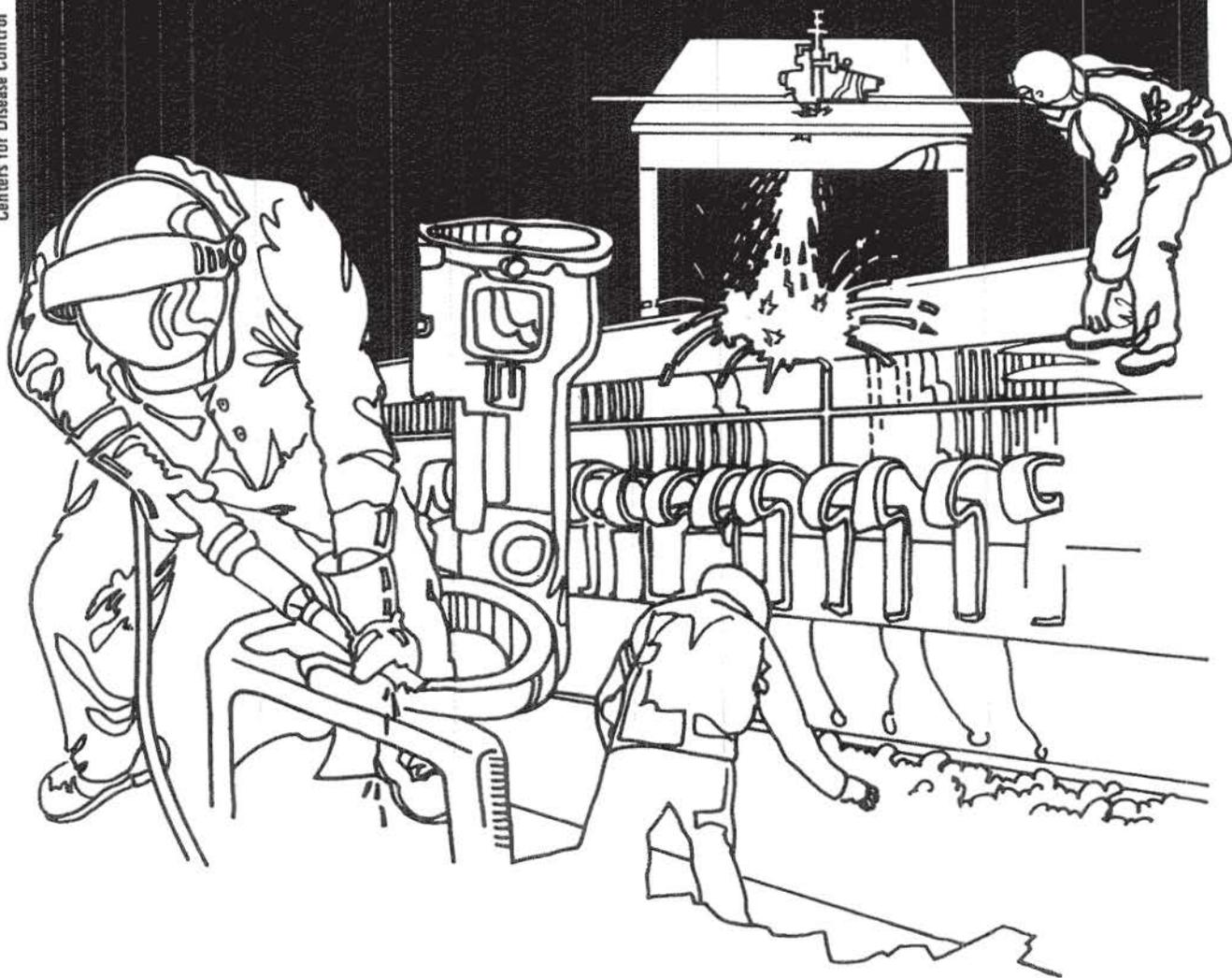


U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service  
Centers for Disease Control ■ National Institute for Occupational Safety and Health

# NIOSH



## Health Hazard Evaluation Report

HHE 80-151-821  
WESTERN ELECTRIC COMPANY  
WESTMINSTER, COLORADO

## PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 699(a)(6), which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

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

HE 80-151-821  
FEBRUARY 1981  
WESTERN ELECTRIC COMPANY  
WESTMINSTER, COLORADO

NIOSH INVESTIGATORS:  
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Theodore W. Thoburn, M.D.

