P-XYLENE:

DEVELOPMENT OF A BIOLOGIC STANDARD FOR THE INDUSTRIAL WORKER BY BREATH ANALYSIS

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SYNOPSIS - ABSTRACT

Adults of both sexes were exposed repetitively to p-xylene vapor concentrations of 0, 20, 100, and 150 ppm for periods of 1, 3, and 7-1/2 hr in a controlled-environment chamber for two purposes: 1) to develop a practical "biologic" test which could be used to limit the magnitude of an industrial exposure; 2) to monitor the physiological response of healthy, sedentary adults to different vapor concentrations and durations of exposure, including the Threshold Limit Value (TLV) of 100 ppm, for five consecutive days.

Repetitive vapor exposure to the current TLV of 100 ppm produced no serious subjective or objective health responses in the 16 subjects, neither were any elicited in the eight male subjects while being exposed for five consecutive days to 150 ppm p-xylene vapor. There was an indication of the saturation of the metabolic pathway(s) of p-xylene when four subjects exercised briefly while breathing 150 ppm; however, the certainty and nature of this response requires confirmation.

Analysis of methyl hippuric acid metabolite in 24-hr urine samples, and of p-xylene in post exposure blood, saliva, and breath samples all revealed the certainty of p-xylene vapor exposures. For the greatest practicality for routine biologic monitoring, combined with assurance of limiting p-xylene exposures in workers, we recommend breath sampling. An alveolar breath sample, obtained 15 min after the termination of a p-xylene exposure, should have a p-xylene concentration of no greater than 4.5 ppm if from a male worker or 3.5 ppm if from a female worker. Concentrations below these limits would give assurance that the workers had not been exposed during the previous 8 hr to deleterious concentrations of p-xylene.

p-XYLENE

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INTRODUCTION

p-Xylene is a key raw material in the burgeoning polyester fiber and film business, and is one of the three isomers in the mixed xylenes solvent, now finding a new use in low-lead gasoline. Annual production and imports of p-xylene in 1974 totalled 2,586 million lb, and this figure is expected to increase to 4,735 million lb in 1980[1]. To protect the American worker from harmful exposures to the mixed xylenes solvent, a Threshold Limit Value of 100 ppm for an eight-hr work day was established in 1965[2] and readopted annually thereafter. No attempt was made to set separate values for the individual isomers in the mixture, and it has been assumed that none individually is more hazardous than the mixture of isomers. In this study, one isomer was chosen to prevent any confounding effect of a mixture, and to allow an exact measurement of the exposure concentrations at all times. p-Xylene was chosen because of its highest volume usage of the three isomers by American industry.

In the series of experiments to be reported, 16 adults of both sexes were exposed repetitively to p-xylene vapor concentrations of 0, 20, 100, and 150 ppm for varying periods of time in an environmentally controlled chamber. The goals were to: 1) observe the physiologic response of sedentary persons upon exposure to p-xylene vapor, and 2) develop a practical biologic test useful for estimating the magnitude of exposure to p-xylene.

EXPERIMENTAL

Healthy adults of both sexes were exposed to known concentrations of p-xylene vapor in a controlled-environment chamber. These studies were designed to simulate the type of exposures encountered in the industrial setting and consisted of both steady, non-fluctuating vapor concentrations as well as widely fluctuating vapor concentrations of p-xylene.

Exposure Schedule:

The vapor exposure sequence is presented in Table I. The sequence was initiated with male subjects who were exposed to p-xylene vapor concentrations of 0, 20, 100, and 150 ppm for periods of 1, 3, or 7-1/2-hr. The female subjects were exposed to 0 and 100 ppm for identical periods of time. The vapor concentrations in the controlled-environment chamber were not permitted to fluctuate widely except for the male subjects' exposure during Week 5 when the wide fluctuation experiment was performed. The female subjects' exposure sequence occurred subsequent to the exposure of male subjects and duplicated Week 2 for males.

The widely fluctuating concentrations of p-xylene vapor during Week 5 of exposure of male subjects was attained by varying the concentration of p-xylene in the chamber from 50 to 100 to 150 ppm during equal periods of time. The sequence of the up and down concentrations was designed so that the last 15 min of exposure for all subjects was to a vapor concentration of 100 ppm p-xylene.

Subjects:

The subjects were selected from the Caucasian, middle-class, working population of the Milwaukee metropolitan area. They were recruited for this study by a private employment agency. Each subject who completed the study received $2.50 per hr spent at the laboratory, plus overtime, with a 3-hr minimum payment for the Saturday morning medical surveillance check. After the objectives of the study and the nature of the procedures to be used were fully explained to them, all subjects signed an informed consent form, a copy of which is attached as Appendix I.

Eleven healthy males volunteered for this study. Their ages ranged from 19 to 55 years, height from 173 to 185 cm, and their weight from 62.7 to 110.1 kg. The one volunteer that was obese, weight--110.1 kg and height--173 cm, dropped out of the study after the first day (0 ppm p-xylene) and thus was not exposed to the vapor of the chemical. Of 9 volunteer subjects initially available, 4 were assigned to Group I (7-1/2-hr exposure), 2 to Group II (3-hr exposure), and 3 to Group III (1-hr exposure). In addition to the Group III subject who dropped out of the study during the 0-ppm exposures, another Group III subject dropped out after Day 1 of Week 2. His exposure to p-xylene was limited to 1 day at 100 ppm. Two new volunteers joined Group III during Week 3. The last subject remaining of the 3 original Group III subjects dropped out at the end of Week 3.

The ages of the 7 participating females ranged from 22 to 39 years, their height from 156 to 172 cm, and their weight from 56.7 to 93.5 kg. One Group I subject was obese. Two additional females volunteered but

dropped out of the study after the first day (0 ppm p-xylene). The division of subjects into Groups I, II, and III was 3, 2, and 2, respectively.

All subjects were cautioned to abstain from the use of drugs and to limit their use of alcohol to very moderate amounts. Subjects who were smokers were not allowed to smoke during their stay in the controlled-environment chamber. Subjects who underwent behavioral testing (3-hr and 7-1/2-hr males) were asked to refrain from consuming any caffeine prior to the end of each day's study (1 hr post-exposure).

Most of the subjects had no other wage-earning job during the time of the study, and none experienced any exposure to p-xylene outside of the laboratory.

Exposure Chamber:

All exposures to the vapor of p-xylene were conducted in a controlled-environment chamber 20 x 20 x 8 ft in size, which was adjoined by a 3 x 5 x 8 ft toilet facility and a 7 x 7-1/2 x 8 ft room shielded against electromagnetic radiation. Both the toilet facility and the shielded room were ventilated by air from the chamber. This three room complex had its independent air handling system and all outside doors were self-sealing when closed. Air flow through the complex was approximately 1500 cu ft per min and approximately 25% of this flow was exhausted causing a slight negative pressure within the complex at all times. Air temperature was maintained at 72-74° F while relative humidity ranged between 45-55%. The p-xylene vapor was introduced by sweeping the concentrated vapor from a warm flask with a stream of air

into the chamber's circulating air. A reciprocal dual-piston pump maintained a steady flow of liquid p-xylene into the flask.

Analysis of Exposure Chamber Atmosphere:

Each 3-kg container of p-xylene (Aldrich Chemical, p-xylene, 99%) used to contaminate the chamber atmosphere was individually analyzed by gas chromatography for benzene contamination before use. No benzene at levels greater than the sensitivity of the instrument (1 ppm) were found.

Standards were prepared by filling saran bags with room air pumped in sequence through a charcoal column, a wet test meter, a Drierite column, and a type N all-service gas mask cannister. After filling a bag with a known amount of clean, dry air, a calculated amount of p-xylene was injected into the bag using a microliter syringe. Necessary amounts of p-xylene were calculated taking into account bag volume, ambient temperature and barometric pressure. Calibration of analytical devices was accomplished by attaching the saran bag standard to the necessary probe within the chamber. At least three standards were analyzed prior to allowing subjects to enter the chamber each day and then standards were analyzed at approximately 2-hr intervals throughout the day.

Two completely independent systems were used to monitor the chamber atmosphere. In both cases, air was withdrawn from the chamber through 1/4" I.D. polyethylene tubes at approximately 7ℓ/min, through or past the analytical device, to a small diaphragm pump which discharged back into the chamber.

A Wilks MIRAN-I Infrared Analyzer was used as the primary monitoring and chamber concentration control device. The 20-m cell was operated at 13.5, 19.5, or 20 m path-length and the absorption band at 12.65 μ with a 2-mm slit was used. Voltage output of the MIRAN-I was connected to a strip-chart recorder, and a voltage proportional to the pen position of that recorder was conducted to the analog-to-digital input of a PDP-12 (DEC) computer. The computer sampled pen position voltage each sec, averaged those voltages every 30 sec, recorded the average on magnetic tape, and using the best-fit inverse regression line based on standards wrote on a CRT the concentration over that 30-sec interval and the cumulative or time-weighted average concentration since the beginning of the run.

A gas chromatograph (GC) was used as the "backup" method of chamber air analysis. The Varian Aerograph Model 940 GC was equipped with a column packed with Apiezon L on Chromosorb W, 60/80 mesh, operated at 140° C. Nitrogen was used as the carrier gas to a hydrogen flame detector operated at 270-290° C. An automatic device injected a sample of chamber air into the GC every 120 sec. Output of the GC was connected to a strip-chart recorder. Peak-height values read manually were transformed into concentrations based on the standards that had been analyzed during the day and compared with the values obtained using the infrared spectrometer. Concentrations found by the two methods were in agreement throughout the study.

Medical Surveillance:

Each subject was given a comprehensive medical examination prior to the study and after the last exposure day of the study. These exam-

inations included a complete history and physical examination with the following laboratory studies: complete blood count, complete panel of clinical chemistries (23 values plus 2 calculated), and a 12-lead electrocardiogram (EKG). A complete blood count and the panel of clinical chemistries were repeated at least once per week during the weekly exposures. Prior to each day's exposure the subjects were given a brief medical examination which included blood pressure, temperature, subjective signs or symptoms, and urinalysis (Labstix^{R}, Ames). During the time that they were in the environmental chamber, each subject's EKG (lead-II) was continuously monitored by telemetry and recorded at hourly intervals. The subjects were under continual surveillance by medical personnel while they were in the study.

Breath Sample Collection and Analysis:

Alveolar breath samples were obtained daily from each subject prior to entry into the environmental chamber, immediately upon exit from the chamber, and at the following times after exiting the chamber (post exposure): 15 and 30 min; 1, 2, and 3 hr. These samples were each collected in 5-ℓ saran bags. The pre-exposure sample from the following morning represented the 15-1/2-, 20-, or 22-hr post exposure sample for Group I, II, or III, respectively. Alveolar breath samples were obtained by expelling a breath which had been held for at least 20 sec into the saran bag and stoppering the bag securely. Sampling of the breath in the bag was accomplished by puncturing with a syringe needle. All samples, except the 2- and 3-hr post exposure samples, were analyzed the same day that they were obtained. The 2- and 3-hr post exposure

samples were collected by the subjects after leaving the laboratory, and they were analyzed the following day.

A Varian Aerograph Model 900 gas chromatograph (GC) equipped with a hydrogen flame ionization detector was used to determine p-xylene in the breath samples. The GC was fitted with a stainless steel column, 5 ft x 1/3 in, packed with 10% FFAP on Chromosorb W, 80/100 mesh. The column was preconditioned at 220° C overnight prior to use. The operating conditions of the GC were as follows: carrier gas (nitrogen) flow rate of 40/ml per min; column temperature of 110° C; injection port, 190° C; and detector, 240° C. Both hydrogen and air flow were kept at 20 psig. The sample size was usually 1 ml. Standards at 3 concentrations to bracket the unknown levels were prepared with clean air as diluent. A single injection from the saran bags was used because of the reproducibility of the analysis. The concentration of p-xylene in the unknowns was obtained by direct comparison of peak heights to the standards. The minimal amount of p-xylene detectable in breath by this method was 0.05 ppm with an accuracy of ±0.1 ppm.

Blood Sampling and p-Xylene Analysis in Blood:

Blood samples were withdrawn from an antecubital vein of each subject on Days 1 and 4 of each exposure week. The blood samples were obtained pre-exposure, immediately pre-exit from the chamber, 30 min, and 60 min post exposure, by syringe. Analysis of p-xylene was carried out on 2 ml of blood that was introduced immediately upon withdrawal from the subject into a 40 ml saran-lined-capped glass vial containing 1 ml aqueous solution of 5 ppm toluene as internal standard. The headspace

technique was then employed for the analysis. After complete mixing and equilibration at room temperature for at least 1 hr, 1 ml of the head-space air was withdrawn and injected into a gas chromatograph. Samples were analyzed the same day that they were obtained.

A Varian Aerograph Model 2700 Moduline^{R} gas chromatograph (GC) equipped with a hydrogen flame ionization detector was used to determine the p-xylene levels in the blood. The GC was fitted with a stainless steel column 3-1/2 ft x 1/8 in, packed with 25% Apiezon L on Chromosorb W, 45/60 mesh. The column was preconditioned at 200° C overnight prior to its use. Throughout the analysis for p-xylene in blood, the column was baked at 200° C when it was not in use. The operating conditions of the GC were: carrier gas (nitrogen) flow rate of 45/min; column temperature, 120° C; injection port, 235 C; and detector, 250° C. A calibration curve (peak height ratio of p-xylene to toluene vs concentration) was prepared daily. Samples were injected in duplicate and the concentration of p-xylene in blood was obtained directly from the calibration curve. The detectable limit of p-xylene by this method was 0.001 ppm while the accuracy was ±0.02 ppm.

Analysis of p-Xylene in Saliva Samples:

To demonstrate potential monitoring of another compartmental source where p-xylene might be stored, a cursory study of p-xylene levels in saliva was carried out.

Two ml of saliva were collected in a 35-ml saran-lined-capped glass vial from both Group I male and female subjects. The time schedule for sample collections included: prior to exposure, immediately upon exit,

15 and 30 min post exposure. The analysis precedure for p-xylene in saliva was identical to that of blood, except that no internal standard was added.

Analysis of a p-Xylene Metabolite in Urine: Methyl Hippuric Acid:

Methyl hippuric acid (p-toluric acid) has been proposed as the major metabolite of p-xylene in the urine of humans[3,4]. Twenty-four hr urine collections were made by all subjects on Days 1 and 4 of each week. Plastic jars placed in iced foam buckets were used. Daily excretion was measured prior to sampling for analysis of methyl hippuric acid.

A colorimetric method developed by Tomukuni and Ogata[5] that measures total hippuric acids was adopted with modification for the analysis. A Coleman Junior II A Linear Absorbance Spectrophotometer Model 6-20A was used. One ml of urine was diluted with 4 ml of distilled water, 0.5 ml of this diluted urine was pipetted into a glass tube, followed by 0.5 ml pyridine. The resulting solution was well mixed before introducing a 0.2-ml aliquot of benzenesulfonyl chloride (Aldrich Chemical Company). An orange color developed immediately. The colored solution was well mixed by means of gentle shaking and was allowed to stand at room temperature for 30 min. The sample was then diluted to 5 ml with 95% ethanol. The concentration of hippuric acids in urine was read against a 95% ethanol blank at 410 nm. At least two aqueous standard solutions, e.g., 0.25 mg/ml and 0.5 mg/ml respectively, were used to bracket the unknown concentrations. All samples were determined in duplicate with an accuracy of ± 0.05 mg/ml.

Neurological Studies:

Within 5 min of entry into the environmental chamber on each exposure day, and within 10 min prior to exit, each subject performed a modified Romberg and heel-to-toe equilibrium test which was videotaped for later inspection if necessary. The test consisted of standing upon each leg singly with arms at the side for a minimum of 3 sec, and walking heel-to-toe in a straight line for approximately 5 ft. This was first done with the eyes open and then repeated with the eyes shut.

Spontaneous electroencephalograms (EEG) and visual evoked responses (VER) were recorded 4 times each on Monday, Wednesday, and Friday on Group I (7-1/2-hr) subjects. Recordings were normally made once during the first hr and 3 times after the fifth hr of exposure. A complete description and illustration of the EEG-VER monitoring system is found in a previous publication[6] from this laboratory. Gold-plated silver disk electrodes were oriented on the scalp according to a modified 10-20 International Electrode System[7]. Grass EEG paste was used to secure the electrodes to the scalp. An 8-channel Grass polygraph fitted with EEG amplifiers was utilized for recording. EEG activity was recorded for 15-30 sec before, during, and 15-30 sec after acquisition of the VER. The EEG recordings were analyzed by visual examination.

The VER was recorded from the electrode at the inion, referred to the left ear. An EEG channel was used to amplify the VER, and the output was fed to an on-line averaging computer (Nuclear Chicago, 7100). The VER was triggered by a strobe flash (3 μsec) at the rate of 1 per sec for 100 sec. The strobe was operated to deliver 18 million beam candles at 1 m from the subject's eyes, which were closed throughout the

period of strobe flashing. Analysis time was 250 msec. Flash delay from the synchronizing pulse which initiated the computer sweep was 25 msec. The computer averaged the response to the 100 flashes, and the resultant VER was recorded on an X-Y plotter for analysis.

It has been shown that VER amplitude can be altered by varying levels of attention, cortical desynchronization, and sleep[8]. Accordingly, standardized conditions were used throughout each exposure day, specifically immediately preceding the actual recordings. After entering the booth, the subject was always allowed 3-5 min to achieve a relaxed state, and then immediately prior to initiating the strobe flash, in an attempt to standardize "attention," the subject clapped his hands 5 times slowly and forcibly.

The most prominent and reproducible portions of the VER complex are the 3rd, 4th, and 5th waves (designation by Gastaut)[9]. Our analysis was thus restricted to these waves. Wave 3 was identified as proceeding in a positive direction 80-120 msec after initiation of the strobe flash. Waves 4 and 5 were the succeeding negative and positive segments of the VER. Our analysis involved 1) measuring the amplitude of these waves and 2) measuring whether changes had occurred in latency and wave form of the VER complex. A paired t-test was used to ascertain whether the amplitude of any single wave of each subject differed significantly during p-xylene exposure from 0-ppm exposure conditions. Furthermore, each subject's daily mean total amplitude was calculated, and then using paired t-test, analyses of variance, and group t-test methods, the 0-ppm data was compared with the p-xylene exposure data (technique employed by Forster et al[10]).

Before and after each recording session the equipment was calibrated as a system. Ten μv square waves, 100 msec in duration, were fed into the amplifiers, averaged over 100 trials, and recorded.

Cardio-Pulmonary Function Studies:

Minute ventilation was measured under 0-ppm conditions before and after the p-xylene exposure and on the 2nd and 4th days of each week of exposure to p-xylene. Measurements were made while in the sitting position during the last one-half hour of exposure. The expiration port of a breathing valve was connected via corrugated tubing (1 inch I.D.) to a 13 ℓ spirometer (W.E. Collins). After approximately 5 min breathing on the valve, ventilation was collected for 3-4 min and the average minute volume over this time period was tabulated.

Measurements designed to evaluate functional integrity of pulmonary airways, alveolar-capillary gas exchange, and regulation of pulmonary ventilation and heart rate were made on male Group I subjects only.

Three maximum and partial forced expiratory maneuvers were performed by each male Group I subject under resting conditions between the 5th and 6th exposure hours on Day 5 of each week. The components of the system employed in these forced expiratory maneuvers were: a) in series a mouthpiece, a flexible tube, a heated Fleisch No. 3 Pneumotachograph, and a water spirometer, and b) the essentials of a computer system for analysis, i.e. PDP-12 mini-computer, oscilloscope, teletype, etc. Initially, under control conditions, each subject's vital capacity (VC) and functional residual capacity (FRC) were determined on the water spirometer. For the actual maneuver, the subject in sequence: a)

breathed quietly on the system for 3 or 4 breaths, b) inspired to his 70% VC mark on the spirometer (based on FRC), c) expired maximally, d) inspired maximally, and finally, e) expired maximally. Step-by-step software analysis of the acquired flow-time data included: a) integration to determine volumes, b) generation of flow-volume curves, and c) calculation and print out of such variables as total expiratory volumes (VC), volume expired in one second (FEV_1), and flow rates at 40% and 25% of vital capacity for both the maximum and partial expiration. It is important to note that in our system, because expired flow rate was dependent on lung volume, necessary adjustments were made so that all flow rate determinations were at the same absolute lung volume.

Metabolic, pulmonary, cardiac, and hematologic parameters were measured on Group I male subjects at rest and during two levels of dynamic muscular exercise between the 5th and 7th hours of exposure on Day 4 of each week (Day 2 of Week 6). The exercise was performed on a bicycle ergometer for 11 consecutive min, 6 min at 350 KPM followed by 5 min at 750 KPM.

The essential components of the expired gas collection and measurement system were a breathing valve, corrugated tubing, a Parkinson-Cowan gas meter, a 150-ℓ Douglas bag, and a Hewlitt-Packard recorder. Minute ventilation was quantitated using the gas meter and recorder. Expired gas was collected in the Douglas bag for 1 min at rest and 1 min at each exercise intensity (between 4.5 and 5.5, and 9.5 and 10.5 min of exercise). Fifty ml of this mixed expired air was stored in a glass syringe and subsequently analyzed for $[CO_2]$ and $[O_2]$ using a Quintron gas chromatograph. Ventilation and $[CO_2]$ and $[O_2]$ were used to calculate metabolic rate and respiratory quotient.

For sampling of blood, a 21-gauge needle was placed in a superficial dorsal hand vein. The needle was attached to a tubing stopcock arrangement which during non-sampling periods was filled with heparinized saline. For 5 min prior to sampling, the entire hand was heated to approximately 42° C. This procedure sufficiently "arterialized" the venous blood so that P_{CO_2} and pH were virtually identical to arterial[11]. Three to 5 ml of blood were sampled over the 1-min period of expired air collection. The blood was analyzed within 15 min for P_{CO_2} and pH with the Radiometer electrode arrangement.

Alveolar-capillary gas exchange was assessed by the single breath carbon monoxide diffusion technique[12] ($D_L CO$). Measurements were made twice on each subject at rest and after 5.5 and 10.5 min of exercise. The previously described computerized system was used to calculate inspired, residual, and total lung volume and $D_L CO$. Neon was used as the inert gas to measure residual volume. Neon and CO concentrations in the collected alveolar sample were analyzed using a Quintron chromatograph.

Heart rate was measured using the Biotel 170 ECG patient telemetry system developed by Spacelabs, Inc. (Chatworth, California). Heart rate was measured during the 30-sec interval preceding initiation of the exercise and over the final 30-sec interval of each exercise period (350 and 750 KPM).

Systolic and diastolic blood pressure were measured by the auscultatory method. Measurements were made at rest and after 4 and 9 minutes of exercise.

Cognitive Testing:

A battery of cognitive tests were performed in a group situation by the male Group I and II subjects on days 1, 3, and 5 of each week. The testing was carried out 3 and 2 hr after the start of exposure for the 7-1/2 and 3-hr groups, respectively. The subjects were trained to a performance plateau before these tests were used during exposures to p-xylene.

The subjects sat in comfortable chairs at individual carrels to perform the cognitive tests. The subjects were not permitted to talk or have access to watches, food, soft drinks, radios, etc. during the testing. All instructional commands were made from outside of the chamber via an intercom system. The tests, in order of performance, are described below.

Ten and Thirty Second Time Estimation Test: Each subject, upon verbal signal (ready, begin) depressed a hand-held, silent, push-button micro-switch for an interval of time he estimated to be 10 seconds. This was repeated two additional times, and then three 30-second estimates were made. The micro-switches were connected to the PDP-12 Digital computer which measured the time intervals. This test took approximately 3 min to perform.

Marquette Time Estimation Test: This test consisted of a series of nine tone stimuli followed by nine light stimuli of approximately 1, 3, and 5 seconds duration presented in a random sequence but always with three stimuli of each time interval. At the termination of each stimulus, the subject depressed the push-button for that interval of time he estimated to be equal in length to the original auditory or light stimulus. A detailed description of the test and the instrumentation

used to carry it out has been described by Stewart, et al[13]. This test took approximately 7 min to perform.

Coordination Test: This test was the Flanagan Aptitude Classification Tests, 7A, Coordination, published by Science Research Associates, Inc., 259 East Erie Street, Chicago, Illinois. This test asked the subject to rapidly follow a spiral pathway with a pencil. The subject was allowed 40 sec to complete each of 6 spirals. The first 2 were considered practice and the last 4 were scored and totaled. The total score depended upon the longest distance attained in each spiral minus the number of times the sides of the spiral pathway were touched with the pencil. This test took approximately 5 min to perform.

Arithmetic Test: This test, which measured the subject's ability to work with numbers, was divided into 2 parts. The first part, lasting 5 min, consisted of simple addition and subtraction problems while the second part, lasting 3 min, consisted of multiplication and division. The maximum score attainable if all answers were correct was 140; however, no subject completed the tests in the allotted time. In order to minimize memorization of answers, 10 randomly generated problem tests were used.

Inspection Test: This test was a measure of the subject's ability to spot the number "3" in rows of random numbers on an 8-1/2" x 11" page. The subject was asked to scan each row, beginning at the top of the page, and slash out with a red pencil each "3" encountered. The subject was given 2 min to strike out as many as possible. No subject ever finished the entire page. A subject's score was the total number of "3's" struck. Six differing pages with random numbers were utilized

so that no subject received an identical number sheet on successive tests.

Subjective Responses:

Each subject was asked to note on an individualized form any subjective responses occurring during the exposure in the chamber or during the first 3 hr post exposure. The form contained rows for noting headache, nausea, dizziness, abdominal pain, eye, nose, throat irritation, other, and odor, and columns for the "immediate", "1/2-hr", and hourly periods of time thereafter. The adjectives "mild, moderate, and strong" appeared on the sheet as cue words, and the phrase "only abnormalities recorded" was prominently typed at the bottom. The home telephone numbers of each of the Department physicians appeared on the form and the subjects were encouraged to phone if they became ill while away from the laboratory.

RESULTS

Exposure Schedule:

The exposure schedule for volunteer male subjects was designed in a manner that included two days of exposure to zero ppm concentration (control) of p-xylene before and after actual exposure to the vapor of the chemical. A two-day weekend separated these control days from the five-day per week actual exposures. As is customary in our studies, the chamber was contaminated with an odor level (approximately 10 ppm) of p-xylene when Groups I and III entered the environmental chamber on the two control days at the end of the study. Within 10 min the p-xylene concentration was reduced to zero ppm. A pre-exposure and a post-exposure control day were also carried out for the female exposures, with initial odor contamination on the post-exposure control day when the subjects readily recognized the odor of p-xylene.

The 5-day weekly sequence of male subject exposures to p-xylene vapor began with the TLV concentration, 100 ppm, at a steady level, dropped to 20 ppm steady the second week, was increased to 150 ppm steady the third week, and finished with five days at 100 ppm fluctuating from 50 to 100 to 150 ppm. The female subjects were exposed to 100 ppm steady for five days. All time-weighted average exposure concentrations were within two percent of the desired concentrations as shown in Table I.

Figure I demonstrates the planned execution of the fluctuating concentration exposures wherein each group of subjects was to be exposed to a time-weighted average of 100 ppm. The discrepancy in actual

exposure concentrations of the two Group III subjects (see Table I) during this week was due to the one subject's inability to be present at the usual time reserved for the Group III subjects.

Subjects:

Obtaining and retaining ten volunteer subjects for each study (male, female) with p-xylene proved to be difficult. Although ten subjects passed their physical examination for each study, one in each study decided not to participate after orientation, and two from each study dropped out during the study. None of the drop-outs did so because of the exposure to the vapor of p-xylene. Because the study with male subjects was of longer duration, we were able to add two subjects to the study after it had begun. The number of subjects exposed daily by group is shown in Table I.

Absenteeism was also a problem in the study with male subjects. Again, this could not be attributed to the chemical, the usual excuse being a personal reason.

Cooperation of subjects in carrying out their assigned tasks, and in refraining from over-indulgence in alcohol or other drugs, was excellent. All subjects accepted the required venipunctures, collection of 24-hr urine samples, and breath samples with equanimity.

Exposure Chamber:

Because of the low odor threshold of p-xylene (<1 ppm), it was possible to detect the vapor when it escaped from the environmental chamber. Air sampling outside of the chamber demonstrated that 1-3 ppm

p-xylene contaminated the subject lounge occasionally. Although this should have had no measurable effect upon breath sample concentrations, as a precaution the subjects gave their pre-exposure breath samples in the uncontaminated foyer immediately upon entry to the building.

The large size of the environmental chamber (20 x 20 x 8 ft) allowed freedom of movement and sufficient comfort for all subjects while in the chamber. The subjects, with the exception of the 11 min of exercise by Group I male subjects on day 4 of each week, were sedentary during their stay in the chamber. Residence in the chamber for each group was continuous on a daily basis. During the periods of time that they were not being tested, they read, played cards, watched TV, or occupied themselves with other sedentary activities.

Analysis of Exposure Chamber Atmosphere:

Use of the infrared analyzer connected to the computer allowed for precise control of the chamber's atmosphere with regard to p-xylene vapor concentration. As shown in Table I, the standard deviation of continuous, repeated 30-sec samples during the weeks of steady concentrations was never more than three ppm. Damping of rapid excursions did take place in the analyzer cell, however response to changes of 20 ppm p-xylene concentration of standards was always complete in three min.

Agreement between the two assay methods, with a possible variance of up to five percent, continually assured the avoidance of an accidental over-exposure of the subjects.

Medical Surveillance:

Comprehensive medical examination of each subject at least three days after the last exposure to p-xylene revealed that all subjects were in good health after the study. The attached forms (History--Appendix II, Physical Examination--Appendix III) were used and are retained in each subject's personal file. Weekly blood clinical chemistries and complete blood counts revealed the usual number (approximately 5%) of slightly "out-of-normal range" values; however, none were considered significant or related to the exposure. Daily medical surveillance revealed the usual number of wintertime colds. Daily urinalysis by the dip-stick technique, and continual monitoring of EKG's (lead-II) while subjects were in the environmental chamber, revealed no abnormalities. No female became pregnant while a subject in this study.

Breath Analysis:

p-Xylene concentration in breath samples obtained before entering the chamber, upon exit, and at specified times post exposure was determined by gas chromatography and reported as ppm (v/v) in the breath. Group means, ranges, and standard deviations were calculated for each time period of each day. The results for the male subjects are listed in Tables II through XIII and for the female subjects in Tables XVII through XIX. Perusal of the data indicated no obvious differences in breath concentrations related to the day of the week, and therefore, weekly data for each group was pooled for Tables XIV, XV, and XVI, representing 7-1/2-, 3-, and 1-hr

exposures of male subjects, while Table XX presents pooled data for each group of female subjects. On each table, the 1 min post exit values represent breath concentrations as subjects exited the chamber and before breathing non-contaminated air, while the baseline values represent concentrations the morning following the exposure.

Breath levels of p-xylene upon exit from the chamber were only a small fraction of the level of the vapor in the chamber. At 20 ppm exposure, this breath level averaged 5.1% of the exposure level, at 100 ppm it averaged 5.7%, and at 150 ppm, 6.4%. These low breath levels indicate uptake by the body of 93 to 95% of the inhaled p-xylene vapor from the alveolar spaces of the lungs.

Blood p-Xylene Concentrations:

The concentrations of p-Xylene found in the pre-exposure, pre-exit, 30-min post, and 1-hr post exposure blood samples obtained on Days 1 and 4 of each exposure week are listed in Tables XXI through XXIV. All values are reported in ppm on a w/w basis, assuming blood to have a specific gravity of 1.0. Perusal of the values found for the male subjects on all Day 1 pre-exposure blood samples reveals 0.0 to 0.8 ppm p-xylene. It is felt that many of the high results found on Day 1 were due to contamination, because from 0.1 to 0.5 ppm was found in pre-exposure samples from subjects prior to any exposure to p-xylene. This

was not true of samples taken from female subjects on Day 1 as shown in Table XXIV. By this time the contamination problem had been solved, and the pre-exposure values found for Day 4 are believed to be real, indicating a slight build-up of p-xylene in the blood of all subjects upon four consecutive days of exposure to p-xylene. Even though there may be a contamination error in p-xylene blood values for males, the data reveals a positive relationship between exposure concentration and blood level, but no clear relationship between length of daily exposure and blood level.

Table XXV demonstrates the effect of exercise on p-xylene blood levels. On day 4 of each exposure week, Group I male subjects exercised on bicycle ergometers for a short time (see Cardiopulmonary Function Studies). Arteriolized venous blood was obtained from a catheter in the back of the hand, and aliquots were analyzed for p-xylene in the same manner as the other venous blood samples. Average concentrations of p-xylene in the blood increased two to three fold during 11 min of moderate exercise.

