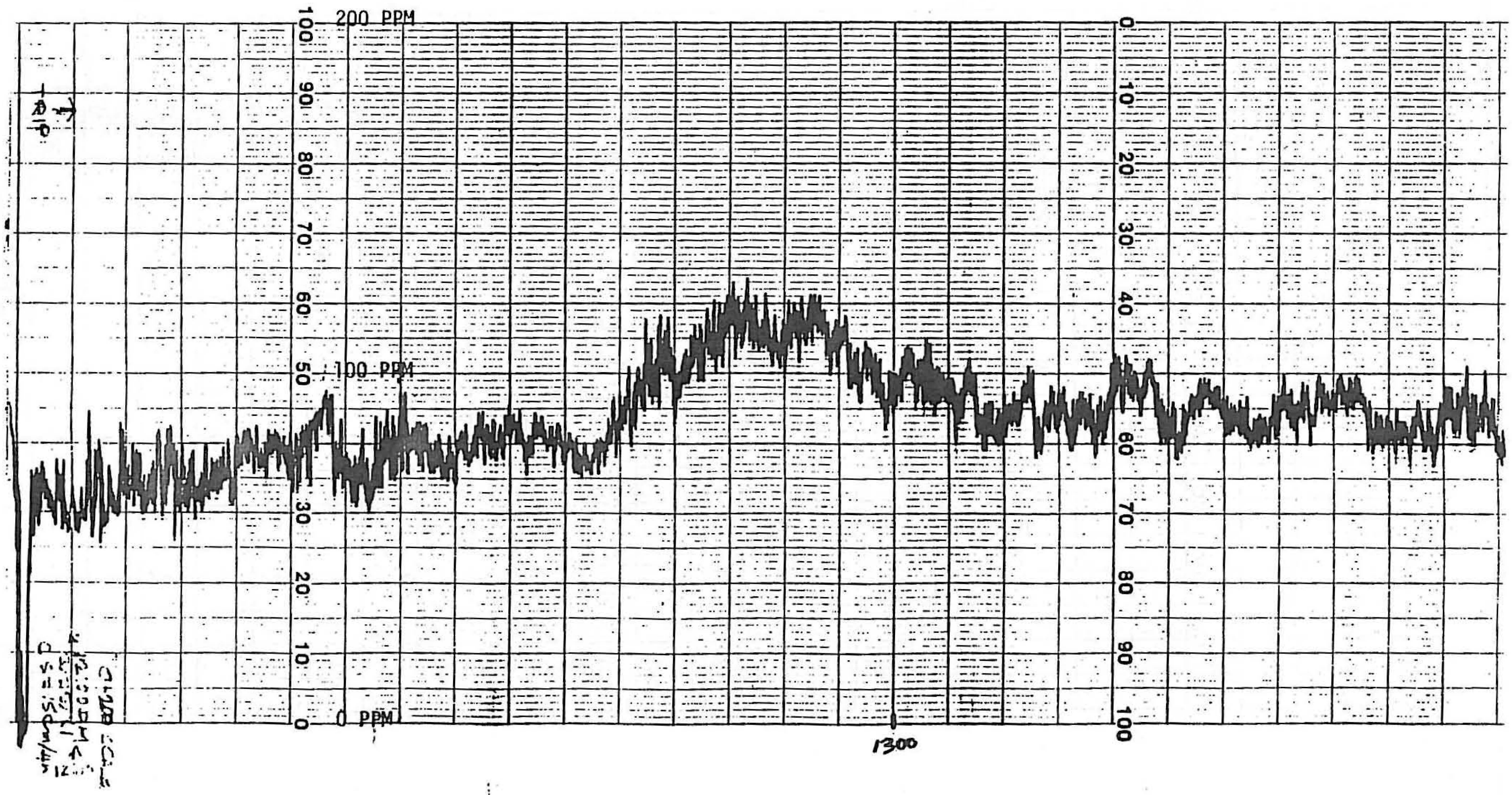


MILL CREEK TREATMENT PLANT

PROCESS FLOW DIAGRAM

Fig. No. 3

METROPOLITAN SEWER DISTRICT
BAR SCREEN AREA
CINCINNATI, OHIO
HETA 81-240



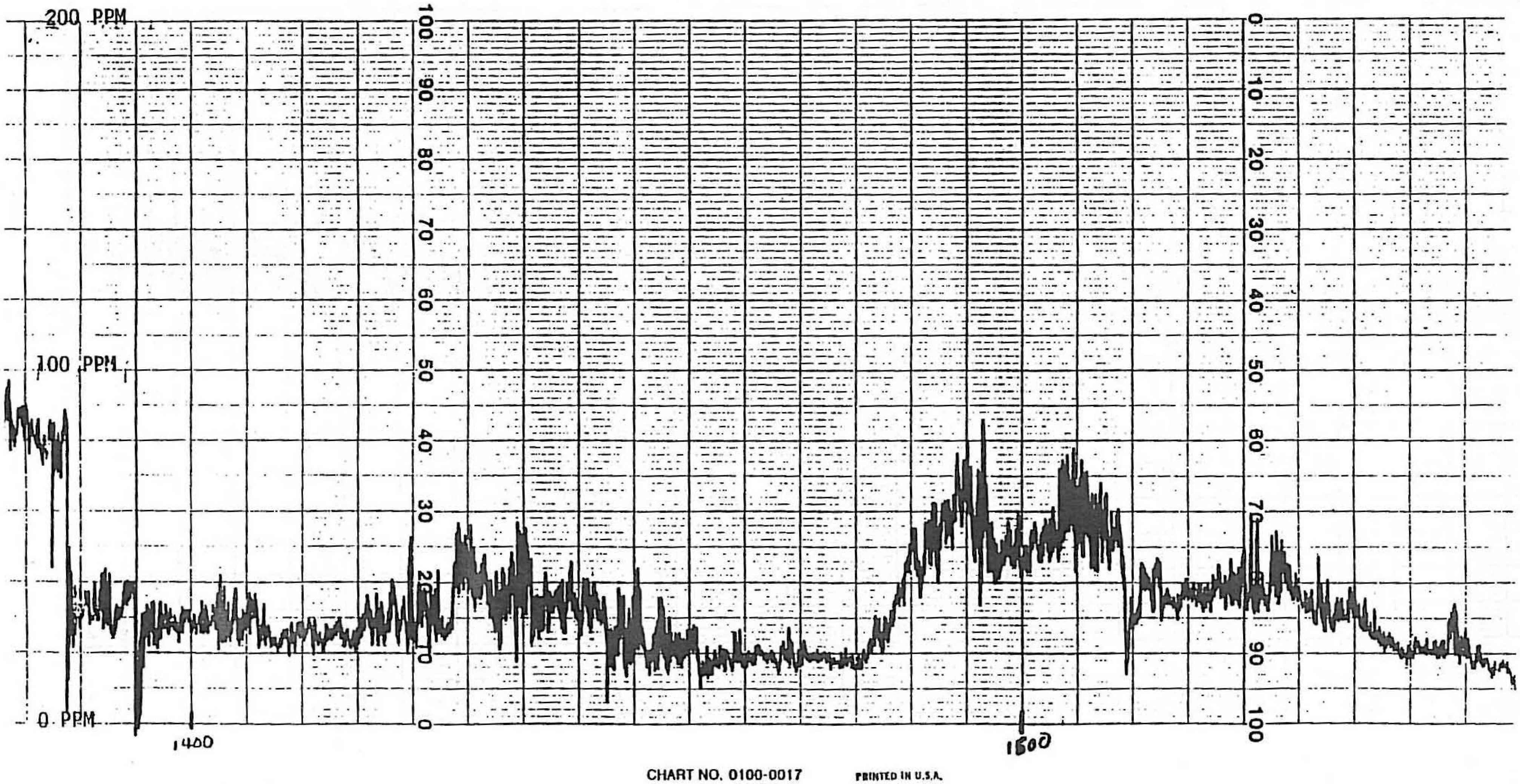
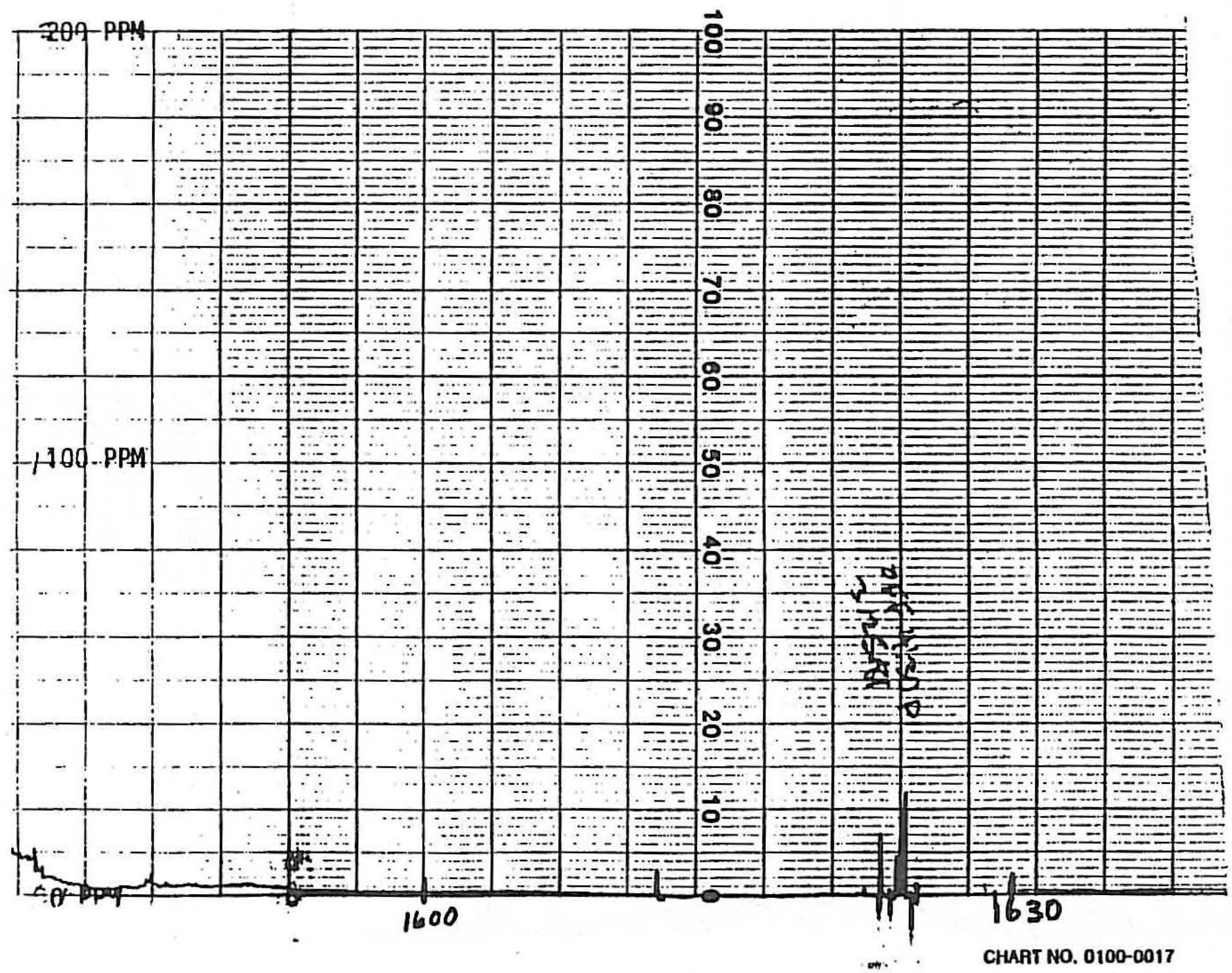
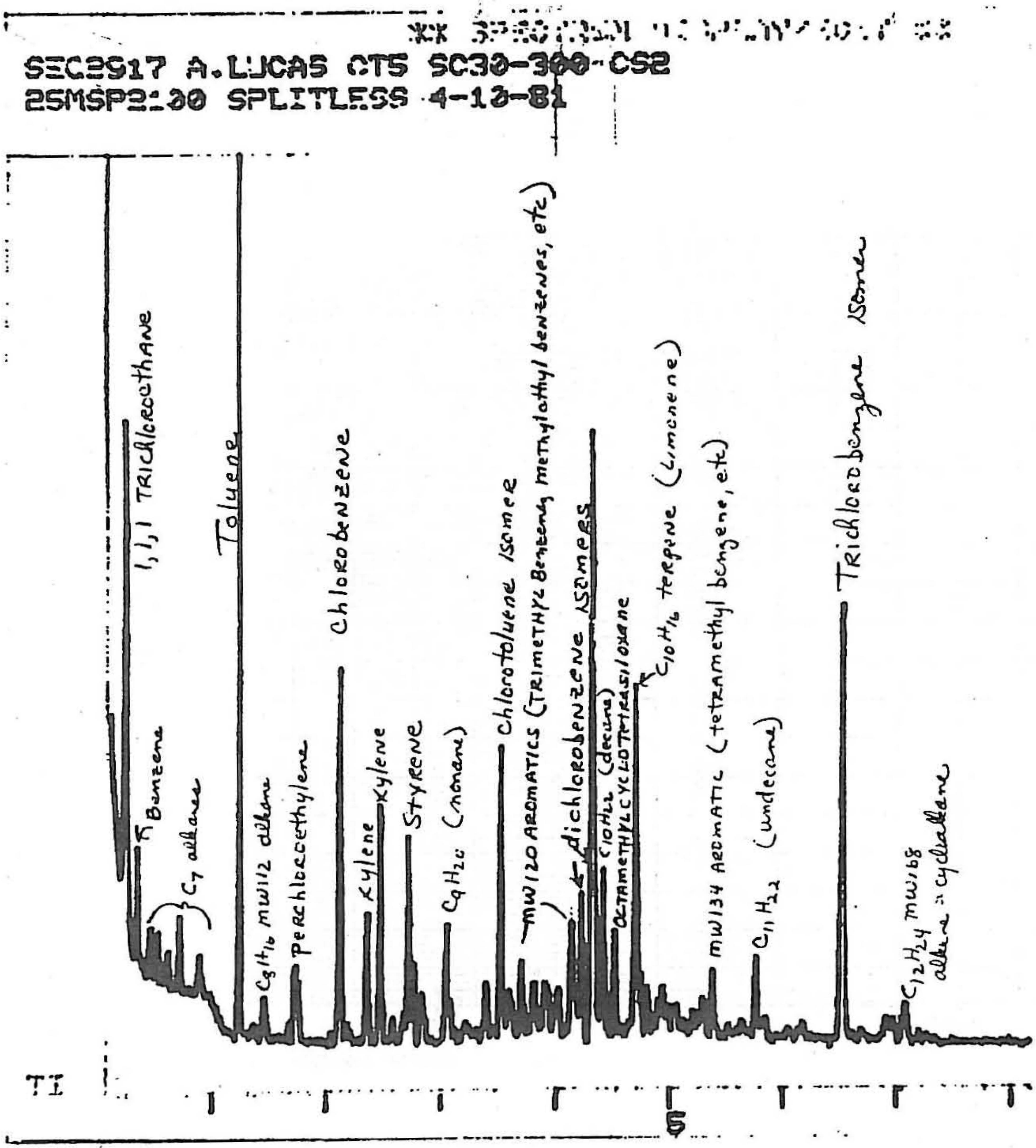