## I. SUMMARY

In May 1980 the National Institute for Occupational Safety and Health (NIOSH) received a request from the International Brotherhood of Electrical Workers Local 2300, Denver, Colorado, to evaluate occupational exposures to airborne emissions from a wave solder machine and the surrounding areas at Western Electric Company, Westminster, Colorado. This facility manufactures telecommunication switchboards. Workers involved in this study take flexible plastic circuit boards (flex boards) and place them on metal templates. These templates are placed on a conveyor then enter the wave solder machine. The flex boards are conveyed through a pine rosin flux, then through the molten solder.

All of the wave solder operators and helpers, as well as a sample of workers in the surrounding area, were environmentally and medically evaluated. Exposures to isopropyl alcohol, rosin fluxes, and fluorides ranged from less than  $0.003 \text{ mg/M}^3$  to  $0.03 \text{ mg/M}^3$ . Extensive laboratory evaluation of the flex boards and soldering fluxes by mass spectrography and gas chromatography failed to identify an appreciable amount of any contaminants. The spectrographic data did not indicate chemicals that could be emitted from the hot flexible boards that required measurement.

Medical interview data did show that 12 of 17 workers had some adverse reaction to the soldering fumes. Eye irritation (9 of 12) and headaches (7 of 12) were the major complaints. Nausea, irritation of nose, throat, and/or sinuses, skin rashes, and breathing problems were also mentioned. Unnecessary contamination of the work place from soldering fumes occurred due to an inadequate exhaust hood over the wave soldering machine.

On the basis of the environmental and medical data, NIOSH concluded that a potential health hazard did exist at the time of this survey at Western Electric Company, Westminster, Colorado, from exposure to soldering flux fumes. Recommendations on work practices and improved ventilation necessary to control the fumes are included on page 5 of this report.

KEYWORDS: SIC 3661 (Telephone and Telegraph Apparatus), Soldering flux, Isopropyl alcohol, Fluoride.

## II. INTRODUCTION

NIOSH received a request in May 1980 from the International Brotherhood of Electrical Workers Local 2300, Denver, Colorado, to evaluate occupational exposures to airborne emissions from a wave soldering machine and the area in close proximity at Western Electric Company, Westminster, Colorado. An environmental survey was conducted on June 18, 1980, and a combination environmental and medical survey on August 27, 1980, to evaluate potential exposures and the medical effects. The requester was notified in September of environmental and medical results.

## III. BACKGROUND

Western Electric Company is engaged in the manufacture of telecommunication switchboard systems at the facility at Westminster, Colorado. The main area of concern was a particular wave soldering machine. This was the only machine that processes flexible plastic circuit boards (flex boards). To support the flex boards in this area, a metal template is used in the frames when flex boards are run through the wave solder machine. It was observed that flux coated the top side and continued to give off fumes after the frames had left the solder machine. Reportedly the frames retain heat longer when the flex boards are run. There are 17 workers in this area.

## IV. METHODS AND MATERIALS

### A. Environmental

On the preliminary visit bulk samples of the flex boards soldering flux and wipe samples were obtained. The laboratory performed spectrographic and chromatographic analysis of the samples. The only identifiable compounds of significance are closely related to emissions that would come from decomposition of a white pine tar rosin. For review of compounds found, see Figures 1, 2, and 3.

During the follow-up survey breathing zone and general room air samples for isopropyl alcohol were collected on charcoal tubes and analyzed according to NIOSH Method P&CAM No. S-65. Breathing zone and general room air samples for fluoride were collected on AA filters and analyzed according to NIOSH Method P&CAM No. 117-2, Section 7.7. These two chemicals were the only potential hazards that could be monitored.