Saliva p-Xylene Concentrations:

Analysis of saliva samples for p-xylene revealed concentrations that were very similar to the concentrations of p-xylene in blood samples obtained at approximately the same time. Tables XXVI and XXVII list the results of saliva analysis for Group I male subjects during the weeks of exposure to 150 ppm and 100 ppm fluctuating p-xylene vapor concentrations, while Table XXVIII lists the results from Group I female subjects during their week of exposure to 100 ppm p-xylene vapor.

Rather wide ranges and variability on different days of the same week were noted. Again, as in the blood analyses, low-grade contamination of the head-space, or imprecision of the procedure, may have contributed to the scatter of results. This could be particularly true in the case of the saliva analyses because, contrary to the blood analyses, no internal standard was used.

Urinary Methyl Hippuric Acid Concentrations:

Twenty-four hr urine collections were analyzed for hippuric acids, including methyl hippuric acid (p-toluric acid) concentration,on Days 1 and 4 of each week. Tables XXIX through XXXII list individual values for each subject, noting both the urinary concentration in mg/ml, and the calculated daily excretion in g/24 hr, based upon the measured volume of urine excreted in 24 hr. From the values obtained it is apparent that hippuric acids excretion is extremely variable due to the presence of hippurates in the urine prior to any exposure to p-xylene. As an example of the extreme variability between two subjects in one group, female subjects 264 and 265 excreted 4.90 and 0.69 g of hippuric acids, respectively, during Day 1 of identical 1-hr exposures to 100 ppm p-xylene. Interestingly, the highest excreters of a group were generally highest on every day, and conversely the lowest was generally always lowest, even on a non-exposure day.

Neurological Studies:

No significant neurological abnormalities occurred during the exposures of these subjects to p-xylene. Equilibrium as measured sub-

jectively on a twice daily basis by the modified Romberg test and heel-to-toe test remained normal at all times. EEG recordings were analyzed visually for changes from the normal alpha rhythm, and only an increased incidence of large amplitude waves in the delta frequency range (5-8 hz) were noted. Examples of EEG recordings made during 0 ppm exposures prior to actual exposure and some showing increased delta activity during exposures to 100 ppm p-xylene are shown in Figures 2 through 9. Although all Group I subjects demonstrated this trend to increased delta activity, it was not evident in any subject during every exposure, its incidence was poorly correlated with exposure concentration, and some subjects admitted that they were drowsy or sleepy during some EEG recordings (condition characterized by increased delta activity). However, these abnormal rhythms were not noted on the 0 ppm day after exposures to p-xylene were complete. The general stability of VER tracings throughout exposures to p-xylene vapor is demonstrated in Figure 10, a compilation of tracings from female subject 258 taken from days before, during, and after exposure to 100 ppm p-xylene vapor. Tables XXXIII and XXXIV list the daily summed amplitudes and the means of the weekly exposures for the 3, 4, and 5 complex of the VERs for all Group I subjects. Values significantly different ($p<0.05$) from pre-exposure by the paired t-test were spurious and not thought to be related to the breathing of air with p-xylene vapor at a concentration of up to 150 ppm.

Cardiopulmonary Function Studies:

Pulmonary ventilation ($\dot{V}_E$) values in ℓ/min (B.T.P.S., body temperature and pressure, saturated) are listed for individual subjects in

Table XXXV. There were some spurious high values for several individuals, probably reflecting a heightened emotional state; however, in general the values were consistent from day to day. Also, values of females were generally lower than those of males, reflecting the generally lower metabolic rate of females. The values are all in the range expected from subjects in the seated position[14].

The results of the extensive cardiopulmonary testing carried out on Day 4 of each week on the Group I, male subjects are given in Tables XXXVI through XXXVIII. Maximum and partial expiratory volumes and flow rates were measured three times each day, and the means of the three trials were used to calculate the daily means for the four subjects (Table XXXVI). Table XXXIX demonstrates the within-day trial to trial variability of each parameter, and except for the flow rates during maximum expiration the intertrial variability was less than 5%. Flow rates during the second and third maximum expiration of each day were significantly higher (two-tailed t-test) than the first expiration (11 to 17%). One possible explanation of this difference is that, with the initial expiration, residual bronchomotor tone was alleviated. Hence, during the subsequent expirations the flow rates were increased[15]. Taking into account the above reliability of the meaned trials, the daily means found in Table XXXVI indicate that there was no decrement in expiratory volumes and flow rates due to the p-xylene vapor.

Metabolic rate, pulmonary, cardiac, and hematologic data as expressed in mean values of four subjects at rest and at two levels of exercise (work 1 = 350 KPM for 6 min, work 2 = 750 KPM for 5 min) during Day 4 of each exposure week are found in Tables XXXVII and XXXVIII. The

results demonstrate that there was no consistent effect of p-xylene vapor on mechanisms regulating pulmonary ventilation, alveolar-capillary gas exchange, metabolic rate, heart rate, peak systolic and diastolic blood pressure, and arterial acid-base status. Alveolar-capillary gas exchange ($D_{L_{CO}}$) seemed to increase with p-xylene exposure each week, but the increases were not dose-related, and the mean values did not return to pre-exposure values, indicating the possibility of spuriously low pre-exposure values, or an actual prolonged effect of p-xylene upon this parameter.

Cognitive Testing:

Extensive data accumulated from the battery of cognitive tests given to Group I and II male subjects on Days 1, 3, and 5 of each week. The daily means (± one standard deviation, S.D.) of the test results vs. the day performed, along with bar graphs showing the concentration of p-xylene, were graphed for rapid visual assessment. Figures 11 through 20 contain the data for Group I subjects while Figures 21 through 30 are for Group II subjects. In order to assess the significance of the exposure to p-xylene on test results, analysis of variance for the Group I scores were made for the parameters measured in each test. There were insufficient test subjects in Group II to make such an assessment feasible. Results of the analysis of variance are shown in Tables XL through L. Significant variance ($p<0.05$), other than that attributed to learning (linear day trend) and people, was noted only in the effect of p-xylene exposure upon the Flanagan coordination test. Figures 31 and 32 show the test performance means (± S.D.) versus exposure level for

Day 5 and Days 1,3, and 5 combined, respectively. These graphs show a decrement in performance at the 150 ppm exposure level. Table LI presents the individual daily test scores throughout the study, and it can be seen that the decrement in performance at 150 ppm is due almost wholly to one subject (#117). This subject had been ill, consequently absent, on Days 1 and 3 of the previous week during the 20 ppm exposure, and did poorly on the coordination test on Day 5. Therefore, it appears that his poorer than normal performance during the exposures to 150 ppm could have been related to his illness. A second subject (#248) also had a poorer than normal performance on Day 3 of this week, and this occurred shortly after he had noted eye irritation on his subjective response sheet. The other two subjects scores were unaffected. Unfortunately, the results of the testing of only one or two subjects from Group II during this week sheds little light on the effect of 150 ppm p-xylene on this test. It is evident from the Group I test scores that 100 ppm, steady or fluctuating, had no detrimental effect upon the performance of this test.

Subjective Responses:

Subjective responses to the vapor of p-xylene are summarized in Table LII as total mentions by male or female subjects at each exposure concentration. Of the six specific responses from the male subjects, only ENT irritation appeared to be related to the concentration of p-xylene, and this was primarily because one 7-1/2-hr subject who wore contact lenses noted eye irritation on almost a daily basis, and he was joined by one other subject twice at 100 ppm and 3 times at 150 ppm.

There was no visible reddening of the eyes or conjunctiva in these subjects. No male 3-hr subjects ever listed ENT irritation, and only once (at 150 ppm) did a 1-hr subject mention it. Interestingly, ENT irritation was also mentioned very often by females during the week of exposure to 100 ppm p-xylene, but in these mentions it was almost always nose or throat irritation. It appears that p-xylene has a weakly irritating effect on soft tissues at a concentration of 100 ppm, and may particularly irritate the eyes of persons wearing contact lenses.

The odor of p-xylene was noted by all subjects upon entering the environmental chamber at all times when the vapor was present. It was generally judged to be moderate in intensity at a concentration of 100 ppm, and strong at 150 ppm, upon first contact. Usually within one hr the intensity rating was reduced by at least one (strong to moderate to mild to none). No subject complained that the odor was completely objectionable.

DISCUSSION

The Threshold Limit Value (TLV) of 100 ppm for the mixed xylene isomers was selected primarily due to eye irritation and possible impairment of reaction time in some workers at 200 ppm[16]. The studies described in this report tend to confirm the validity of the TLV of 100 ppm for one of the isomers, p-xylene. Sedentary male subjects were exposed to vapor concentrations of p-xylene that bracketed this TLV, specifically 20 and 150 ppm, for up to 7-1/2 hr per day, five days per week for one week, in addition to two weeks of exposure to the TLV. Also, female subjects were exposed to the TLV for one week to compare their responses to the male subjects. It must be pointed out that this comprehensive study of subject responses was made on individuals who were usually sedentary during the exposure periods. Under these conditions, only eye, nose, and/or throat irritation could be directly related to the p-xylene exposure. Especially sensitive to eye irritation was one subject who wore contact lenses. Other responses that were suggestive of changes at 100 and 150 ppm exposure levels were changes from alpha to delta EEG activity on some occasions and a decrease in coordination in one subject as measured by the Flanagan Coordination test. However, neither of these changed responses could be associated without question to p-xylene exposure. Furthermore, the decrement in coordination exhibited by the one male subject was not correlatable with increased delta EEG activity.

There is a dearth of recent literature regarding the toxicity of any xylenes in man or animal. Of some interest to this study is a paper

by Mikulski, et al.[17] wherein urinary hippuric acids concentration, which also included methyl hippuric acid, was correlated to combined toluene and xylene exposure in ship's painters. The correlation between total hippuric acid concentration and exposure levels somewhat differentiated <100 ppm from >200 ppm exposures, though there was considerable overlap. In this paper, the authors report a decrease in urinary uric acid concentration inversely proportional to the amount of hippuric acid excreted. They attributed this decrease to the "contribution of the glycine pool to the excretion of toluene and xylene metabolites." The subjects in our study, though urinary uric acid was not measured, did not experience an increase in blood uric acid concentration, as shown in Table LIII. Almost all subjects had a mild decrease in blood uric acid levels, though the decreases were not of great magnitude. If the excretion of urinary uric acid, as reported by Mikulski, et al., is in fact decreased upon toluene and xylene exposure, our data would support the theory that the reduction is not caused by greater retention of uric acid in the blood, but possibly by a decrease in the formation of uric acid. Glycine is a precursor of endogenous uric acid, however, it seems improbable that the glycine needed for hippuric acid excretion would decrease the large glycine pool sufficiently to cause a decrease in uric acid biosynthesis, as postulated by Mikulski and coworkers. It would seem more likely that an as yet unknown mechanism for this alleged reduction in urinary uric acid excretion should be postulated.

Moeschlin[18] in his review of poisoning by aromatic hydrocarbons lumps benzene, toluene, and xylene together as myelotoxic agents, though in none of his examples of xylene and toluene implication was a previous

exposure to benzene excluded. In our study, every p-xylene container was assayed for benzene to entirely prevent any benzene exposure. The blood picture of all subjects who were repeatedly exposed to p-xylene remained normal. The white blood count of all male subjects who were exposed for more than one week to p-xylene vapor are listed in Table LIV. In a more recent publication[19] from Moeschlin's own laboratory, studies with rabbits convinced the authors that pure xylene, uncontaminated with benzene, lacked myelotoxicity.

Ogata and co-workers[3,4] have published data relating urinary methyl hippuric acid and hippuric acid concentrations of painters to exposures to toluene and p-xylene. As experienced with our subjects, correlation of urinary metabolite excretion with exposure was only valuable as a gross measure of exposure. Other biologic measures that we found to be useful as gross measures of exposure were p-xylene concentration in blood and in saliva. Concentrations of the chemical in both of these biologic fluids were measurable by gas chromatography of headspace samples taken from an enclosed container. However, contamination was a problem in our hands, and the intersubject values obtained were quite variable.

Sedivec and Flek[20,21] reported on the absorption, metabolism, and excretion of xylenes in man in papers published after our study was completed. These authors developed a chromatographic procedure for the analysis of the methyl hippuric acids which has the advantage of specificity for quantifying the metabolite of p-xylene. They found that 95.1% of the p-xylene taken up by the body was excreted in the urine as the p-toluric acid, and only 0.05% as the 2,5-xylenol. Most of the remainder, or 3.5% was primarily excreted in the breath. These authors propose[21] the measurement of toluric acids in an 8- or 24-hr urine sample, and expression of the results in mg excreted per 1 kg of body weight, as the most suitable measure of determining the magnitude of an exposure. They suggest a range of from 4.29 to 7.1 mg/kg as acceptable for a worker doing light physical work for an 8-hr day while exposed to the Czechoslovakian MAC of 200 µg/ℓ (46 ppm).

Our reported concentrations of p-toluric acids excreted for a 24-hr period including exposure cannot be favorably compared with the results reported by Sedivec and Flek[21] because our colorimetric procedure was not as specific for the metabolite of p-xylene as was their chromatographic procedure. For instance, our 7-1/2-hr subjects excreted from 0.77 to 2.19 gm of methyl hippuric acid during exposures to 20 ppm p-xylene, while they report a range of 0.46 to 0.85 gm from 8-hr exposures to 46 ppm. It is reasonable to assume that the more specific procedure employed by Sedivec and Flek[20], though technically more difficult to carry out, would result in lower, and more consistent, concentrations of metabolite.

Another apparent difference noted between our studies and those reported by Sedivec and Flek[20] is that of post exposure breath concentrations of xylene. Although their data are shown for only one subject who was exposed to 86 ppm of m-xylene for 8 hr, it appears from the figure that they were obtaining much higher breath levels at all periods than we obtained with p-xylene at 100 ppm. It is most likely that this difference is due primarily to the method of sampling. Whereas we used a 20-second breath holding technique and measured the concentration in alveolar air samples, they simply captured a sample of exhaled air and measured the xylene concentration. The difference points out the necessity of defining the procedure when recommending breath sampling as a tool for evaluating exposures.

Upon perusal of the mean p-xylene post exposure breath concentrations in Tables XIV, XV, XVI, and XX for 7-1/2-, 3-, and 1-hr exposures to identical concentrations of p-xylene in the chamber air, it is obvious that concentration and duration of exposure were not directly correlatable. Although the breath concentrations from 7-1/2-hr exposures were generally somewhat higher than those from 1-hr exposures, the differences were usually small and there was considerable overlap in individual values. The differences between 7-1/2- and 3-hr subjects were even less, with means from the latter often higher than the former. It is interesting to note that the same picture is present in the comparison of blood and saliva concentrations after 7-1/2-, 3-, or 1-hr exposures as seen in Tables XXI through XXVIII.

Comparison of breath concentrations after 150-, 100-, or 20-ppm exposures reveals a slightly better correlation of breath to exposure

concentrations. Figure 33 presents the means and ranges of breath concentrations after the four 7-1/2-hr subjects were exposed to the three steady concentrations on a weekly basis. Hand-drawn curves represent the breath analysis decay curves. It can be noted that there is very little overlap in values when only these three weeks are considered. However, when the values from the week of 100-ppm fluctuating concentrations (between 50 and 150 ppm p-xylene) were considered, there was considerable overlap with the 150-ppm week. These data seem to indicate that an equilibrium exists between free p-xylene and either bound or metabolized product, with the equilibrium in favor of the bound or metabolized product. From the work of Sedivec and Flek[20] who found that approximately 72% of the xylenes were excreted as the bound metabolites during 8 hr of exposure, it is probable that at the levels of exposure studied a metabolite of p-xylene was being formed almost as rapidly as the blood could carry the free chemical to the liver. As the metabolized product was conjugated with glycine, it was being excreted rapidly by the kidneys. Only during exercise and exposure to 150 ppm p-xylene did the blood concentration rise dramatically, as shown in Table XXV. This indicates that a saturation of the metabolic mechanism, plus the shunting of more blood away from the liver to the musculature, was taking place during the high exposure with exercise.

Because of the overlap and resultant lack of clarity of breath analysis decay curves that could be drawn from the data obtained, and because of the rapid drop of breath concentrations with time after exposure, bar graphs of means and ranges of p-xylene breath concentrations immediately and 15 min post exposure were drawn and are presented in

Figures 34 and 35, respectively. Female subjects generally gave lower breath p-xylene concentrations than did male subjects exposed to identical concentrations of p-xylene. In neither male nor female sedentary subjects exposed for 7-1/2 hr per day for five consecutive days was there any clear cut evidence of deleterious response to 100 ppm of p-xylene. Even at 150 ppm for the same time period, male subjects evidenced no deleterious responses, with only a possible saturation of the metabolic pathways as a potential indication of deleterious effect. Because of the need for a relatively simple method of assessing the body burden of p-xylene as related to a safe exposure for 7-1/2 or 8 hr we recommend an alveolar breath sample be obtained exactly 15 minutes after termination of the exposure. The concentration of p-xylene should be no greater than 4.5 ppm if a male worker and no more than 3.5 ppm if a female worker. If this standard is met, all workers should be protected from any deleterious effects of p-xylene vapor exposure.

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APPENDIX I

STATEMENT OF VOLUNTARY CONSENT

FOR RESEARCH INVESTIGATION OF

HUMAN EXPOSURE TO:

p-XYLENE

I, _____, hereby agree to participate as a subject, in a program of research investigation under the direction and supervision of Dr. R. D. Stewart.

The general purpose of this research is to determine rates of uptake, excretion and metabolism of p-XYLENE.

The studies have been described to me and the known risks involved in this experimental procedure have been explained to me. I understand that the most frequently described known risks are: none known at this level of exposure.

I understand also that it is not possible to identify all potential risks in experimental procedures which involve controlled exposures to the chemical in a specially designed chamber.

I further understand that reasonable precautions and safeguards have been and will be taken to remove and reduce both the known and the potential but unknown risks and to provide for my safety and comfort.

I also understand that, while the program will be under the direction and supervision of Dr. R. D. Stewart, other professional persons who work with him may be designated to assist him or to act for him.

In view of those considerations, I hereby authorize Dr. R. D. Stewart and his representatives to proceed with the investigation on the understanding that I may terminate my service as a subject in this research at any time I so desire. I also authorize Dr. R. D. Stewart to use any type of data, pictures, films etc. for use in any scientific report or publication.

I am offering my service freely, in consideration of similar actions on the part of other subjects involved in like voluntary efforts to improve our society through research.

Witness _____ Signed _____

Investigator Subject

Date _____

HISTORY

PART 1

NAME

DATE

HISTORY

PART 2

NAME | DATE

P. M. H.

GENERAL HEALTH | WT.

ILLNESSES	OP	HOSP.	INJ.

S.F

R.F.

D. MELL

T.B.C.

TYPHOID

MALARIA

NER. BK.

GOUT

MEDICATION

P. H.

RELIG.	ED.

VOCAT.

MARITAL

HABITS	SLEEP	COFFEE	CIG.	ALCOL.

WK. HRS./WK.

IMMUNIZATIONS
SMALLPOX
TETANUS
DIPTH.
POLIO
INFLU.
TYPH.
MEAS.

F. H.

	W/H		
M		D. MELL	CA
F		LARGE INFANTS	ASTHMA
		STILLBORN	HAY FEVER
		TBC	EPILEPSY
		B.P.	NER. BK.
		HEART	INSANITY
MM		COR. THROM	GOUT
MF		ANGINA	KIDNEY
FM		STROKE	
FF		BLEED. TEND.	

EYES	VISION	PAIN	GLASSES	
EARS	HEARING	DISCHARGE	PAIN	TINNITUS
NOSE	SMELL	OBST.	EPIS	DISCH.
C.R.	URI/YR	SORE THROATS	HORSENESS	COUGH
	SPUTUM	HEMOP	NIGHT SWEATS	FEVER
	WHEEZE	PAIN	DOE	
	EPEMA	OTHOP	PND	↑ B.P
G.I.	MOUTH			
	APPETITE	DIET	DYSPHAGIA	
	N & V	PAIN		
	STOOLS			
	JAUNDICE	MASS		
G.U.	FREQ.	NOC	PAIN	DYSURIA
	INCONTIN.	COLOR		
	ALB.	SUGAR	WBC	RBC
	V. D.			
M.S.	PREV. TRAUMA			
	NECK	BACK	VAR. VEIN	
	JOINTS	LEG CRAMPS		
NEURO	HEADACHE	TRAUMA		
	ATAXIA	PARALYSIS		
	ANESTH-PARE	TREMOR		
	FAINTING	CONVUL.		
	MEMORY	PERSONALITY		
SKIN	ERUPTION			
	ITCHING	COLOR CHANGE		
LYMPH-HEMAT.	BLEEDING DISORDER			
END.				
ALLERGY				
MENSES	ONSET	LAST WEEKS AGO	DURATION	FREQUENCY / PAIN
	MENOPAUSE	SPOTTING		
	V. D.	VAGINAL DISCHARGE		
BREASTS				

PHYSICAL EXAMINATION

X = NOT EXAMINED - = NO; NEGATIVE
✓ = NORMAL; YES O = ABSENT

NAME | DATE

TEMP. | B.P. | P. | HT. | WT. | ST. WT.

APPEARANCE | POSTURE

HAIR: COLOR | TEXTURE | DISTRIBUTION

SCALP: CLEAN | ERUPTION | ALOPECIA

SKULL: DEFORMITIES | TENDERNESS

FACE: PALSIES | EXPRESSION | LIPS

EARS: CERUMEN | TYM MEMB | WATCH HEARD R L | TOPHI

NOSE: DISCHARGE | OBSTRUCTION | PERFORATION

MOUTH: BREATH | ULCERS | AB. PIGMENTATION

TEETH: R 8 7 6 5 4 3 2 1 | 1 2 3 4 5 6 7 8 L | X = CARIOUS, O = ABSENT

R 8 7 6 5 4 3 2 1 | 1 2 3 4 5 6 7 8 L | CLEAN | ADEQUATE CHEWING SURFACE

GUMS: RETRACTION | PYORRHEA

TONGUE: PROTRUDED MIDLINE | TREMOR | ATROPHY

TONSILS: STATUS | ENLARGED | INJECTION | EXUDATE

PHARYNX: GAG REFLEX | INJECTION | EXUDATE

EYES: COLOR | ARCUS SENILIS | PERRLA | NEOM | NYSTAGMUS

EXOPHTHAL | LID LAG | PTOSIS | PERIORBITAL EDEMA

VISION | NEAR R L | FAR R L | FIELDS

OPHTHAL | DISC | H GR. | A GR. | TONOMETER R L

LARYNX: VOICE NORMAL | MIDLINE | TUG

TRACHEA

NECK: STIFFNESS | NODES | VEINS | CAROTID | PALPABLE THYROID

SPINE: TENDERNESS | RIGIDITY | AB. CURVATURE

THORAX: SYMMETRICAL | CVA TENDERNESS | STERNAL TENDERNESS

RESPIRA: RATE | REGULAR | DEPTH | SYMMETRICAL | FORCED

LUNGS: COUGH | SPUTUM | PERCUSSION

RESONANT | BREATH SOUNDS | VESICULAR

RALES | TACTILE FREMITUS | VOICE SOUNDS

HEART: HEAVE | SHOCK | THRILL

APEX IMPULSE PALPABLE IN _____ I.C.S. _____ CM. TO L. OF M.C.L. FROM M.S.L. | B.C.D. EXTENDS _____ CM. TO L. OF M.S.L. _____ I.C.S.

SOUNDS A_2 P_2 M_1 M_2 | RHYTHM | MURMUR

BREASTS: SIZE NORMAL | TENDERNESS | MASSES

ABDOMEN: SYMMETRICAL | DILATED VEINS | ASCITES

PALPABLE LIVER | SPLEEN | KIDNEY | MASSES

TENDERNESS | RIGIDITY | SOUNDS | HERNIA

GENIT-ALIA: DISCHARGE | SKIN LESION | TESTES

PELVIC

ARMS: RADIAL PULSE | TREMOR | CLUBBING | CYANOSIS | JOINTS

LEGS: DORSALIS PEDIS | VARICOSITIES | EDEMA | ULCER

JOINTS

NODES	CERVICAL	AXILLARY	INGUINAL	ENLARGED
	IDENT. MARKS			TEXTURE
N	COLOR	JAUNDICE	ERUPTION	AB. PIGMENTATION
CTAL	HEMORRHOIDS	MASSES	TENDERNESS	COLOR FECES
OSTATE	ENLARGED	TENDER	MASS	
URO-GICAL				

CRANIAL NERVES

R		L
	SMELL	
	VISION	
	FIELD	
	FUNDUS	
	OCULAR MOVEMENTS	
	PTOSIS	
	NYSTAGMUS	
	PUPILS SIZE - SHAPE	
	PUPILS REFLEXES	
	HEARING	
	TASTE	

ALLOWING

REFLEXES (ENCIRCLE REINFORCED)

R		L
	CORNEAL CR.	
	SUCKING	
	PHARYNX CR. IX, X	
	JAW CR. V	
	BICEPS C56	
	BRACHIORADIALIS C-56	
	TRICEPS C678	
	HOFFMANN	
	EPIGASTRIC T6-9	
	MID. ABD. T9-11	
	HYPOGASTRIC T11-L1	
	CREMASTERIC L 12	
	QUADRICIPS L 234	
	GASTROC. SOLEUS L5 S12	
	CLONUS (ANKLE)	
	HAMSTR. INT. L45 S12	
	HAMSTR. EXT. L5 S12	
	ANAL S34	
	BULBOCAV S34	
	BABINSKI	

OMBERG

ACIES - POSTURE

EECH

ANDEDNESS RT. LT.

ENTAL STATUS

REMOR

TATION

GAIT

R		L
	ON TOES	
	ON HEELS	
	HOPPING	
	ARM SWING	

TRAIGHT AWAY

N TURNS

ANDEM

ESCRIPTION

MUSCLES

A = ATROPHY F = FASICULATION

R	STRENGTH	L
	TEMPORAL CR V	
	MASSETER V	
	FOREHEAD VII	
	ORBIC. OC. VII	
	MOUTH VII	
	SOFT PALATE X	
	PHARYNX X	
	STERNOMASTOID XI	
	TONGUE XII	
	NECK FLEX. C 1-6	
	NECK EXT. C1-TI	
	SCAPULAR C4-7	
	PECTORALIS MAJ. 5-TI	
	DELTOID C 56	
	BICEPS BRACH. 56	
	TRICEPS 6 78	
	WRIST EXT. 678	
	WRIST FLEX. 678 TI	
	DIGITS EXT. 678	
	DIGITS FLEX. 78 TI	
	THENAR 8 1	
	HYPOTHENAR 8 1	
	INTEROSSEI 8 1	
	BACK	
	ABDOMAN T6-L1	
	ILIOPSOAS L1234	
	ADDUCTORS, THIGH 234	
	ABDUCTORS, THIGH 45 S1	
	GLUTEUS MAX. 5 12	
	QUADRICEPS 234	
	HAMSTRINGS 45 12	
	TIBIALIS ANT. 45 1	
	TOES EXT. 45 1	
	PERONEI 45 1	
	TIBIALIS POST 5 1	
	GASTROC. SOLEUS 5 12	
	TOES FLEX. 5 12	

ALT. MOT. RATE (A.M.R.)

R		L
	HANDS (PRO. SUP.)	
	FINGERS	
	FEET	

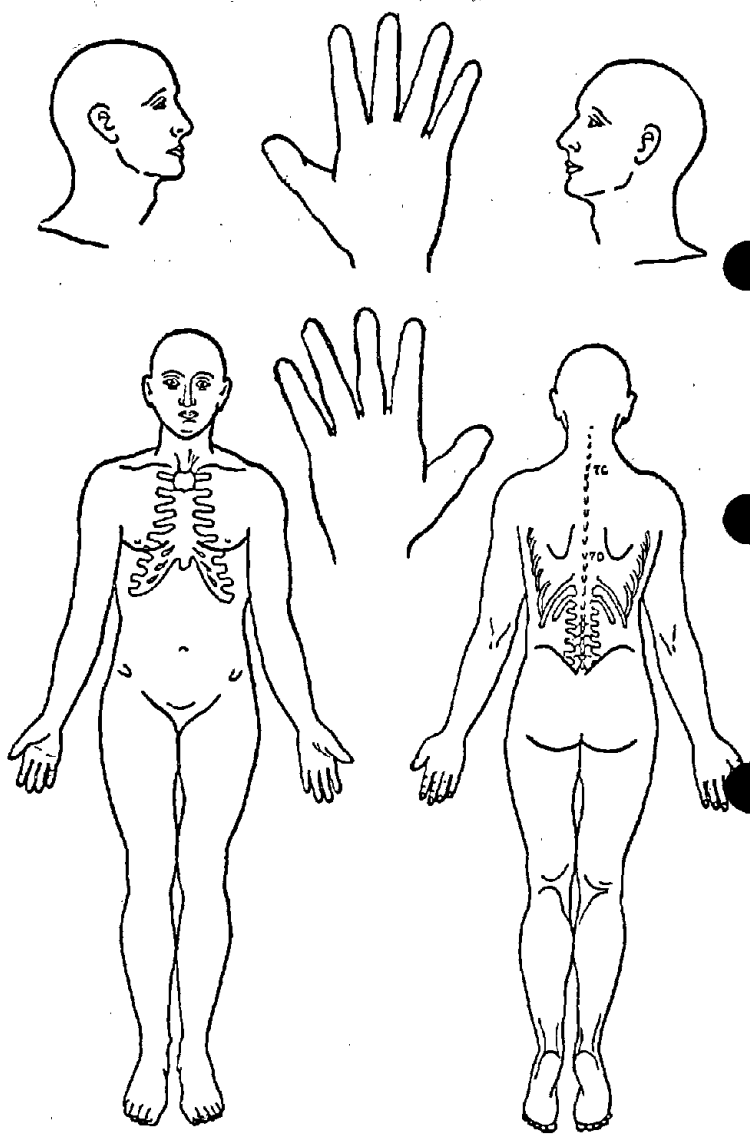
TONGUE

COORDINATION

R		L
	NOSE-FINGER-NOSE	
	KNEE PAT. (PRO. SUP)	
	TOE-FINGER	
	FINGER - NOSE	
	HEEL - KNEE	

(UNDERLINE IF NORMAL - OTHERWISE ENCIRCLE AND CHART)

TOUCH	JOINT SENSE
PAIN	STEREOGNOSIS
TEMPERATURE	TRACED FIGURES
DEEP PAIN	TWO POINT
VIBRATION	



TOUCH - ARABIC; PAIN - ARABIC IN CIRCLE; TEMP. - ROMAN

LOW BACK SYNDROMES

R		L
	S.L.R.	
	LOC. PAIN	
	FABERE	
	KERNIG	
	SPASM	

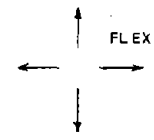
CHIN-CHEST

LIST

SCOLIOSIS

LORDOSIS

L R



RECTAL (SACRUM, SPHINETER)

STIFF NECK

CRANIUM

BRUIT

NAME

IMPRESSIONS:

PROGRAM:

TABLE I

p-XYLENE EXPOSURE SCHEDULE

Week	Day of Week	Desired Conc. PPM	ACTUAL TIME-WEIGHTED AVERAGE VAPOR CONCENTRATION, PPM								
			Group I, 7-1/2 hr			Group II, 3 hr			Group III, 1 hr		
			No. of Subj.	Mean	±S.D.	No. of Subj.	Mean	±S.D.	No. of Subj.	Mean	±S.D.
			MALE								
1	4	0	4	0		2	0		3	0	
	5	0	4	0		2	0		2	0	
2	1	100	4	99	2	2	99	2	2	99	3
	2	100	4	100	2	2	100	2	1	99	2
	3	100	4	100	2	2	100	2	1	98	2
	4	100	4	100	1	2	100	1	1	100	1
	5	100	4	100	1	2	100	1	1	100	1
3	1	20	3	20	1	2	20	1	2	20	<1
	2	20	4	20	<1	1	20	<1	3	20	<1
	3	20	3	20	<1	2	20	<1	3	20	<1
	4	20	4	20	<1	2	20	<1	3	20	<1
	5	20	4	20	1	2	20	<1	3	20	<1
4	1	150	4	149	2	2	148	2	2	148	2
	2	150	4	150	2	2	150	2	2	150	2
	3	150	4	149	2	2	148	2	2	149	2
	4	150	4	150	2	2	150	2	2	148	2
	5	150	4	150	2	1	150	2	2	149	2
5	1	100f	3	101	39	2	102	37	2	101	39
	2	100f	4	101	40	2	100	40	2	143	14
	3	100f	4	101	40	2	102	39	2	100	39
	4	100f	4	101	39	1	102	38	1	146	12
	5	100f	3	101	39	1	101	39	2	100	41
										143	13
										102	38
										146	9
6	1	0	4	0		1	0		1	0	
	2	0	4	0		1	0		2	0	
			FEMALE								
1	5	0	4	0		3	0		2	0	
2	1	100	3	100	2	2	99	1	2	99	1
	2	100	3	99	1	2	98	1	2	98	1
	3	100	3	100	1	2	100	1	2	99	2
	4	100	3	100	1	2	100	1	2	99	1
	5	100	3	100	1	2	99	1	2	99	1
3	1	0	3	0		2	0		2	0	