200 PPM
100 PPM
0 PPM
1400
1600
CHART NO. 0100-0017
PRINTED IN U.S.A.

FIGURE 2 CONTINUED





FRN 5999
1

Seg 2917
CT-5 / CS_2 desorbed

FIGURE 3: RECONSTRUCTED CHROMATOGRAM FROM MASS SPECTRAL ANALYSIS BAR SCREEN AREA
MARCH 25, 1981 1645 - 2224
METROPOLITAN SEWER DISTRICT
CINCINNATI, OHIO
HETA 81-240

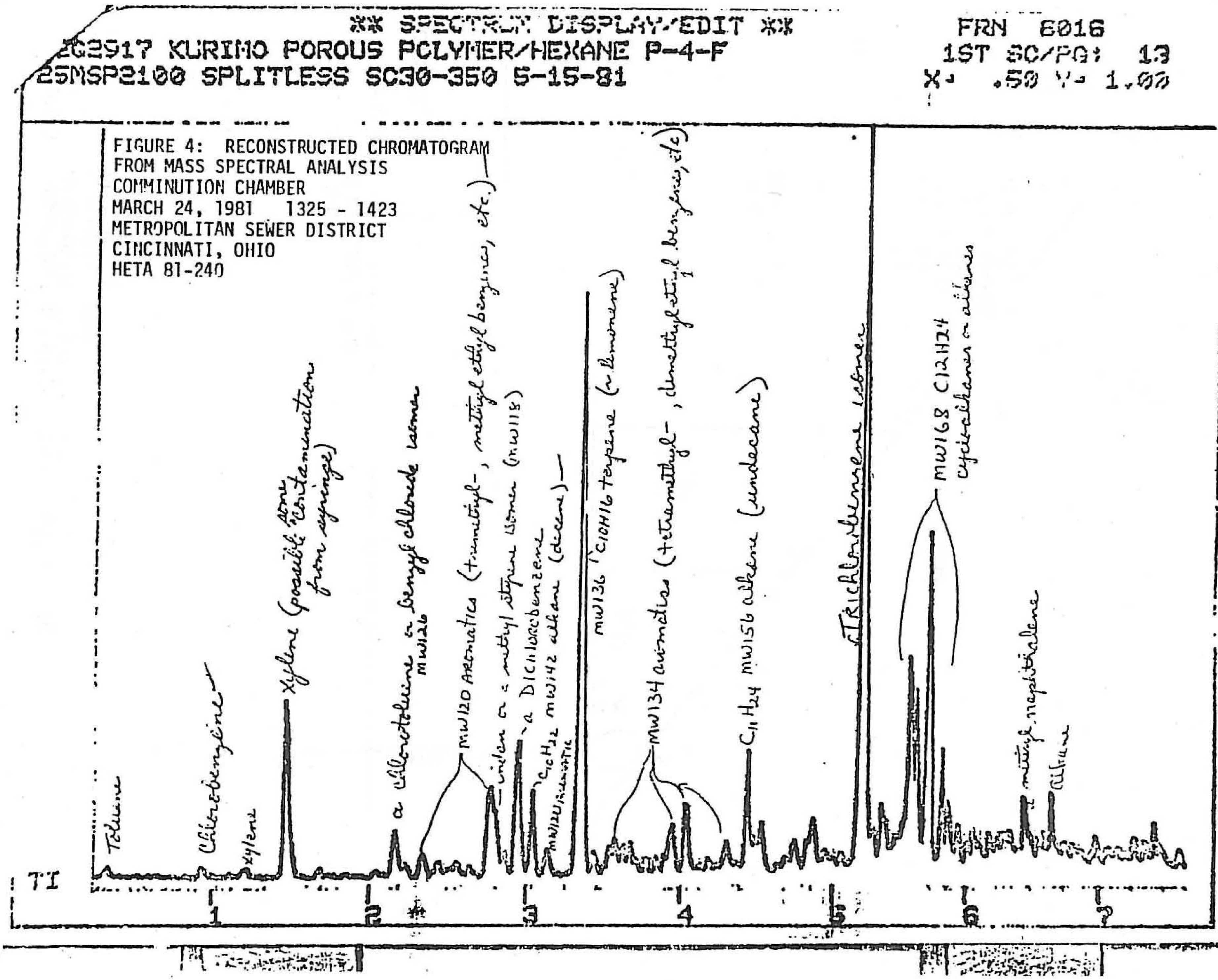
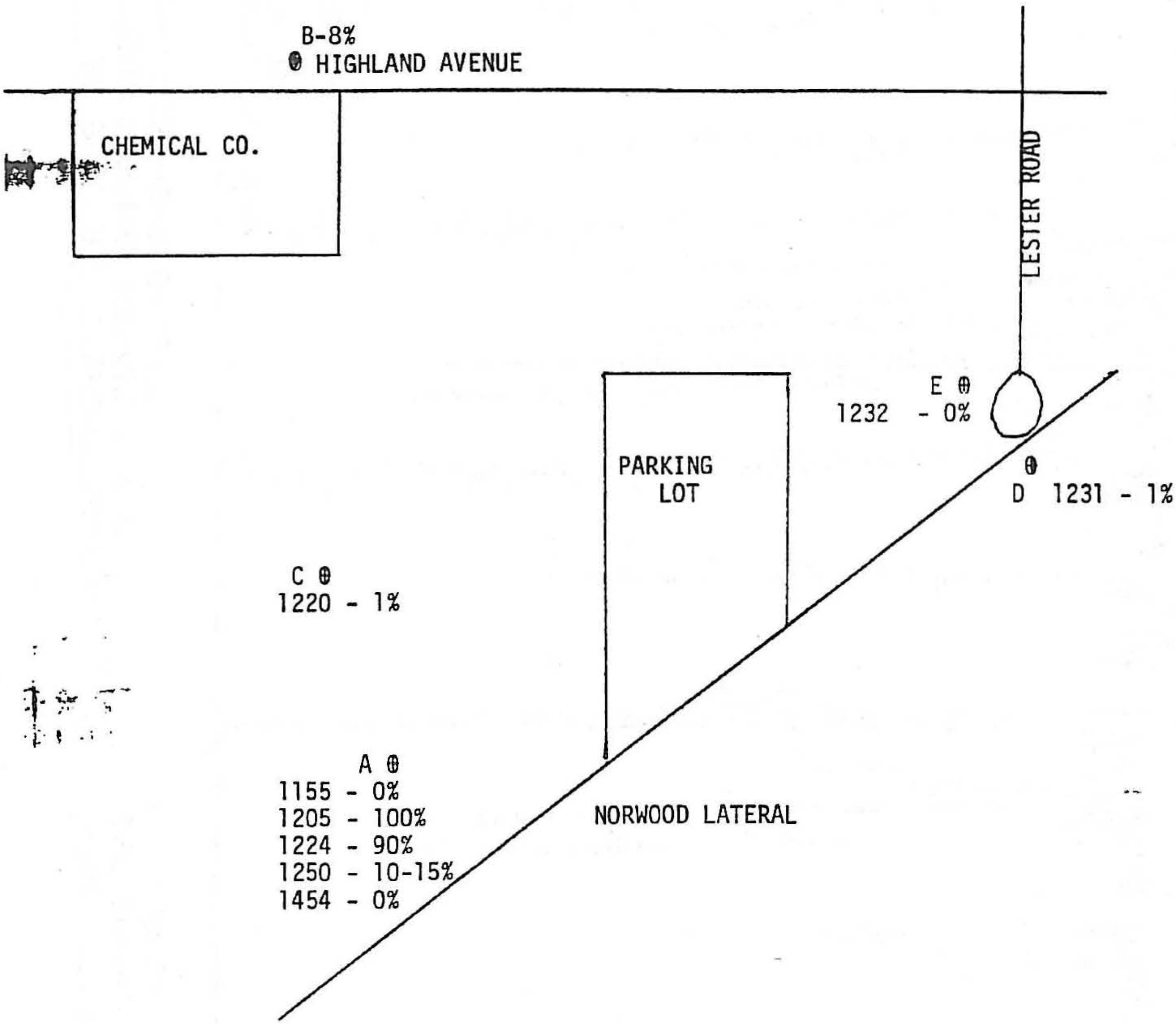


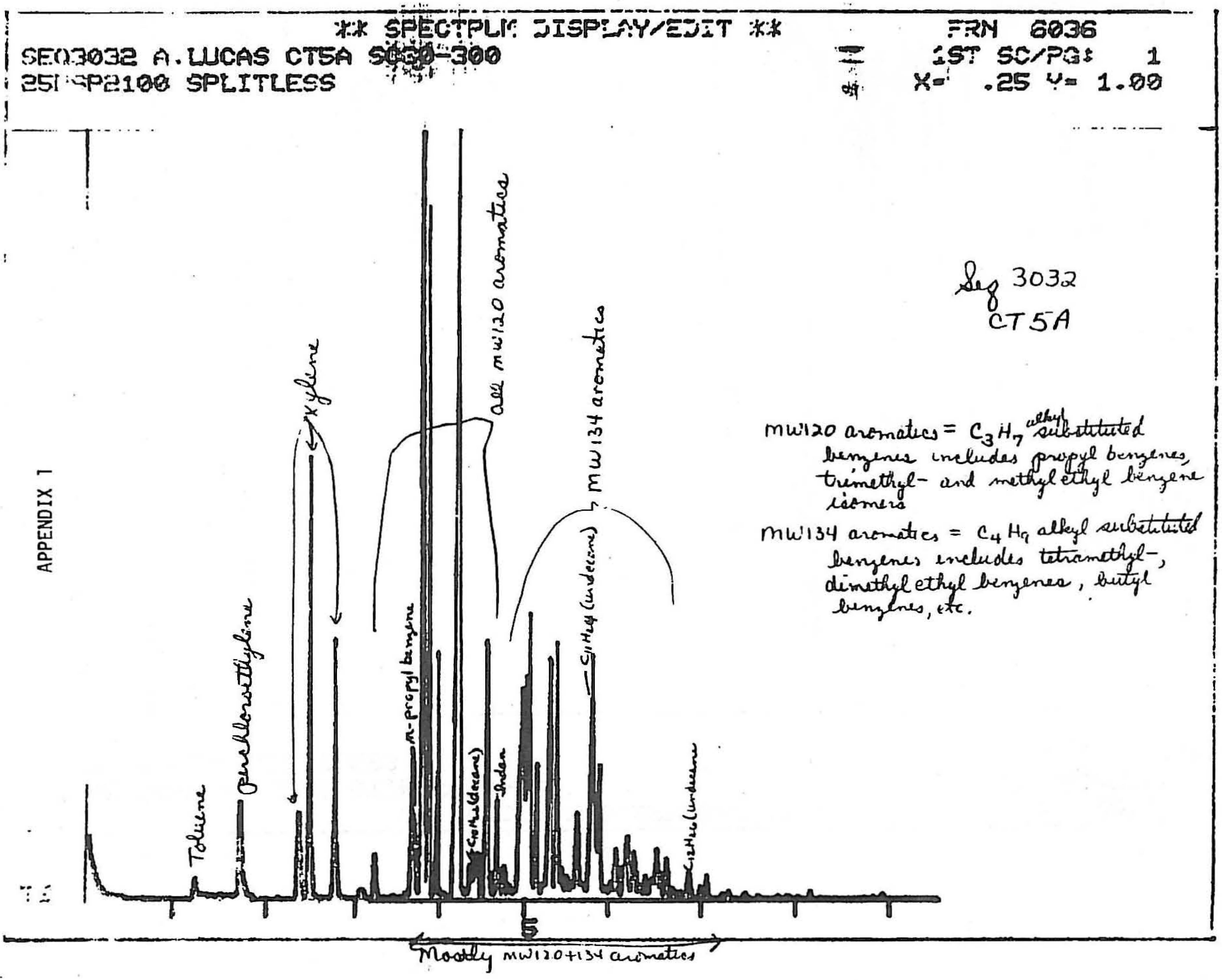
FIGURE 4: RECONSTRUCTED CHROMATOGRAM
FROM MASS SPECTRAL ANALYSIS
COMMINUTION CHAMBER
MARCH 24, 1981 1325 - 1423
METROPOLITAN SEWER DISTRICT
CINCINNATI, OHIO
HETA 81-240