### B. Medical

During the follow-up survey seventeen workers were individually interviewed including all those wearing sampling pumps (eight), every third worker on the assembly line adjacent to the wave solder machine (five), and four other workers who had health problems possibly related to their work. Medical records were obtained from private doctors when indicated.

V. EVALUATION CRITERIA

A. Environmental

Two sources of criteria used to assess the workroom concentrations were the Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910.1025), January 1978, and the NIOSH criteria for a recommended standard.

	Permissible Exposures 8-Hour Time-Weighted Exposure Basis (mg/M <sup>3</sup> )	
Isopropyl alcohol.....	980 (NIOSH)	980 (OSHA)
Fluoride.....	2.5 (NIOSH)	2.5 (OSHA)

---

mg/M<sup>3</sup> = milligrams of substance per cubic meter of air

Occupational health standards are established at levels designed to protect individuals occupationally exposed to toxic substances on an 8-hour per day, 40-hour per week basis over a normal working lifetime.

B. Toxicological

Pine rosin flux (colophony) -- When heated, the rosin fluxes can give off a poorly defined irritating mixture of organic material, including aldehydes and the solvent (isopropyl alcohol in this case)<sup>1</sup>. Rosin fluxes are known allergic sensitizers<sup>2</sup>, causing dermatitis although it is not nearly as potent a sensitizer as some other allergens, such as nickel, chromates, cobalt, neomycin or formaldehyde<sup>3,4</sup>. Fumes from electronic soldering fluxes have been implicated in respiratory symptoms and allergic occupational asthma<sup>5</sup>.

VI. RESULTS AND DISCUSSION

A. Environmental

All breathing zone and general room air samples taken for isopropyl alcohol and fluoride were below the NIOSH recommended criteria and the OSHA standard. Results may be reviewed in Tables 1 and 2. Laboratory evaluation of bulk samples did not reveal any hazardous fumes emitted from either the flex boards or the soldering fluxes when heated to temperatures of 200 to 650 degrees Fahrenheit.

B. Medical

Twelve of the 17 workers interviewed had some adverse reaction to the soldering fumes at least occasionally. Eye irritation (9 of 12) and headaches (7 of 12) were the major complaints, with nausea, irritation of nose, throat and/or sinuses, skin rashes, and breathing problems also being mentioned. Several mentioned transient headaches from alcohol fumes when the machine was cleaned.

Several workers were significantly irritated by soldering fumes (presumably the flux). Irritation was primarily to the eyes, although one worker gave a history of considerable irritation on forearms, and several mentioned irritation of their face. It is not clear whether these complaints represented an allergic response or simply a lower tolerance or greater exposure than is the case with most workers in the area. Not all complaints were in the immediate vicinity of the wave solder machine.

One worker apparently has a rather severe respiratory allergy to the soldering flux fumes. Past history included a severe exposure to flux fumes while soldering without adequate ventilation leading to significant tissue damage of the eyes. Such an exposure would be much more likely to induce sensitivity, even with a weak allergen, than would exposures only leading to transient irritation. About one month following the introduction of the flex boards this worker developed asthma for the first time. Medical work-up strongly suggested an allergic basis for the problem, but to date the allergen has not been identified. Attacks have been avoided by moving the worker out of the area when flex boards are to be run. A lag period following initial exposure before seeing clinical effects is characteristic of allergic sensitization.

Several distinctions could be made between the running of hard boards and flex boards:

1. The flex boards gave off more flux fumes than the hard boards when run through the wave solder machine, and not all fumes were captured by the hood.
2. The flex boards also gave a slightly sweetish odor of burnt plastic, although this was not felt by the workers to be causing the problem.
3. The flex boards required more touch-up soldering at the touch-up table. (Otherwise workers on the touch-up table noted no difference between the two types of boards.)
4. The flex boards could require more operator exposure when being unloaded than the hard boards. (The complaint of forearm irritation when unloading flex boards probably related to the practice of holding one board close to the forearm while releasing the other.)
5. One worker mentioned that the heat was turned up on the wave solder machine when flex boards were to be run (although this is not supposed to be necessary).