TABLE II

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 7-1/2 Hours - Chamber Concentration: 100 ppm

GROUP I

	Time	Mean (in ppm)	Range (in ppm)	Standard ±Deviation	Number of Subjects
Day 1:	1 min., post exit	6.25	5.90 - 6.90	0.47	4
	15 " " "	1.98	1.80 - 2.20	0.17	4
	30 " " "	1.69	1.58 - 1.80	0.13	4
	1 hour " "	1.15	1.00 - 1.30	0.13	4
	2 " " "	0.40	0.22 - 0.59	0.17	4
	3 " " "	0.30	0.18 - 0.39	0.09	4
	Baseline	0.20	0.13 - 0.26	0.08	4
Day 2:	1 min., post exit	3.91	2.93 - 4.98	0.92	4
	15 " " "	1.56	1.51 - 1.57	0.03	4
	30 " " "	1.28	1.12 - 1.33	0.11	4
	1 hour " "	0.91	0.84 - 1.05	0.10	4
	2 " " "	0.75	0.70 - 0.80	0.06	4
	3 " " "	0.48	0.40 - 0.50	0.05	4
	Baseline	0.30	0.20 - 0.40	0.08	4
Day 3:	1 min., post exit	4.78	3.40 - 6.50	1.28	4
	15 " " "	1.90	1.80 - 2.20	0.20	4
	30 " " "	1.05	0.90 - 1.50	0.30	4
	1 hour " "	0.68	0.60 - 0.80	0.10	4
	2 " " "	0.44	0.40 - 0.55	0.08	4
	3 " " "	0.41	0.38 - 0.50	0.06	4
	Baseline	0.20	0.20	0	4
Day 4:	1 min., post exit	5.08	3.70 - 5.70	0.93	4
	15 " " "	2.34	2.02 - 2.90	0.40	4
	30 " " "	1.81	1.65 - 2.02	0.19	4
	1 hour " "	1.33	1.20 - 1.50	0.13	4
	2 " " "	1.02	0.81 - 1.38	0.25	4
	3 " " "	0.63	0.40 - 0.70	0.15	4
	Baseline	0.30	0.22 - 0.38	0.07	4
Day 5:	1 min., post exit	4.99	3.22 - 8.11	2.23	4
	15 " " "	0.99	0.95 - 1.00	0.03	4
	30 " " "	0.70	0.61 - 0.95	0.17	4
	1 hour " "	0.56	0.51 - 0.61	0.06	4
	2 " " "	0.65	0.60 - 0.81	0.11	4
	3 " " "	0.36	0.30 - 0.45	0.08	4
	Baseline	0.19	0.10 - 0.30	0.09	4

TABLE III

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 3 Hours - Chamber Concentration: 100 ppm

GROUP II

	Time	Mean (in ppm)	Range (in ppm)	Standard ±Deviation	Number of Subjects
Day 1:	1 min., post exit	7.65	6.90 - 8.40	1.06	2
	15 " " "	3.25	3.10 - 3.40	0.21	2
	30 " " "	2.40	2.40	0	2
	1 hour " "	1.65	1.50 - 1.80	0.21	2
	2 " " "	0.38	0.21 - 0.54	0.23	2
	3 " " "	0.30	0.12 - 0.47	0.25	2
	Baseline	0.13	0.13	0	2
Day 2:	1 min., post exit	5.87	4.64 - 7.09	1.73	2
	15 " " "	1.84	1.68 - 2.00	0.23	2
	30 " " "	1.23	1.10 - 1.35	0.18	2
	1 hour " "	0.77	0.77 -	0	2
	2 " " "	0.40	0.20 - 0.60	0.28	2
	3 " " "	0.20	0.20	0	2
	Baseline	0.20	0.20	0	2
Day 3:	1 min., post exit	7.40	5.50 - 9.30	2.69	2
	15 " " "	2.30	1.70 - 2.90	0.85	2
	30 " " "	1.25	1.20 - 1.30	0.07	2
	1 hour " "	0.90	0.80 - 1.00	0.14	2
	2 " " "	0.70	0.70	-	1
	3 " " "	0.60	0.60	-	1
	Baseline	0.16	0.12 - 0.20	0.06	2
Day 4:	1 min., post exit	9.25	7.30 -11.20	2.76	2
	15 " " "	2.43	2.30 - 2.55	0.18	2
	30 " " "	1.73	1.50 - 1.95	0.32	2
	1 hour " "	1.25	1.05 - 1.45	0.28	2
	2 " " "	0.67	0.60 - 0.74	0.10	2
	3 " " "	0.53	0.45 - 0.60	0.11	2
	Baseline	0.30	0.30	0	2
Day 5:	1 min., post exit	7.60	5.70 - 9.50	2.69	2
	15 " " "	1.73	1.55 - 1.91	0.25	2
	30 " " "	1.31	0.91 - 1.71	0.57	2
	1 hour " "	0.90	0.72 - 1.08	0.25	2
	2 " " "	0.60	0.60	0	2
	3 " " "	0.38	0.30 - 0.45	0.11	2
	Baseline	0.10	0.10	-	1

TABLE IV

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 1 Hours - Chamber Concentration: 100 ppm

GROUP III

	Time	Mean (in ppm)	Range (in ppm)	Standard ±Deviation	Number of Subjects
Day 1:	1 min., post exit	3.80	3.60 - 4.00	0.28	2
	15 " " "	1.85	1.80 - 1.90	0.07	2
	30 " " "	1.20	1.00 - 1.40	0.28	2
	1 hour " "	0.75	0.70 - 0.80	0.07	2
	2 " " "	0.22	0.22	-	1
	3 " " "	0.11	0.11	-	1
	Baseline	0.13	0.13	-	1
Day 2:	1 min., post exit	1.47	1.47	-	1
	15 " " "	1.33	1.33	-	1
	30 " " "	0.52	0.52	-	1
	1 hour " "	0.45	0.45	-	1
	2 " " "	-	-		
	3 " " "	-	-		
	Baseline	0.20	0.20	-	1
Day 3:	1 min., post exit	2.60	2.60	-	1
	15 " " "	1.10	1.10	-	1
	30 " " "	0.80	0.80	-	1
	1 hour " "	0.60	0.60	-	1
	2 " " "	0.58	0.58	-	1
	3 " " "	0.28	0.28	-	1
	Baseline	0.12	0.12	-	1
Day 4:	1 min., post exit	4.00	4.00	-	1
	15 " " "	1.50	1.50	-	1
	30 " " "	1.05	1.05	-	1
	1 hour " "	0.80	0.80	-	1
	2 " " "	0.40	0.40	-	1
	3 " " "	0.40	0.40	-	1
	Baseline	0.10	0.10	-	1
Day 5:	1 min., post exit	3.82	3.82	-	1
	15 " " "	1.47	1.47	-	1
	30 " " "	0.82	0.82	-	1
	1 hour " "	0.61	0.61	-	1
	2 " " "	0.60	0.60	-	1
	3 " " "	0.15	0.15	-	1
	Baseline	0.10	0.10	-	1

TABLE V

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 7 1/2 Hours - Chamber Concentration: 20 ppm

GROUP I

	Time	Mean (in ppm)	Range (in ppm)	± Standard Deviation	Number of Subjects
Day 1:	1 min., post exit	1.37	1.20 - 1.68	0.27	3
	15 " " "	0.49	0.43 - 0.53	0.05	3
	30 " " "	0.31	0.31	0	3
	1 hour " "	0.20	0.16 - 0.22	0.03	3
	2 " " "	0.12	0.05 - 0.16	0.06	3
	3 " " "	0.08	0.05 - 0.12	0.04	3
	Baseline	0.05	0.05	0	3
Day 2:	1 min., post exit	0.89	0.83 - 0.93	0.05	4
	15 " " "	0.30	0.22 - 0.41	0.09	4
	30 " " "	0.17	0.15 - 0.18	0.02	4
	1 hour " "	0.14	0.12 - 0.15	0.02	4
	2 " " "	0.12	0.11 - 0.13	0.01	3
	3 " " "	0.05	0.05	0	3
	Baseline	0	0	0	3
Day 3:	1 min., post exit	0.65	0.62 - 0.70	0.04	3
	15 " " "	0.37	0.36 - 0.40	0.02	3
	30 " " "	0.27	0.26 - 0.30	0.02	3
	1 hour " "	0.27	0.24 - 0.30	0.03	3
	2 " " "	0.21	0.19 - 0.25	0.03	3
	3 " " "	0.14	0.12 - 0.15	0.02	3
	Baseline	0.08	0.05 - 0.10	0.02	4
Day 4:	1 min., post exit	1.16	1.00 - 1.30	0.13	4
	15 " " "	0.49	0.48 - 0.50	0.01	4
	30 " " "	0.31	0.21 - 0.40	0.08	4
	1 hour " "	0.18	0.15 - 0.24	0.04	4
	2 " " "	0.17	0.14 - 0.24	0.06	3
	3 " " "	0.10	0.08 - 0.10	0.01	4
	Baseline	0.03	0.02 - 0.05	0.02	4
Day 5:	1 min., post exit	0.90	0.70 - 1.05	0.16	4
	15 " " "	0.32	0.26 - 0.41	0.06	4
	30 " " "	0.27	0.21 - 0.36	0.07	4
	1 hour " "	0.22	0.19 - 0.31	0.06	4
	2 " " "	0.25	0.19 - 0.34	0.07	3
	3 " " "	0.15	0.10 - 0.20	0.06	4
	Baseline	0.05	0.05 - 0.06	0.01	4

TABLE VI

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 3 Hours - Chamber Concentration: 20 ppm

GROUP II

	Time	Mean (in ppm)	Range (in ppm)	± Standard Deviation	Number of Subjects
Day 1:	1 min., post exit	1.45	1.36 - 1.54	0.13	2
	15 " " "	0.34	0.31 - 0.36	0.04	2
	30 " " "	0.28	0.25 - 0.31	0.04	2
	1 hour " "	0.20	0.16 - 0.23	0.05	2
	2 " " "	0.16	0.16	-	1
	3 " " "	0.12	0.12	-	1
	Baseline	0.05	0.05	-	1
Day 2:	1 min., post exit	1.55	1.55	-	1
	15 " " "	0.31	0.31	-	1
	30 " " "	0.21	0.21	-	1
	1 hour " "	0.12	0.12	-	1
	2 " " "	0.11	0.11	-	1
	3 " " "	0.05	0.05	-	1
	Baseline	0	0	-	1
Day 3:	1 min., post exit	0.74	0.70 - 0.77	0.05	2
	15 " " "	0.49	0.47 - 0.50	0.02	2
	30 " " "	0.33	0.30 - 0.36	0.04	2
	1 hour " "	0.24	0.22 - 0.25	0.02	2
	2 " " "	0.20	0.19 - 0.20	0.01	2
	3 " " "	0.12	0.12	0	2
	Baseline	0.05	0.05	0	2
Day 4:	1 min., post exit	1.11	1.00 - 1.22	0.16	2
	15 " " "	0.50	0.50	0	2
	30 " " "	0.24	0.22 - 0.25	0.02	2
	1 hour " "	0.18	0.16 - 0.20	0.03	2
	2 " " "	0.11	0.10 - 0.12	0.01	2
	3 " " "	0.07	0.05 - 0.09	0.03	2
	Baseline	0.02	0.02	0	2
Day 5:	1 min., post exit	1.10	0.85 - 1.35	0.35	2
	15 " " "	0.28	0.25 - 0.31	0.04	2
	30 " " "	0.19	0.17 - 0.20	0.02	2
	1 hour " "	0.12	0.11 - 0.12	0.01	2
	2 " " "	0.13	0.12 - 0.14	0.01	2
	3 " " "	0.09	0.08 - 0.10	0.01	2
	Baseline	0	0	-	1

TABLE VII

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 1 Hours - Chamber Concentration: 20 ppm

GROUP III

	Time	Mean (in ppm)	Range (in ppm)	Standard ± Deviation	Number of Subjects
Day 1:	1 min., post exit	1.31	0.90 - 1.71	0.57	2
	15 " " "	0.36	0.22 - 0.50	0.20	2
	30 " " "	0.24	0.17 - 0.30	0.09	2
	1 hour " "	0.16	0.10 - 0.21	0.08	2
	2 " " "	0.14	0.10 - 0.18	0.06	2
	3 " " "	0.11	0.10 - 0.11	0.01	2
	Baseline	0.05	0.05	0	2
Day 2:	1 min., post exit	1.00	0.85 - 1.15	0.15	3
	15 " " "	0.26	0.20 - 0.29	0.05	3
	30 " " "	0.15	0.12 - 0.17	0.03	3
	1 hour " "	0.09	0.08 - 0.10	0.01	3
	2 " " "	0.05	0.05	0	3
	3 " " "	0	0	0	3
	Baseline	0	0	0	3
Day 3:	1 min., post exit	0.63	0.54 - 0.70	0.08	3
	15 " " "	0.32	0.30 - 0.36	0.03	3
	30 " " "	0.27	0.25 - 0.30	0.03	3
	1 hour " "	0.23	0.22 - 0.25	0.02	3
	2 " " "	0.12	0.10 - 0.15	0.03	3
	3 " " "	0.12	0.08 - 0.18	0.05	3
	Baseline	0.05	0.05	0	3
Day 4:	1 min., post exit	1.00	1.00	0	3
	15 " " "	0.30	0.19 - 0.41	0.11	3
	30 " " "	0.18	0.15 - 0.19	0.02	3
	1 hour " "	0.14	0.12 - 0.15	0.02	3
	2 " " "	0.10	0.08 - 0.12	0.02	3
	3 " " "	0.08	0.04 - 0.10	0.03	3
	Baseline	0	0	0	3
Day 5:	1 min., post exit	0.95	0.91 - 1.00	0.05	3
	15 " " "	0.19	0.17 - 0.20	0.02	3
	30 " " "	0.16	0.15 - 0.17	0.01	3
	1 hour " "	0.09	0.08 - 0.10	0.01	3
	2 " " "	0.09	0.08 - 0.10	0.01	2
	3 " " "	0.07	0.05 - 0.08	0.02	2
	Baseline	0.02	0.02	0	2

TABLE VIII

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 7-1/2 Hours - Chamber Concentration: 150 ppm

GROUP I

	Time	Mean (in ppm)	Range (in ppm)	Standard ± Deviation	Number of Subjects
Day 1:	1 min., post exit	9.33	8.21 -11.01	1.37	4
	15 " " "	4.40	4.20 - 4.80	0.28	4
	30 " " "	3.78	3.50 - 4.00	3.78	4
	1 hour " "	2.55	2.22 - 2.84	0.28	4
	2 " " "	1.27	0.55 - 1.65	0.50	4
	3 " " "	0.78	0.55 - 0.90	0.16	4
	Baseline	0.39	0.38 - 0.40	0.01	4
Day 2:	1 min., post exit	9.03	6.30 -11.81	2.25	4
	15 " " "	3.58	3.20 - 4.10	0.38	4
	30 " " "	3.10	2.60 - 3.50	0.39	4
	1 hour " "	2.21	2.08 - 2.30	0.11	4
	2 " " "	1.88	1.75 - 2.05	0.13	4
	3 " " "	0.87	0.81 - 0.95	0.07	4
	Baseline	0.63	0.55 - 0.65	0.05	4
Day 3:	1 min., post exit	8.88	8.00 -10.81	1.30	4
	15 " " "	3.99	3.71 - 4.35	0.32	4
	30 " " "	2.77	1.91 - 3.71	0.74	4
	1 hour " "	2.20	1.91 - 2.30	0.20	4
	2 " " "	1.50	1.31 - 1.60	0.13	4
	3 " " "	0.80	0.50 - 0.95	0.21	4
	Baseline	0.46	0.32 - 0.50	0.09	4
Day 4:	1 min., post exit	12.88	11.80 -14.50	1.16	4
	15 " " "	6.26	5.65 - 7.30	0.75	4
	30 " " "	4.75	4.30 - 5.50	0.52	4
	1 hour " "	3.85	3.50 - 4.10	0.27	4
	2 " " "	1.87	1.80 - 2.00	0.10	4
	3 " " "	1.19	1.15 - 1.20	0.03	4
	Baseline	0.66	0.60 - 0.70	0.05	4
Day 5:	1 min., post exit	10.55	8.20 -12.00	1.67	4
	15 " " "	5.00	4.80 - 5.30	0.25	4
	30 " " "	3.83	3.55 - 4.20	0.33	4
	1 hour " "	3.00	2.60 - 3.60	0.49	4
	2 " " "	1.85	1.75 - 2.00	0.13	3
	3 " " "	1.15	0.95 - 1.50	0.34	3
	Baseline	0.88	0.50 - 1.00	0.25	4

TABLE IX

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 3 Hours - Chamber Concentration: 150 ppm

GROUP II

	Time	Mean (in ppm)	Range (in ppm)	Standard ± Deviation	Number of Subjects
Day 1:	1 min., post exit	8.45	7.46 - 9.44	1.40	2
	15 " " "	3.86	3.72 - 4.00	0.20	2
	30 " " "	2.64	2.55 - 2.72	0.12	2
	1 hour " "	1.90	1.90	0	2
	2 " " "	0.98	0.90 - 1.05	0.11	2
	3 " " "	0.67	0.65 - 0.68	0.02	2
	Baseline	0.38	0.35 - 0.40	0.04	2
Day 2:	1 min., post exit	8.68	7.55 - 9.80	1.59	2
	15 " " "	3.01	2.76 - 3.25	0.35	2
	30 " " "	1.83	1.61 - 2.05	0.31	2
	1 hour " "	1.61	1.60 - 1.61	0.01	2
	2 " " "	1.12	1.03 - 1.21	0.13	2
	3 " " "	0.76	0.72 - 0.80	0.06	2
	Baseline	0.55	0.52 - 0.58	0.04	2
Day 3:	1 min., post exit	8.03	6.66 - 9.40	1.94	2
	15 " " "	2.55	1.80 - 3.30	1.06	2
	30 " " "	2.51	2.21 - 2.80	0.42	2
	1 hour " "	1.75	1.40 - 2.10	0.50	2
	2 " " "	1.05	0.95 - 1.15	0.14	2
	3 " " "	0.95	0.95	-	1
	Baseline	0.48	0.48	0	2
Day 4:	1 min., post exit	9.43	8.85 -10.00	0.81	2
	15 " " "	2.30	1.80 - 2.80	0.71	2
	30 " " "	2.35	2.20 - 2.50	0.21	2
	1 hour " "	1.88	1.85 - 1.90	0.04	2
	2 " " "	1.61	1.61	-	1
	3 " " "	1.35	1.35	-	1
	Baseline	0.65	0.65	-	1
Day 5:	1 min., post exit	11.40	11.40	-	1
	15 " " "	3.55	3.55	-	1
	30 " " "	2.70	2.70	-	1
	1 hour " "	2.00	2.00	-	1
	2 " " "	1.75	1.75	-	1
	3 " " "	1.50	1.50	-	1
	Baseline	0.20	0.20	-	1

TABLE X

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 1 Hours - Chamber Concentration: 150 ppm

GROUP III

	Time	Mean (in ppm)	Range (in ppm)	Standard ± Deviation	Number of Subjects
Day 1:	1 min., post exit	7.58	6.10 - 9.05	2.09	2
	15 " " "	2.10	2.10	-	1
	30 " " "	1.86	1.50 - 2.21	0.50	2
	1 hour " "	1.41	1.28 - 1.54	0.18	2
	2 " " "	0.90	0.90	-	1
	3 " " "	0.65	0.65	-	1
	Baseline	0.35	0.28 - 0.41	0.09	2
Day 2:	1 min., post exit	9.16	7.80 -10.51	1.92	2
	15 " " "	2.11	1.81 - 2.41	0.42	2
	30 " " "	1.54	1.27 - 1.81	0.38	2
	1 hour " "	1.35	1.08 - 1.61	0.38	2
	2 " " "	0.94	0.72 - 1.16	0.31	2
	3 " " "	0.61	0.50 - 0.72	0.16	2
	Baseline	0.43	0.38 - 0.48	0.71	2
Day 3:	1 min., post exit	8.65	8.10 - 9.20	0.78	2
	15 " " "	2.26	2.21 - 2.30	0.06	2
	30 " " "	2.00	1.80 - 2.20	0.28	2
	1 hour " "	1.40	1.20 - 1.60	0.28	2
	2 " " "	0.55	0.30 - 0.80	0.35	2
	3 " " "	0.35	0.20 - 0.50	0.21	2
	Baseline	0.25	0.20 - 0.30	0.07	2
Day 4:	1 min., post exit	10.25	9.70 -10.80	0.78	2
	15 " " "	2.18	2.10 - 2.25	0.11	2
	30 " " "	1.93	1.90 - 1.95	0.04	2
	1 hour " "	1.53	1.15 - 1.90	0.53	2
	2 " " "	0.92	0.79 - 1.05	0.92	2
	3 " " "	0.70	0.61 - 0.79	0.13	2
	Baseline	0.60	0.60	0	2
Day 5:	1 min., post exit	9.48	8.70 -10.25	1.10	2
	15 " " "	2.78	2.60 - 2.95	0.25	2
	30 " " "	2.03	1.65 - 2.40	0.53	2
	1 hour " "	1.61	1.41 - 1.80	0.28	2
	2 " " "	1.10	0.80 - 1.40	0.42	2
	3 " " "	0.75	0.50 - 1.00	0.35	2
	Baseline	0.38	0.38	0	2

TABLE XI

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 7-1/2 Hours - Chamber Concentration: Fluct. 50-150 ppm

GROUP I

	Time	Mean (in ppm)	Range (in ppm)	± Standard Deviation	Number of Subjects
Day 1:	1 min., post exit	6.33	5.80 - 7.20	0.76	3
	15 " " "	2.65	2.20 - 3.21	0.51	3
	30 " " "	2.27	2.10 - 2.50	0.21	3
	1 hour " "	1.82	1.66 - 2.00	0.17	3
	2 " " "	1.52	1.40 - 1.70	0.16	3
	3 " " "	0.62	0.55 - 0.72	0.09	3
	Baseline	0.27	0.10 - 0.40	0.14	4
Day 2:	1 min., post exit	6.88	6.30 - 7.80	0.65	4
	15 " " "	2.53	2.30 - 2.80	0.21	4
	30 " " "	2.00	1.75 - 2.25	0.20	4
	1 hour " "	1.63	1.41 - 1.75	0.16	4
	2 " " "	1.36	1.22 - 1.45	0.11	4
	3 " " "	0.60	0.55 - 0.65	0.06	4
	Baseline	0.30	0.25 - 0.35	0.04	4
Day 3:	1 min., post exit	7.17	5.10 - 9.96	2.04	4
	15 " " "	3.24	3.00 - 3.55	0.28	4
	30 " " "	2.48	2.30 - 2.90	0.29	4
	1 hour " "	1.75	1.70 - 1.80	0.06	4
	2 " " "	1.78	1.60 - 1.90	0.15	4
	3 " " "	1.01	1.00 - 1.04	0.02	4
	Baseline	0.57	0.50 - 0.70	0.10	4
Day 4:	1 min., post exit	7.50	5.10 -11.60	2.85	4
	15 " " "	4.13	3.50 - 4.75	0.62	4
	30 " " "	2.84	2.42 - 3.15	0.34	4
	1 hour " "	2.20	1.92 - 2.42	0.23	4
	2 " " "	1.50	1.35 - 1.80	0.26	4
	3 " " "	0.90	0.70 - 1.10	0.20	4
	Baseline	0.45	0.45	0	3
Day 5:	1 min., post exit	6.43	5.70 - 7.00	0.67	3
	15 " " "	3.72	3.55 - 3.80	0.14	3
	30 " " "	2.55	2.45 - 2.70	0.13	3
	1 hour " "	1.83	1.75 - 2.00	0.14	3
	2 " " "	1.07	0.80 - 1.30	0.25	3
	3 " " "	0.78	0.75 - 0.80	0.03	3
	Baseline	0.28	0.25 - 0.35	0.06	3

TABLE XII

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 3 Hours - Chamber Concentration: Fluct. 50-150 ppm

GROUP II

	Time	Mean (in ppm)	Range (in ppm)	Standard ± Deviation	Number of Subjects
Day 1:	1 min., post exit	6.15	5.60 - 6.70	0.78	2
	15 " " "	2.48	2.48	0	2
	30 " " "	1.78	1.67 - 1.89	0.16	2
	1 hour " "	1.43	1.41 - 1.45	0.03	2
	2 " " "	0.85	0.79 - 0.90	0.08	2
	3 " " "	0.43	0.40 - 0.45	0.04	2
	Baseline	0.29	0.22 - 0.35	0.09	2
Day 2:	1 min., post exit	7.00	5.70 - 8.30	1.84	2
	15 " " "	1.93	1.80 - 2.05	0.18	2
	30 " " "	1.60	1.50 - 1.70	0.14	2
	1 hour " "	1.40	1.35 - 1.45	0.07	2
	2 " " "	1.15	1.15	-	1
	3 " " "	0.75	0.75	-	1
	Baseline	0.30	0.30	0	2
Day 3:	1 min., post exit	7.13	4.75 - 9.50	3.36	2
	15 " " "	2.93	2.30 - 3.55	0.88	2
	30 " " "	1.89	1.67 - 2.10	0.30	2
	1 hour " "	1.50	1.30 - 1.70	0.28	2
	2 " " "	1.50	1.50	-	1
	3 " " "	1.20	1.20	-	1
	Baseline	0.70	0.70	-	1
Day 4:	1 min., post exit	7.40	7.40	-	1
	15 " " "	3.10	3.10	-	1
	30 " " "	2.60	2.60	-	1
	1 hour " "	2.00	2.00	-	1
	2 " " "	1.25	1.25	-	1
	3 " " "	0.90	0.90	-	1
	Baseline	0.48	0.48	-	1
Day 5:	1 min., post exit	7.80	7.80	-	1
	15 " " "	3.50	3.50	-	1
	30 " " "	2.20	2.20	-	1
	1 hour " "	1.80	1.80	-	1
	2 " " "	0.80	0.80	-	1
	3 " " "	0.80	0.80	-	1
	Baseline	0.20	0.20	-	1

TABLE XIII

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 1 Hours - Chamber Concentration: Fluct. 50-150 ppm.

GROUP III

	Time	Mean (in ppm)	Range (in ppm)	± Standard Deviation	Number of Subjects
Day 1:	1 min., post exit	7.10	6.70 - 7.50	0.57	2
	15 " " "	2.20	2.15 - 2.25	0.07	2
	30 " " "	1.72	1.55 - 1.89	0.24	2
	1 hour " "	1.43	1.40 - 1.45	0.04	2
	2 " " "	0.53	0.45 - 0.60	0.11	2
	3 " " "	0.45	0.40 - 0.50	0.07	2
	Baseline	0.25	0.25	0	2
Day 2:	1 min., post exit	6.50	5.60 - 7.40	1.27	2
	15 " " "	1.80	1.50 - 2.10	0.42	2
	30 " " "	1.35	1.20 - 1.50	0.21	2
	1 hour " "	1.10	0.90 - 1.30	0.28	2
	2 " " "	0.80	0.80	-	1
	3 " " "	0.23	0.20 - 0.25	0.04	2
	Baseline	0.23	0.20 - 0.25	0.04	2
Day 3:	1 min., post exit	5.15	5.00 - 5.30	0.21	2
	15 " " "	2.06	1.67 - 2.45	0.55	2
	30 " " "	1.30	1.15 - 1.45	0.21	2
	1 hour " "	1.13	0.90 - 1.35	0.32	2
	2 " " "	0.94	0.70 - 1.18	0.34	2
	3 " " "	0.65	0.45 - 0.85	0.28	2
	Baseline	0.40	0.40	0	2
Day 4:	1 min., post exit	9.20	9.20	-	1
	15 " " "	3.10	3.10	-	1
	30 " " "	2.10	2.10	-	1
	1 hour " "	1.45	1.45	-	1
	2 " " "	NO DATA			
	3 " " "	NO DATA			
	Baseline	0.30	0.25 - 0.35	0.07	2
Day 5:	1 min., post exit	6.95	6.90 - 7.00	0.07	2
	15 " " "	2.35	2.30 - 2.40	0.07	2
	30 " " "	1.88	1.80 - 1.95	0.11	2
	1 hour " "	1.48	1.30 - 1.65	0.25	2
	2 " " "	0.70	0.40 - 1.00	0.42	2
	3 " " "	0.45	0.30 - 0.60	0.21	2
	Baseline	0.20	0.20	-	1

TABLE XIV

WEEKLY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 7-1/2 Hours - Chamber Concentration:

GROUP I

	Time	Chamber Conc. in ppm	Mean (in ppm)	Range (in ppm)	Standard ± Deviation	Number of Subjects
1:	1 min., post exit	100	5.00	2.93 - 8.17	1.39	4
	15 " " "		1.75	0.95 - 2.90	0.50	4
	30 " " "		1.30	0.61 - 2.02	0.45	4
	1 hour " "		0.92	0.51 - 1.33	0.31	4
	2 " " "		0.65	0.22 - 1.38	0.27	4
	3 " " "		0.43	0.18 - 0.70	0.14	4
	Baseline		0.24	0.10 - 0.38	0.08	4
2:	1 min., post exit	20	0.99	0.63 - 1.68	0.27	4
	15 " " "		0.39	0.22 - 0.53	0.10	4
	30 " " "		0.26	0.15 - 0.36	0.07	4
	1 hour " "		0.20	0.12 - 0.31	0.06	4
	2 " " "		0.16	0.05 - 0.33	0.08	4
	3 " " "		0.11	0.05 - 0.15	0.04	4
	Baseline		0.05	0.02 - 0.10	0.02	4
3:	1 min., post exit	150	10.13	6.30 -14.50	2.09	4
	15 " " "		4.65	3.20 - 7.30	1.04	4
	30 " " "		3.62	1.91 - 5.50	0.82	4
	1 hour " "		2.76	1.91 - 4.10	0.69	4
	2 " " "		1.67	0.55 - 2.05	0.34	4
	3 " " "		0.95	0.50 - 1.50	0.24	4
	Baseline		0.60	0.32 - 1.00	0.21	4
4:	1 min., post exit	Fluc.	6.91	5.10 -11.60	1.60	4
	15 " " "	50 - 150	3.26	2.20 - 4.75	0.73	4
	30 " " "		2.43	1.75 - 3.15	0.37	4
	1 hour " "		1.85	1.41 - 2.42	0.25	4
	2 " " "		1.46	0.80 - 1.90	0.29	4
	3 " " "		0.79	0.55 - 1.10	0.18	4
	Baseline		0.38	0.10 - 0.70	0.15	4

TABLE XV

WEEKLY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 3 Hours - Chamber Concentration:

GROUP II

	Time	Chamber Conc. in ppm	Mean (in ppm)	Range (in ppm)	± Standard Deviation	Number of Subjects
: 1:	1 min., post exit	100	7.55	5.50 -11.20	2.05	2
	15 " " "		2.31	1.55 - 3.40	0.65	2
	30 " " "		1.58	0.91 - 2.40	0.52	2
	1 hour " "		1.09	0.72 - 1.80	0.37	2
	2 " " "		0.53	0.20 - 0.74	0.19	2
	3 " " "		0.38	0.12 - 0.60	0.18	2
	Baseline		0.19	0.10 - 0.30	0.07	2
: 2:	1 min., post exit	20	1.15	0.70 - 1.55	0.33	2
	15 " " "		0.39	0.25 - 0.47	0.10	2
	30 " " "		0.25	0.17 - 0.36	0.06	2
	1 hour " "		0.17	0.11 - 0.25	0.05	2
	2 " " "		0.14	0.11 - 0.19	0.04	2
	3 " " "		0.09	0.05 - 0.12	0.03	2
	Baseline		0.04	0.02 - 0.05	0.02	2
: 3:	1 min., post exit	150	8.95	6.66 -11.40	1.49	2
	15 " " "		3.00	1.80 - 4.00	0.79	2
	30 " " "		2.37	1.61 - 2.80	0.39	2
	1 hour " "		1.81	1.40 - 2.10	0.22	2
	2 " " "		1.21	0.90 - 1.75	0.31	2
	3 " " "		0.95	0.65 - 1.50	0.34	2
	Baseline		0.46	0.20 - 0.65	0.14	2
: 4:	1 min., post exit	Fluct.	6.97	4.75 - 9.50	1.58	2
	15 " " "	50-150	2.66	1.80 - 3.55	0.65	2
	30 " " "		1.92	1.50 - 2.60	0.36	2
	1 hour " "		1.56	1.30 - 2.00	0.25	2
	2 " " "		1.07	0.79 - 1.50	0.28	2
	3 " " "		0.75	0.40 - 1.20	0.30	2
	Baseline		0.36	0.20 - 0.70	0.17	2