FIGURE 5: COMBUSTIBLE GAS METER SURVEY - JUNE 15, 1981
METROPOLITAN SEWER DISTRICT
CINCINNATI, OHIO
HETA 81-240



*All numbers expressed as % of lower explosive limit.

APPENDIX 1


** SPECTRUM DISPLAY/EDIT **
FRN 6036
SEQ3032 A.LUCAS CT5A S030-300
1ST SC/PG: 1
25I SP2100 SPLITLESS
X= .25 Y= 1.00
Seq 3032
CT5A
MW120 aromatics = C_3H_7 alkyl substituted benzenes includes propyl benzenes, trimethyl- and methyl ethyl benzene isomers
MW134 aromatics = C_4H_9 alkyl substituted benzenes includes tetramethyl-, dimethyl ethyl benzenes, butyl benzenes, etc.
Toluene
perchloroethylene
xylene
n-propyl benzene
$C_{10}H_{22}$ (decane)
Indan
all MW120 aromatics
MW134 aromatics
$C_{11}H_{24}$ (undecane)
$C_{12}H_{26}$ (undecene)
5
Mostly MW120+134 aromatics

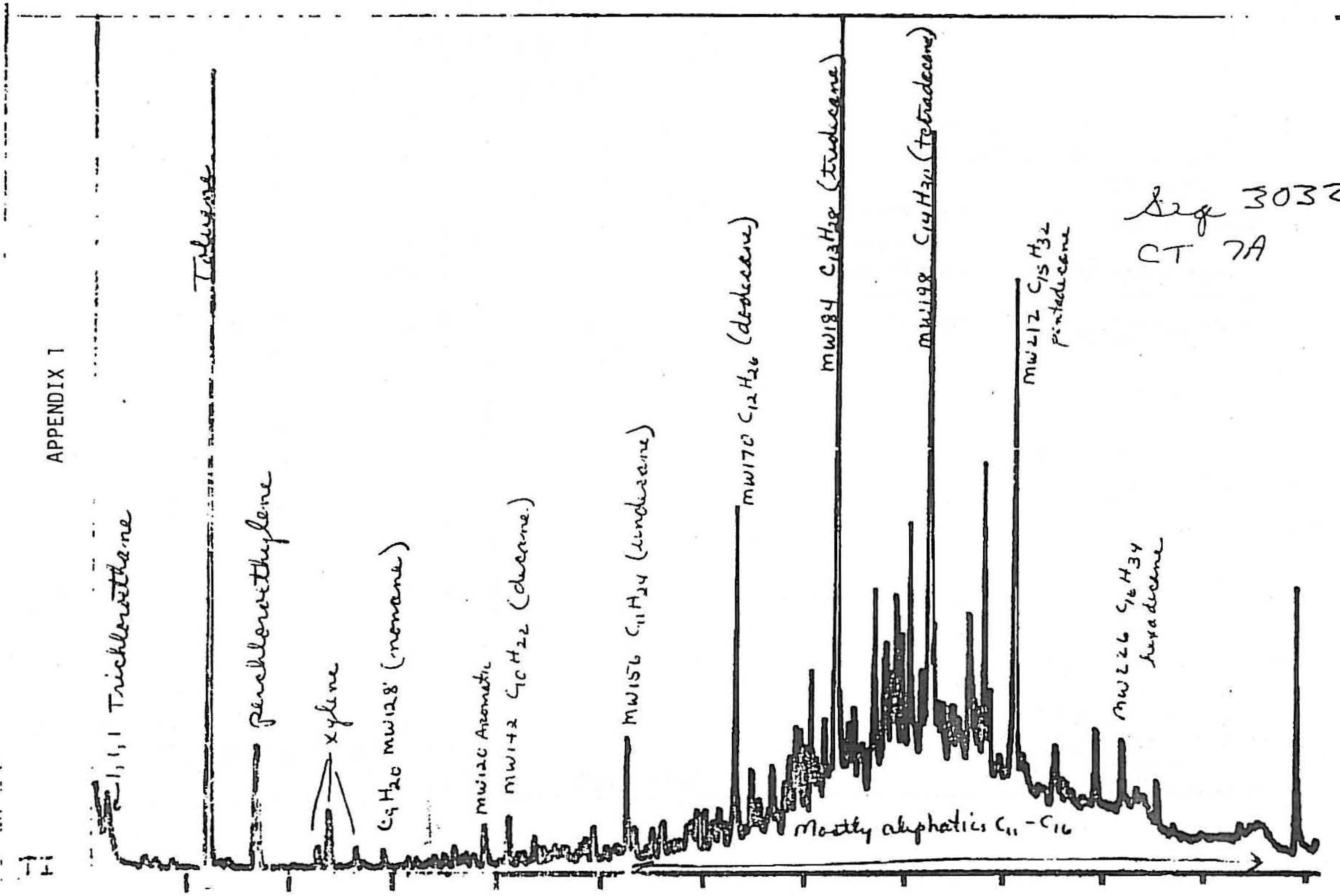
** SPECTRUM DISPLAY/EDIT **

FRN 6035

SEQ3032 A.LUCAS CT7A SC30-300 — 1ST SC/PG: 1

25M SP2100 SPLITLESS 6-22-81 — X= .25 Y= 1.00

APPENDIX I

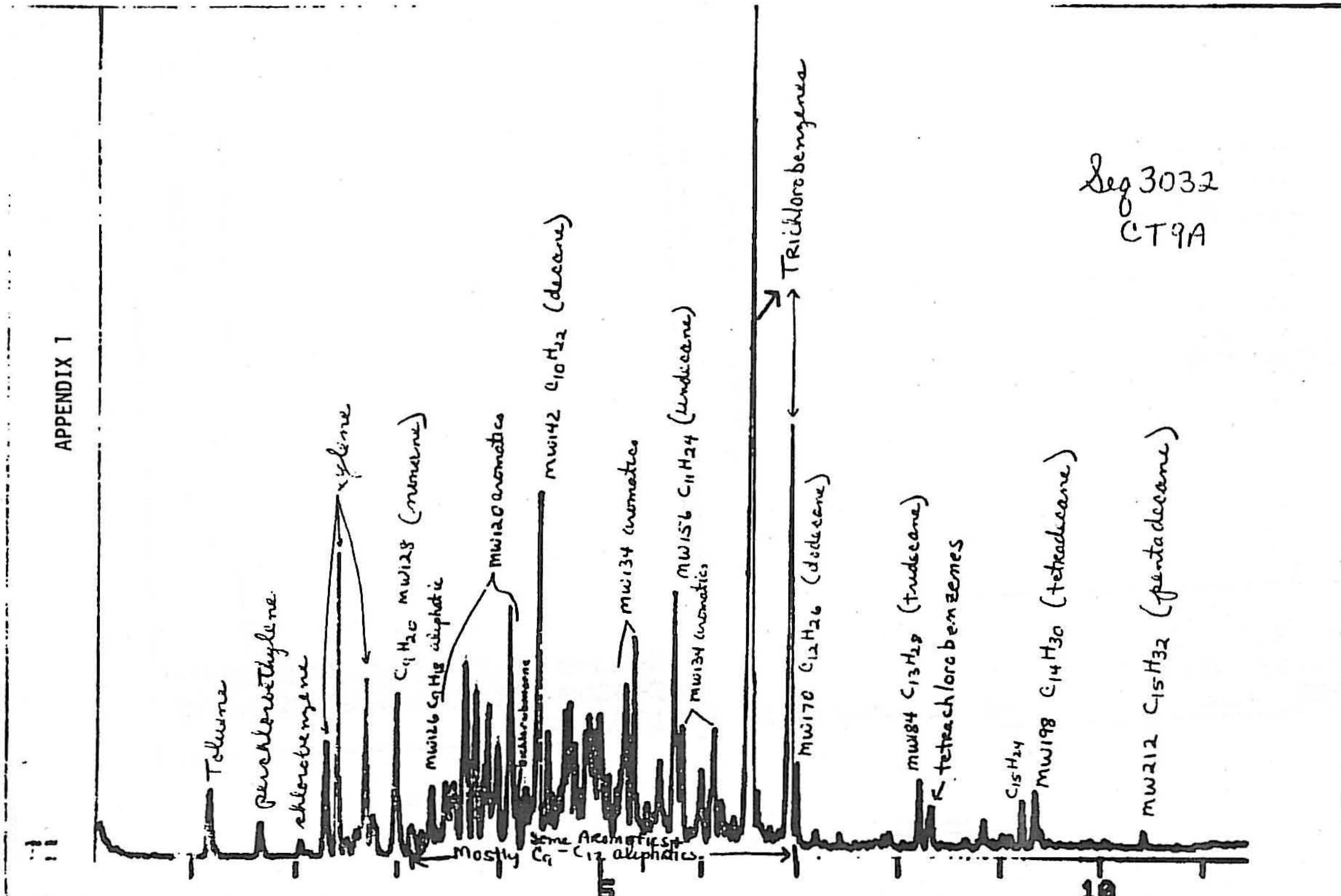


APPENDIX 1

** SPECTRUM DISPLAY/EDIT **

SEG3032 A.LUCAS CT9A SC30-300
25MSP2100 SPLITLESS 6-25-81

FRN 6041
1ST SC/PG: 1
X= .25 Y= 1.00

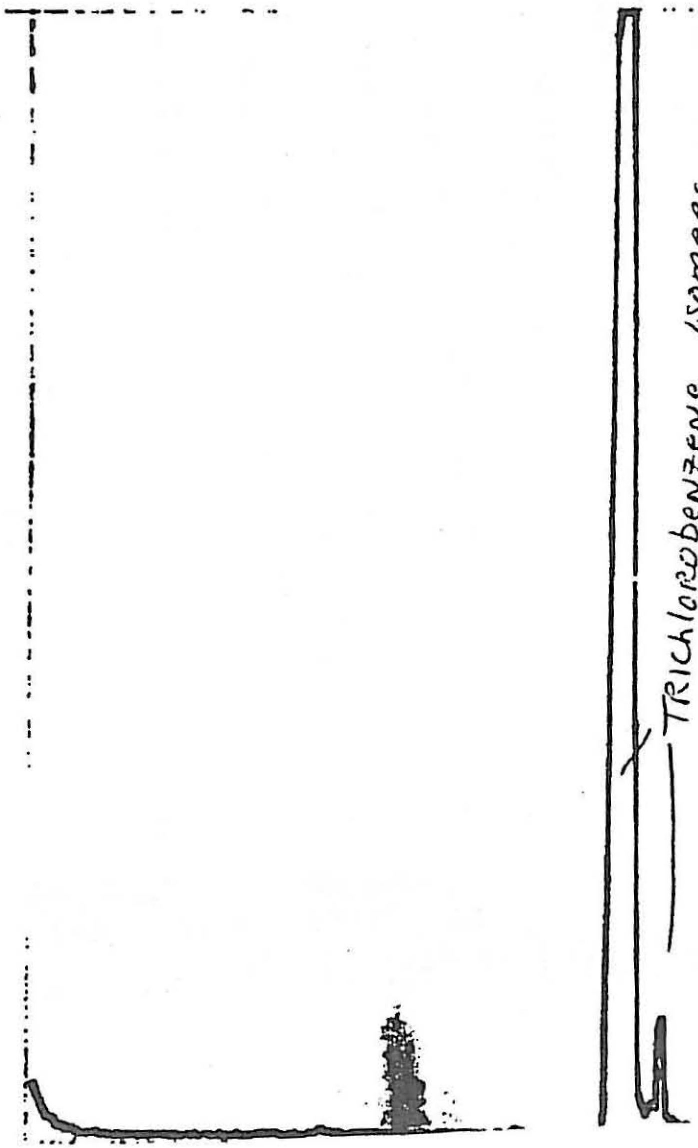


** SPECTRUM DISPLAY/EDIT ** FRN 6045

SEQ3032 CT8A A.LUCAS SC30-300 1ST SC/PG: 1

25MSP2100 SPLITLESS 6-25-81 X= .53 Y= 2.00

APPENDIX 1



Seq 3032
CT8A

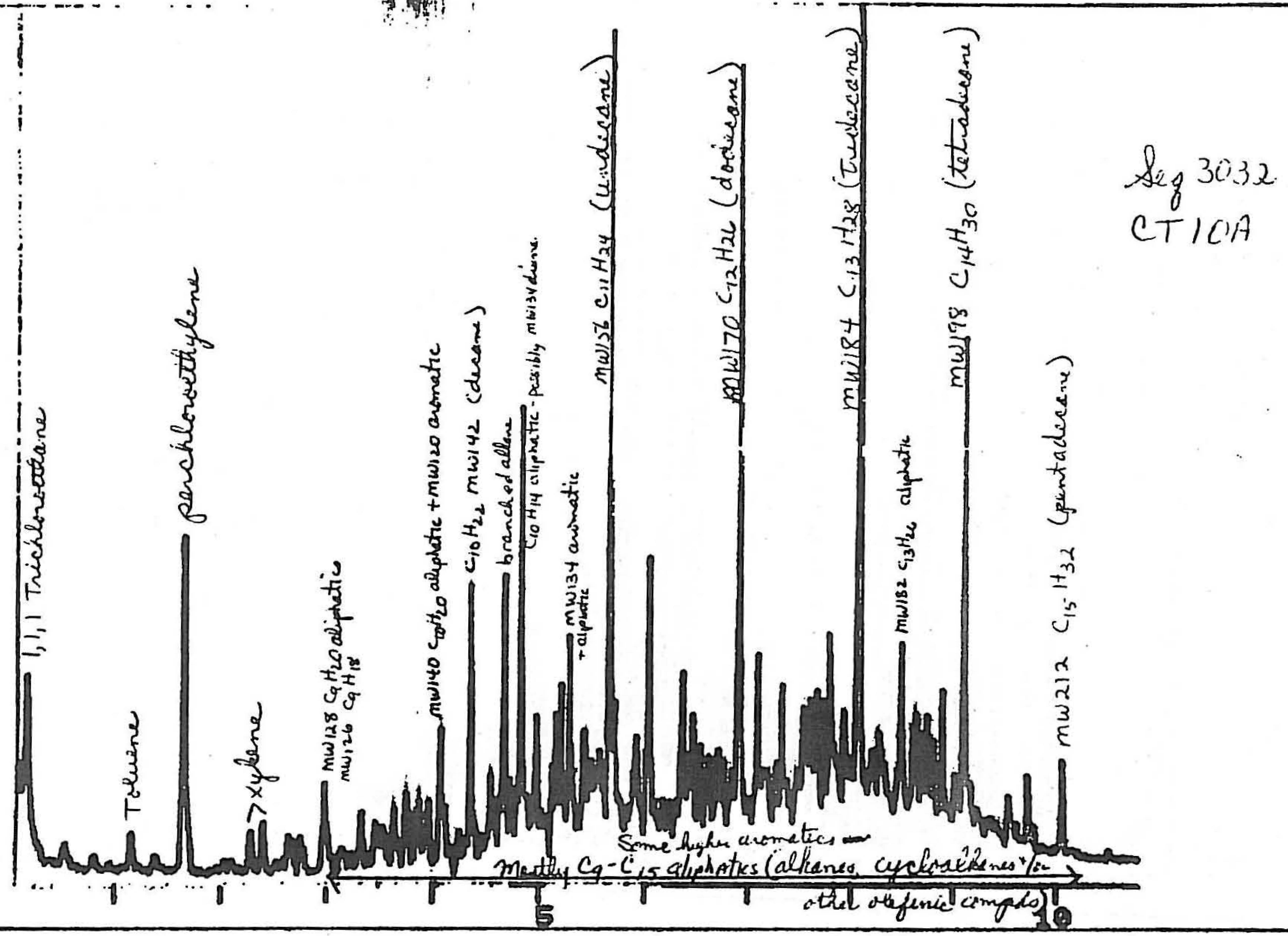
Backup section of 8A also contained trichlorobenzenes only