## VII. CONCLUSION

It would appear that the major problem is exposure to flux fumes which are somewhat irritating and can, under certain circumstances, cause allergic reactions. The flex boards cause more problems because they cause more flux fumes, particularly more fumes outside the hood over the wave solder machine.

The problem should be considerably reduced by either extending the hood to capture the flux fumes after the frames leave the solder machine and/or replacing the metal templates with templates made of a material which will not retain or conduct heat well. This should reduce the amount of fume produced and better handle that this is produced.

#### VIII. RECOMMENDATIONS

1. Extending the exhaust hood over the wave solder machine so that it will trap all soldering fumes should eliminate the hazard.
2. Periodic (every six months) air monitoring should be done to ensure workers are not being exposed to hazardous chemicals.
3. Smoking, eating, and drinking must be prohibited in the work area.

#### IX. REFERENCES

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XI. DISTRIBUTION AND AVAILABILITY

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

Copies of this report have been sent to:

1. International Brotherhood of Electrical Workers, Local 2300.
2. International Brotherhood of Electrical Workers.
3. Western Electric Company.
4. U.S. Department of Labor/OSHA - Region VIII.
5. NIOSH - Region VIII.
6. Colorado State Department of Health.
7. State Designated Agency.

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

TABLE 1

Breathing Zone and General Room Air Concentrations of  
Isopropyl AlcoholWestern Electric Company  
Westminster, Colorado

August 27, 1980

Job Classification	Location	Sampling Time	mg/M <sup>3</sup> Isopropyl Alcohol
Bench Hand (solderer)	Front of wave solder	7:10 AM - 1:56 PM	1.3
Touch-Up (solderer)	North end of wave solder	7:15 AM - 1:33 PM	1.9
Final Assembly (solderer)	North end of wave solder	7:27 AM - 1:55 PM	2.1
General Area	Wave solder	7:35 AM - 2:00 PM	2.6
General Area	Wave Solder	7:35 AM - 1:50 PM	2.7
Touch-Up (solderer)	North end of wave solder	7:18 AM - 12:20 PM	2.6
Touch-Up (solderer)	North end of wave solder	7:23 AM - 12:37 PM	1.9
EVALUATION CRITERIA			980
LABORATORY LIMIT OF DETECTION mg/sample			0.02