TABLE XVI

WEEKLY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY MALES

Exposure Time: 1 Hours - Chamber Concentration:

GROUP III

	Time	Chamber Conc. in ppm	Mean (in ppm)	Range (in ppm)	± Standard Deviation	Number of Subjects
t 1:	1 min., post exit	100	3.25	1.47 - 4.00	1.02	2
	15 " " "		1.52	1.10 - 1.90	0.30	2
	30 " " "		0.93	0.52 - 1.40	0.30	2
	1 hour " "		0.66	0.45 - 0.80	0.13	2
	2 " " "		0.45	0.22 - 0.60	0.18	1
	3 " " "		0.24	0.11 - 0.28	0.13	1
	Baseline		0.13	0.10 - 0.20	0.04	1
t 2:	1 min., post exit	20	0.96	0.54 - 1.71	0.27	3
	15 " " "		0.27	0.17 - 0.50	0.10	3
	30 " " "		0.19	0.12 - 0.30	0.06	3
	1 hour " "		0.14	0.08 - 0.25	0.06	3
	2 " " "		0.10	0.05 - 0.18	0.04	3
	3 " " "		0.09	0.04 - 0.18	0.04	3
	Baseline		0.05	0.05	0	3
t 3:	1 min., post exit	150	9.02	6.10 -10.80	1.43	2
	15 " " "		2.30	1.81 - 2.95	0.33	2
	30 " " "		1.87	1.27 - 2.40	0.34	2
	1 hour " "		1.46	1.08 - 1.90	0.28	2
	2 " " "		0.88	0.30 - 1.40	0.31	2
	3 " " "		0.61	0.20 - 1.00	0.22	2
	Baseline		0.40	0.20 - 0.60	0.13	2
t 4:	1 min., post exit	Fluc.	6.73	5.00 - 9.20	1.30	2
	15 " " "	50-150	2.21	1.50 - 3.10	0.46	2
	30 " " "		1.62	1.15 - 2.10	0.33	2
	1 hour " "		1.30	0.90 - 1.65	0.25	2
	2 " " "		0.73	0.40 - 1.18	0.28	2
	3 " " "		0.44	0.20 - 0.85	0.21	2
	Baseline		0.28	0.20 - 0.40	0.08	2

TABLE XVII

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY FEMALES

Exposure Time: 7-1/2 Hours - Chamber Concentration: 100 ppm

GROUP I

	Time	Mean (in ppm)	Range (in ppm)	Standard ±Deviation	Number of Subjects
Day 1:	1 min., post exit	4.73	3.90 - 5.50	0.80	3
	15 " " "	1.90	1.70 - 2.05	0.18	3
	30 " " "	1.28	1.20 - 1.40	0.10	3
	1 hour " "	1.10	1.10	0	3
	2 " " "	0.53	0.50 - 0.55	0.03	3
	3 " " "	0.40	0.30 - 0.50	0.10	3
	Baseline	0.03	0.00 - 0.10	0	3
Day 2:	1 min., post exit	5.17	4.60 - 5.50	0.49	3
	15 " " "	1.95	1.70 - 2.35	0.35	3
	30 " " "	1.50	1.40 - 1.60	0.10	3
	1 hour " "	1.08	1.05 - 1.10	0.03	3
	2 " " "	0.80	0.80	0	3
	3 " " "	0.60	0.60	0	3
	Baseline	0.23	0.20 - 0.25	0.03	3
Day 3:	1 min., post exit	6.00	4.80 - 7.10	1.15	3
	15 " " "	2.10	1.90 - 2.40	0.27	3
	30 " " "	1.62	1.40 - 1.80	0.20	3
	1 hour " "	1.28	1.15 - 1.40	0.13	3
	2 " " "	0.73	0.70 - 0.75	0.03	3
	3 " " "	0.50	0.45 - 0.55	0.05	3
	Baseline	0.28	0.25 - 0.30	0.03	3
Day 4:	1 min., post exit	6.20	5.10 - 7.30	1.10	3
	15 " " "	3.08	2.65 - 3.50	0.43	3
	30 " " "	2.57	2.45 - 2.65	0.10	3
	1 hour " "	2.00	1.80 - 2.20	0.20	3
	2 " " "	0.75	0.70 - 0.80	0.07	3
	3 " " "	0.53	0.50 - 0.55	0.04	2
	Baseline	0.30	0.30	0	3
Day 5:	1 min., post exit	4.70	4.30 - 5.00	0.36	3
	15 " " "	1.63	1.40 - 1.80	0.21	3
	30 " " "	1.25	1.05 - 1.50	0.23	
	1 hour " "	1.12	1.05 - 1.20	0.08	3
	2 " " "	0.82	0.75 - 0.90	0.08	3
	3 " " "	0.65	0.55 - 0.70	0.09	3
	Baseline	0.35	0.35	0	3

TABLE XVIII

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY FEMALES

Exposure Time: 3 Hours - Chamber Concentration: 100 ppm

GROUP II

	Time	Mean (in ppm)	Range (in ppm)	Standard ±Deviation	Number of Subjects
Day 1:	1 min., post exit	4.90	4.60 - 5.20	0.42	2
	15 " " "	1.55	1.40 - 1.70	0.21	2
	30 " " "	1.08	1.05 - 1.10	0.35	2
	1 hour " "	0.75	0.70 - 0.80	0.07	2
	2 " " "	0.35	0.35	0	2
	3 " " "	0.25	0.00 - 0.50	0	2
	Baseline	0	0	0	2
Day 2:	1 min., post exit	5.48	3.95 - 7.00	2.16	2
	15 " " "	1.35	1.20 - 1.50	0.21	2
	30 " " "	0.85	0.80 - 0.90	0.07	2
	1 hour " "	0.55	0.55	0	2
	2 " " "	0.43	0.40 - 0.45	0.04	2
	3 " " "	0.30	0.30	-	1
	Baseline	0.08	0.00 - 0.15	0	2
Day 3:	1 min., post exit	4.78	3.25 - 6.30	2.16	2
	15 " " "	1.25	1.10 - 1.40	0.21	2
	30 " " "	0.80	0.70 - 0.90	0.14	2
	1 hour " "	0.60	0.60	0	2
	2 " " "	0.35	0.35	-	1
	3 " " "	0.40	0.40	-	1
	Baseline	0.13	0.10 - 0.15	0.04	2
Day 4:	1 min., post exit	4.75	4.20 - 5.30	0.78	2
	15 " " "	1.18	1.15 - 1.20	0.04	2
	30 " " "	0.88	0.80 - 0.95	0.11	2
	1 hour " "	0.68	0.65 - 0.70	0.04	2
	2 " " "	0.50	0.50	0	2
	3 " " "	0.50	0.40 - 0.60	0.141	2
	Baseline	0.10	0.10	0	2
Day 5:	1 min., post exit	4.00	3.00 - 5.00	1.41	2
	15 " " "	1.23	1.20 - 1.25	0.04	2
	30 " " "	0.88	0.80 - 0.95	0.11	2
	1 hour " "	0.55	0.50 - 0.60	0.07	2
	2 " " "	0.50	0.50	-	1
	3 " " "	0.20	0.20	-	1
	Baseline	0.15	0.15	-	1

TABLE XIX

DAILY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY FEMALES

Exposure Time: 1 Hours - Chamber Concentration: 100 ppm

GROUP III

	Time	Mean (in ppm)	Range (in ppm)	Standard ±Deviation	Number of Subjects
Day 1:	1 min., post exit	3.40	3.20 - 3.60	0.28	2
	15 " " "	1.20	1.10 - 1.30	0.14	2
	30 " " "	0.98	0.90 - 1.05	0.11	2
	1 hour " "	0.68	0.65 - 0.70	0.04	2
	2 " " "	0.10	0.10	-	1
	3 " " "	0.10	0.10	0	2
	Baseline	0	0	0	2
Day 2:	1 min., post exit	5.83	3.90 - 7.75	2.72	2
	15 " " "	1.10	0.90 - 1.30	0.28	2
	30 " " "	0.73	0.55 - 0.90	0.25	2
	1 hour " "	0.63	0.55 - 0.70	0.11	2
	2 " " "	0.35	0.30 - 0.40	0.07	2
	3 " " "	0.20	0.20	0	2
	Baseline	0	0	0	2
Day 3:	1 min., post exit	5.45	4.40 - 6.50	1.49	2
	15 " " "	1.38	1.05 - 1.70	0.46	2
	30 " " "	0.95	0.80 - 1.10	0.21	2
	1 hour " "	0.65	0.50 - 0.80	0.21	2
	2 " " "	0.28	0.20 - 0.35	0.11	2
	3 " " "	0.10	0.00 - 0.20	0	2
	Baseline	0.03	0.00 - 0.05	0	2
Day 4:	1 min., post exit	3.75	3.00 - 4.50	1.06	2
	15 " " "	1.15	1.00 - 1.30	0.21	2
	30 " " "	0.80	0.70 - 0.90	0.14	2
	1 hour " "	0.63	0.55 - 0.70	0.11	2
	2 " " "	0.40	0.40	0	2
	3 " " "	0.30	0.30	0	2
	Baseline	0.10	0.10	0	2
Day 5:	1 min., post exit	4.60	3.60 - 5.60	1.41	2
	15 " " "	1.15	1.00 - 1.30	0.21	2
	30 " " "	0.88	0.80 - 0.95	0.11	2
	1 hour " "	0.58	0.55 - 0.60	0.04	2
	2 " " "	0.40	0.40	-	1
	3 " " "	0.20	0.20	-	1
	Baseline	0.10	0.10	0	2

TABLE XX

WEEKLY p-XYLENE BREATH CONCENTRATION OF

SEDENTARY FEMALES

Chamber Concentration: 100 ppm

Time	Mean (in ppm)	Range (in ppm)	± Standard Deviation	Number of Subjects
GROUP I:				
1 min., post exit	5.03	3.90 - 7.30	1.63	3
15 " " "	2.13	1.40 - 3.50	0.58	3
30 " " "	1.64	1.05 - 2.65	0.52	3
1 hour " "	1.32	1.05 - 2.20	0.37	3
2 " " "	0.73	0.50 - 0.90	0.12	3
3 " " "	0.54	0.30 - 0.70	0.11	3
Baseline	0.24	0.00 - 0.35	0.12	3
GROUP II:				
1 min., post exit	4.78	3.00 - 7.00	1.26	2
15 " " "	1.31	1.10 - 1.70	0.19	2
30 " " "	0.90	0.70 - 1.10	0.12	2
1 hour " "	0.63	0.50 - 0.80	0.09	2
2 " " "	0.43	0.35 - 0.50	0.07	2
3 " " "	0.40	0.00 - 0.80	0.25	2
Baseline	0.07	0.00 - 0.15	0.07	2
GROUP III:				
1 min., post exit	4.61	3.00 - 7.75	1.55	2
15 " " "	1.20	0.90 - 1.70	0.23	2
30 " " "	0.87	0.55 - 1.10	0.16	2
1 hour " "	0.63	0.50 - 0.80	0.10	2
2 " " "	0.32	0.10 - 0.40	0.11	2
3 " " "	0.18	0.00 - 0.30	0.10	2
Baseline	0.04	0.00 - 1.00	0.05	2

TABLE XXI

p-XYLENE LEVELS IN BLOOD FOR MALE SUBJECTS

GROUP I 7-1/2 HR EXPOSURE

	Mean	Range	±S.D.	N.
Day 4,Wk 1		Chamber Concentration: zero		
Day 1,Wk 2		Chamber Concentration: 100 ppm		
Pre-exposure	0.31	0.25 - 0.40	0.08	4
Pre-exit	1.29	1.05 - 1.55	0.21	4
30 min post-exit	0.89	0.50 - 1.10	0.27	4
1 hr post-exit	0.48	0.40 - 0.60	0.09	4
Day 4,Wk 2				
Pre-exposure	0.13	0.09 - 0.17	0.03	4
Pre-exit	0.97	0.83 - 1.11	0.16	4
30 min post-exit	0.45	0.35 - 0.52	0.09	4
1 hr post-exit	0.29	0.26 - 0.31	0.02	4
Day 1,Wk 3		Chamber Concentration: 20 ppm		
Pre-exposure	0.13	0.12 - 0.13	0.01	3
Pre-exit	0.42	0.40 - 0.45	0.03	3
30 min post-exit	0.29	0.27 - 0.30	0.02	3
1 hr post-exit	0.19	0.15 - 0.22	0.04	3
Day 4,Wk 3				
Pre-exposure	0.00	0.00	0.00	4
Pre-exit	0.51	0.43 - 0.60	0.07	4
30 min post-exit	0.49	0.26 - 0.80	0.26	4
1 hr post-exit	0.40	0.21 - 0.58	0.15	4
Day 1,Wk 4		Chamber Concentration: 150 ppm		
Pre-exposure	0.34	0.24 - 0.47	0.10	4
Pre-exit	3.86	3.11 - 4.67	0.65	4
30 min post-exit	1.96	1.75 - 2.09	0.15	4
1 hr post-exit	1.29	1.24 - 1.43	0.09	4
Day 4,Wk 4				
Pre-exposure	0.99	0.65 - 1.35	0.35	4
Pre-exit	5.99	5.09 - 6.88	0.90	4
30 min post-exit	3.76	3.38 - 4.62	0.58	4
1 hr post-exit	2.77	2.49 - 2.95	0.22	4
Day 1,Wk 5		Chamber Concentration: Fluct. 50-150 ppm		
Pre-exposure	0.32	0.20 - 0.40	0.11	3
Pre-exit	3.02	2.80 - 3.25	0.23	3
30 min post-exit	1.40	1.20 - 1.60	0.20	3
1 hr post-exit	1.45	1.00 - 1.92	0.46	3
Day 4,Wk 5				
Pre-exposure	0.31	0.27 - 0.40	0.061	4
Pre-exit	1.68	1.40 - 2.03	0.30	4
30 min post-exit	0.81	0.70 - 1.00	0.14	4
1 hr post-exit	0.67	0.49 - 1.01	0.24	4
Day 1,Wk 6		Chamber Concentration: zero		

TABLE XXII

p-XYLENE LEVELS IN BLOOD FOR MALE SUBJECTS

GROUP II 3 HR EXPOSURE

	Mean	Range	±S.D.	N.
Day 4,Wk 1		Chamber Concentration: zero		
Day 1,Wk 2		Chamber Concentration: 100 ppm		
Pre-exposure	0.48	0.45 - 0.50	0.04	2
Pre-exit	1.65	1.30 - 2.00	0.50	2
30 min post-exit	0.78	0.65 - 0.90	0.18	2
1 hr post-exit	0.58	0.50 - 0.65	0.11	2
Day 4,Wk 2				
Pre-exposure	0.12	0.09 - 0.14	0.04	2
Pre-exit	0.95	0.90 - 0.99	0.06	2
30 min post-exit	0.44	0.44	0.00	2
1 hr post-exit	0.37	0.35 - 0.39	0.03	2
Day 1,Wk 3		Chamber Concentration: 20 ppm		
Pre-exposure	0.12	0.11 - 0.12	0.01	2
Pre-exit	0.41	0.34 - 0.47	0.09	2
30 min post-exit	0.24	0.24	0.00	2
1 hr post-exit	0.24	0.24	0.00	2
Day 4,Wk 3				
Pre-exposure	0.08	0.00 - 0.08	0.00	2
Pre-exit	0.43	0.40 - 0.46	0.04	2
30 min post-exit	0.24	0.23 - 0.25	0.01	2
1 hr post-exit	0.26	0.15 - 0.36	0.15	2
Day 1,Wk 4		Chamber Concentration: 150 ppm		
Pre-exposure	0.40	0.22 - 0.57	0.25	2
Pre-exit	3.18	3.10 - 3.25	0.11	2
30 min post-exit	1.55	1.50 - 1.60	0.07	2
1 hr post-exit	1.11	0.97 - 1.25	0.20	2
Day 4,Wk 4				
Pre-exposure	0.53	0.46 - 0.59	0.09	2
Pre-exit	6.19	4.05 - 8.32	3.02	2
30 min post-exit	2.18	1.97 - 2.38	0.29	2
1 hr post-exit	1.80	1.73 - 1.86	0.09	2
Day 1,Wk 5		Chamber Concentration: Fluct. 50-150 ppm		
Pre-exposure	0.45	0.40 - 0.50	0.07	2
Pre-exit	3.41	3.09 - 3.73	0.45	2
30 min post-exit	1.36	1.27 - 1.45	0.13	2
1 hr post-exit	1.07	1.00 - 1.13	0.09	2
Day 4,Wk 5				
Pre-exposure	0.26	0.26	-	1
Pre-exit	1.33	1.33	-	1
30 min post-exit	0.67	0.59	-	1
1 hr post-exit	0.59	0.67	-	1
Day 1,Wk 6		Chamber Concentration: zero		

TABEE XXIII

p-XYLENE LEVELS IN BLOOD FOR MALE SUBJECTS

GROUP III 1 HR EXPOSURE

	Mean	Range	±S.D.	N.
Day 4,Wk 1		Chamber Concentration: zero		
Day 1,Wk 2		Chamber Concentration: 100 ppm		
Pre-exposure	0.18	0.10 - 0.25	0.11	2
Pre-exit	1.23	1.10 - 1.35	0.18	2
30 min post-exit	0.55	0.45 - 0.65	0.14	2
1 hr post-exit	0.33	0.30 - 0.35	0.04	2
Day 4,Wk 2				
Pre-exposure	0.12	0.12	-	1
Pre-exit	0.69	0.69	-	1
30 min post-exit	0.35	0.35	-	1
1 hr post-exit	0.23	0.23	-	1
Day 1,Wk 3		Chamber Concentration: 20 ppm		
Pre-exposure	0.00	0.00	-	1
Pre-exit	0.24	0.24	-	1
30 min post-exit	0.18	0.18	-	1
1 hr post-exit	0.00	0.00	-	1
Day 4,Wk 3				
Pre-exposure	0.00	0.00	0.00	3
Pre-exit	0.58	0.27 - 0.76	0.27	3
30 min post-exit	0.25	0.15 - 0.40	0.13	3
1 hr post-exit	0.26	0.12 - 0.48	0.19	3
Day 1,Wk 4		Chamber Concentration: 150 ppm		
Pre-exposure	0.30	0.15 - 0.45	0.21	2
Pre-exit	2.04	1.50 - 2.57	0.76	2
30 min post-exit	0.77	0.67 - 0.87	0.14	2
1 hr post-exit	0.67	0.60 - 0.73	0.09	2
Day 4,Wk 4				
Pre-exposure	0.38	0.38	0.00	2
Pre-exit	3.37	3.35 - 3.38	0.02	2
30 min post-exit	1.45	1.35 - 1.54	0.13	2
1 hr post-exit	1.12	1.05 - 1.19	0.10	2
Day 1,Wk 5		Chamber Concentration: Fluct. 50-150 ppm		
Pre-exposure	0.49	0.18 - 0.80	0.44	2
Pre-exit	2.93	2.55 - 3.30	0.53	2
30 min post-exit	1.25	1.25	0.00	2
1 hr post-exit	0.82	0.73 - 0.90	0.12	2
Day 4,Wk 5				
Pre-exposure	0.15	0.15	-	1
Pre-exit	1.30	1.30	-	1
30 min post-exit	0.78	0.78	-	1
1 hr post-exit	0.41	0.41	-	1
Day 1,Wk 6		Chamber Concentration: zero		

TABLE XXIV

p-XYLENE LEVELS IN BLOOD FOR FEMALE SUBJECTS

Chamber Concentration: 100 ppm

	Mean	Range	±S.D.	N.
		Day 1, Week 2		
		Group I, 7-1/2 hr exposure		
Pre-exposure	0.00	0.00	0.00	3
Pre-exit	1.59	1.48 - 1.79	0.18	3
30 min post-exit	0.59	0.49 - 0.72	0.12	3
1 hr post-exit	0.50	0.46 - 0.58	0.07	3
		Group II, 3 hr exposure		
Pre-exposure	0.00	0.00	0.00	2
Pre-exit	0.95	0.85 - 1.05	0.14	2
30 min post-exit	0.38	0.26 - 0.49	0.16	2
1 hr post-exit	0.29	0.27 - 0.31	0.03	2
		Group III, 1 hr exposure		
Pre-exposure	0.00	0.00	0.00	2
Pre-exit	0.88	0.82 - 0.93	0.08	2
30 min post-exit	0.46	0.39 - 0.52	0.09	2
1 hr post-exit	0.26	0.17 - 0.34	0.12	2
		Day 4, Week 2		
		Group I, 7-1/2 hr exposure		
Pre-exposure	0.50	0.38 - 0.59	0.11	3
Pre-exit	2.28	2.01 - 2.47	0.24	3
30 min post-exit	1.07	0.98 - 1.16	0.09	3
1 hr post-exit	0.91	0.74 - 1.25	0.29	3
		Group II, 3 hr exposure		
Pre-exposure	0.36	0.31 - 0.41	0.07	2
Pre-exit	1.86	1.79 - 1.92	0.09	2
30 min post-exit	0.73	0.71 - 0.74	0.02	2
1 hr post-exit	0.62	0.57 - 0.67	0.07	2
		Group III, 1 hr exposure		
Pre-exposure	0.39	0.37 - 0.40	0.02	2
Pre-exit	1.74	1.41 - 2.06	0.46	2
30 min post-exit	0.60	0.57 - 0.62	0.04	2
1 hr post-exit	0.48	0.45 - 0.50	0.04	2

TABLE XXV

EFFECT OF EXERCISE ON p-XYLENE LEVELS IN BLOOD

GROUP I MALE SUBJECTS

	Mean	Range	±S.D.	N.
		Chamber Concentration: 100 ppm		
Resting	0.79	0.71 - 0.90	0.08	4
6 min exercise	1.25	0.96 - 1.53	0.40	2
11 min exercise	1.83	1.53 - 2.35	0.45	3
		Chamber Concentration: 20 ppm		
Resting	0.51	0.40 - 0.68	0.12	4
6 min exercise	0.71	0.55 - 0.87	0.13	4
11 min exercise	1.61	1.49 - 1.67	0.08	4
		Chamber Concentration: 150 ppm		
Resting	4.64	4.07 - 5.95	0.88	4
6 min exercise	7.12	5.95 - 8.55	1.32	3
11 min exercise	12.52	11.06 - 14.61	1.86	3
		Chamber Concentration: 50-150 ppm Fluct.		
Resting	1.23	0.84 - 1.74	0.40	4
6 min exercise	1.87	1.41 - 2.22	0.42	3
11 min exercise	3.13	1.95 - 4.46	1.04	4

TABLE XXVI

DAILY p-XYLENE LEVELS IN SALIVA

FOR SEDENTARY MALE SUBJECTS

GROUP I 7-1/2 HR EXPOSURE

Chamber Concentration: 150 ppm

WEEK 4

		Mean	Range	±S.D.	N.
AY 1:	Pre-exposure	1.64	1.23 - 1.94	0.30	4
	Exit	5.83	5.50 - 6.13	0.31	4
	15 min post-exit	2.69	2.38 - 2.88	0.24	4
	30 min post-exit	1.63	1.50 - 1.75	0.10	4
AY 2:	Pre-exposure	0.72	0.50 - 1.06	0.25	4
	Exit	2.87	2.31 - 4.06	0.815	4
	15 min post-exit	1.58	1.25 - 1.88	0.312	4
	30 min post-exit	0.99	0.88 - 1.13	0.107	4
AY 3:	Pre-exposure	0.71	0.30 - 1.30	0.42	4
	Exit	5.52	3.63 - 7.25	1.50	4
	15 min post-exit	1.99	1.81 - 2.13	0.13	4
	30 min post-exit	1.42	1.25 - 1.63	0.18	4
AY 4:	Pre-exposure	0.41	0.19 - 0.73	0.23	4
	Exit	3.54	2.50 - 4.25	0.76	4
	15 min post-exit	1.87	1.58 - 2.33	0.34	4
	30 min post-exit	1.27	1.00 - 1.58	0.29	4
AY 5:	Pre-exposure	0.36	0.16 - 0.52	0.154	4
	Exit	3.35	3.13 - 3.53	0.20	4
	15 min post-exit	2.08	1.90 - 2.30	0.17	4
	30 min post-exit	1.81	1.60 - 1.93	0.16	4

TABLE XXVII

DAILY p-XYLENE LEVELS IN SALIVA

FOR SEDENTARY MALE SUBJECTS

GROUP I 7-1/2 HR EXPOSURE

Chamber Concentration: 50-150 ppm fluctuating

WEEK 5

	Mean	Range	±S.D.	N.
DAY 1: Pre-exposure	0.22	0.19 - 0.28	0.05	3
Exit	2.03	1.52 - 2.61	0.55	3
15 min post-exit	0.99	0.78 - 1.13	0.19	3
30 min post-exit	0.65	0.50 - 0.75	0.13	3
DAY 2: Pre-exposure	0.25	0.16 - 0.31	0.07	4
Exit	3.26	2.67 - 4.24	0.69	4
15 min post-exit	1.53	1.31 - 1.81	0.21	4
30 min post-exit	1.07	0.75 - 1.38	0.27	4
DAY 3: Pre-exposure	0.55	0.39 - 0.79	0.18	4
Exit	3.28	2.76 - 4.03	0.61	4
15 min post-exit	1.86	1.83 - 1.97	0.08	4
30 min post-exit	1.08	1.00 - 1.25	0.12	4
DAY 4: Pre-exposure	0.16	0.09 - 0.22	0.05	4
Exit	3.56	3.13 - 4.40	0.57	4
15 min post-exit	1.61	1.43 - 2.00	0.26	4
30 min post-exit	1.02	0.93 - 1.13	0.10	4
DAY 5: Pre-exposure	0.16	0.11 - 0.24	0.07	3
Exit	1.21	1.08 - 1.43	0.19	3
15 min post-exit	0.75	0.68 - 0.81	0.07	3
30 min post-exit	0.47	0.41 - 0.54	0.07	3

TABLE XXVIII

DAILY p-XYLENE LEVELS IN SALIVA

FOR SEDENTARY FEMALE SUBJECTS

GROUP I 7-1/2 HR EXPOSURE

Chamber Concentration: 100 ppm

		Mean	Range	±S.D.	N.
DAY 1:	Pre-exposure	0.21	0.19 - 0.22	0.02	3
	1 min post-exit	0.79	0.56 - 1.10	0.28	3
	15 min post-exit	0.37	0.33 - 0.42	0.05	3
	30 min post-exit	0.25	0.19 - 0.28	0.05	3
DAY 2:	Pre-exposure	0.34	0.31 - 0.41	0.06	3
	1 min post-exit	1.26	1.04 - 1.37	0.19	3
	15 min post-exit	0.51	0.41 - 0.56	0.09	3
	30 min post-exit	0.42	0.37 - 0.46	0.05	3
DAY 3:	Pre-exposure	0.52	0.32 - 0.71	0.20	3
	1 min post-exit	1.07	0.85 - 1.35	0.26	3
	15 min post-exit	0.57	0.47 - 0.65	0.09	3
	30 min post-exit	0.39	0.35 - 0.41	0.03	3
DAY 4:	Pre-exposure	0.51	0.48 - 0.55	0.04	3
	1 min post-exit	1.15	0.65 - 1.45	0.44	3
	15 min post-exit	0.95	0.93 - 0.98	0.03	3
	30 min post-exit	0.60	0.50 - 0.75	0.13	3
DAY 5:	Pre-exposure	0.33	0.17 - 0.52	0.18	3
	1 min post-exit	1.96	1.60 - 2.45	0.44	3
	15 min post-exit	1.00	0.95 - 1.05	0.05	3
	30 min post-exit	0.69	0.60 - 0.76	0.08	3

TABLE XXIX

DAILY METHYL HIPPURIC ACID EXCRETION

GROUP I MALE SUBJECTS

Exposure Time: 7-1/2 HR

Date	Subject	Urine Vol ml/24 hr	Concentration mg/ml	g/24 hr	p-xylene Chamber Conc: ppm
Day 4,Wk 1	117	650	1.81	1.18	0
	248	1400	0.84	1.17	
	249	900	0.77	0.70	
	250	1050	0.94	0.98	
Day 1,Wk 2	117	600	4.11	2.46	100
	248	1050	4.64	4.87	
	249	1000	1.78	1.78	
	250	1175	1.71	2.00	
Day 4,Wk 2	117	2350	1.17	2.74	100
	248	1400	1.70	2.38	
	249	1300	1.45	1.89	
	250	800	2.65	2.12	
Day 1,Wk 3	117	Absent	-	-	20
	248	1350	0.57	0.77	
	249	1100	0.78	0.86	
	250	1100	1.24	1.37	
Day 4,Wk 3	117	950	2.30	2.19	20
	248	1150	1.28	1.48	
	249	625	1.44	0.90	
	250	500	2.38	1.19	
Day 1,Wk 4	117	950	3.57	3.39	150
	248	1000	2.82	2.82	
	249	650	3.57	2.32	
	250	800	3.28	2.62	
Day 4,Wk 4	117	1050	3.53	3.70	150
	248	1200	2.22	2.66	
	249	650	2.69	1.75	
	*250	170	2.25	0.38	
Day 1,Wk 5	117	1100	2.77	3.05	Fluct.
	248	1025	1.67	1.71	50-150
	250	750	2.67	2.00	
Day 4,Wk 5	**117	1150	0.72	0.83	Fluct.
	248	1125	1.89	2.13	50-150
	249	500	3.90	1.95	
	250	650	3.06	1.98	
Day 1,Wk 6	117	1425	2.32	3.31	0
	248	1300	1.10	1.43	
	249	650	2.60	1.69	
	250	850	1.20	1.02	

* Subject voided once in 24 hr period

** Sample was not refrigerated

TABLE XXX

DAILY METHYL HIPPURIC ACID EXCRETION

GROUP II MALE SUBJECTS

Exposure Time: 3 HR

Date	Subject	Urine Vol ml/24 hr	Concentration mg/ml	g/24 hr	p-xylene Chamber Conc: ppm
Day 4,Wk 1	251	800	0.62	0.50	0
	252	1925	0.64	1.24	
Day 1,Wk 2	251	1125	0.75	0.85	100
	252	1750	0.66	1.16	
Day 4,Wk 2	251	1000	1.09	1.09	100
	252	1400	0.43	0.60	
Day 1,Wk 3	251	550	0.66	0.36	20
	252	1525	0.62	0.94	
Day 4,Wk 3	251	750	0.54	0.41	20
	252	1275	1.05	1.34	
Day 1,Wk 4	251	550	0.73	0.40	150
	252	1350	0.96	1.30	
Day 4,Wk 4	251	600	1.61	0.97	150
	252	1100	1.12	1.23	
Day 1,Wk 5	251	600	1.31	0.79	Fluct.
	252	900	1.11	1.00	50-150
Day 4,Wk 5	252	1300	0.82	1.07	Fluct. 50-150
Day 1,Wk 6	251	1150	0.83	0.95	0

TABLE XXXI

DAILY METHYL HIPPURIC ACID EXCRETION

GROUP III MALE SUBJECTS

Exposure Time: 1 HR

Date	Subject	Urine Vol ml/24 hr	Concentration mg/ml	Concentration g/24 hr	p-xylene Chamber Conc: ppm
Day 4,Wk 1	253	775	0.74	0.58	0
	254	1575	1.05	1.65	
	255	375	0.36	0.13	
Day 1,Wk 2	255	375	1.16	0.44	100
	254	1500	0.76	1.14	
Day 4,Wk 2	255	1100	0.67	0.74	100
Day 1,Wk 3	255	975	0.62	0.61	20
Day 4,Wk 3	255	750	0.23	0.17	20
	*256	1100	0.62	0.68	
	*257	1520	1.23	1.87	
Day 1,Wk 4	256	1400	0.44	0.62	150
	257	1050	1.09	1.14	
Day 4,Wk 4	256	1100	0.61	0.68	150
	257	1100	0.87	0.95	
Day 1,Wk 5	256	1050	1.42	1.45	Fluct.
	257	1450	1.61	2.33	50-150
Day 4,Wk 5	257	850	1.76	1.49	Fluct. 50-150
Day 1,Wk 6	256	1100	0.53	0.58	0
	257	1025	1.24	1.27	

* Entered study during progress - no baseline data.