** DISPLAY/ ** — FRN 6044

SEQ3032 A.LUCAS CT10A 9030-300 1ST SC/PG: 1

25MSP2100 SPLITLESS 6-8 X= .25 Y= 1.00

APPDENIX 1



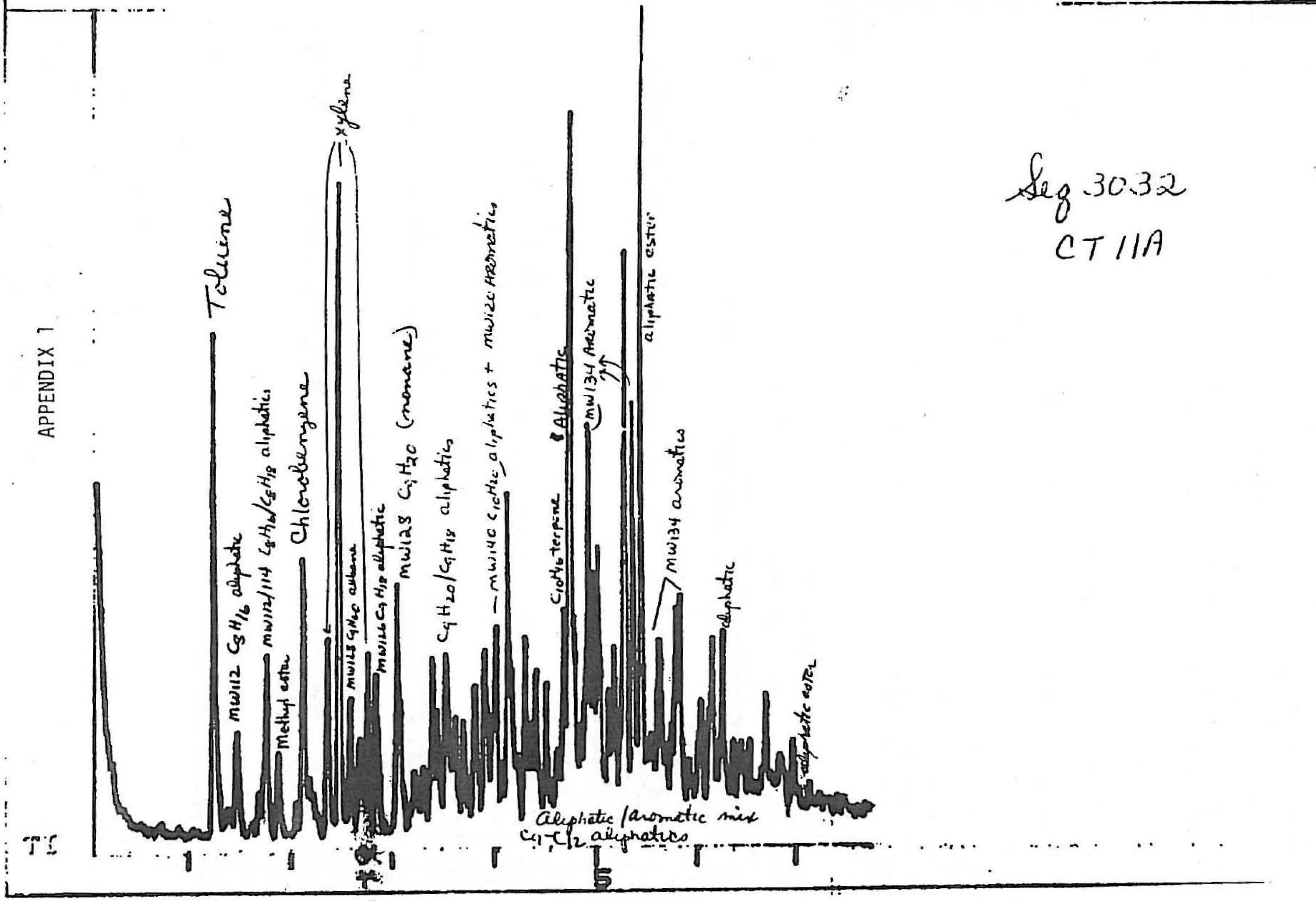
** SPECTRUM DISPLAY/EDIT **

SEQ3032 A.LUCAS CT11A SC30-300
25MSP2100 SPLITLESS 6-25-81

FRN 6043
1ST SC/PG: 1
X= .25 Y= 1.00

Seq 3032
CT 11A

APPENDIX 1

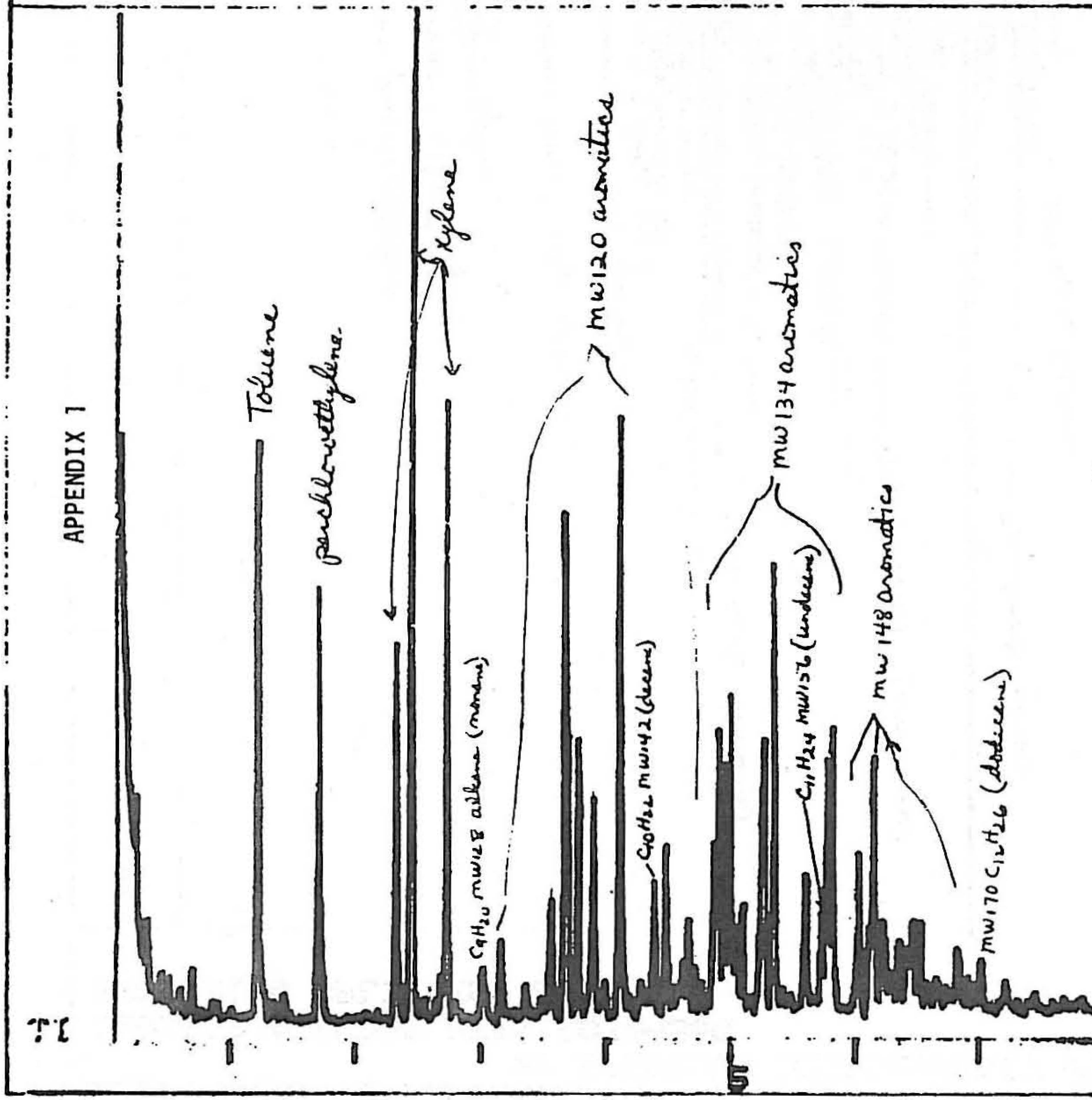


** SPECTRUM DISPLAY/EDIT **

SEQ3032 CT12A A.LUCAS [illegible]C30-300
25MSP2100 SPLITLESS 6-[illegible]-81

FRN 6042
1ST SC/PG: 1
X= .25 Y= 1.00

APPENDIX 1



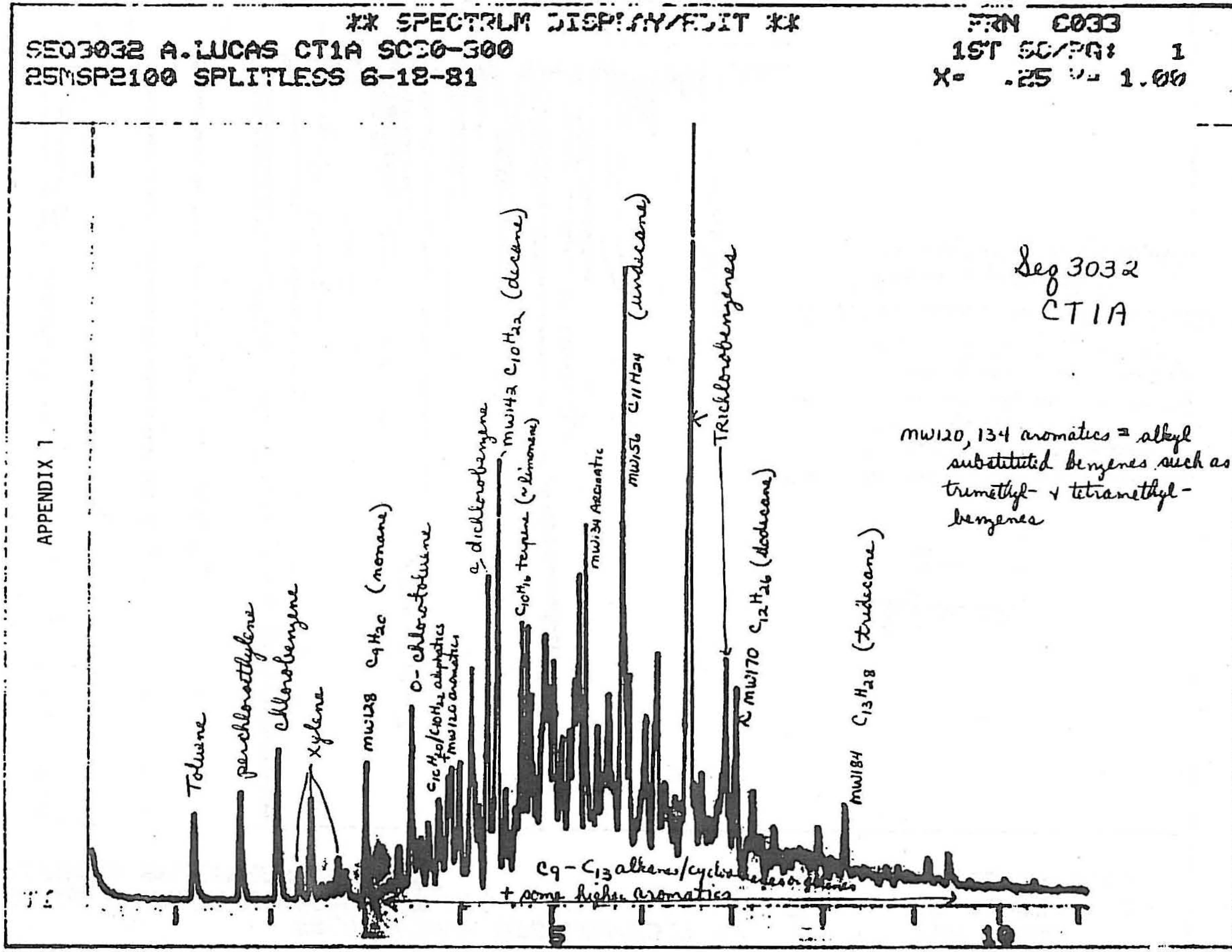
Seq 3032
CT12A

MW120 aromatics: C_3H_7 alkyl substituted benzenes (trimethyl- (propyl), methyl ethyl benzenes, etc)

MW134 aromatics: C_4H_9 alkyl substituted benzenes (tetramethyl-, dimethyl ethyl-, butyl benzenes, etc)

MW148 aromatics: C_5H_{11} alkyl substituted benzenes (pentamethyl-, trimethyl ethyl benzenes, etc)

APPENDIX 1


** SPECTRUM DISPLAY/EDIT **
FRN C033
SEQ3032 A.LUCAS CT1A SC30-300
25MSP2100 SPLITLESS 6-18-81
1ST SC/PG: 1
X= .25 Y= 1.00
Seq 3032
CT1A
mw120, 134 aromatics = alkyl substituted benzenes such as trimethyl- + tetramethyl-benzenes
Toluene
perchloroethylene
chlorobenzene
xylene
MW128 C_9H_{20} (nonane)
o-chlorotoluene
$C_{10}H_{20}$/$C_{10}H_{22}$ aliphatics + MW120 aromatics
o-dichlorobenzene
MW142 $C_{10}H_{22}$ (decane)
$C_{10}H_{16}$ terpene (~limonene)
MW134 AROMATIC
MW156 $C_{11}H_{24}$ (undecane)
Trichlorobenzenes
MW170 $C_{12}H_{26}$ (dodecane)
MW184 $C_{13}H_{28}$ (tridecane)
C_9 – C_{13} alkanes/cycloalkanes or olefines
+ some higher aromatics
5
10