TABLE 2

Breathing Zone and General Room Air Concentrations of  
Fluoride

Western Electric Company  
Westminster, Colorado

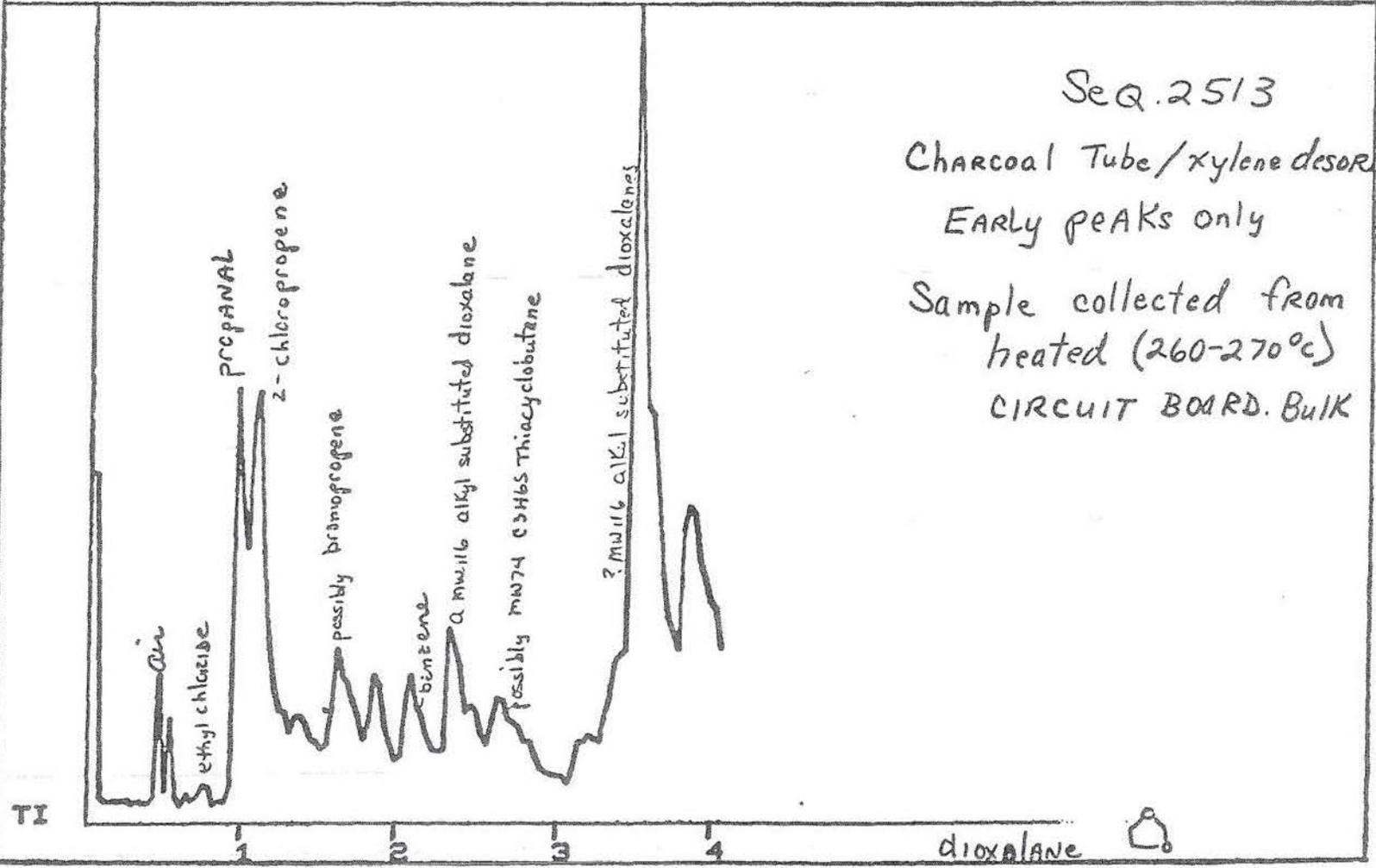
August 27, 1980

Job Classification	Location	Sampling Time	mg/M <sup>3</sup> Fluoride
General Room	North end of wave solder	7:30 AM - 2:00 PM	*
Assembler	East side of wave solder	7:25 AM - 1:55 PM	0.03
EVALUATION CRITERIA			2.5
LABORATORY LIMIT OF DETECTION mg/sample			0.003

\* below laboratory limit of detection

\*\* SPECTRUM DISPLAY/EDIT \*\*  
SEC2513 GUNTER GEN SAMP CTA/XYL  
SC20-300 12FT6XSP2100 EARLY PEAKS 7-17-8

FRN 5663  
1ST SC/PG: 1  
X= 1.00 V= 1.00



Seq. 2513  
Charcoal Tube/xylene desorbed  
EARLY PEAKS only  
Sample collected from  
heated (260-270°C)  
CIRCUIT BOARD. Bulk #1