TABLE XXXII

DAILY METHYL HIPPURIC ACID EXCRETION

FOR FEMALE SUBJECTS

Date	Subject	Urine Vol ml/24 hr	Concentration mg/ml	g/24 hr	p-xylene Chamber Conc: ppm
		Group I, Exposure Time: 7-1/2 hr			
Day 4,Wk 1	95	1900	0.85	1.62	0
	258	1300	0.79	1.03	
	259	1450	1.46	2.12	
Day 1,Wk 2	95	1500	2.29	3.44	100
	258	1525	2.32	3.54	
	259	1350	2.65	3.58	
Day 4,Wk 2	95	2000	2.32	4.64	100
	258	1350	1.85	2.50	
	259	950	2.76	2.62	
Day 1,Wk 3	95	1190	2.11	2.51	0
	258	1480	0.70	1.03	
	259	960	1.12	1.08	
		Group II, Exposure Time: 3 hr			
Day 4,Wk 1	261	1000	0.56	0.56	0
	262	1200	1.55	1.86	
Day 1,Wk 2	261	650	0.92	0.60	100
	262	1100	3.70	4.07	
Day 4,Wk 2	261	800	1.36	1.09	100
	262	1450	2.76	4.00	
Day 1,Wk 3	261	1210	0.48	0.58	0
	262	1140	1.32	1.50	
		Group III, Exposure Time: 1 hr			
Day 4,Wk 1	264	850	1.60	1.36	0
	265	750	1.07	0.80	
Day 1,Wk 2	264	600	8.20	4.90	100
	265	850	0.81	0.69	
Day 4,Wk 2	264	750	6.19	4.64	100
	265	450	1.86	0.84	
Day 1,Wk 3	264	860	2.09	1.80	0
	265	1200	1.22	1.46	

TABLE XXXIII

THE DAILY SUMMED AMPLITUDE (MV)

OF THE 3, 4, AND 5 COMPLEX OF THE VER

UNDER CONTROL CONDITIONS (pre and post 0 ppm)

AND DURING EXPOSURE AT VARIOUS CONCENTRATIONS OF XYLENE

Subject		Pre		100 ppm			20 ppm			150 ppm			100 ppm,F			Post	S.D.
		0 ppm	0 ppm	D-1	D-3	D-5	D-1	D-3	D-5	D-1	D-3	D-5	D-1	D-3	D-5	0 ppm	$\frac{S.D.}{\bar{x}}$
117	$\bar{x}$	25.7	22.9	23.6*	22.3	22.1			21.8	15.9	23.5	23.6	22.5	21.1		17.6	13.1
	SEM	1.4	0.9	1.8	1.0	2.8			2.2	2.4	0.7	1.4	1.1	0.9		1.6	
248	$\bar{x}$	23.0	29.0	21.4	27.0	21.8	18.5*	26.7	23.3	21.8	20.5*	21.6	21.3	25.2	21.5	21.5	17.8
	SEM	2.5	1.3	1.2	3.3	3.4	1.5	3.2	4.1	2.6	0.8	1.8	2.0	2.0	3.2	1.6	
249	$\bar{x}$	24.0	25.4	23.6	23.5	24.4	27.8	22.5	20.0	25.0	19.8*	23.3		21.3	22.4	21.4	11.8
	SEM	1.9	1.1	1.6	1.1	0.4	2.2	0.8	3.5	0.7	1.0	0.4		0.8	1.6	3.7	
250	$\bar{x}$	63.1	57.0	51.3	48.2	52.0	49.4	47.5*	66.4	55.0	71.1	63.3	57.7	61.8	60.7	65.2	15.6
	SEM	4.7	4.9	4.2	6.0	2.5	4.3	1.3	1.6	9.8	3.9	4.0	2.6	4.2	10.4	11.3	
95	$\bar{x}$	38.0	35.3	32.9	38.4											31.1	11.8
	SEM	2.7	2.8	2.4	2.0											1.2	
258	$\bar{x}$	49.6	44.2	51.1	51.8											47.1	11.7
	SEM	3.4	4.0	5.2	2.0											1.9	
259	$\bar{x}$	48.7	47.3	48.7	41.1											44.6	8.7
	SEM	2.2	2.3	2.0	3.6											1.0	

* - denotes significantly different from 2nd pre-exposure 0 ppm, $P < .05$, paired t-test.

$\frac{S.D.}{\bar{x}}$ - mean daily coefficient of variation in VER wave amplitude.

TABLE XXXIV

THE MEAN DAILY SUMMED AMPLITUDE (MV)
OF THE 3, 4, AND 5 COMPLEX OF THE VER
FOR CONTROL AND VARIOUS EXPOSURE CONDITIONS

Subject		0 ppm Pre	20 ppm	100 ppm	150 ppm	100 ppm,F	0 ppm Post
117	$\bar{x}$	24.3	21.8	22.2	20.6	20.7	17.6+
	SEM	0.9	2.2	1.0	1.4	0.8	1.6
	S.D./$\bar{x}$	7.0%	17.5%	14.0%	21.0%	8.9%	15.8%
248	$\bar{x}$	25.4	22.8	23.6	21.1	22.6	22.3
	SEM	2.3	1.9	1.8	1.0	1.8	1.2
	S.D./$\bar{x}$	20.6%	25.5%	22.0%	14.0%	24.0%	9.5%
249	$\bar{x}$	24.7	23.5	23.1*	22.7	21.8+	21.5*
	SEM	0.8	1.7	0.9	0.8	0.8	3.7
	S.D./$\bar{x}$	7.8%	21.0%	11.0%	11.0%	9.6%	30.0%
250	$\bar{x}$	60.0	54.0	50.3+	63.2	59.8	65.2
	SEM	3.3	3.2	2.6	4.0	3.1	11.3
	S.D./$\bar{x}$	13.5%	18.8%	16.3%	19.0%	16.4%	30.0%
95	$\bar{x}$	38.0		34.1			31.1
	SEM	2.7		1.5			1.2
	S.D./$\bar{x}$	12.5%		13.0%			6.9%

TABLE XXXIV (continued)

THE MEAN DAILY SUMMED AMPLITUDE (MV)

OF THE 3, 4, AND 5 COMPLEX OF THE VER

FOR CONTROL AND VARIOUS EXPOSURE CONDITIONS

Subject		0 ppm Pre	100 ppm	0 ppm Post
258	$\bar{x}$	49.6	49.0	47.1
	SEM	3.4	2.3	1.9
	$\frac{S.D.}{\bar{x}}$	11.7%	14.2%	6.9%
259	$\bar{x}$	48.7	46.0	44.6
	SEM	2.2	1.7	1.0
	$\frac{S.D.}{\bar{x}}$	7.8%	11.7%	4.0%

* - denotes significantly different from pre-exposure 0 ppm, $P < .05$, group t-test.

+ - denotes F-value was significant ($P < .05$) in analysis of variance, comparison with pre-exposure 0 ppm.

$\frac{S.D.}{\bar{x}}$ - mean daily coefficient of variation in VER wave amplitude.

TABLE XXXV

PULMONARY VENTILATION ($\dot{V}_E$ - ℓ/min, B.T.P.S.)

ON GROUPS II AND III MALE SUBJECTS

AND ALL GROUPS OF FEMALE SUBJECTS

WEEK-DAY	1-4	2-2	2-4	3-2	3-4	4-2	4-4	5-2	5-4	6-2	1-5	2-2	2-4	3-1
Date '75	1-16	1-21	1-27	1-28	1-30	2-4	2-6	2-11	2-13	2-18	2-21	2-25	2-27	3-3
Conc. ppm	0	100	100	20	20	150	150	100,F	100,F	0	0	100	100	0
251 M, Gr.II	8.85	8.61	8.53		9.27	13.3	10.67	10.97		8.88				
252 M, Gr.II	11.29	12.5	12.32	11.01	11.76	11.3	10.35		11.03					
255 M, Gr.III	9.31	10.3	8.68	9.54										
256 M, Gr.III				8.08	9.42	7.64	14.23	6.51		14.04				
257 M, Gr.III				10.85	9.42	11.33	8.33	9.79	9.66	8.26				
95 F, Gr.I												7.16	8.78	7.49
258 F, Gr.I												9.62	9.14	8.04
259 F, Gr.I												7.09	7.46	5.51
261 F, Gr.II											8.09	7.47	8.13	7.68
262 F, Gr.II											10.11	11.07	6.92	8.51
264 F, Gr.III											8.54	9.71	8.78	8.21
265 F, Gr.III											8.31	7.06	7.49	8.63

TABLE XXXVI

EXPIRATORY VOLUMES AND FLOW RATES

OF GROUP I MALE SUBJECTS

DURING p-XYLENE STUDY ($\bar{x}$ and SEM, n=4)

Week-Day	1 - 5	2 - 5	3 - 5	4 - 5	5 - 5	6 - 1
Date	1-17-75	1-24-75	1-31-75	2-7-75	2-14-75	2-17-75
Concentration ppm	0	100	20	150	100 fluctuating	0
Maximum Expiration Volume	5.656 ±.107	5.695 ±.127	5.473 ±.125	5.567 ±.119	5.513 ±.227	5.707 ±.127
PEFR	10.398 ±.464	10.948 ±.621	10.702 ±.529	11.051 ±.567	10.330 ±.719	10.789 ±.483
Flow 35-45%	3.927 ±.227	3.879 ±.170	3.415 ±.314	3.636 ±.424	3.27 ±.427	3.524 ±.245
Flow 20-30%	2.064 ±.176	2.128 ±.199	1.875 ±.249	1.973 ±.218	1.809 ±.307	1.848 ±.209
FEV_1/FVC%	70.08 ±2.411	82.04 ±2.769	72.683 ±2.692	77.367 ±3.002	73.24 ±4.721	70.644 ±2.139
Partial Expiration Volume	4.055 ±.195	4.177 ±.146	3.917 ±.096	3.947 ±.12	3.998 ±.127	4.078 ±.135
Flow 35-45%	3.515 ±.219	3.699 ±.218	3.398 ±.31	2.816 ±.589	2.910 ±.344	3.268 ±.232
Flow 20-30%	1.701 ±.161	2.073 ±.173	1.869 ±.234	1.706 ±.361	1.514 ±.271	1.653 ±.184
PEFR	7.875 ±.367	9.127 ±.43	8.635 ±.328	8.70 ±.570	8.512 ±.405	9.049 ±.441

Volume = The volume of the maximum vital capacity and partial expiration (ℓ-BTPS).
PEFR = Maximum rate of air flow during expiration (ℓ-sec).
Flow-40 = Expiratory flow rate at a lung volume corresponding to 40% of the vital capacity (ℓ-sec).
Flow-25 = Expiratory flow rate at a lung volume corresponding to 25% of the vital capacity (ℓ-sec).
FEV_1/FVC = Percent of vital capacity exhaled in one second.

TABLE XXXVII

METABOLIC RATE, PULMONARY, CARDIAC, AND HEMATOLOGIC DATA

OBTAINED UNDER RESTING CONDITIONS

GROUP I. MALE SUBJECTS (Group $\bar{x}$ and SEM)

Date	Conditions	HR	BP	$\dot{V}E$	$\dot{V}_{O_2}$	R	$\dot{V}E/\dot{V}_{O_2}$	Pa_{CO_2}	pHa	$D_{L_{CO}}$
1-16-75	Day 4, Wk 1	82.0	117.5/73.0	9.88	0.311	0.87	31.8	41.7	7.401	36.9
	0 ppm	3.8	1.3/ 2.9	0.6	0.000	0.02	1.6	0.5	0.009	2.9
1-23-75	Day 4, Wk 2	75.8	118.8/78.8	9.43	0.296	0.85	31.9	40.8	7.405	38.1
	100 ppm	6.9	1.3/ 2.7	0.4	0.008	0.04	1.1	0.4	0.009	2.8
1-30-75	Day 4, Wk 3	88.8	114.8/77.5	9.82	0.308	0.82	31.9	41.7	7.391	37.7
	20 ppm	5.2	4.8/ 5.3	0.5	0.004	0.01	1.8	0.3	.004	2.6
2-6-75	Day 4, Wk 4	69.8	115.3/77.5	9.71	0.321	0.80	30.5	39.0	7.383	38.5
	150 ppm	3.8	6.1/ 3.2	0.3	0.01	0.05	1.6	0.3	0.004	2.7
2-13-75	Day 4, Wk 5	83.0	118.8/80.0	9.54	0.301	0.89	32.1	40.4	7.403	38.9
	100 ppm, F	7.2	3.1/ 5.4	0.6	0.02	0.03	2.7	0.7	0.007	3.2
2-18-75	Day 2, Wk 6	74.5	114.5/76.3	9.14	0.278	0.92	32.1	41.6	7.386	40.3
	0 ppm	5.7	5.9/ 3.1	0.3	0.01	0.02	0.7	0.7	0.006	3.7

Within-day Trial 1 vs Trial 2 comparison (n=22)

	$\bar{x}\Delta$/SEMΔ	$\bar{x}\Delta$ as % of grand $\bar{x}$
Pa_{CO_2}	3.04	.018
DL_{CO}	2.47	5.5
pHa	1.67	.001

For definition of parameters see TABLE XXXVIII.

TABLE XXXVIII

METABOLIC RATE, PULMONARY, CARDIAC, AND HEMATOLOGIC DATA

OBTAINED UNDER EXERCISE CONDITIONS

GROUP I. MALE SUBJECTS (Group $\bar{x}$ and SEM)

Date	Conditions	HR	BP	$\dot{V}E$	$\dot{V}_{O_2}$	R	$\dot{V}E/\dot{V}_{O_2}$	Pa_{CO_2}	pHa	$D_{L_{CO}}$
				WORK-1 - p-XYLENE						
1-16-75	Day 4, Wk 1	124.8	134.3/75.8	33.62	1.456	0.93	23.5	42.0	7.388	42.8
	0 ppm	5.8	3.2/ 4.9	0.8	0.03	0.03	0.7	0.5	0.00	2.2
1-23-75	Day 4, Wk 2	114.5	134.8/72.3	33.15	1.329	0.95	25.1	42.0	7.392	46.9
	100 ppm	8.7	6.3/ 3.2	1.08	0.07	0.02	0.8	0.0	0.00	3.0
1-30-75	Day 4, Wk 3	122.5	132.8/72.5	34.89	1.428	0.91	24.4	42.7	7.385	48.7
	20 ppm	2.5	5.1/ 5.4	2.0	0.05	0.3	0.8	0.2	0.003	3.6
2-6-75	Day 4, Wk 4	122.5	133.8/72.5	33.55	1.333	0.97	25.2	39.5	7.390	48.8
	150 ppm, F	6.3	7.2/ 3.2	1.3	0.06	0.03	0.1	0.8	0.006	3.1
2-13-75	Day 4, Wk 5	122.5	122.0/68.8	34.68	1.268	1.02	27.3	41.4	7.397	49.1
	100 ppm, F	2.5	2.0/ 5.2	1.9	0.06	0.3	0.5	1.2	0.006	3.9
2-18-75	Day 2, Wk 6	118.8	125.0/66.2	29.44	1.114	1.00	26.5	42.2	7.416	47.8
	0 ppm	3.8	3.5/ 5.2	1.3	0.06	0.02	0.2	0.4	0.007	2.9

TABLE XXXVIII (continued)

METABOLIC RATE, PULMONARY, CARDIAC, AND HEMATOLOGIC DATA

OBTAINED UNDER EXERCISE CONDITIONS

GROUP I. MALE SUBJECTS (Group $\bar{x}$ and SEM)

Date	Conditions	HR	BP	$\dot{V}E$	$\dot{V}_{O_2}$	R	$\dot{V}E/\dot{V}_{O_2}$	Pa_{CO_2}	pHa	$D_{L_{CO}}$
					WORK-2 - p-XYLENE					
1-16-75	Day 4,Wk 1	151.0	148.0/75.5	60.19	2.315	1.07	26.0	38.0	7.367	51.6
	0 ppm	4.2	2.8/ 6.0	2.9	0.04	0.05	1.1	0.5	0.01	2.5
1-23-75	Day 4,Wk 2	152.3	157.5/77.0	61.72	2.281	1.06	27.1	39.0	7.378	51.6
	100 ppm	8.7	4.5/ 2.4	3.3	0.08	0.03	1.1	0.9	0.008	2.2
1-30-75	Day 4,Wk 3	163.0	160.0/75.8	65.23	2.393	1.05	27.2	40.0	7.374	53.2
	20 ppm	4.4	7.1/ 6.9	4.3	0.06	0.03	1.2	0.4	0.006	3.4
2-6-75	Day 4,Wk 4	162.5	153.0/75.0	61.94	2.199	1.09	28.1	39.7	7.380	58.7
	150 ppm	10.3	14.0/ 2.9	4.9	0.04	0.04	1.6	0.9	0.004	2.8
2-13-75	Day 4,Wk 5	161.3	153.0/71.3	60.74	2.060	1.13	27.9	40.4	7.389	58.1
	100 ppm, F	3.1	4.7/ 7.7	4.5	0.07	0.03	0.4	0.9	0.006	2.3
2-18-75	Day 2,Wk 6	152.5	146.3/81.3	50.3	1.791	1.14	28.2	41.6	7.398	54.7
	0 ppm	4.3	2.4/ 4.3	1.3	0.02	0.03	0.9	0.7	0.003	5.2

TABLE XXXVIII (continued)

METABOLIC RATE, PULMONARY, CARDIAC, AND HEMATOLOGIC DATA

OBTAINED UNDER EXERCISE CONDITIONS

GROUP I. MALE SUBJECTS (Group $\bar{x}$ and SEM)

Date	Conditions	HR	BP	$\dot{V}E$	$\dot{V}_{O_2}$	R	$\dot{V}E/\dot{V}_{O_2}$	Pa_{CO_2}	pHa	$D_{L_{CO}}$

DEFINITION OF PARAMETERS

HR - Heart beats per minute.

BP - mm Hg - Pressure in arterial blood vessels immediately after (systolic), or before (diastolic) ejection of blood by the heart.

$\dot{V}_E$ - liters/minute, BTPS - Liters of air expired per minute.

$\dot{V}_{O_2}$ - liters/minute, STPD - liters of oxygen consumed per minute.

R - Respiratory quotient ($\dot{V}_{CO_2}/\dot{V}_{O_2}$) - CO_2 produced per unit consumption of O_2.

Pa_{CO_2} - mm Hg - Partial pressure of CO_2 in the lung - Sensitive to changes in ventilation unassociated with changes in metabolic rate.

pHa - Sensitive to arterial blood acid-base disorders of both respiratory and metabolic origin.

$D_{L_{CO}}$ - ml/min/mm Hg - Reflects capability for alveolar-capillary gas exchange.

TABLE XXXIX

WITHIN-DAY VARIABILITY IN VARIOUS FUNCTIONS AS MEASURED FROM MAXIMUM AND PARTIAL FORCED EXPIRATORY MANEUVERS

(Between Trial Mean Difference / Actual Mean x 100)

	Trial 1 vs. Trial 2	Trial 1 vs. Trial 3
Max. Vol.	-2.21%	-2.39%
Partial Vol.	-3.38%	-5.13%
Partial - Flow @ 25%	.114%	-3.90%
Max. - Flow @ 25%	-17.390*	-8.13%
Partial - Flow @ 40%	-5.72%	-5.16%
Max. - Flow @ 40%	-14.53%*	-10.85%*
Peak Flow	-1.01%	.88%
FEV_1 / FVC	-3.11%	-5.12%

* Significant increase at p = .05 (two-tailed t-test)

TABLE XL

Analysis of Variance for the

10 Second Time Estimations

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	55	165.08		
DAYS	13	21.94	1.64	
LINEAR DAY TREND	1	1.80	1.80	1.86
LINEAR P-XYLENE	1	3.12	3.12	3.22
OTHER	11	15.85	1.44	1.08
PEOPLE	3	105.30	35.10	
RESIDUAL	39	37.84	0.97	

TABLE XLI

Analysis of Variance for the

30 Second Time Estimations

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	55	1158.80		
DAYS	13	58.91	4.53	
LINEAR DAY TREND	1	3.45	3.45	0.79
LINEAR P-XYLENE	1	5.19	5.19	1.20
OTHER	11	48.19	4.81	1.11
PEOPLE	3	930.54	310.18	
RESIDUAL	39	169.42	4.34	

TABLE XLII

Analysis of Variance for the Marquette Test

Estimate/Stimulus--Sound Stimulus

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	51	2.409		
DAYS	12	0.222	0.018	
LINEAR DAY TREND	1	0.125	0.125	10.42**
LINEAR P-XYLENE	1	0.029	0.029	2.42
OTHER	10	0.041	0.004	0.33
PEOPLE	3	1.742	0.581	
RESIDUAL	36	0.445	0.012	

**Significant $p \leq .01$

TABLE XLIII

Analysis of Variance for the Marquette Test

|Estimate-Stimulus|--Sound Stimulus

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	51	6.570		
DAYS	12	0.927	0.077	
LINEAR DAY TREND	1	0.365	0.365	6.51*
LINEAR P-XYLENE	1	0.054	0.054	0.96
OTHER	10	0.444	0.044	0.72
PEOPLE	3	3.627	1.209	
RESIDUAL	36	2.016	0.056	

* Significant $p \leq .05$

TABLE XLIV

Analysis of Variance for the Marquette Test

Reaction Time--Sound Stimulus

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	51	0.938		
DAYS	12	0.082	0.007	
LINEAR DAY TREND	1	0.030	0.030	7.50**
LINEAR P-XYLENE	1	0.001	0.001	0.25
OTHER	10	0.052	0.005	1.25
PEOPLE	3	0.721	0.240	
RESIDUAL	36	0.135	0.004	

**Significant $p \leq .01$

TABLE XLV

Analysis of Variance for the Marquette Test

Estimate/Stimulus--Light Stimulus

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	51	0.971		
DAYS	12	0.130	0.011	
LINEAR DAY TREND	1	0.068	0.068	11.33**
LINEAR P-XYLENE	1	0.0003	0.0003	0.05
OTHER	10	0.062	0.006	1.00
PEOPLE	3	0.634	0.211	
RESIDUAL	36	0.207	0.006	

**Significant $p \leq .01$

TABLE XLVI

Analysis of Variance for the Marquette Test

|Estimate-Stimulus|--Light Stimulus

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	51	1.322		
DAYS	12	0.448	0.37	
LINEAR DAY TREND	1	0.016	0.016	0.94
LINEAR P-XYLENE	1	0.035	0.035	2.06
OTHER	10	0.404	0.040	2.35
PEOPLE	3	0.247	0.082	
RESIDUAL	36	0.627	0.017	

TABLE XLVII

Analysis of Variance for the Marquette Test

Reaction Time--Light Stimulus

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	51	1.160		
DAYS	12	0.025	0.002	
LINEAR DAY TREND	1	0.00008	0.00008	0.04
LINEAR P-XYLENE	1	0.000001	0.000001	0.001
OTHER	10	0.025	0.003	1.50
PEOPLE	3	1.053	0.351	
RESIDUAL	36	0.081	0.002	

TABLE XLVIII

Analysis of Variance for the

Arithmetic Test

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	55	38664.87		
DAYS	13	865.36	66.57	
LINEAR DAY TREND	1	195.61	195.61	5.02*
LINEAR P-XYLENE	1	20.32	20.32	0.52
OTHER	11	250.18	22.74	0.58
PEOPLE	3	36281.62	12093.87	
RESIDUAL	39	1517.80	38.92	

* Significant at $p \leq .05$

TABLE XLIX

Analysis of Variance for the

Coordination Test

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	55	27841.84		
DAYS	13	985.43	75.80	
LINEAR DAY TREND	1	34.99	34.99	0.60
LINEAR P-XYLENE	1	233.29	233.29	4.39*
OTHER	11	743.16	67.56	1.27
PEOPLE	3	24784.13	8261.38	
RESIDUAL	39	2072.29	53.14	

* Significant $p \leq .05$

TABLE L

Analysis of Variance for the

Inspection Test

During Exposure to p-Xylene (7-1/2 Hr/Day)

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	MSR(F)
TOTAL	55	518290.75		
DAYS	13	125333.31	9641.02	
LINEAR DAY TREND	1	11431.04	11431.04	1.20
LINEAR P-XYLENE	1	1047.74	1047.74	0.11
OTHER	11	110947.49	10086.13	1.06
PEOPLE	3	21134.93	7044.97	
RESIDUAL	39	371822.56	9533.91	

TABLE LI

COORDINATION TEST PERFORMANCE DURING EXPOSURE TO p-XYLENE

SUBJECT	0 PPM	100 PPM			20 PPM			150 PPM			100 PPM F			0 PPM
	F	M	W	F	M	W	F	M	W	F	M	W	F	M
117	35	36	33	49	-[A]	-[A]	16	16	12	14	36	30	-[A]	48
248	67	72	67	85	75	78	85	76	62[B]	68	82	81	66	80
249	85	87	83	77	83	86	89	82	79	86	-[A]	86	84	83
250	63	67	81	77	78	74	67	74	72	76	67	77	77	80

A: Subject out due to illness

B: Subject complained of eye irritation 1 hour prior to tests

TABLE LII

SUBJECTIVE RESPONSES TO p-XYLENE VAPOR

8 MALES

	0 ppm 4 days	20 ppm 5 days	100 ppm 5 days	100 ppm (fluctuating) 5 days	150 ppm 5 days
			(Mentions)		
Headache	3	3	3	5	3
Nausea	0	1	0	0	1
Dizziness	3	0	3	1	1
Abdominal Pain	0	0	0	0	0
Chest Pain	0	0	0	0	0
ENT Irritation	3	4	7	4	8
Other	0	0	2	1	2

7 FEMALES

	0 ppm 2 days	100 ppm 5 days
	(Mentions)	
Headache	1	8
Nausea	0	1
Dizziness	3	6
Abdominal Pain	0	0
Chest Pain	1	0
ENT Irritation	5	17
Other	3	0

TABLE LIII

p-XYLENE EXPOSURE

SERUM URIC ACID CONCENTRATIONS

in mg/dl*

Subject No.	Previous to study	Wk 2,Day 4 100 ppm	Wk 3,Day 4 20 ppm	Wk 4,Day 4 150 ppm	Wk 6,Day 2 0 ppm
			Group I, Males		
117	5.50	4.50	4.70	4.20	4.10
248	6.50	6.00	5.30	6.00	5.40
249	7.20	8.70**	8.20	6.50	6.30
250	6.50	5.20	5.10	5.30	4.40
			Group II, Males		
251	8.50	5.90	5.60	5.90	4.50
252	6.10	5.70	5.10	5.40	5.00
			Group III, Males		
255	7.40	5.50	4.20	--	--
256	4.40	--	3.80	3.90	2.60
257	5.50	--	5.60	5.90	5.20

*Normal range for laboratory: 2.5-8.5 mg/dl.

**Out-of-normal range.

TABLE LIV

p-XYLENE EXPOSURE

WHITE BLOOD COUNT, thousands*

Subject No.	Previous to study	Wk 2, Day 4 100 ppm	Wk 3, Day 4 20 ppm	Wk 4, Day 4 150 ppm	Wk 6, Day 2 0 ppm
			Group I, Males		
117	5.10	4.60**	4.90	4.40**	4.50**
248	6.70	5.70	5.90	6.20	5.70
249	5.90	6.20	6.60	8.20	6.90
250	5.40	4.60**	6.00	5.20	3.70**
			Group II, Males		
251	5.10	5.80	6.40	5.60	6.80
252	8.40	8.60	11.80**	8.60	8.30
			Group III, Males		
255	5.30	4.30**	5.10	--	--
256	4.90	--	5.00	6.00	5.20
257	5.70	--	5.80	5.60	5.20

*Normal range for laboratory: 48-108 thousand.