** SPECTRUM DISPLAY/EDIT **

FRN 6029

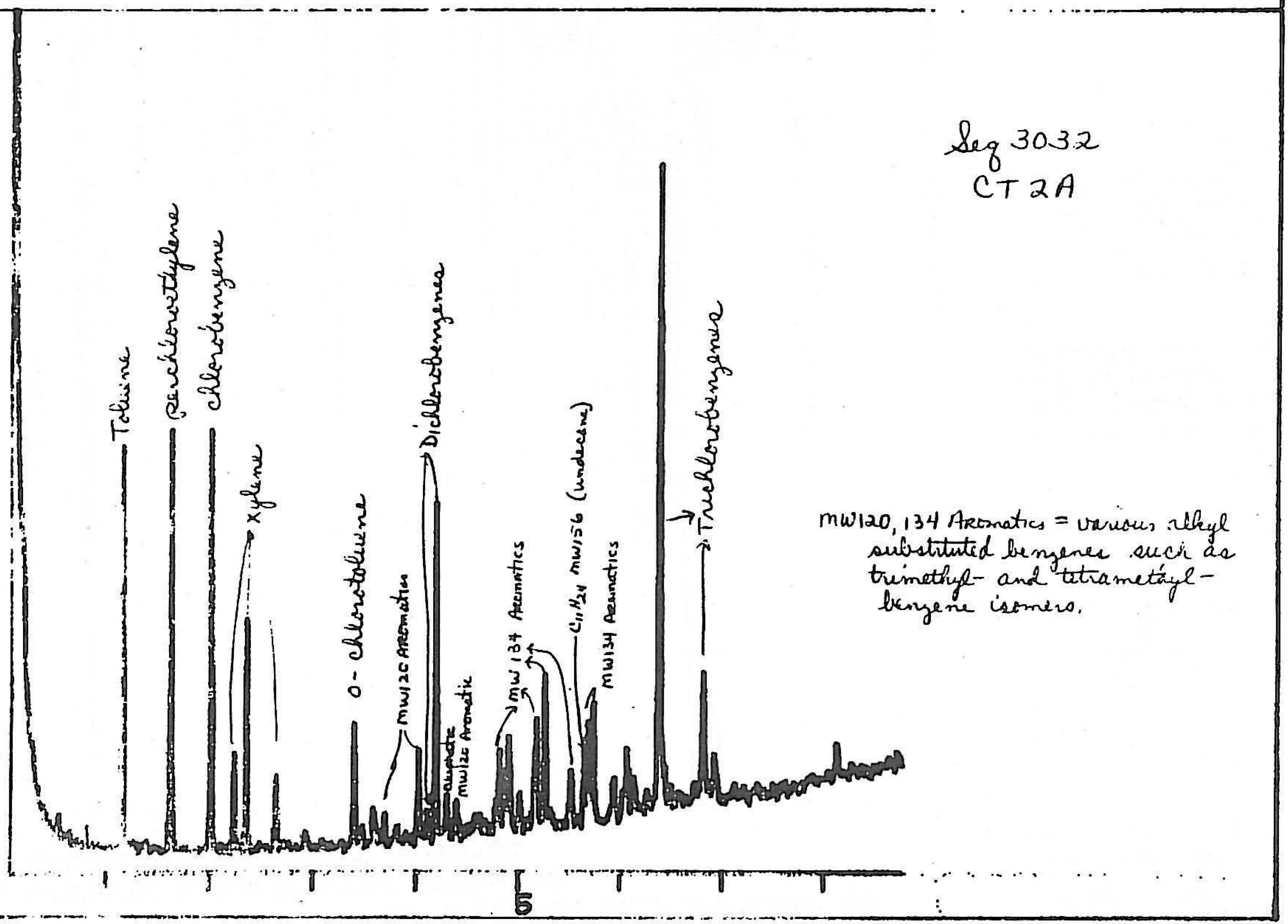
SEG3032 .LUCAS CT2A S030-360

1ST SC/PG: 1

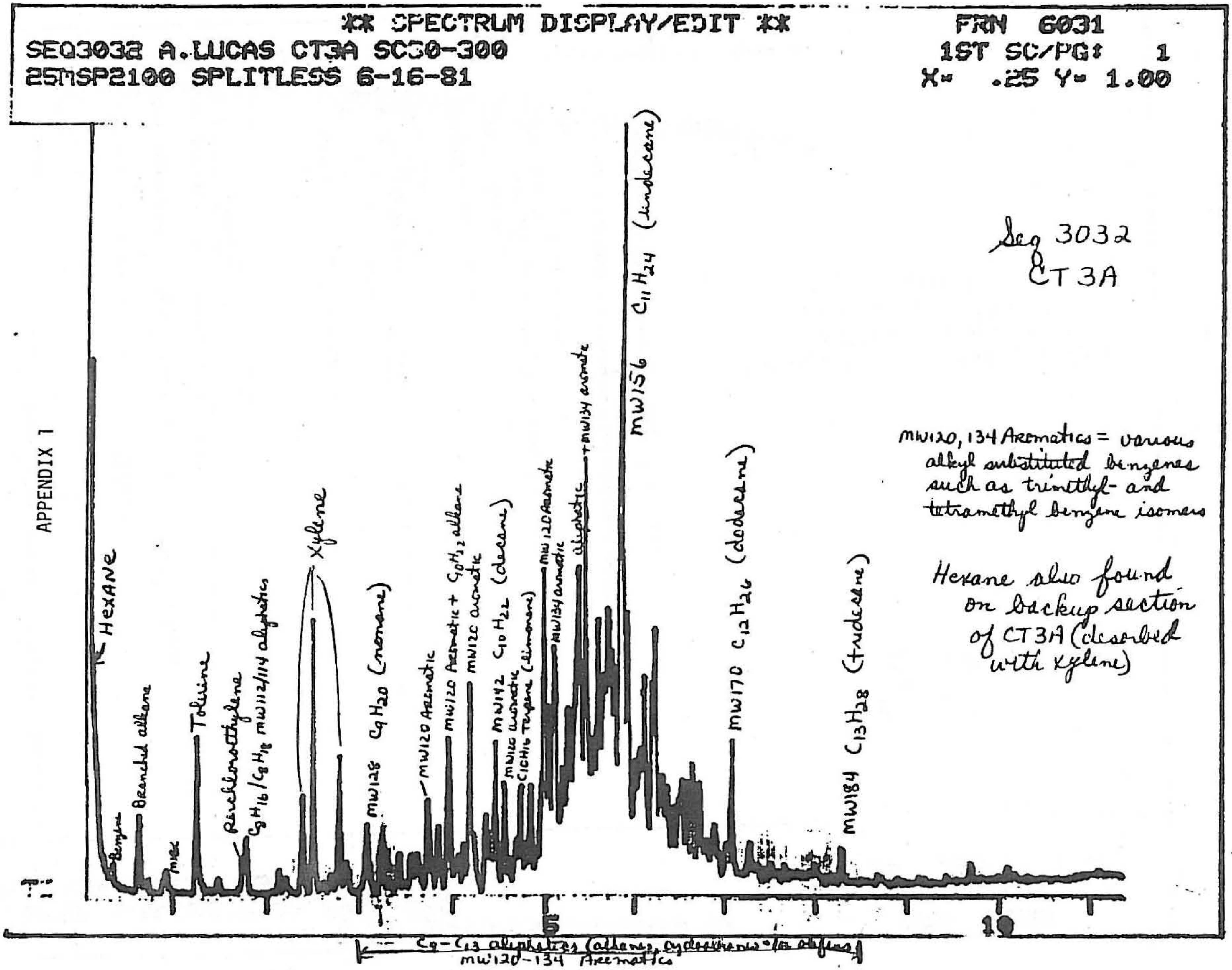
5MSH?10 SPLITLESS 6-1?-81

X= .25 Y= 1.00

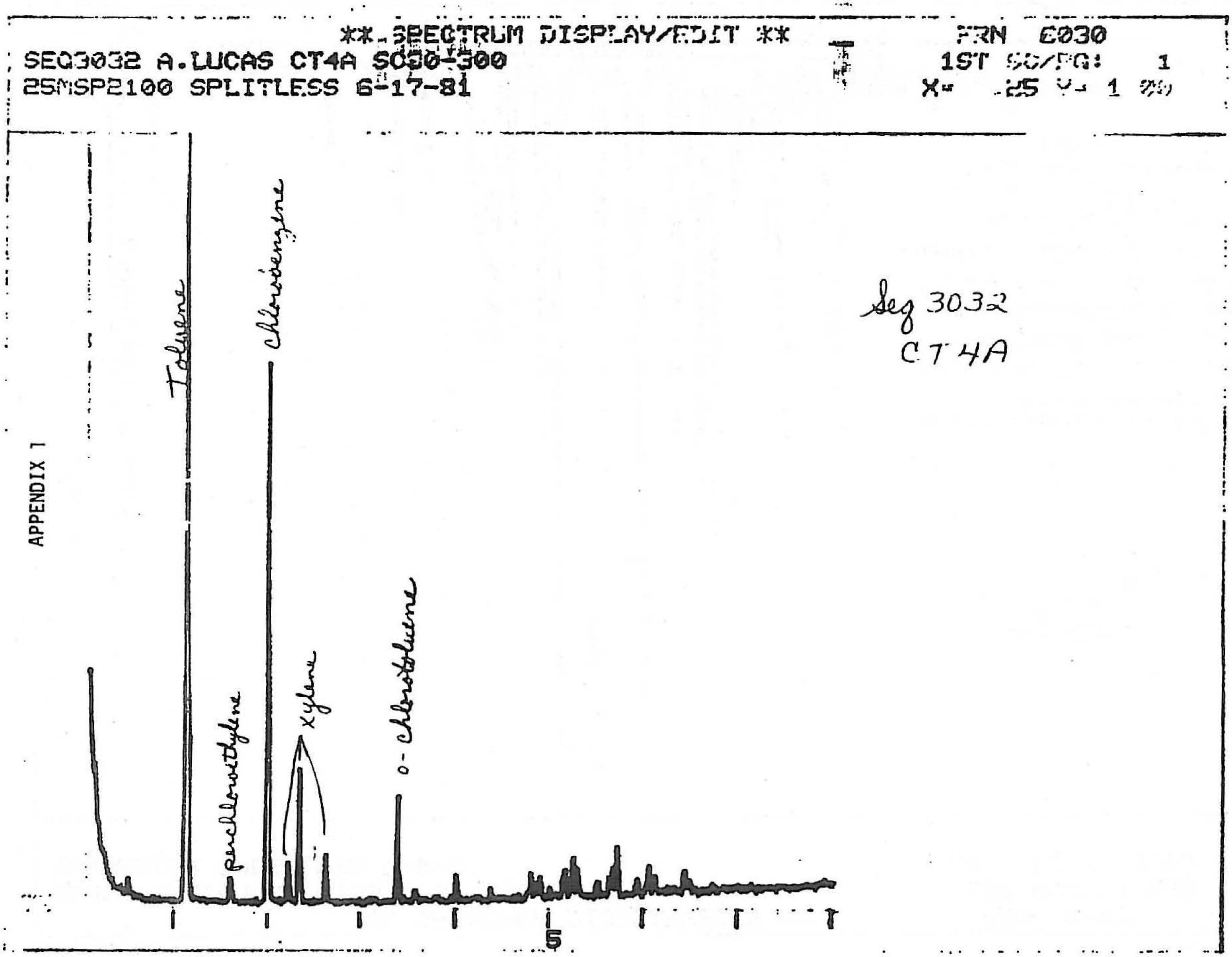
APPENDIX 1



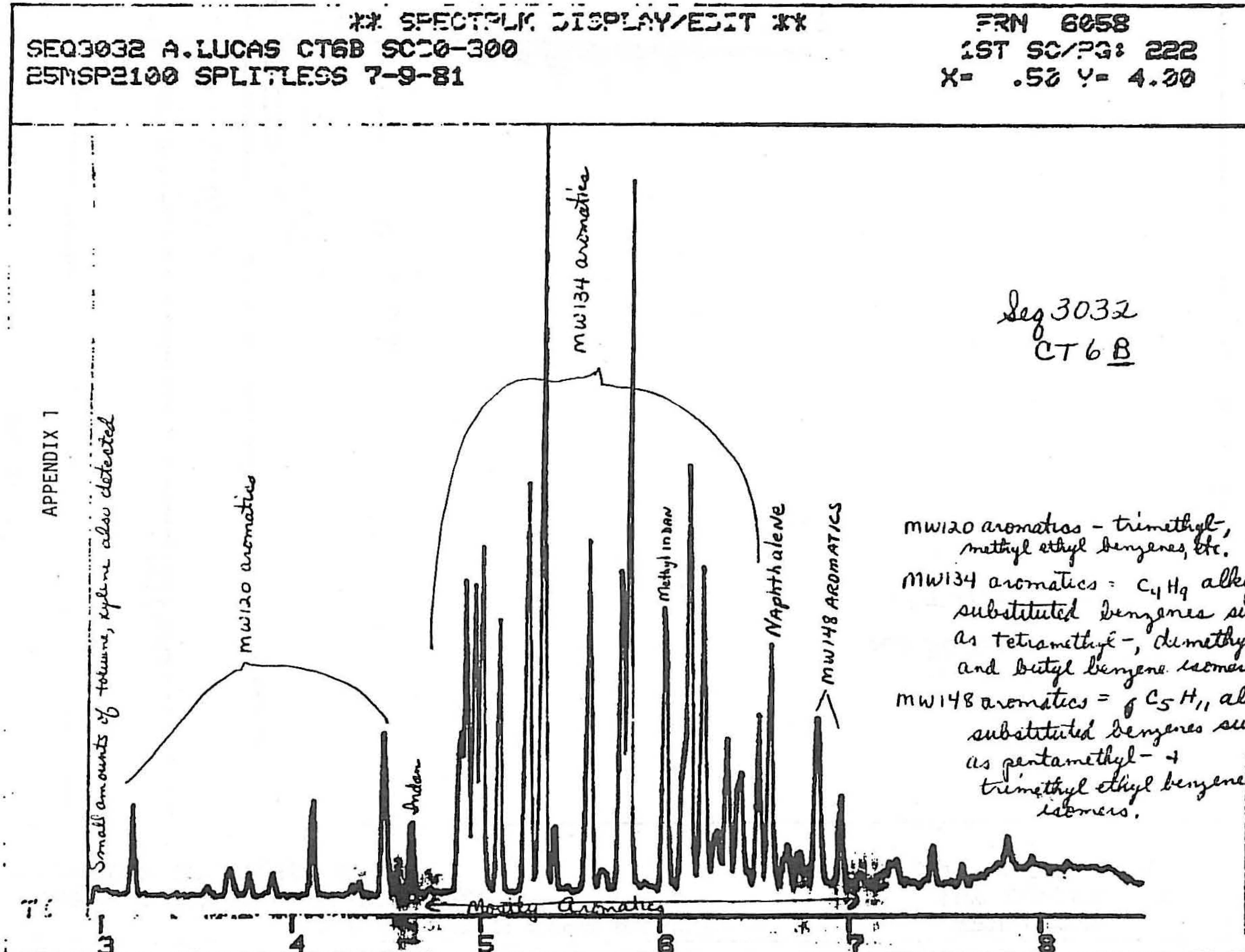
APPENDIX 1


** SPECTRUM DISPLAY/EDIT **
SEQ3032 A.LUCAS CT3A SC30-300
25MSP2100 SPLITLESS 6-16-81
FRN 6031
1ST SC/PG# 1
X= .25 Y= 1.00
Seq 3032
CT3A
HEXANE
Benzene
Branched alkane
MEK
Toluene
Perchloroethylene
C9H16/C9H18 MW112/114 aliphatic
Xylene
MW128 C9H20 (nonane)
MW120 Aromatic
MW120 Aromatic + C10H22 alkane
MW120 aromatic
MW142 C10H22 (decane)
MW120 aromatic