FIGURE 1

\*\* SPECTRUM DISPLAY/EDIT \*\*  
SE02513 GUNTER GEN SAMP CT1/CS2 SC20-300  
12FT6XSP2100 7-15-80

FRN 5662  
1ST SC/PG: 1  
X= .50 Y= 1.00

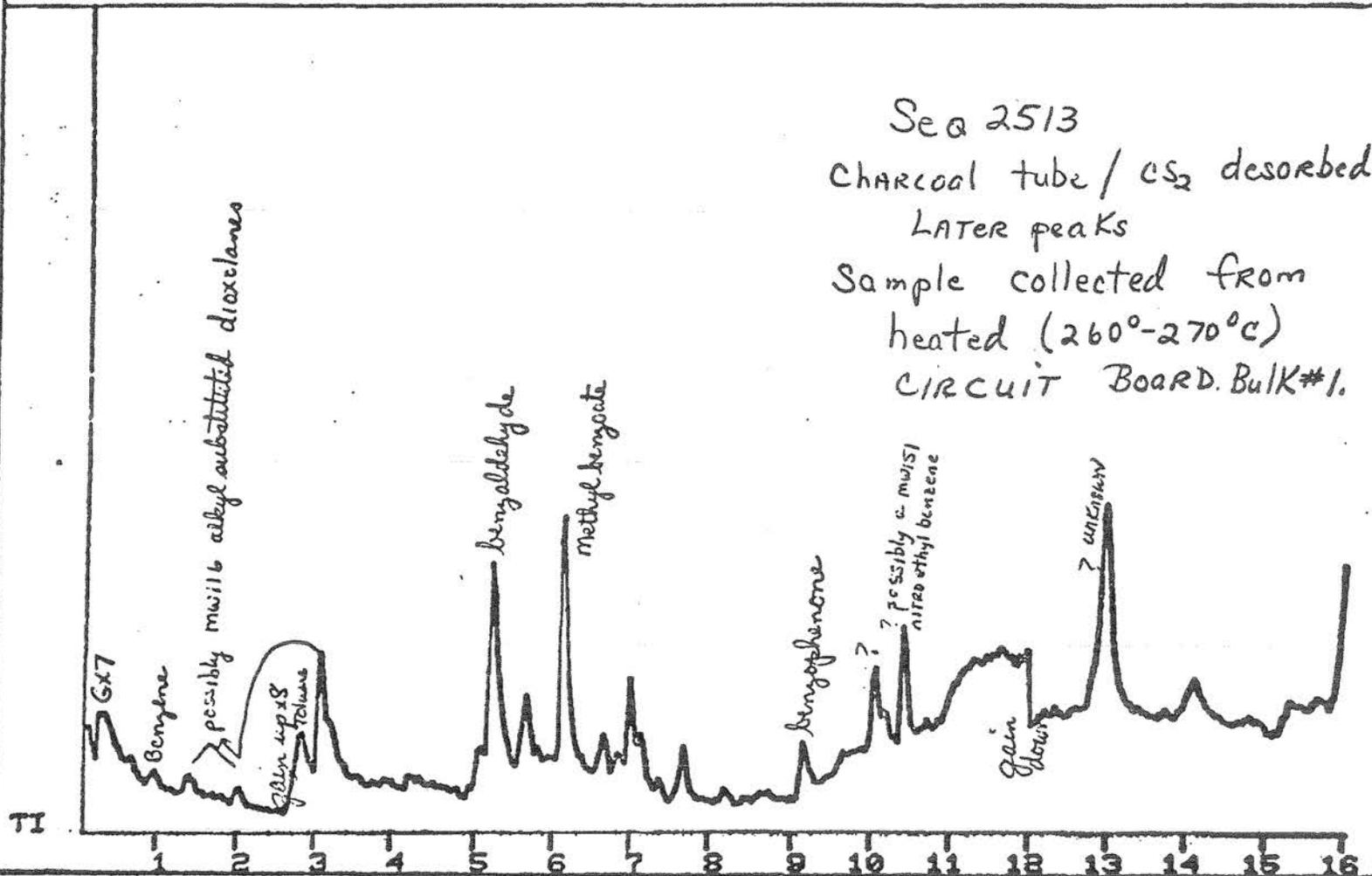


FIGURE 2