**Out-of-normal range.

FIGURE 1

FLUCTUATION OF p-XYLENE VAPOR CONCENTRATION IN CHAMBER
MALES, WEEK 5, DAYS 1-5

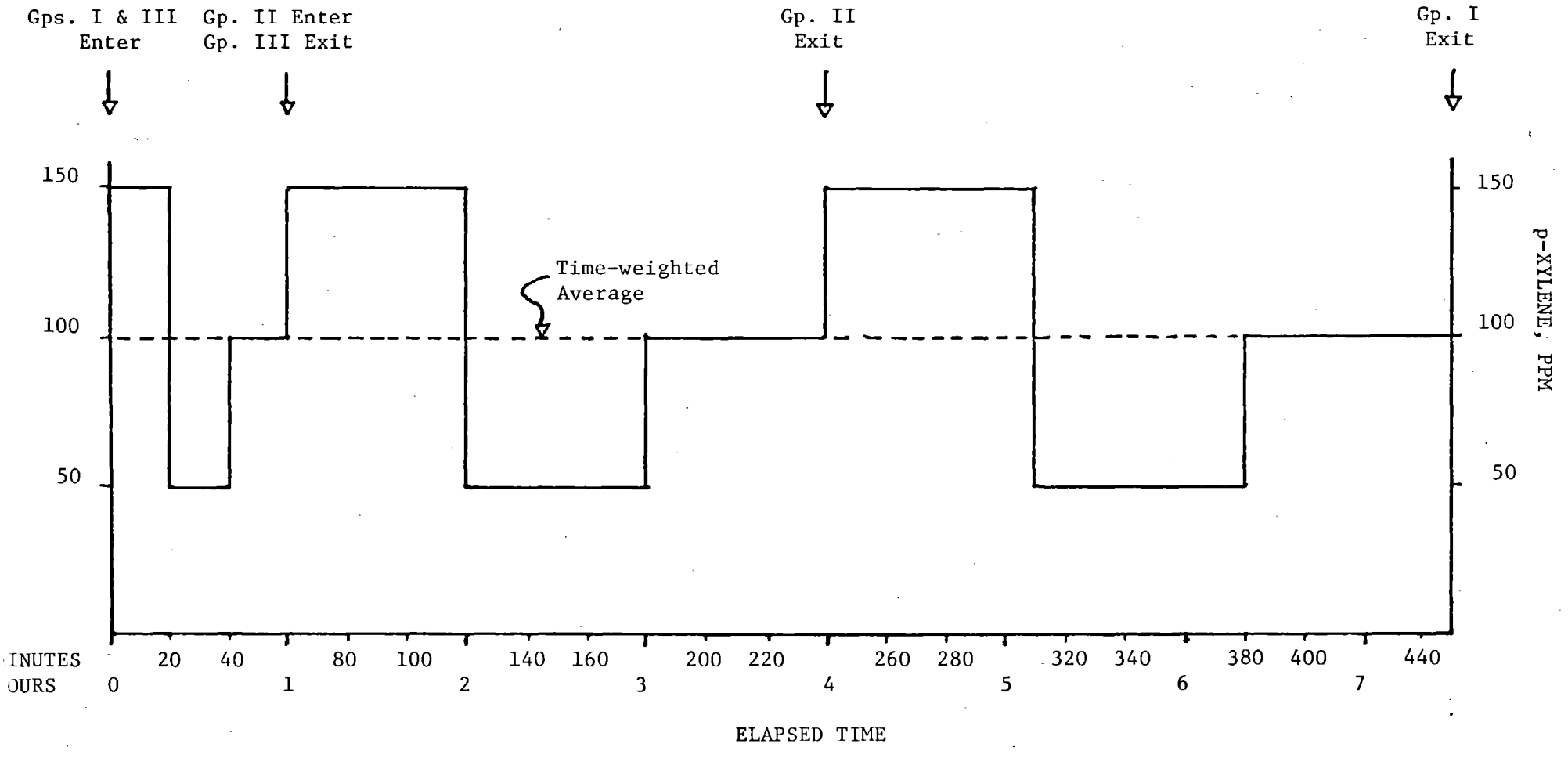


FIGURE 2

SPONTANEOUS EEG OF SUBJECT 117

DURING 0-PPM CONDITIONS PRIOR TO XYLENE EXPOSURE

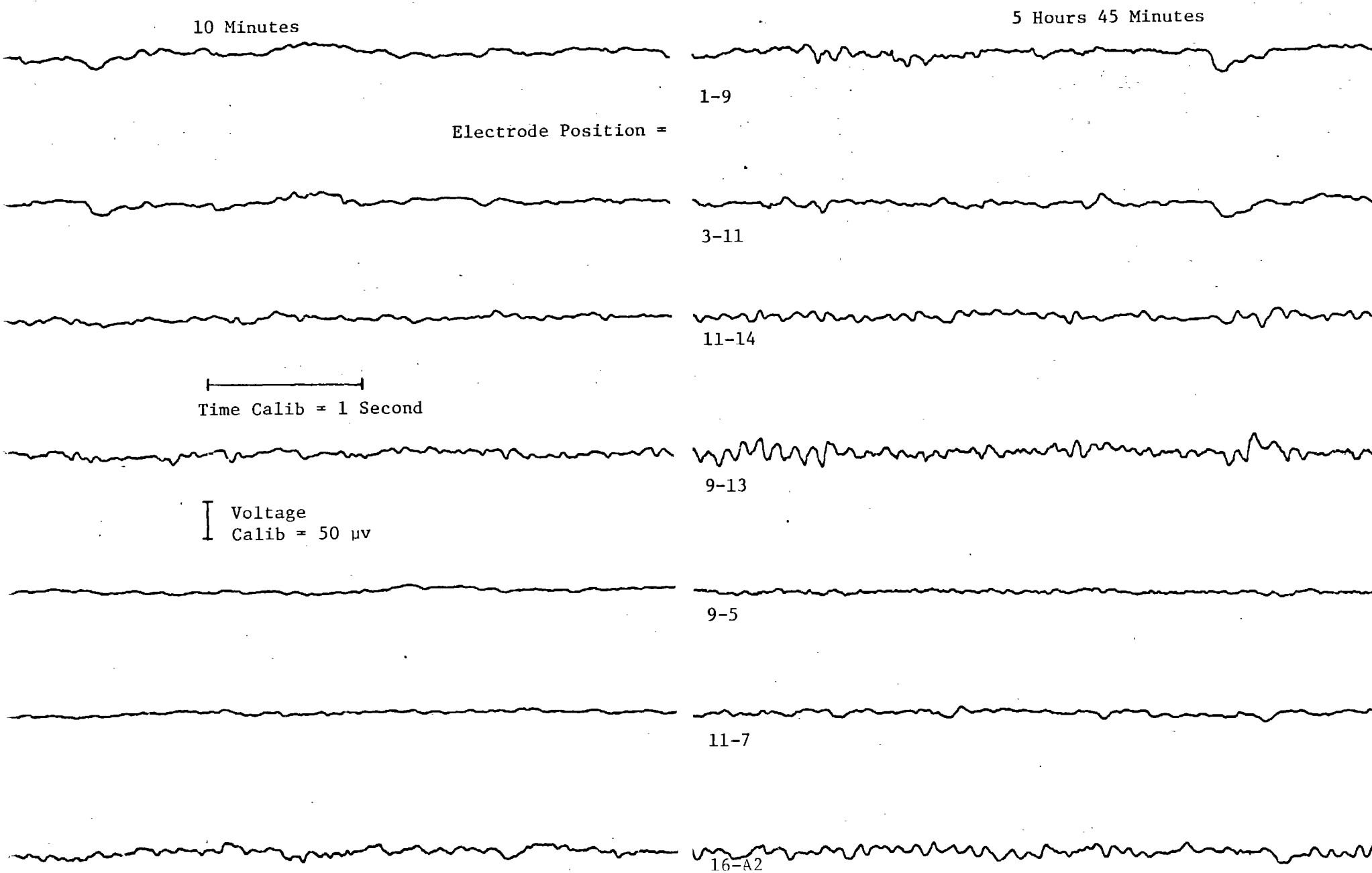
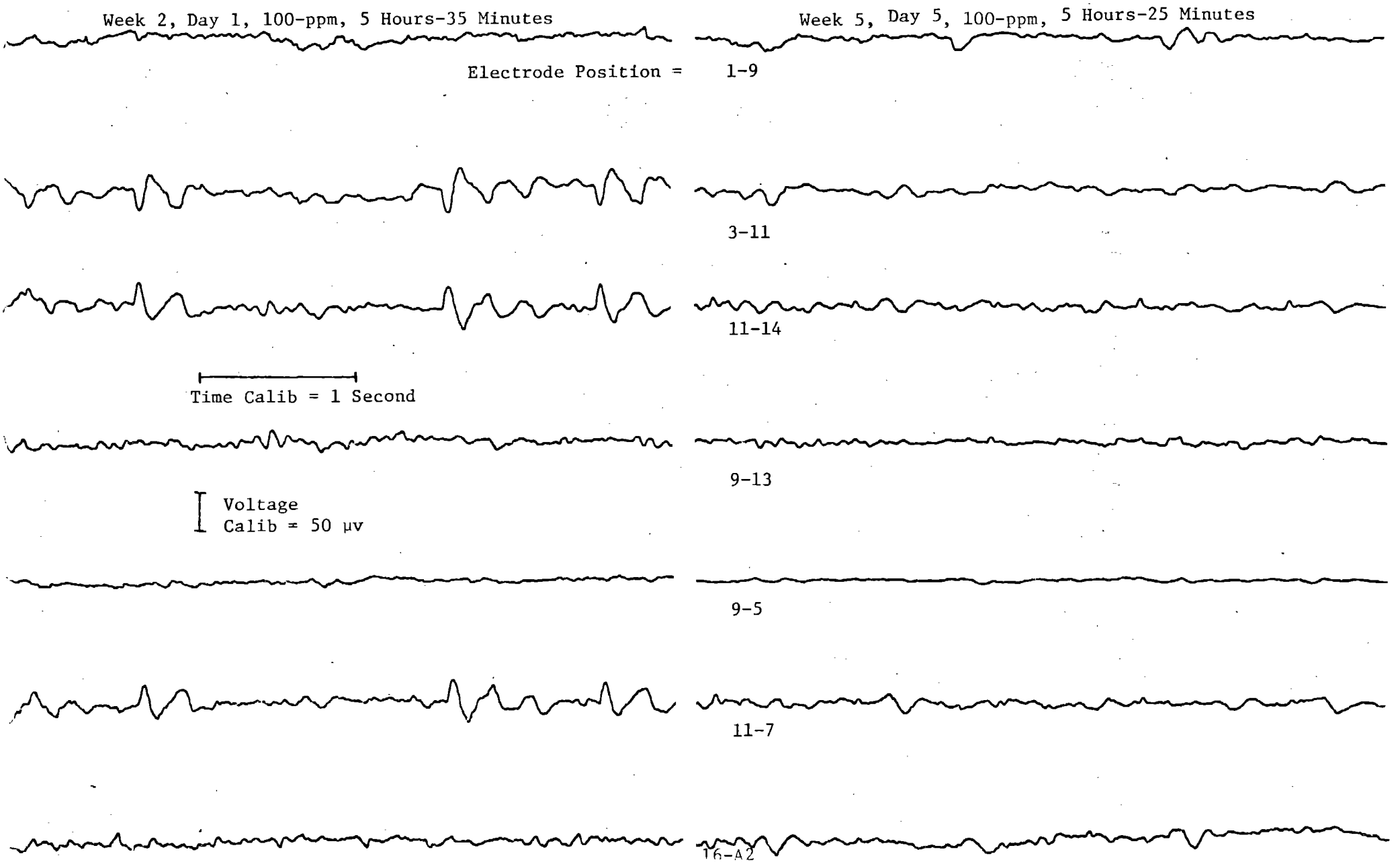


FIGURE 3

SPONTANEOUS EEG OF SUBJECT 117

ON TWO DIFFERENT DAYS OF EXPOSURE TO XYLENE



T6-A2

FIGURE 4

SPONTANEOUS EEG OF SUBJECT 249

DURING 0-PPM CONDITIONS PRIOR TO XYLENE EXPOSURE

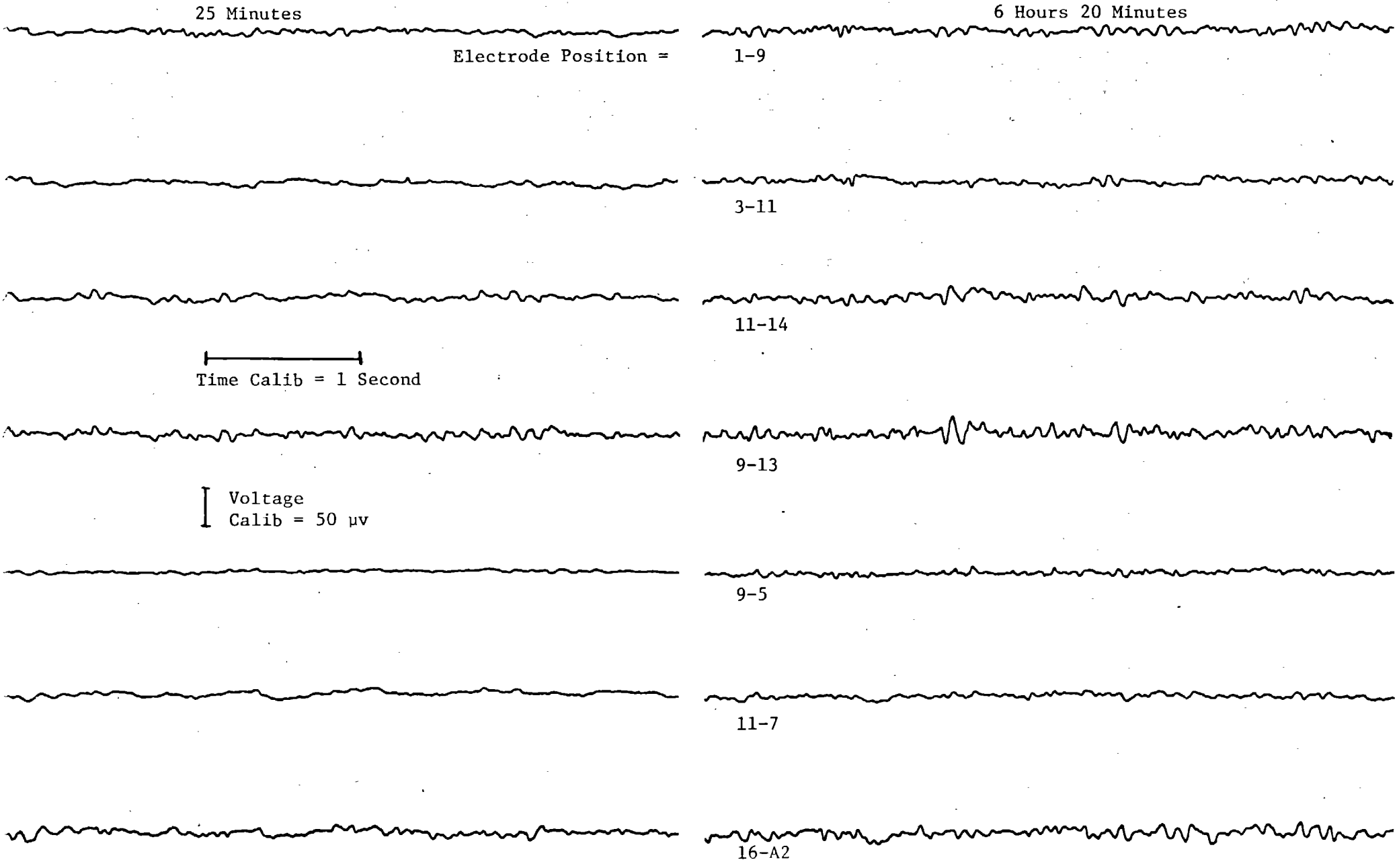


FIGURE 5

SPONTANEOUS EEG OF SUBJECT 249

ON TWO DIFFERENT DAYS OF EXPOSURE TO XYLENE

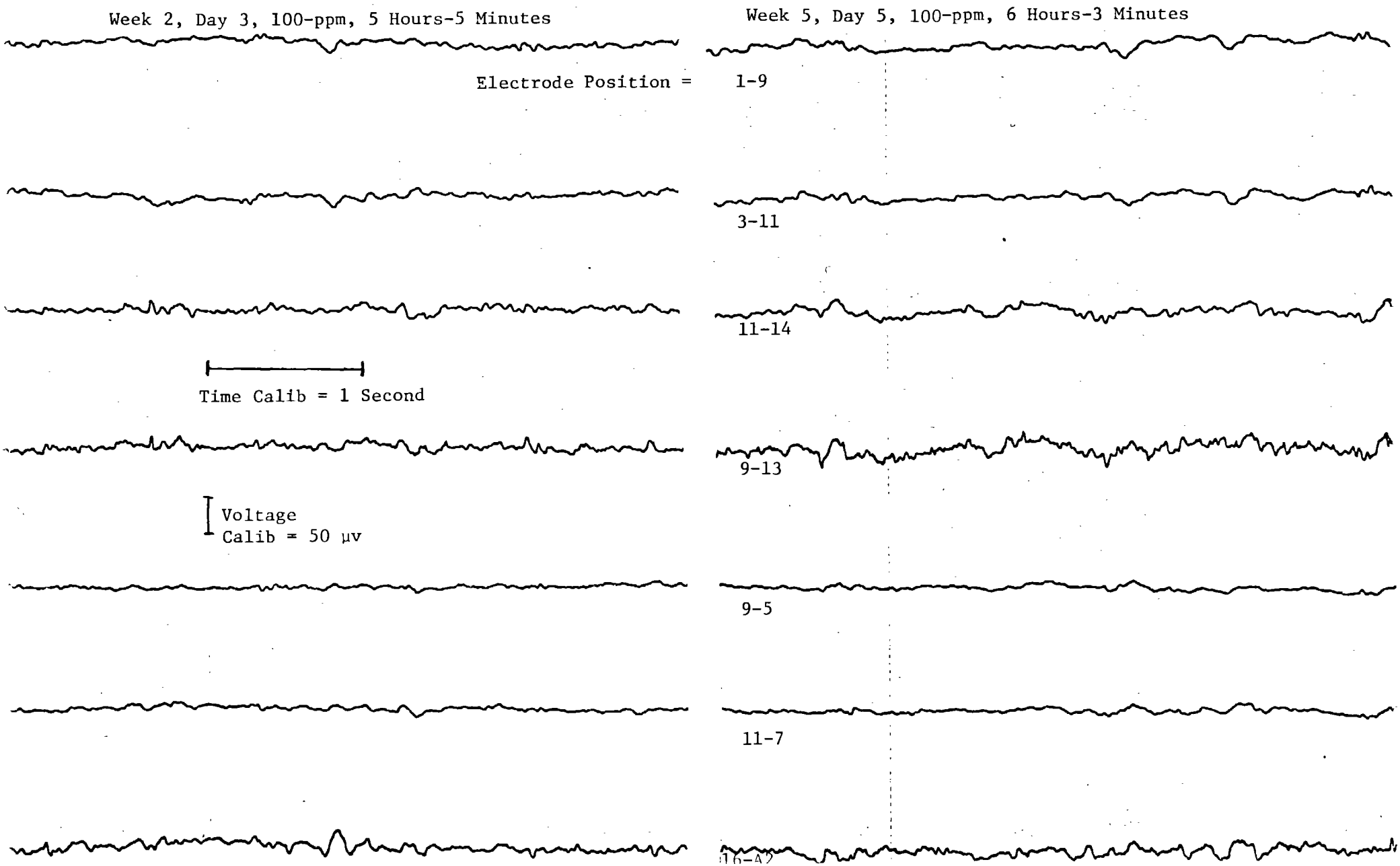


FIGURE 6

SPONTANEOUS EEG OF SUBJECT 250

DURING 0-PPM CONDITIONS PRIOR TO AND AFTER XYLENE EXPOSURE

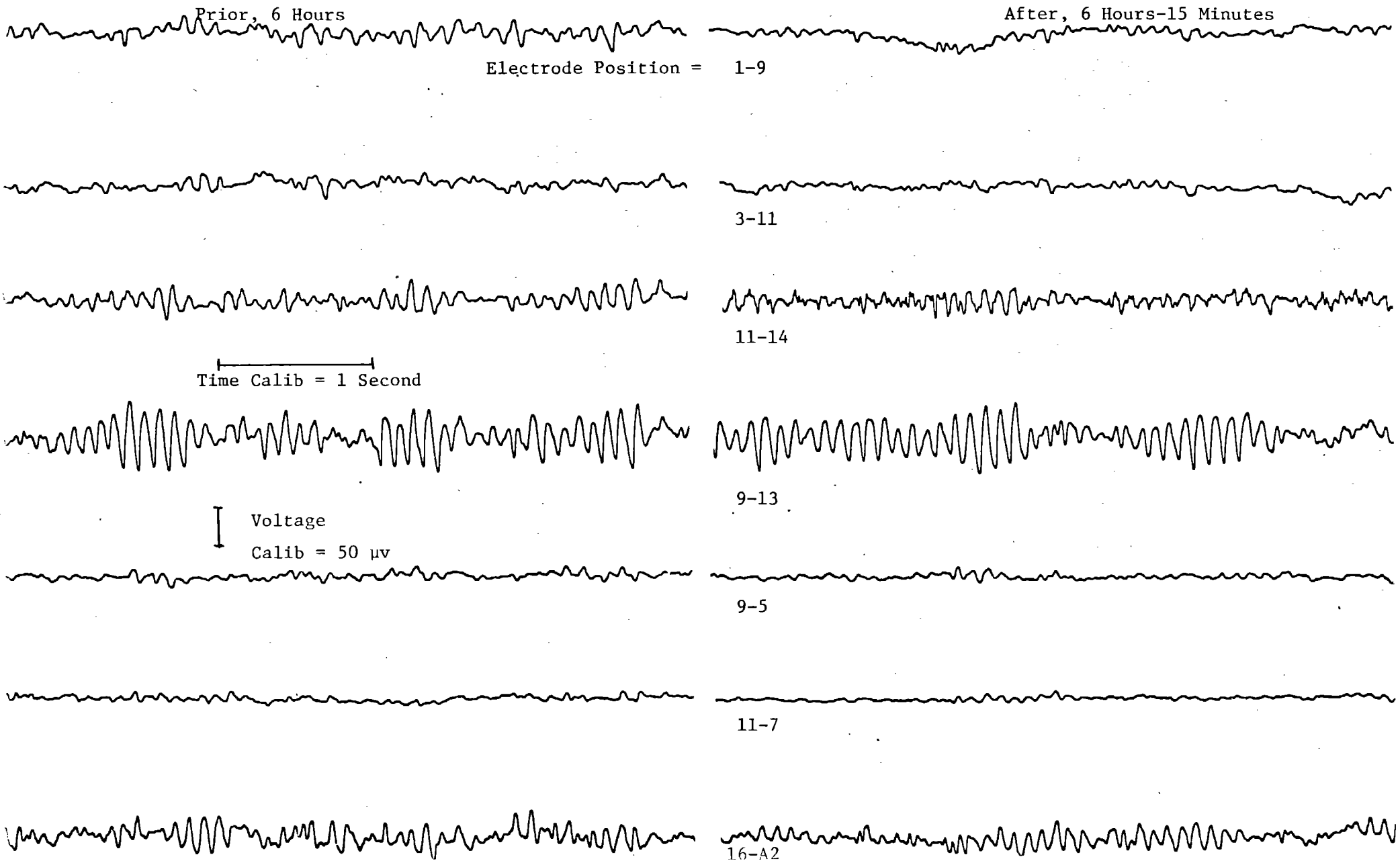


FIGURE 7

SPONTANEOUS EEG OF SUBJECT 250

ON TWO DIFFERENT DAYS DURING EXPOSURE TO XYLENE

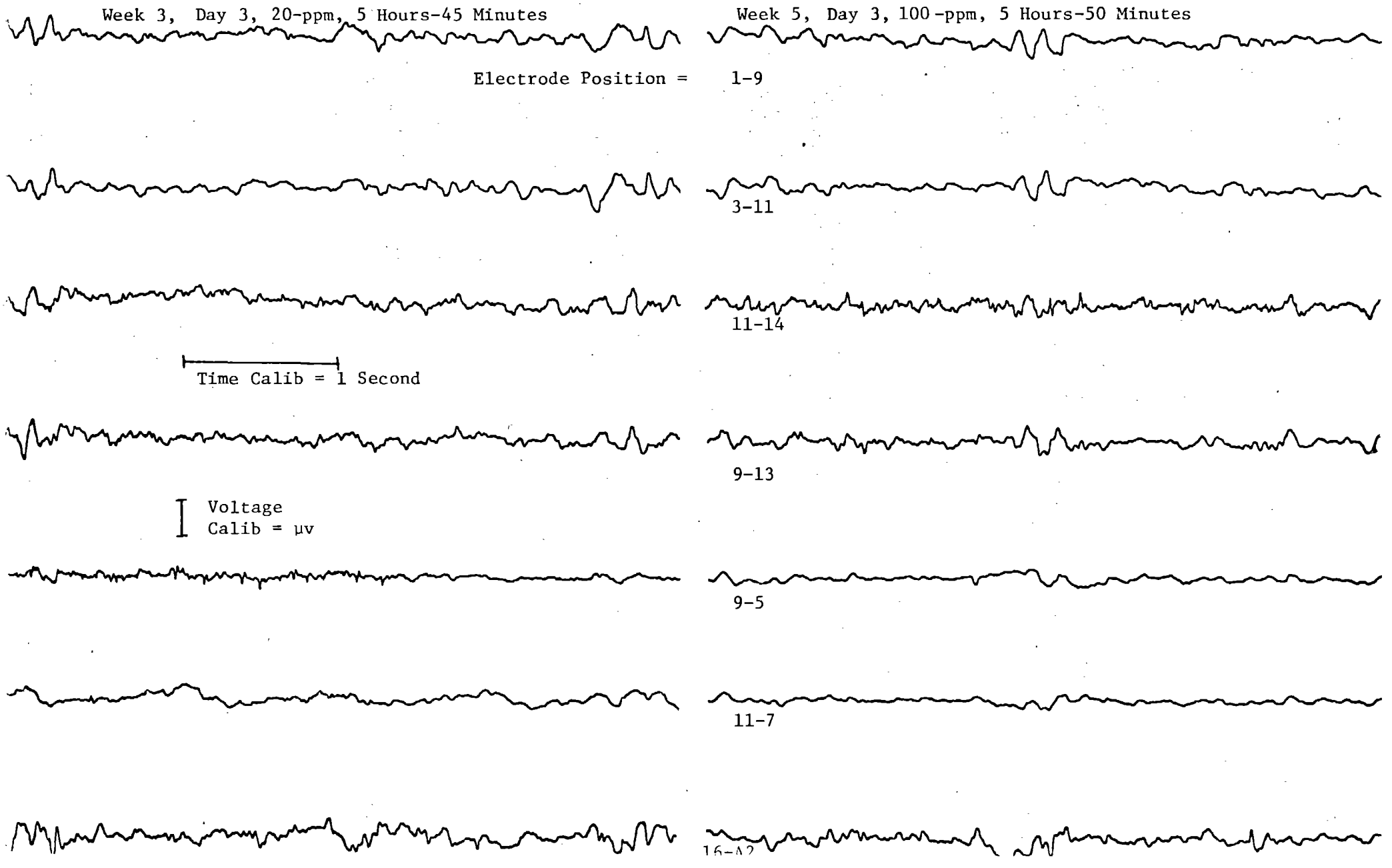


FIGURE 8

SPONTANEOUS EEG OF SUBJECT 259

DURING 0-PPM CONDITIONS PRIOR TO XYLENE EXPOSURE

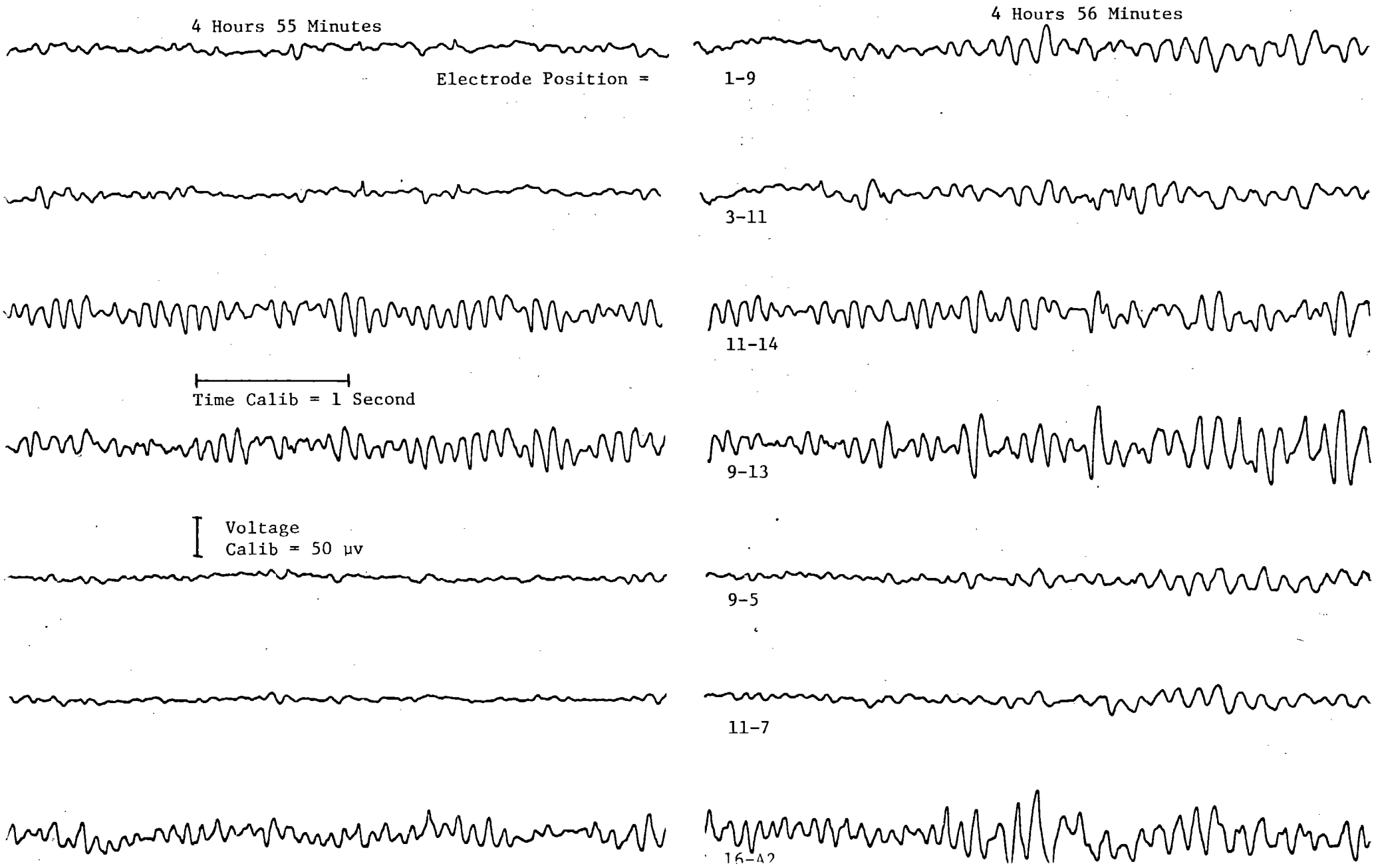


FIGURE 9

SPONTANEOUS EEG OF SUBJECT 259

ON TWO DIFFERENT DAYS OF EXPOSURE TO XYLENE

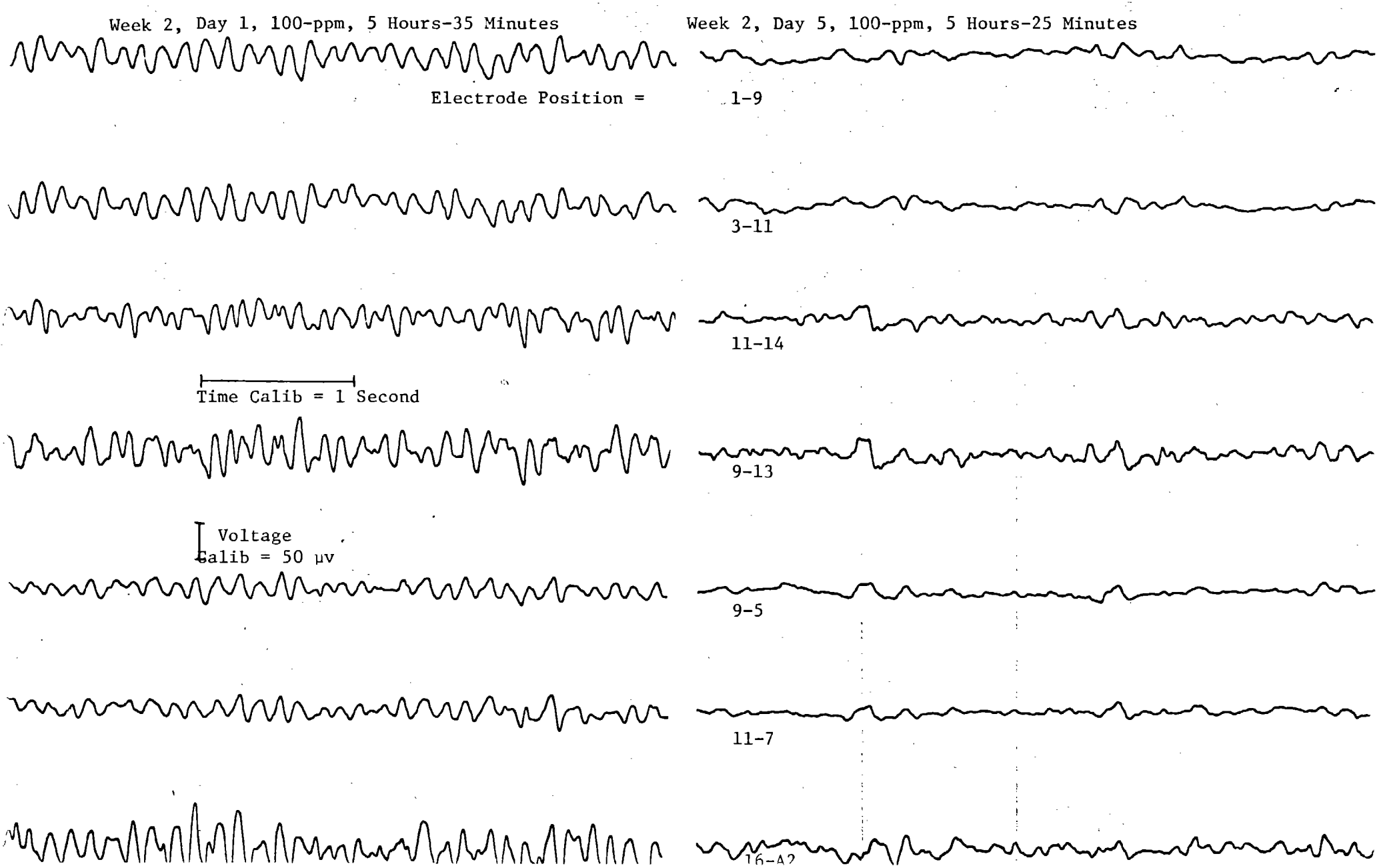


FIGURE 10

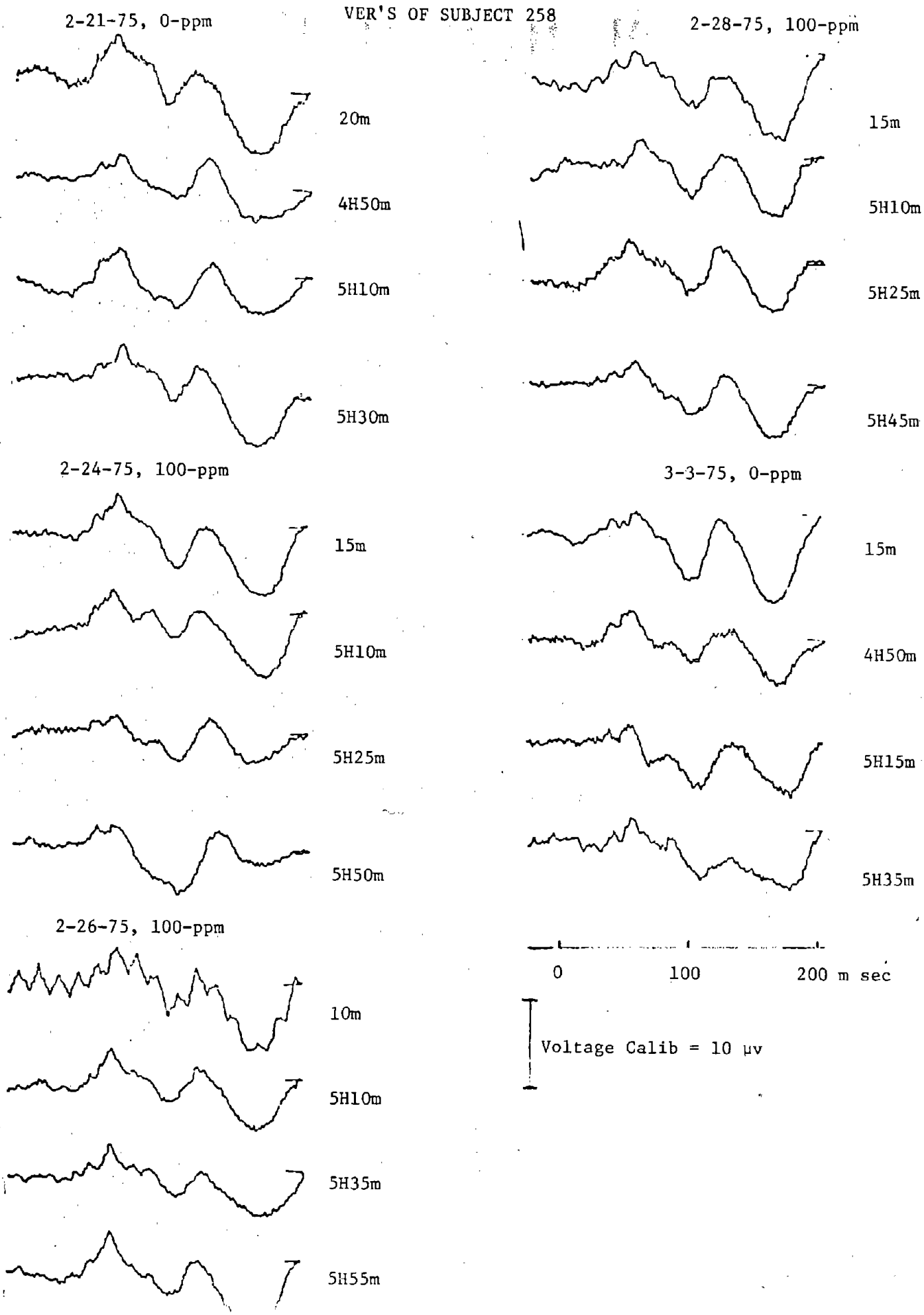

VER'S OF SUBJECT 258
2-21-75, 0-ppm
20m
4H50m
5H10m
5H30m
2-28-75, 100-ppm
15m
5H10m
5H25m
5H45m
2-24-75, 100-ppm
15m
5H10m
5H25m
5H50m
3-3-75, 0-ppm
15m
4H50m
5H15m
5H35m
2-26-75, 100-ppm
10m
5H10m
5H35m
5H55m
0
100
200 m sec
Voltage Calib = 10 μv