C10H16 Terpene (limonene)
MW120 Aromatic
MW134 aromatic
aliphatic
+ MW134 aromatic
MW156 C11H24 (undecane)
MW170 C12H26 (dodecane)
MW184 C13H28 (tridecane)
MW120, 134 Aromatics = various alkyl substituted benzenes such as trimethyl- and tetramethyl benzene isomers
Hexane also found on backup section of CT3A (desorbed with xylene)
5
10
C9 - C13 aliphatics (alkanes, cycloalkanes, olefins)
MW120-134 Aromatics

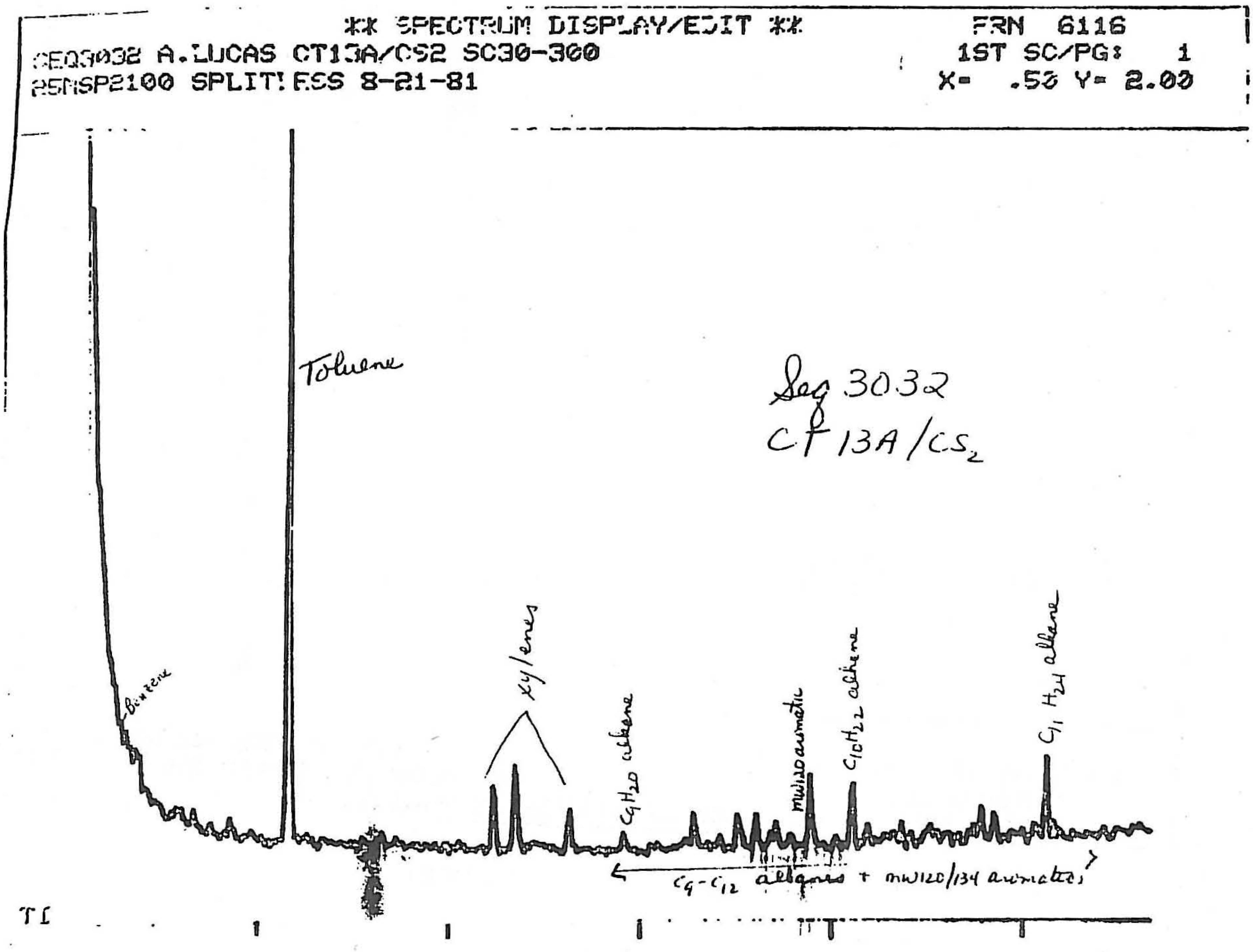
APPENDIX 1


**.SPECTRUM DISPLAY/EDIT **
FRN E030
SEQ3032 A.LUCAS CT4A SO30-300
1ST SC/PG: 1
25MSP2100 SPLITLESS 6-17-81
X= .25
Toluene
perchloroethylene
Chlorobenzene
xylene
o-Chlorotoluene
5
Seq 3032
CT4A