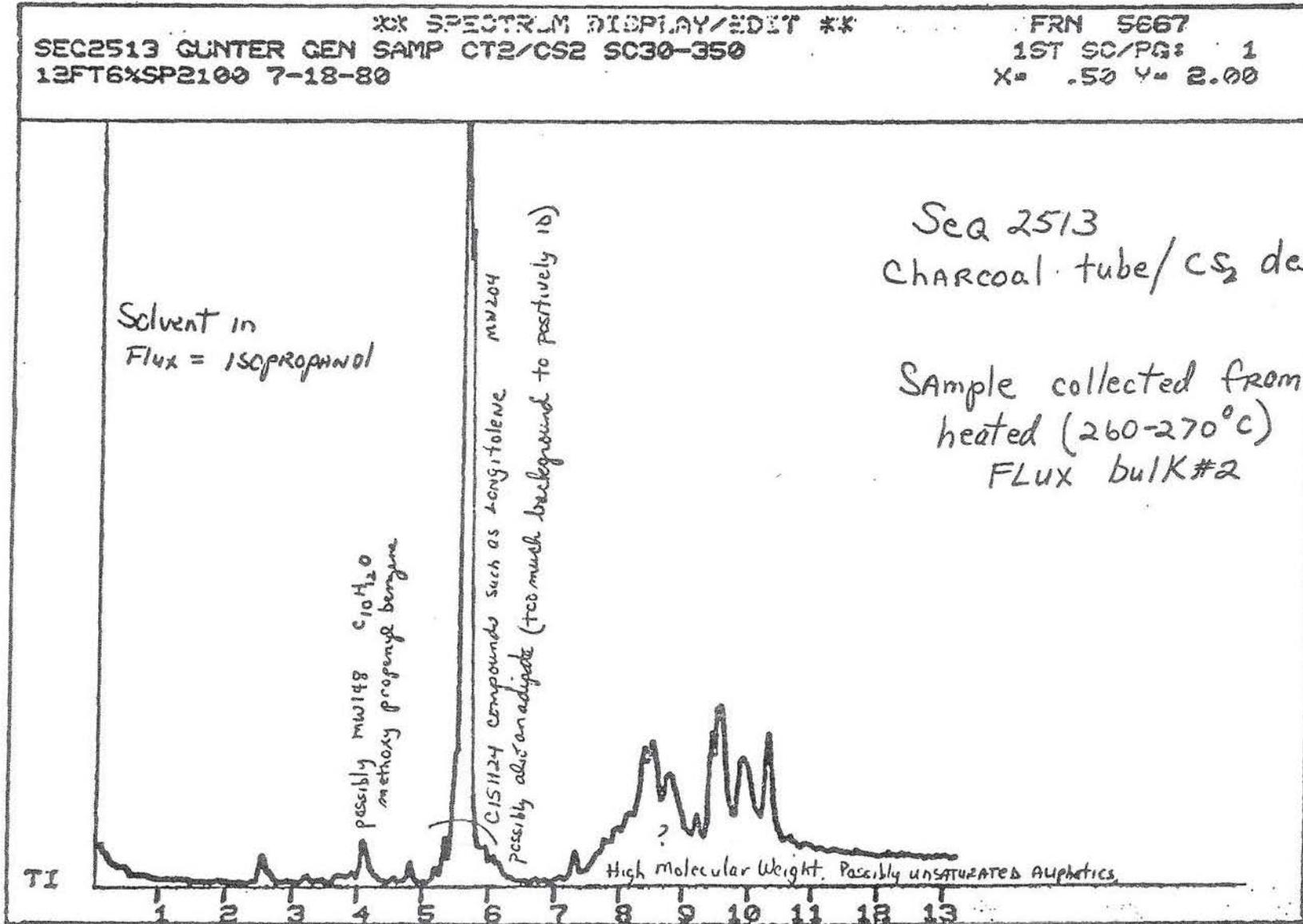


FIGURE 3

Longifolene - a tricyclic sesquiterpene  
 (Possibly from a natural product such  
 as the soybean oil-epoxidized)

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