FIGURE 11

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on Time Estimations

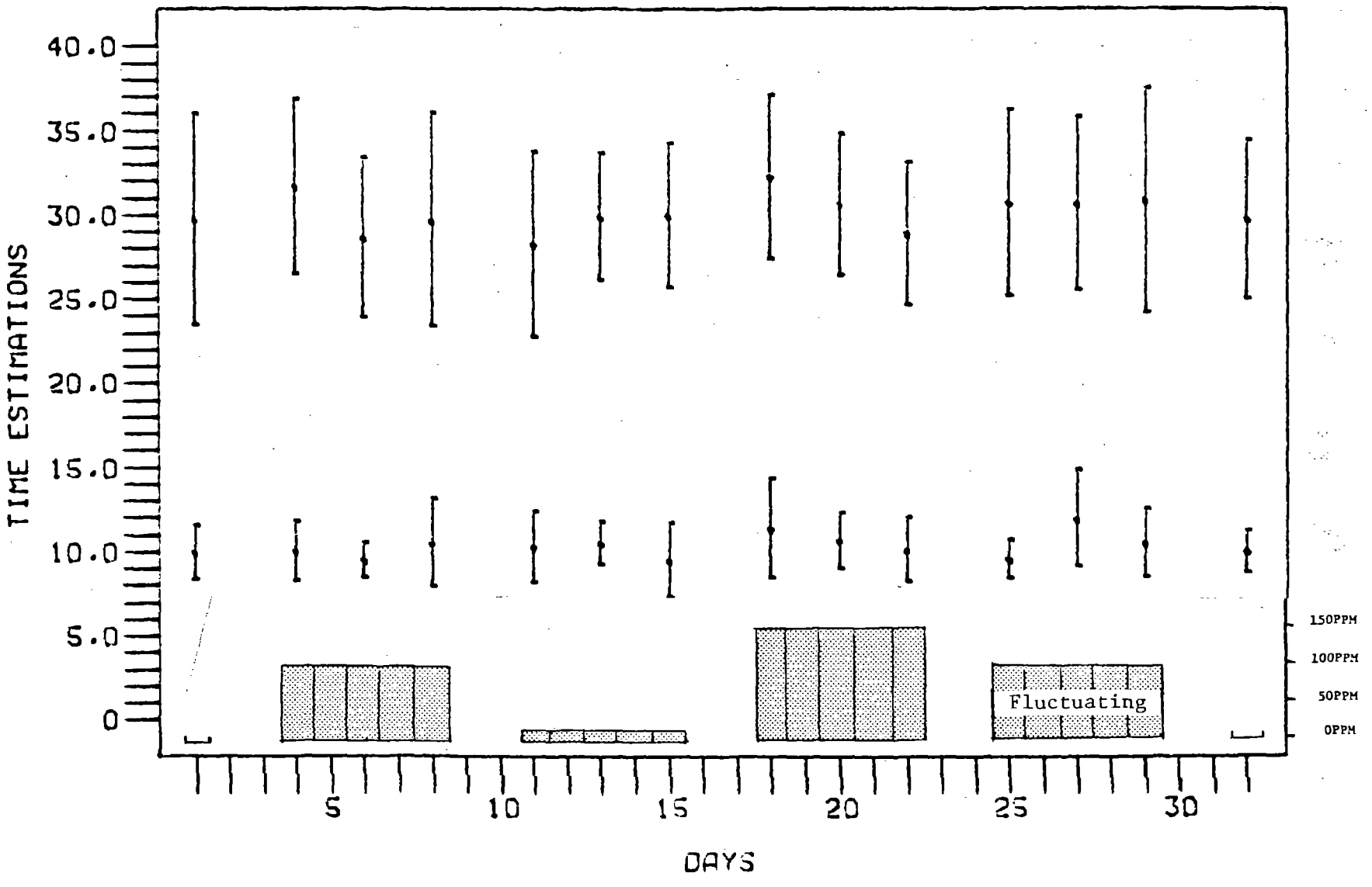


FIGURE 12

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on the Marquette Test

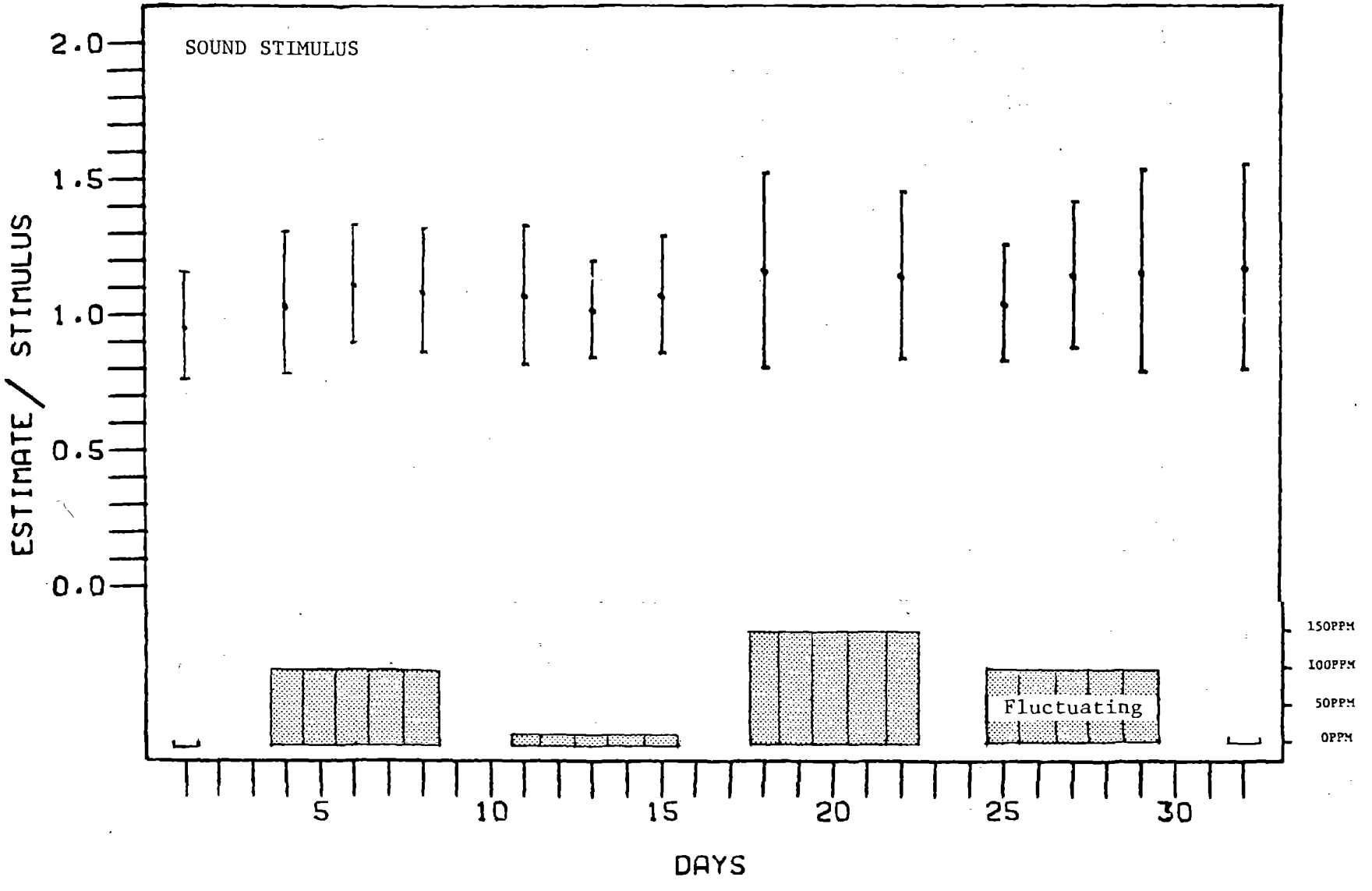


FIGURE 13

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on the Marquette Test

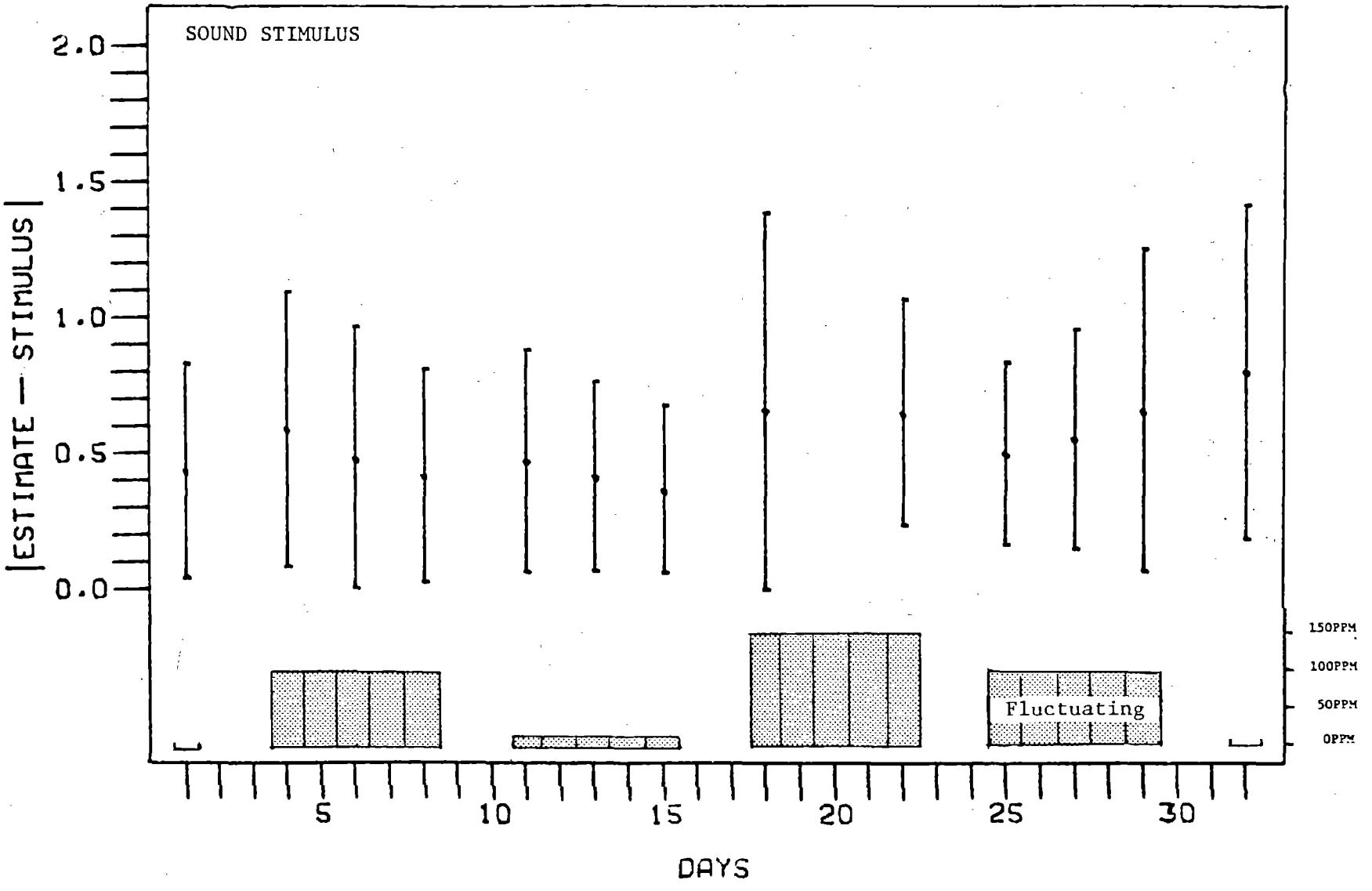


FIGURE 14

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on the Marquette Test

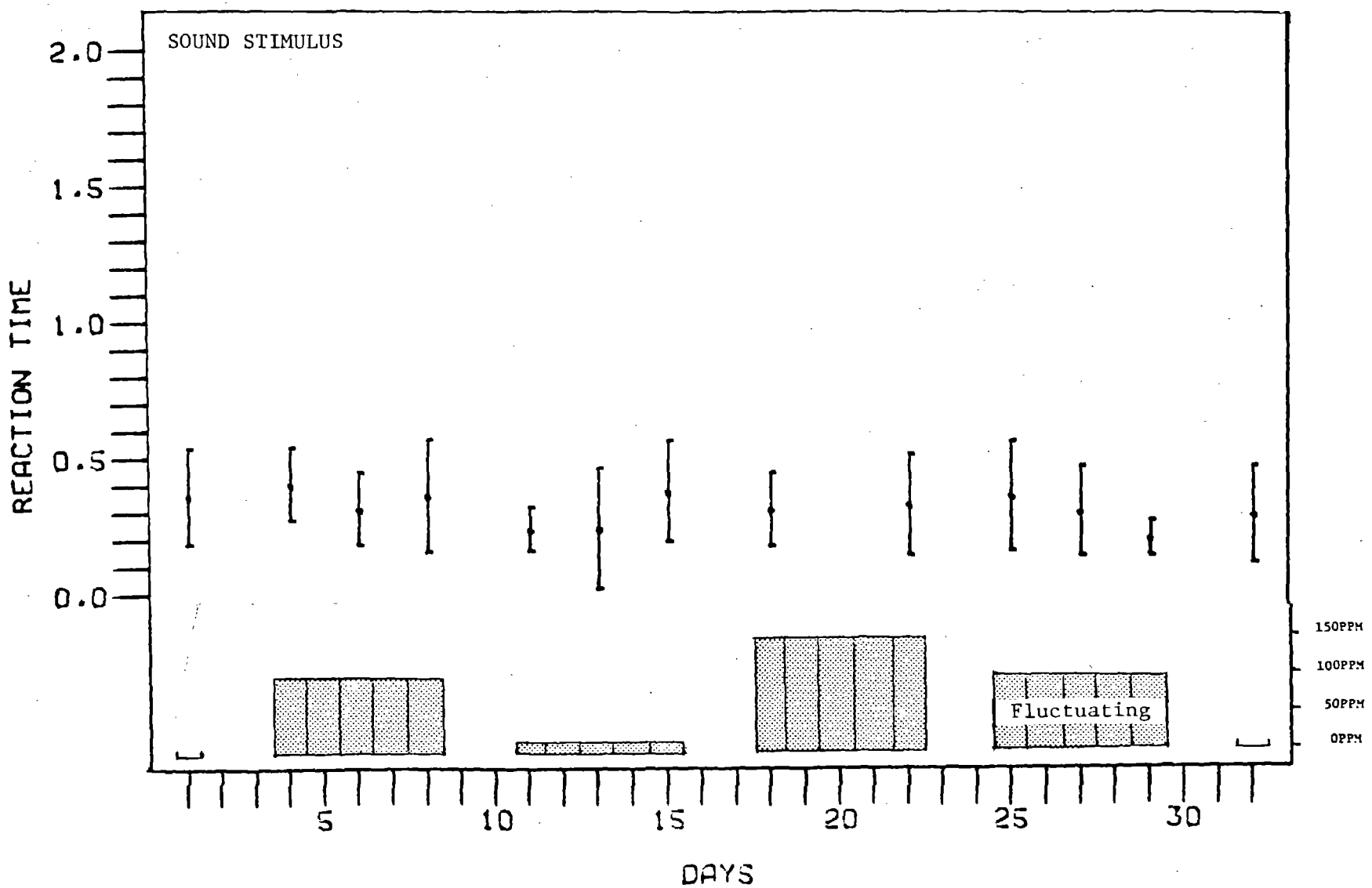


FIGURE 15

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on the Marquette Test

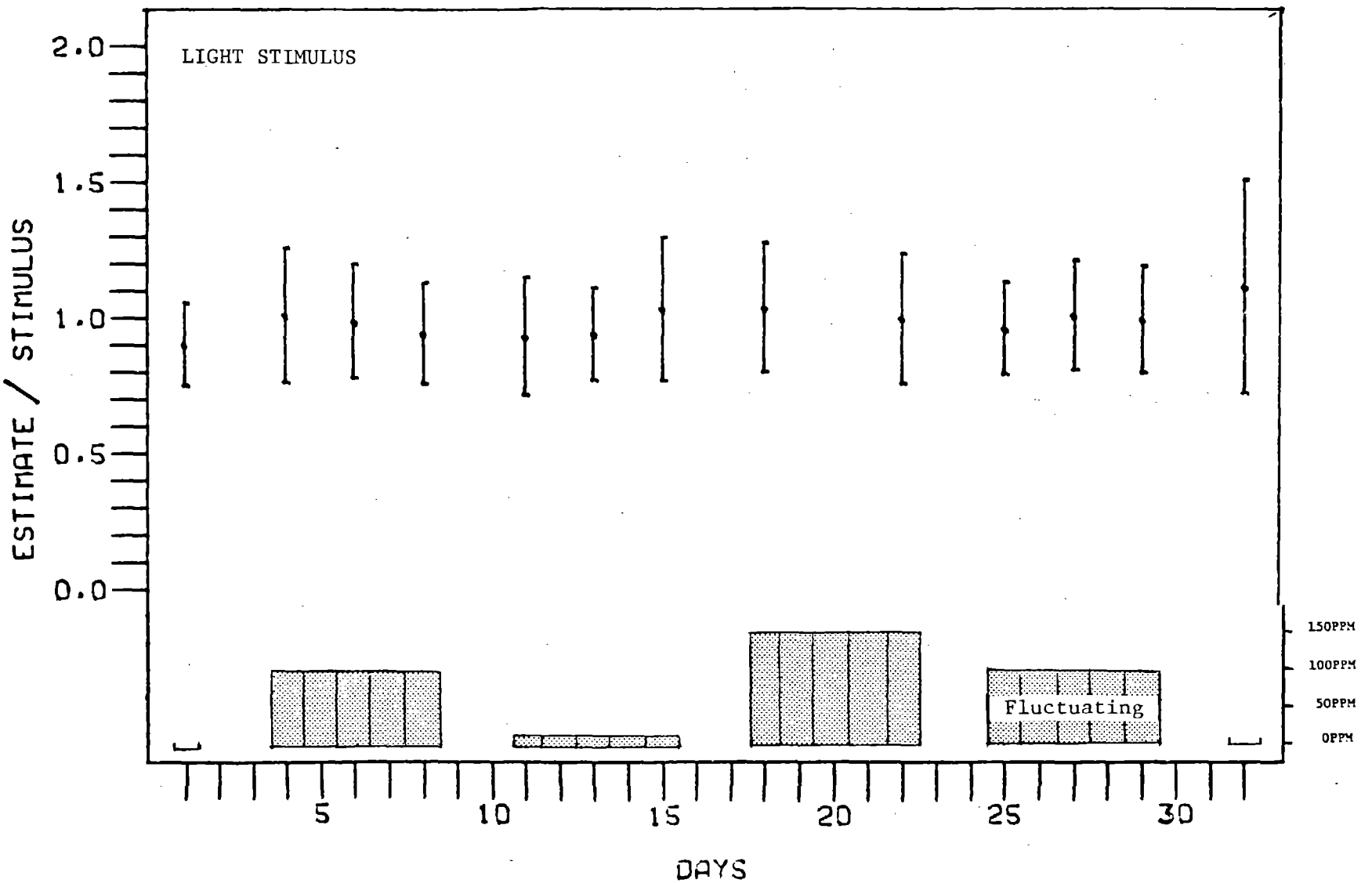


FIGURE 16

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on the Marquette Test

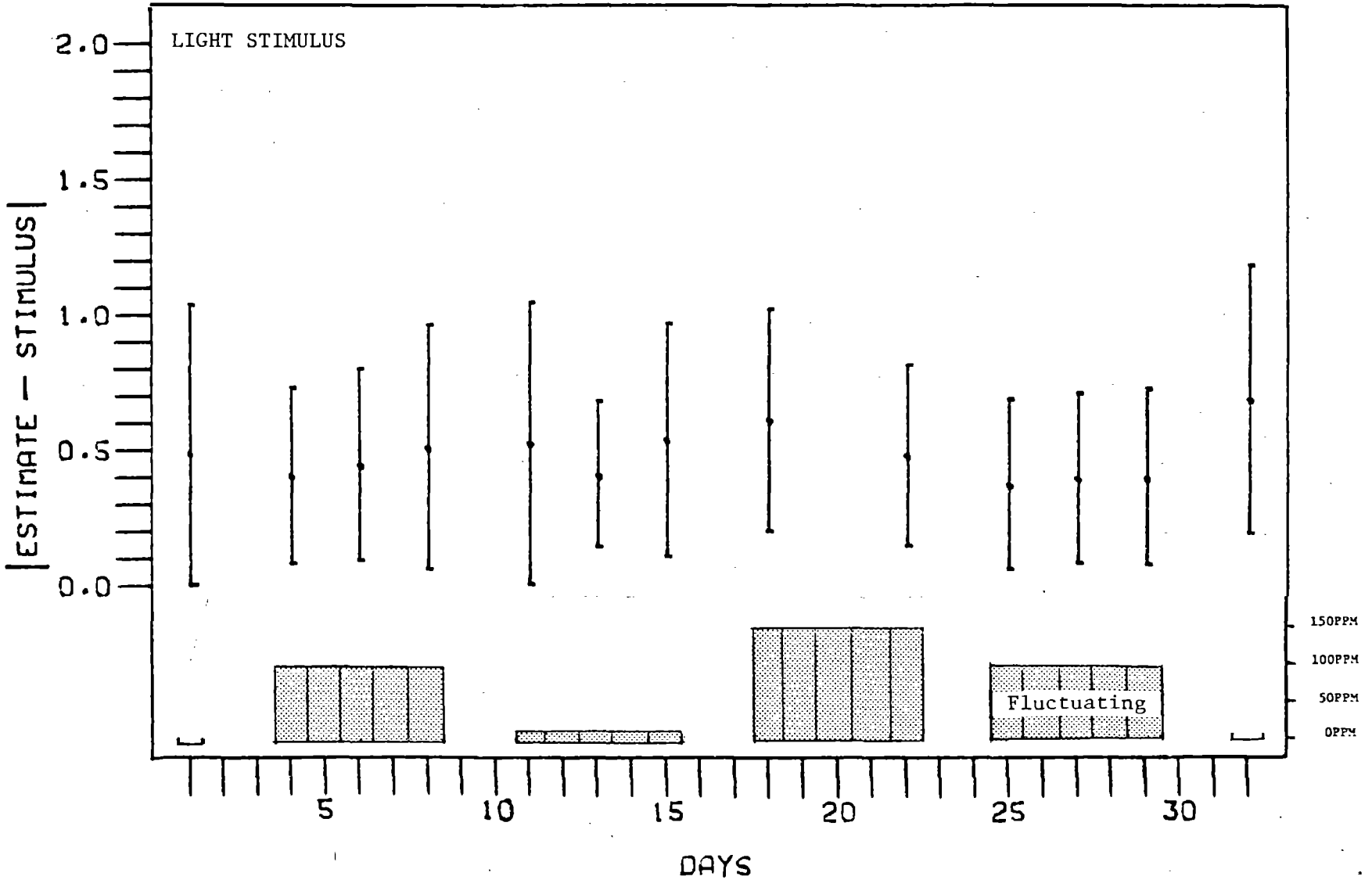


FIGURE 17

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on the Marquette Test

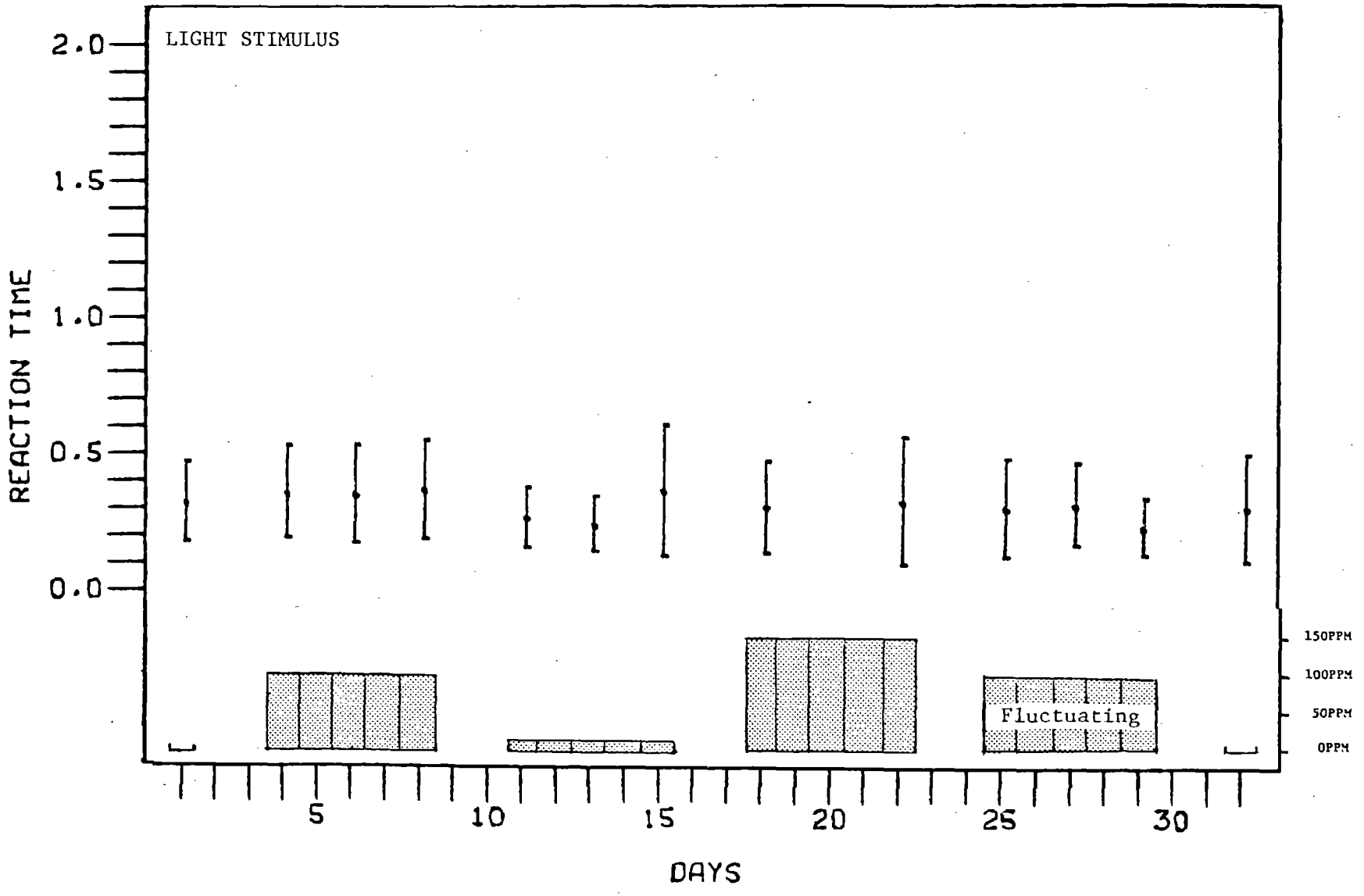


FIGURE 18

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on the Arithmetic Test

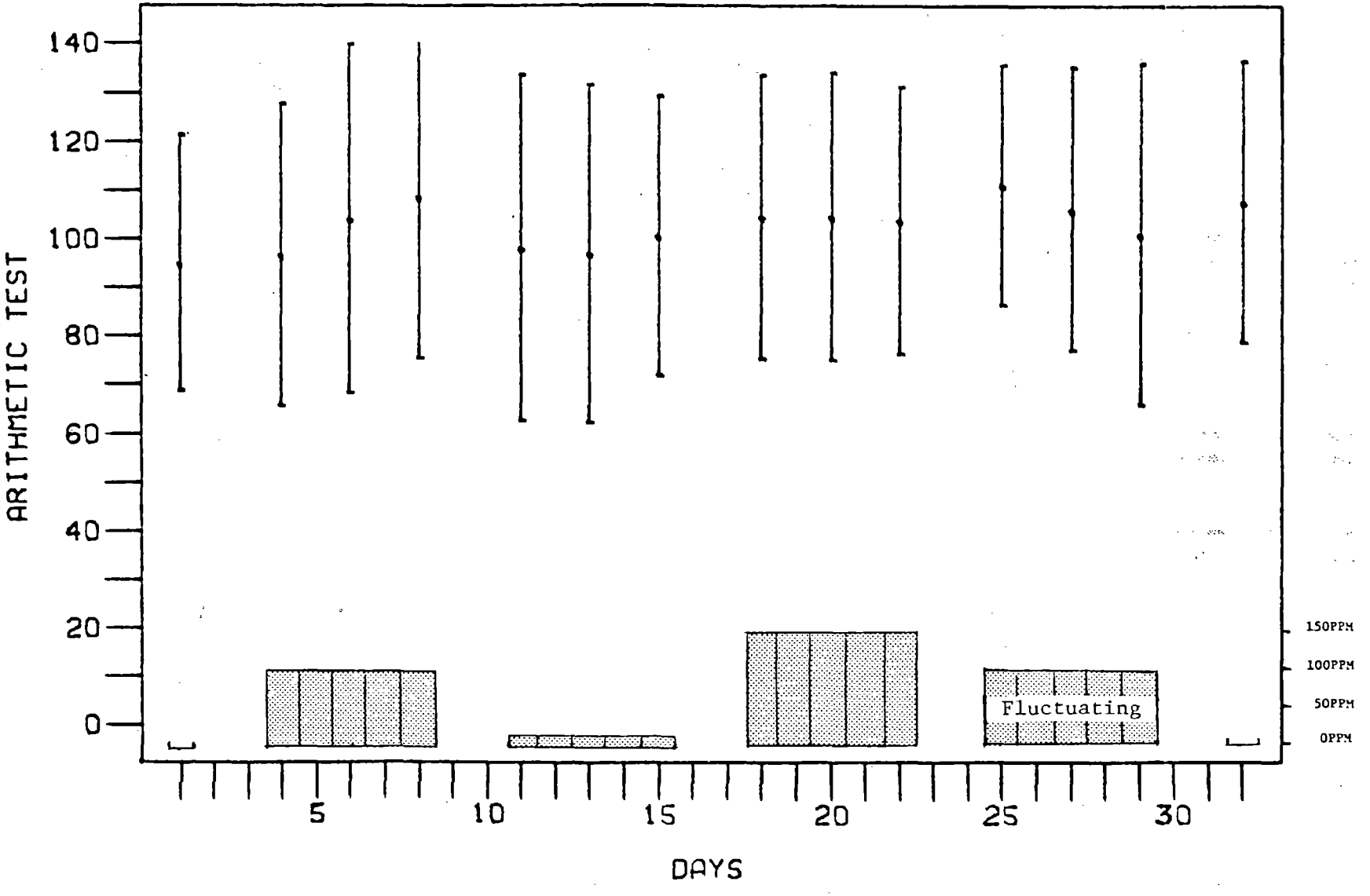


FIGURE 19