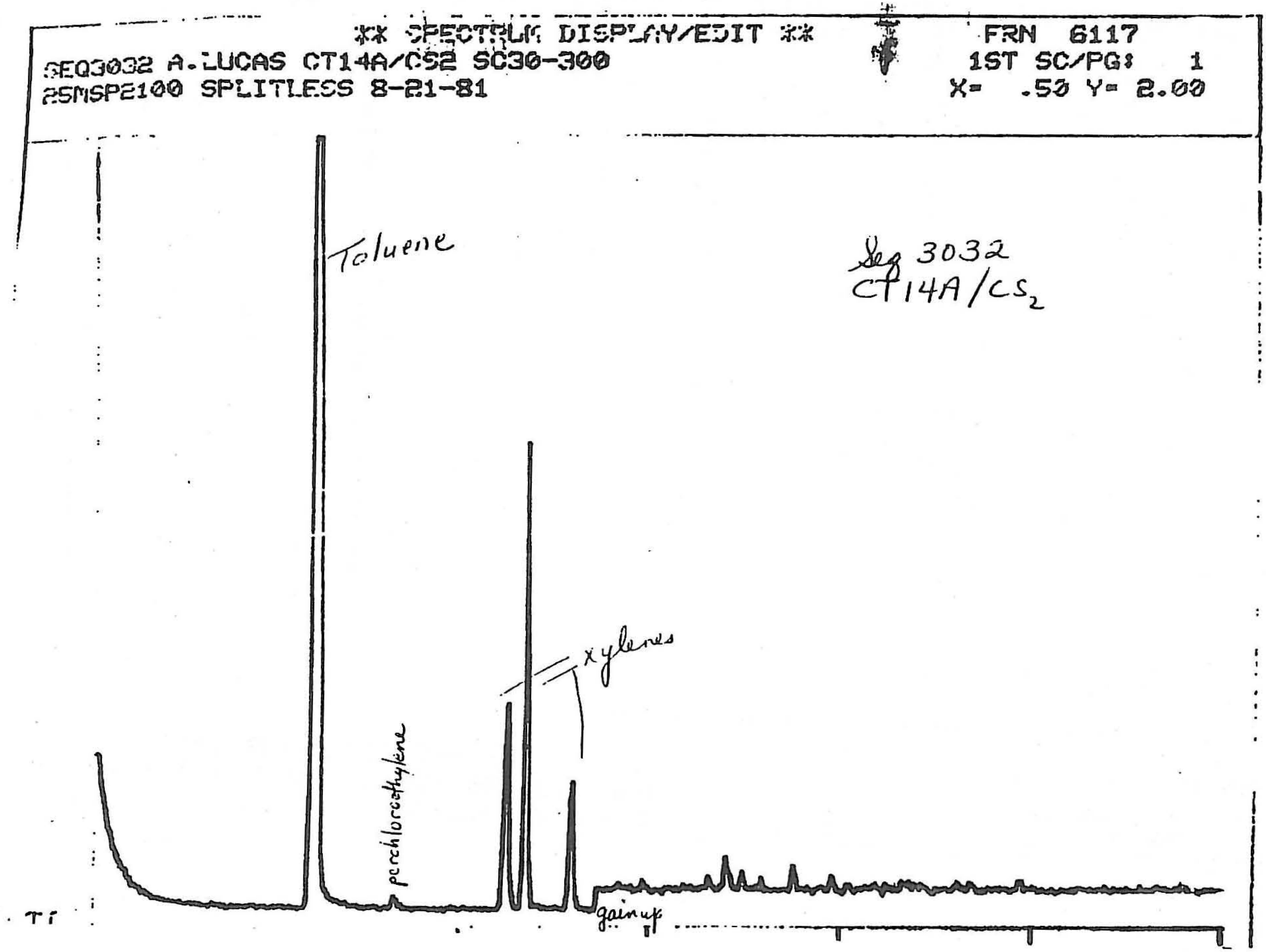
APPENDIX 1



** SPECTPLK DISPLAY/EDIT **
SEQ3032 A.LUCAS CT6B SC30-300
25MSP2100 SPLITLESS 7-9-81
FRN 6058
1ST SC/PG: 222
X= .52 Y= 4.00
Seq 3032
CT 6 B
Small amounts of toluene, xylene also detected
MW120 aromatics
Indan
MW134 aromatics
Methyl indan
Naphthalene
MW148 AROMATICS
Mostly Aromatics
MW120 aromatics - trimethyl-, methyl ethyl benzenes, etc.
MW134 aromatics = C_4H_9 alkyl substituted benzenes such as tetramethyl-, dimethyl ethyl-, and butyl benzene isomers
MW148 aromatics = C_5H_{11} alkyl substituted benzenes such as pentamethyl- + trimethyl ethyl benzene isomers.
3
4
5
6
7
8


** SPECTRUM DISPLAY/EDIT **
FRN 6116
CEQ3032 A.LUCAS CT13A/CS2 SC30-300
1ST SC/PG: 1
25MSP2100 SPLITLESS 8-21-81
X= .53 Y= 2.00
Toluene
Seq 3032
CT 13A/CS_2
Benzene
xylenes
C_9H_{20} alkane
MW120 aromatic
$C_{10}H_{22}$ alkane
$C_{11}H_{24}$ alkane
C_9-C_{12} alkanes + MW120/134 aromatics
TI

APPENDIX 1


** SPECTRUM DISPLAY/EDIT **
FRN 6117
SEQ3032 A.LUCAS CT14A/CS2 SC30-300
1ST SC/PG: 1
25MSP2100 SPLITLESS 8-21-81
X= .50 Y= 2.00
Toluene
Seq 3032
CT14A/CS2
xylenes
perchloroethylene
gain up
TI

APPENDIX 2

FIGURE 1.

DESCRIPTION

The Robertshaw Air Capsule is an emergency escape device that provides the user with a continuous 5 minute air supply through a transparent hood. In an emergency, a trained user can activate and don an Air Capsule in less than 10 seconds.

Breathing air is stored in a double coil of stainless steel tubing at an operating pressure of 5000 psig. The air flow from the reservoir to the hood is controlled and regulated by an air module. This mechanism contains the start/relief valve, the pressure and flow regulator, and the pressure gage/ recharging fill port.

The hood is made of polyurethane material and has an elastic neck band that stretches to a circumference of 28" to allow donning over beards and glasses, and will fit virtually all neck sizes. In use, the continuous air flow maintains a slight positive pressure in the hood, which prevents the entry of toxic fumes or smoke. This flow of cool air also helps to prevent fogging or overheating of the hood.

The unit is stored in a strong plastic case with a webbed nylon hinge and Velcro latch that provide a sparkless closure for use in potentially explosive atmospheres. The case is also equipped with a shoulder strap, pressure gage view plate, and a tamper proof seal.

Wall brackets and storage boxes are also available for wall mounting Air Capsules. The bracket is for indoor use only and is spring loaded to facilitate rapid removal of the Air Capsule during an emergency. The storage box is for indoor and outdoor use and is equipped with a pressure gage view plate.

SPECIFICATIONS

Operating Pressure — 5000 ± 250 psig @ 70^{0}F
Breathing Gas — Gaseous air as set forth in CGA Commodity Specification G-7.1, Type 1, Grade D or higher quality
Flow Rate — 0.90 ± 0.07 SCFM @ 1000-5000 psig
Flow Duration — 5 minutes Minimum
Shelf Life — Reservoir coils - 3 years (If specified conditions are met)
Hood assembly - 2 years
Weight — 5.75 pounds

OPERATION

Six simple steps are used in actuating and donning the Air Capsule.

Figure 2.

1. Open the hard plastic case.

Figure 3.

2. Pull out the Air Capsule.

Figure 4.

3. Unfold the hood.

Figure 5.

4. Pull the start ring located on the end of the air reservoir. A slight tug will start the air flow.

Figure 6.

5. Slip the hood over the head. Start by pulling the hood over the back of the head so the reservoir will rest at the back of the neck.

Figure 7.

6. Adjust the elastic neckband, pull the drawstring tight, and breathe normally. The elastic neckband should touch the skin all around the neck to form a comfortable seal. The drawstring is elastic and should be extended approximately 12-18" during the "tightening" operation. The main purpose of the drawstring is to pull the pouch and reservoir against the back

When the sound of flowing air has diminished, or if the mask starts to collapse around the face, remove the hood as the air supply is deleted. Note: High work loads and heavy breathing may cause the hood to tend to collapse around the face during inhalation. As long as the hood reinflates during exhalation, the air supply is not depleted.

MISCELLANEOUS INFORMATION

1. Emergency Flame Protection: The Air Capsule will protect the face from open flame for a short period of time; however, IT IS NOT A FIRE FIGHTING DEVICE. If caught in a flash fire while wearing the device, or if it is necessary to run through a short flame zone, the Air Capsule will function normally and protect the face for approximately 5 seconds. THE AIR CAPSULE IS APPROVED FOR ESCAPE ONLY.
2. Water Immersion: Compartments flooded with water may be crossed while wearing an Air Capsule. The inflated hood will provide buoyancy to keep the user's head above water without hindering the ability to swim.
3. Hood Damage: If the hood is accidentally ripped or punctured during escape, there is a possibility of smoke entering the hood. Holes can be closed to some extent by pinching the plastic around the hole with the fingers.
4. Smoke in the hood: If the Air Capsule is donned in a smoke filled area, some smoke may get into the hood during the donning procedure. The user should hold his breath for a few seconds to give the unit time to purge the smoke.
5. Accidental Start: The Air Capsule cannot be shut off after the air flow has been started. If the start ring is accidentally pulled the air supply will be released, and the unit must be returned to an Air Capsule maintenance shop for recharging.
6. Drop: If an Air Capsule is dropped, check the reservoir coils for damage. If the coils are damaged return the unit to the factory for repair. Otherwise, as long as the pressure gage indicates 5000 ± 250 psig @ 70°F, the Air Capsule is ready for use.
7. Crush or Puncture: If an Air Capsule is punctured or crushed so that the reservoir is ruptured, the unit should be discarded. Air may escape for several minutes, but it is not hazardous.
8. Fire: There is no explosive hazard if an Air Capsule is exposed to a fire. When the reservoir is heated, the pressure will rise until the relief valve opens. The air will then escape and the pressure will drop.

PERIODIC INSPECTION

The pressure level of the Air Capsule must be checked monthly, as required by OSHA per paragraph 1910.134 of the Code of Federal Regulations, Title 29. The pressure must be at least 4750 psig @ 70°F. See Figure 8 for the correct pressure at temperatures other than 70°F.

Robertshaw recommends the unit be inspected every six months as follows:

1. Open the case and remove the Air Capsule. Check the pressure level. Recharge the unit if the pressure is less than 4750 psig @ 70°F. See Figure 8 for the correct pressure at temperatures other than 70°F.
2. Unfold the hood for examination. Check for holes, cuts, or other damage that would allow air to leak from the hood. Check the hood for clarity and cleanliness. Hoods that are not clear enough to see through after wiping clean should be replaced. Check to make sure the air hose is securely attached to the hood.
3. Check the elastic neckband and drawstring for damage or deterioration.
4. Check the case and latch for damage. Open and pull aside the pouch and examine the reservoir assembly. Check for any sign of corrosion on the reservoir coil or fittings. Send the entire assembly to Robertshaw or a Robertshaw approved repair facility for repair if any corrosion is found.
5. Record the date, the inspection findings, and the inspector's name in the appropriate places on the Inspection Record Tag. When the inspection is complete, replace the Air Capsule assembly (pressurized to 5000 ± 250 psig @ 70°F) in the case, close the latch, and install a new seal (P/N 539-900-114-07) on the Velcro latch.

RECHARGING

After an Air Capsule has been used, it must be inspected, cleaned, and recharged. Recharging requires special support equipment and trained personnel. For detailed recharging instructions, refer to the Robershaw Instruction Manual No. 909-005-033B, titled "Air Capsule Model 5000".

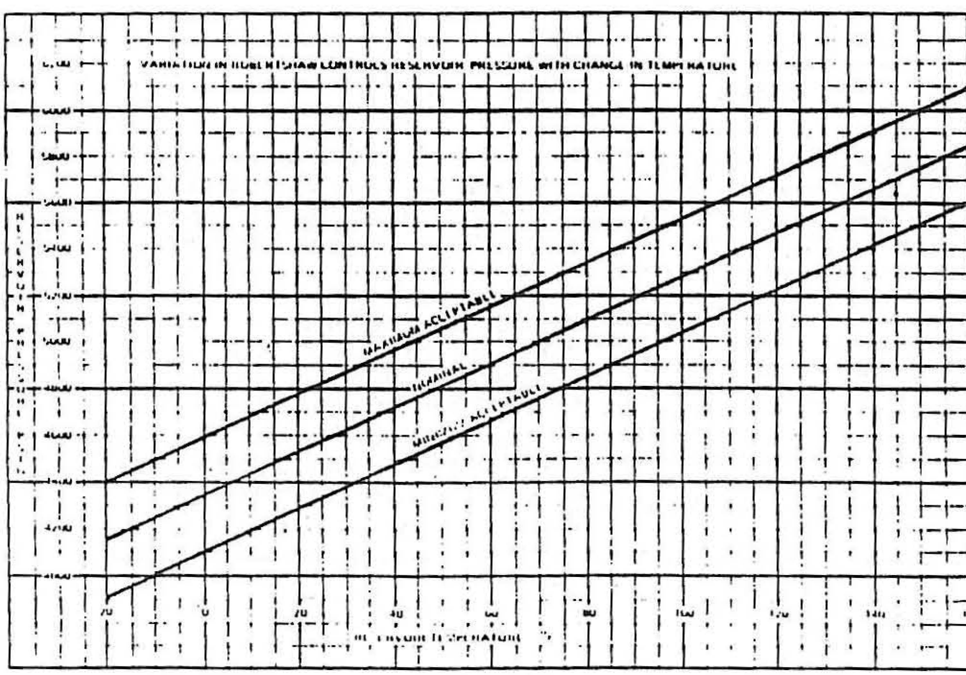


FIGURE 8. TEMPERATURE CORRECTION CHART

STORAGE

Do not store an Air Capsule in any area that is exposed to or involved with chlorine, ammonia, or any other highly corrosive atmosphere, unless the unit is stored in a sealed container. An Air Capsule can be safely stored at temperatures from $0^{\circ}F$ to $+150^{\circ}F$. The pressure gage will read low when the temperature is low, and will read high when the temperature is high. See Figure 8 for a temperature correction chart.

An Air Capsule can be stored for three years if the conditions listed above are met, and if the unit is periodically inspected as required by OSHA.

SERVICE LIFE

The Robershaw Air Capsule has a three-year service life from the date of manufacture. After the three-year period, the unit must be returned to Robertshaw or a Robertshaw-approved repair facility for inspection, any necessary repairs, and recharging. The unit can then be put back into service for another three-year period.

The date of manufacture can be determined from the serial number found on the yellow pouch that contains the reservoir coil or on the coil itself. The serial number can be decoded as shown in Figure 9.

8042108

- 80 — Manufactured in 1980
- 42 — 42nd week of year
- 108 — 108th unit made that week

FIGURE 9.

PERMISSIBLE

FIVE-MINUTE SELF-CONTAINED COMPRESSED-AIR BREATHING APPARATUS FOR ESCAPE ONLY

MSHA NIOSH

MINE SAFETY AND HEALTH ADMINISTRATION
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

APPROVAL NO. TC-13F-28

ISSUED TO ROBERTSHAW CONTROLS COMPANY ANAHEIM, CALIFORNIA, U.S.A.

LIMITATIONS

Approved for respiratory protection during escape only from oxygen deficient atmospheres, gases, and vapors, at temperatures above $20^{\circ}F$. Approved only when the compressed-air container is fully charged with air meeting the requirements of the Compressed Gas Association Specification G-7.1 for type 1, Grade D air, or equivalent specifications. The container shall be marked "Fill With Compressed Air Only," and shall meet applicable DOT specifications.

CAUTION

Use with adequate skin protection when worn in gases and vapors that poison by skin absorption (for example, hydrocyanic-acid gas).

In making renewals or repairs, parts identical with those furnished by the manufacturer under this approval shall be maintained.

This respirator shall be selected, fitted, used, and maintained in accordance with Mine Safety and Health Administration, Occupational Safety and Health Administration, and other applicable regulations.

MSHA-NIOSH APPROVAL TC-13F-28
ISSUED TO ROBERTSHAW CONTROLS COMPANY, FEBRUARY 1977

The approved assembly consists of the following RCC part numbers: 900-002-269-01 or 900-002-269-11 storage case, 904-003-206-01 or 904-003-206-02 compressed-air container, and 595-900-084 01 facemask and exhalation valve system.

Air Capsule Warranty.

Robertshaw Controls Company, Life Support Products Marketing Group, warrants its Air Capsule to be free from defects in workmanship and materials for a period of (1) year from the date of manufacture by Robertshaw. Robertshaw's obligation under this warranty is limited to replacing or repairing (at Robertshaw's option) such product if returned to Robertshaw at Anaheim, California, with shipping charges prepaid by the buyer, and which upon inspection by Robertshaw shall prove to have become defective in normal use and service.

This warranty does not apply to equipment malfunction or damage resulting from accident, alteration, misuse, or abuse of the equipment or improper preventive-maintenance. Moreover, this warranty does not apply to any plastic or rubber components, since they can be affected adversely by undue exposure to heat, sun, water, ozone, or to other deteriorative elements.

This warranty is in lieu of all other warrants, expressed or implied, and Robertshaw neither assumes or authorizes any other firm or person to assume on Robertshaw's behalf any liability in any way connected with the sale of Robertshaw's Air Capsule products.

This warranty becomes void immediately should any repairs of, or alterations to, the warranted equipment be made without authorization by Robertshaw.

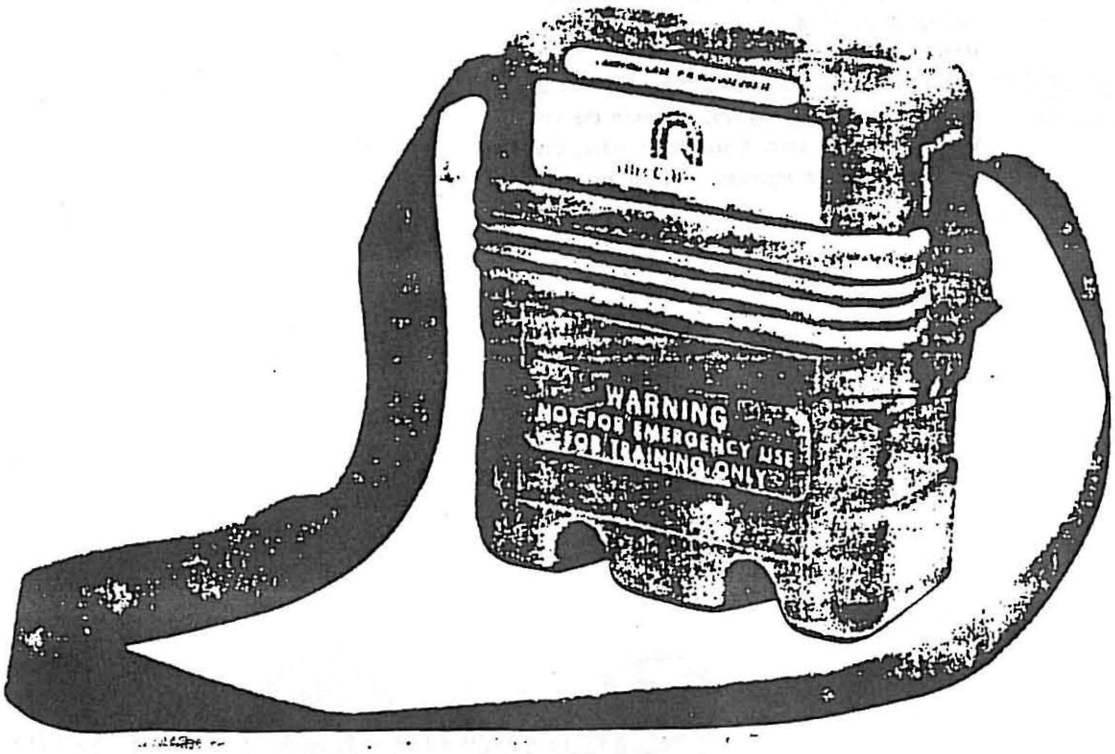
Robertshaw
CONTROLS COMPANY
Life Support Products Marketing Group
333 N. Euclid Way, Anaheim, CA 92803
Telephone (714) 535-8151

Robertshaw
CONTROLS COMPANY

ENDIX 2

INSTRUCTION SHEET
NUMBER: 900-086-064
DATE: JANUARY 1, 1981

TRAINING AIR CAPSULE



Training Air Capsule, Part No. 900-002-292

DESCRIPTION

The Robertshaw Training Air Capsule is designed for use as a training device to demonstrate the proper method of operating and donning the Model 5000 Air Capsule. The Training Air Capsule differs from the standard model in that the air flow is controlled by a start/stop valve that allows the user to start and stop the flow of air as desired. Recharging and maintenance of the Training Air Capsule are carried out in the same manner as the standard Air Capsule.

SPECIFICATIONS

Operating Pressure	5000 ± 250 psi
Breathing Gas	Gaseous Air as set forth in CGA Commodity Specification G-7.1, Type 1, Grade D or higher quality
Flow Duration	5 minutes Minimum
Donning Time	Less than 10 seconds
Recharging Time	Less than 10 minutes depending on inlet pressure

OPERATION

1. Check the pressure gage to verify that the reservoir is charged.
2. Open hard case.
3. Pull out Air Capsule.
4. Unfold hood.
5. Pull start ring. A slight tug will start the air flow.
6. Slip hood over head. Position hood so that reservoir is at back of neck.
7. Pull drawstring tight. Breath and speak normally.

   CAUTION: If the hood begins to collapse and it becomes hard to breath, immediately remove the hood from the head.
8. Remove hood and push button on start ring shaft to stop air flow.

   CAUTION: Do not operate the start/stop valve if the air supply is depleted, as this will cause severe internal wear.

   WARNING: The Training Air Capsule must not be used as an emergency escape device. Because the device is equipped with a start/stop valve, the air supply in the reservoir may be partially depleted.

MAINTENANCE

Clean and recharge the Training Air Capsule per the instructions in the Air Capsule instruction manual, P/N 909-005-033B.

OVERHAUL

Because of the start/stop valve, the Training Air Capsule must be returned to the factory for overhaul and repair.

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APPENDIX 3

RECOMMENDATIONS

Recommendations below are intended to aid the MSD in preventing occupational health programs in its future operations.

1. Instrumentation and Training:

   a. Before entering the sewers, MSD personnel should test the atmosphere with rugged, portable, direct-reading instruments such as explosimeters, oxygen detectors, and supplemented if appropriate by organic vapor detectors, and colorimetric indicator tubes.

   b. Training of MSD personnel in the use of direct-reading instruments should be conducted before MSD personnel use equipment at a work site.

2. Respiratory Protection:

   a. Because of the chemical composition of the sewer's atmosphere and its potential to change rapidly and without notice, particularly in the industrial section which receives both commercial and industrial sewage, the underground personnel should use open-circuit air-line supplied respirators when direct-reading instruments indicate the presence of toxic substances in concentrations immediately dangerous to health or life. At lower concentrations, NIOSH-approved full- or half-face chemical cartridge respirators should be worn by personnel entering industrial sewers.

   b. A respiratory protection program meeting the requirements of 29 CFR 1910.134 should be established and enforced by MSD management. The NIOSH publication titled "A Guide to Industrial Respiratory Protection," will serve as a reference source for establishing and maintaining a respiratory protection program.

3. Engineering Controls:

   a. Forced-air ventilation should be used whenever possible when working in sewers, especially industrial sewers.

   b. The jet exhaust venturi blower (air horn) connected to the end of the compressor air hose (with organic filter) and used to aspirate fresh air into the workspace should be kept at street level. The air intake should be away from automobile or diesel exhaust emissions. A flexible elephant duct should be attached to the blower and extended to the work area to bring fresh air from the surface.

4. Medical Surveillance:

   Employee Health Service, City of Cincinnati, should develop a system for reporting symptoms following exposure to chemical contaminants in sewers. A log of such reports should be maintained. In combination with results of such medical tests as deemed necessary, such a log will enable MSD and its medical consultant to determine any adverse trends in exposure incidents.

5. Safety:

   a. The City Safety program should be strengthened, and should have industrial hygiene support.

   b. Each underground worker should be provided with arm wristlets, safety lines, and harnesses for rapid removal from the sewer.

6. Other:

   a. The City Fire Department's Emergency Response Team should be alerted whenever MSD workers are entering a sewer environment that may be hazardous to the worker. Contact with the fire department closest to the work area may be sufficient.

   b. When the source of the chemical contaminant(s) in sewers is known, and MSD personnel are working downstream from this source, MSD authorities should contact the Company and tell them to hold their discharge until survey or sewer repairs are completed.

   c. Sewer permits for industrial workers should include liquid waste compounds, and potentially volatile compounds which may be present in sewer vapor spaces after discharge.