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on the Coordination Test

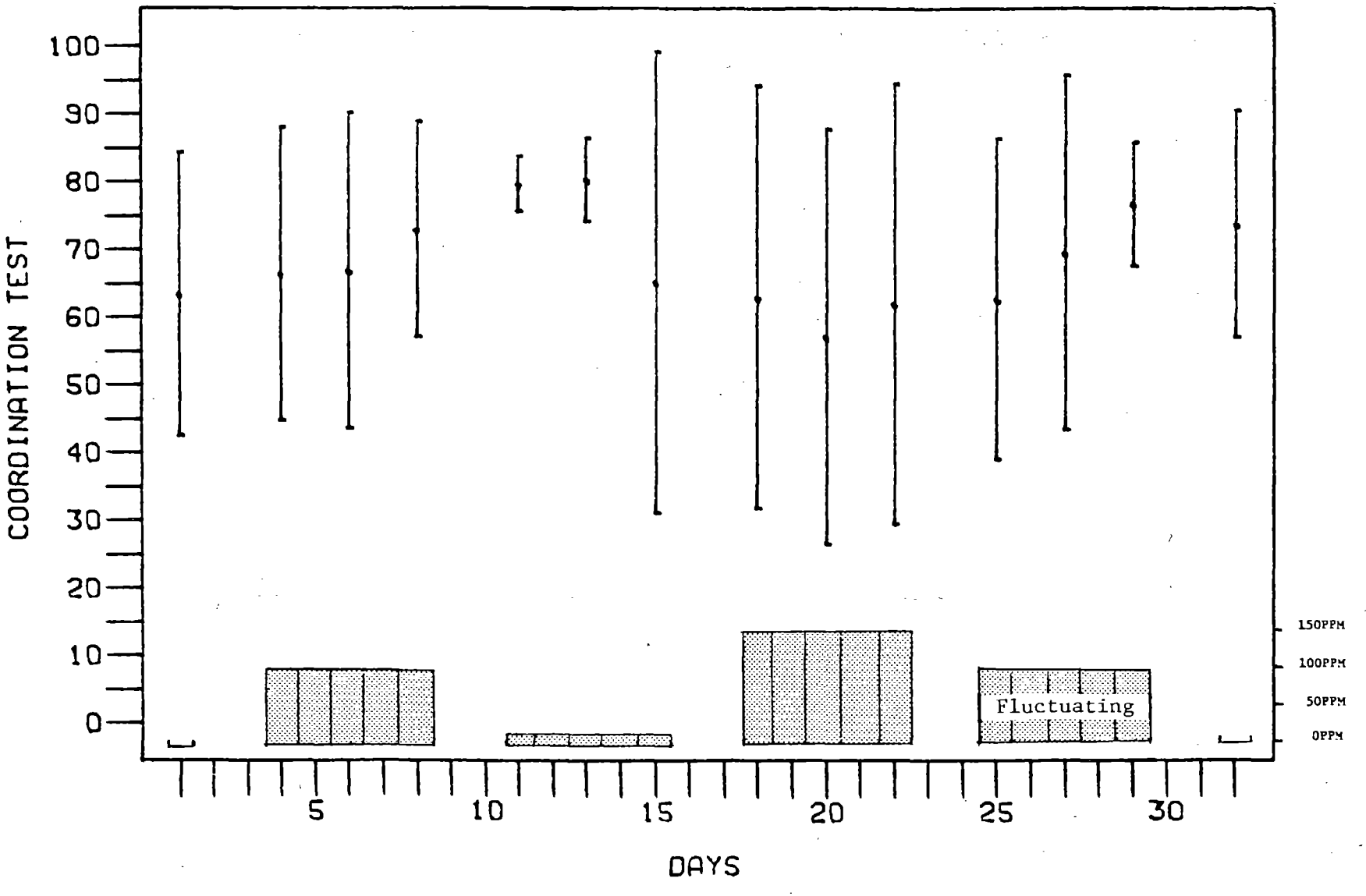


FIGURE 20

The Effect of Exposure (7-1/2 Hr/Day)

to p-Xylene on the Inspection Test

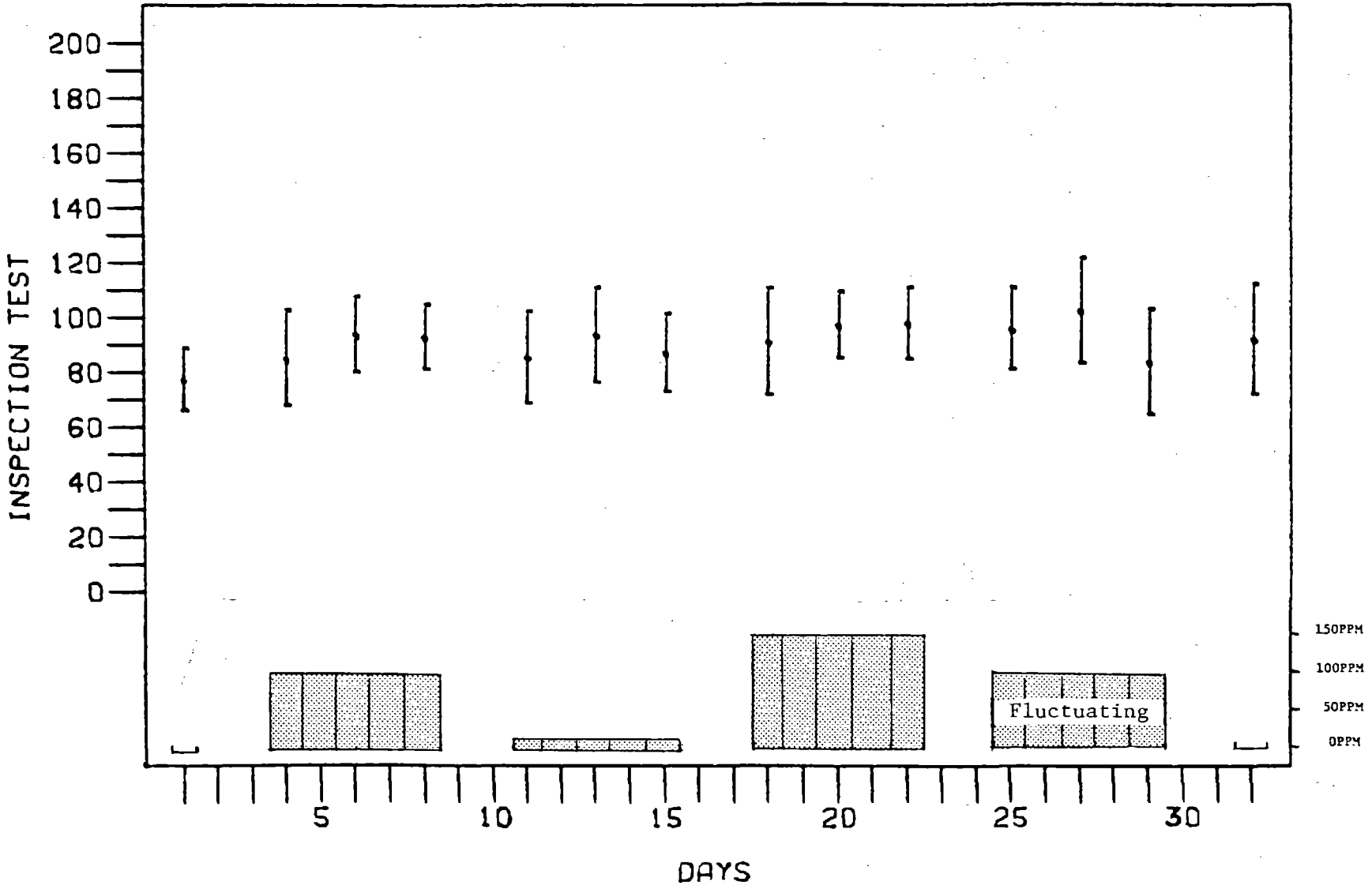


FIGURE 21

The Effect of Exposure (3 Hr/Day)

to p-Xylene on Time Estimations

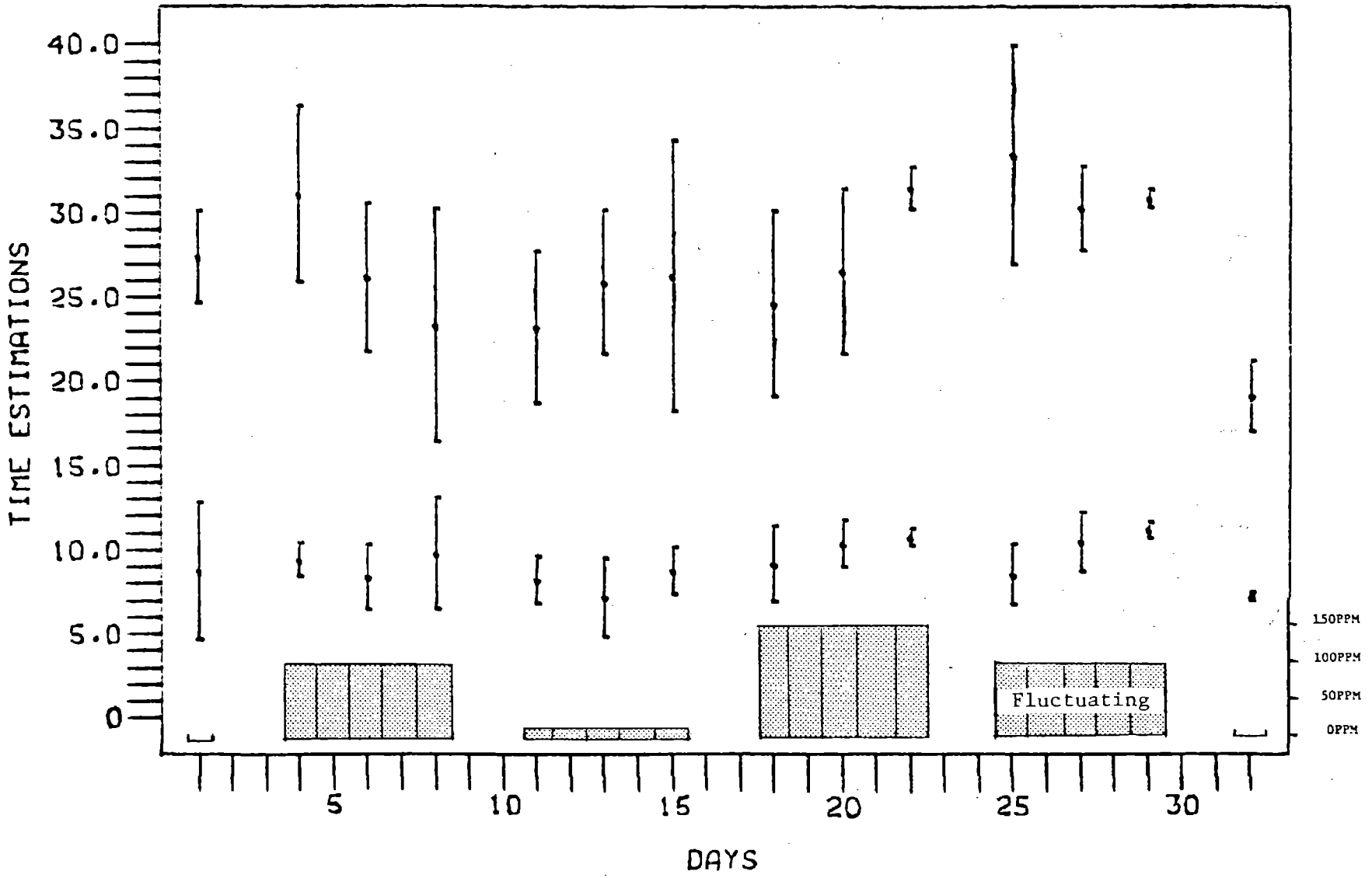


FIGURE 22

The Effect of Exposure (3 Hr/Day)

to p-Xylene on the Marquette Test

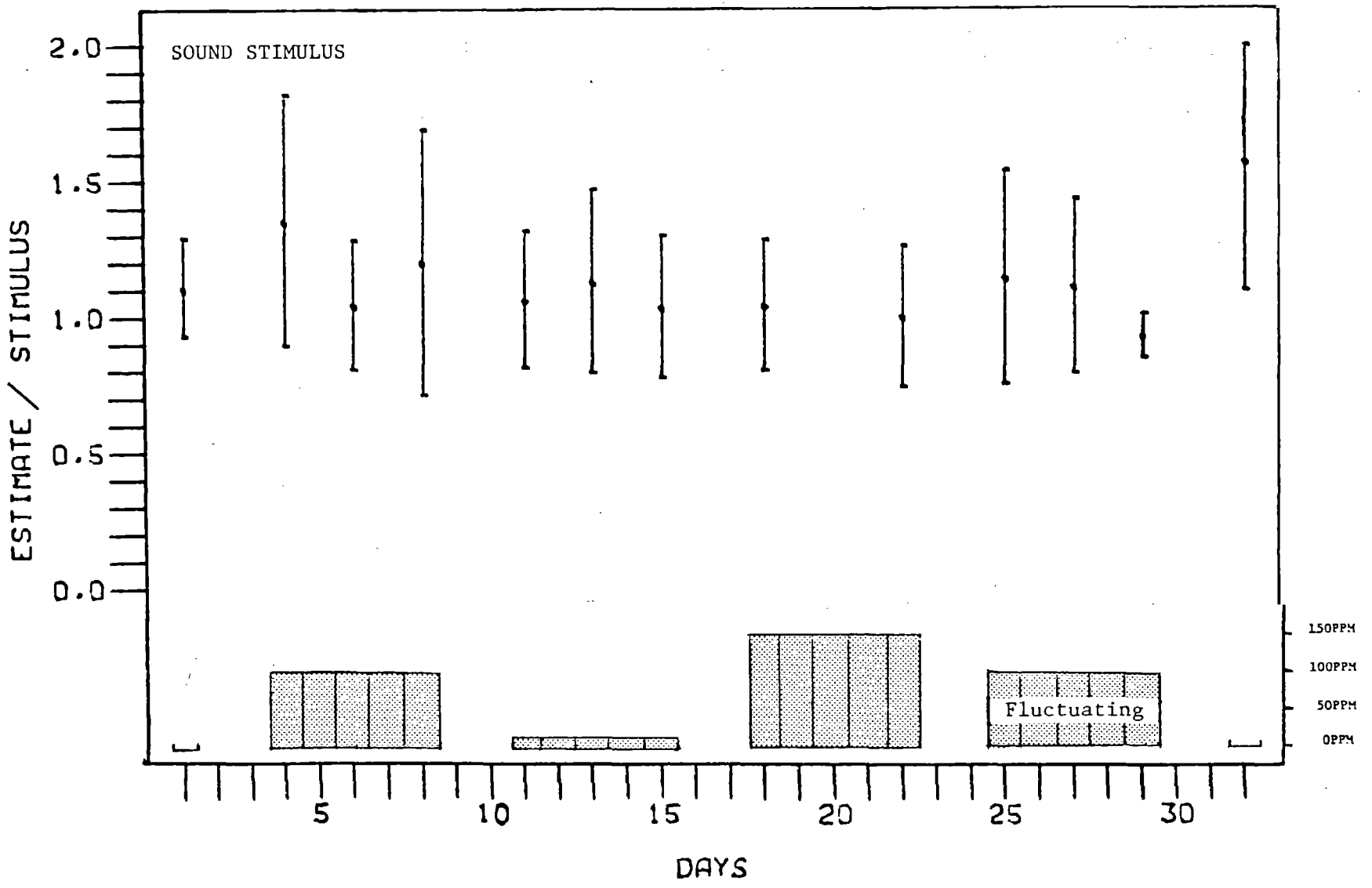


FIGURE 23

The Effect of Exposure (3 Hr/Day)

to p-Xylene on the Marquette Test

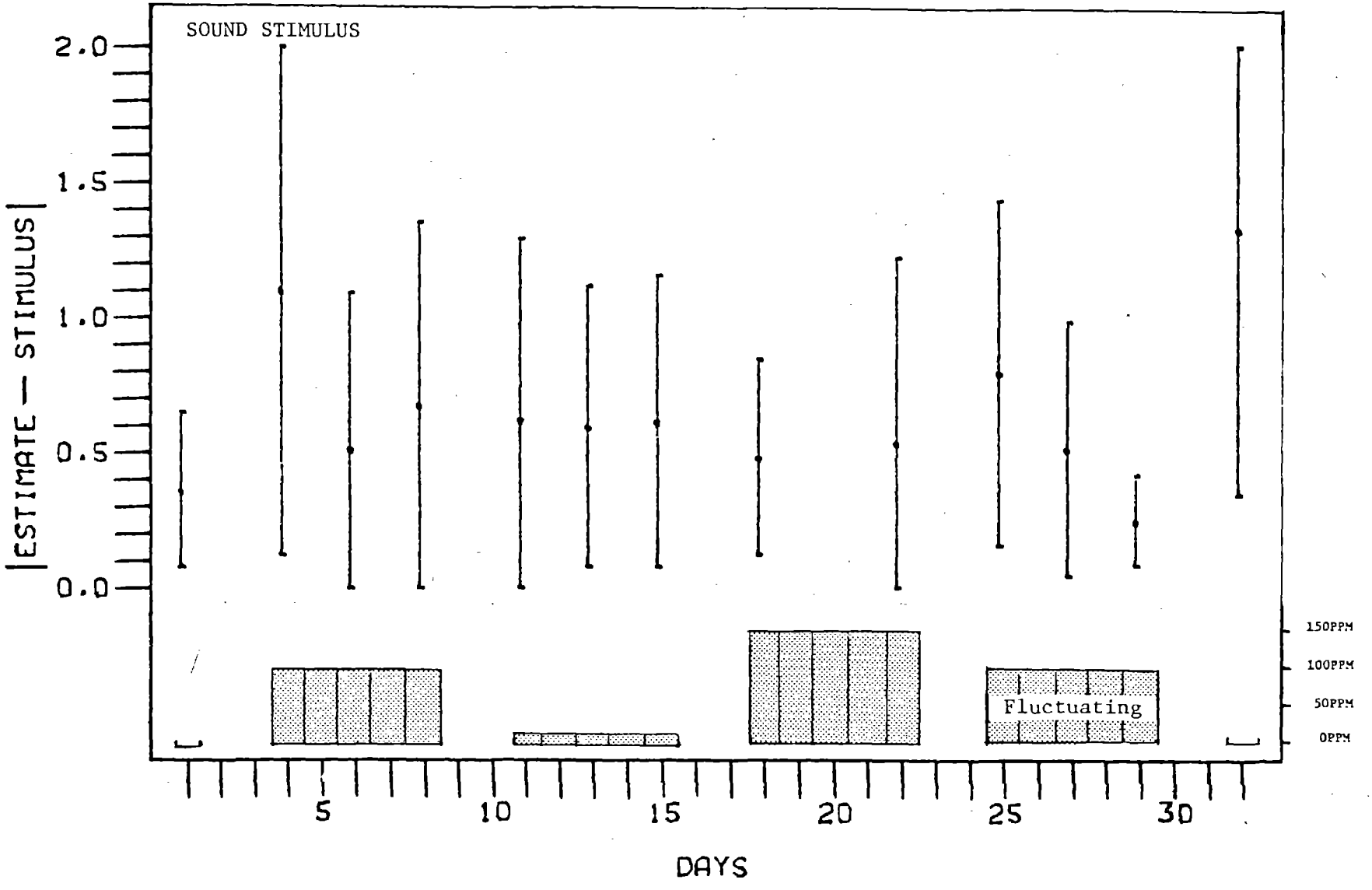


FIGURE 24

The Effect of Exposure (3 Hr/Day)

to p-Xylene on the Marquette Test

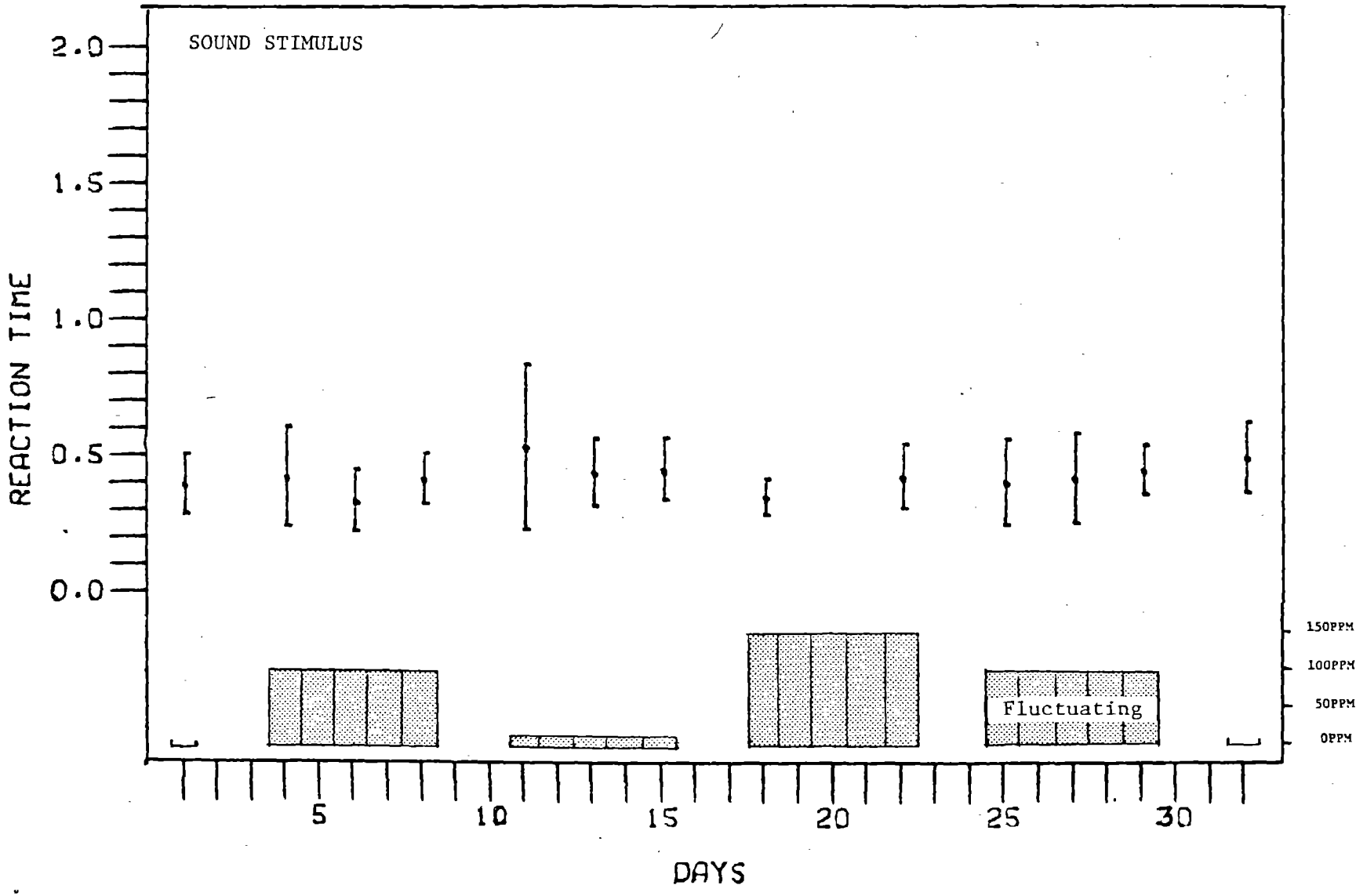


FIGURE 25

The Effect of Exposure (3 Hr/Day)

to p-Xylene on the Marquette Test

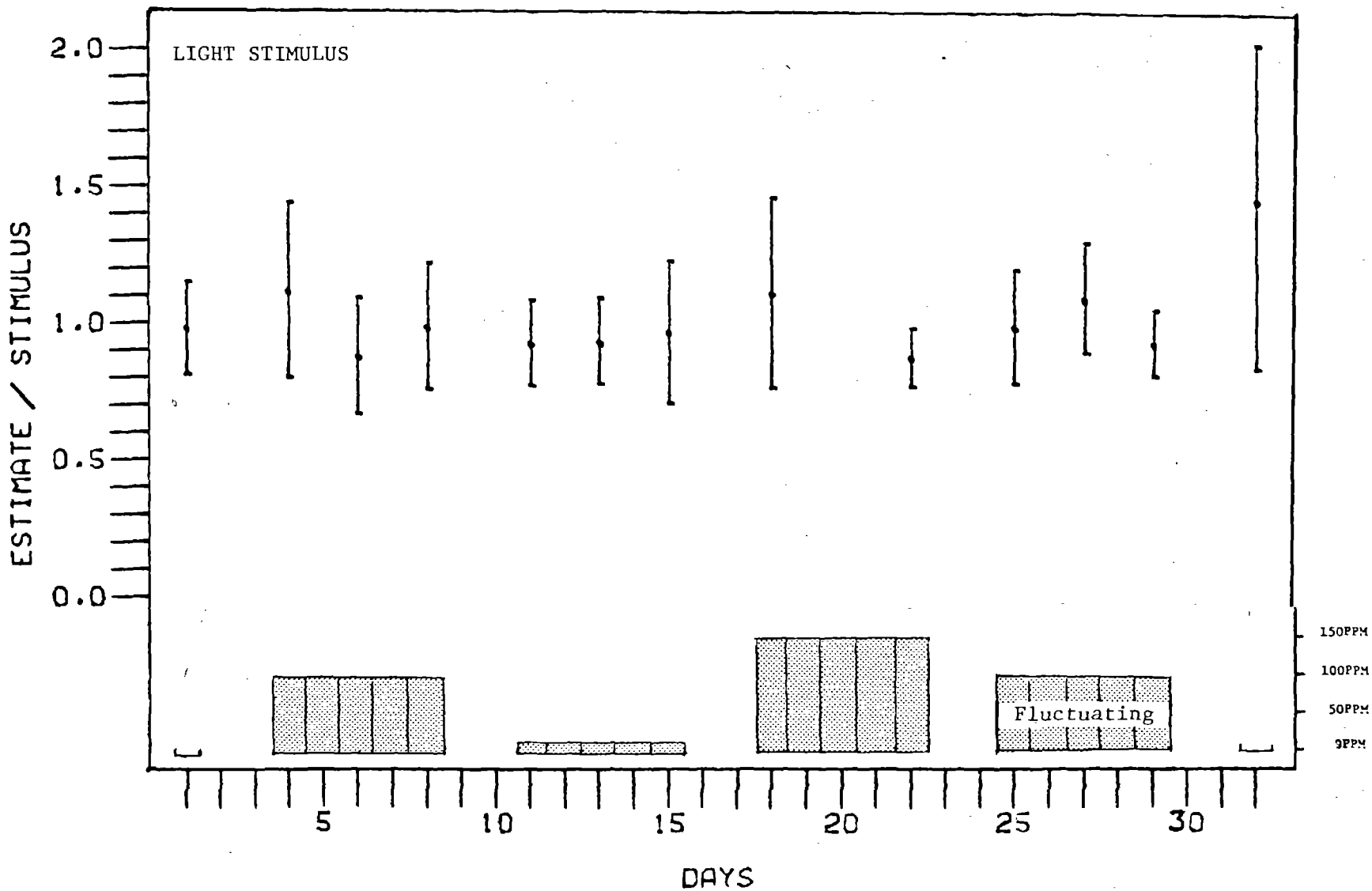


FIGURE 26

The Effect of Exposure (3 Hr/Day)

to p-Xylene on the Marquette Test

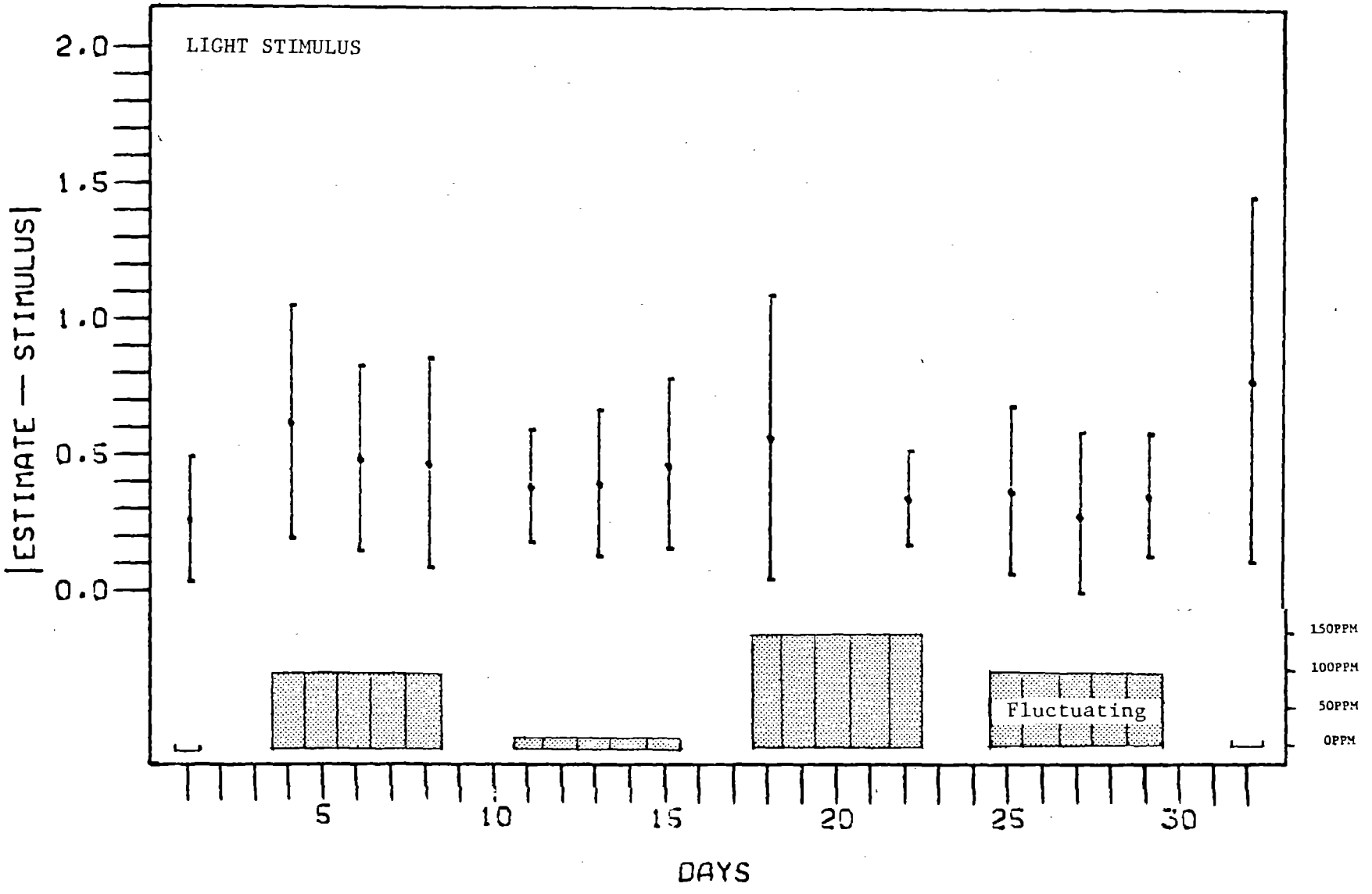


FIGURE 27

The Effect of Exposure (3 Hr/Day)

to p-Xylene on the Marquette Test

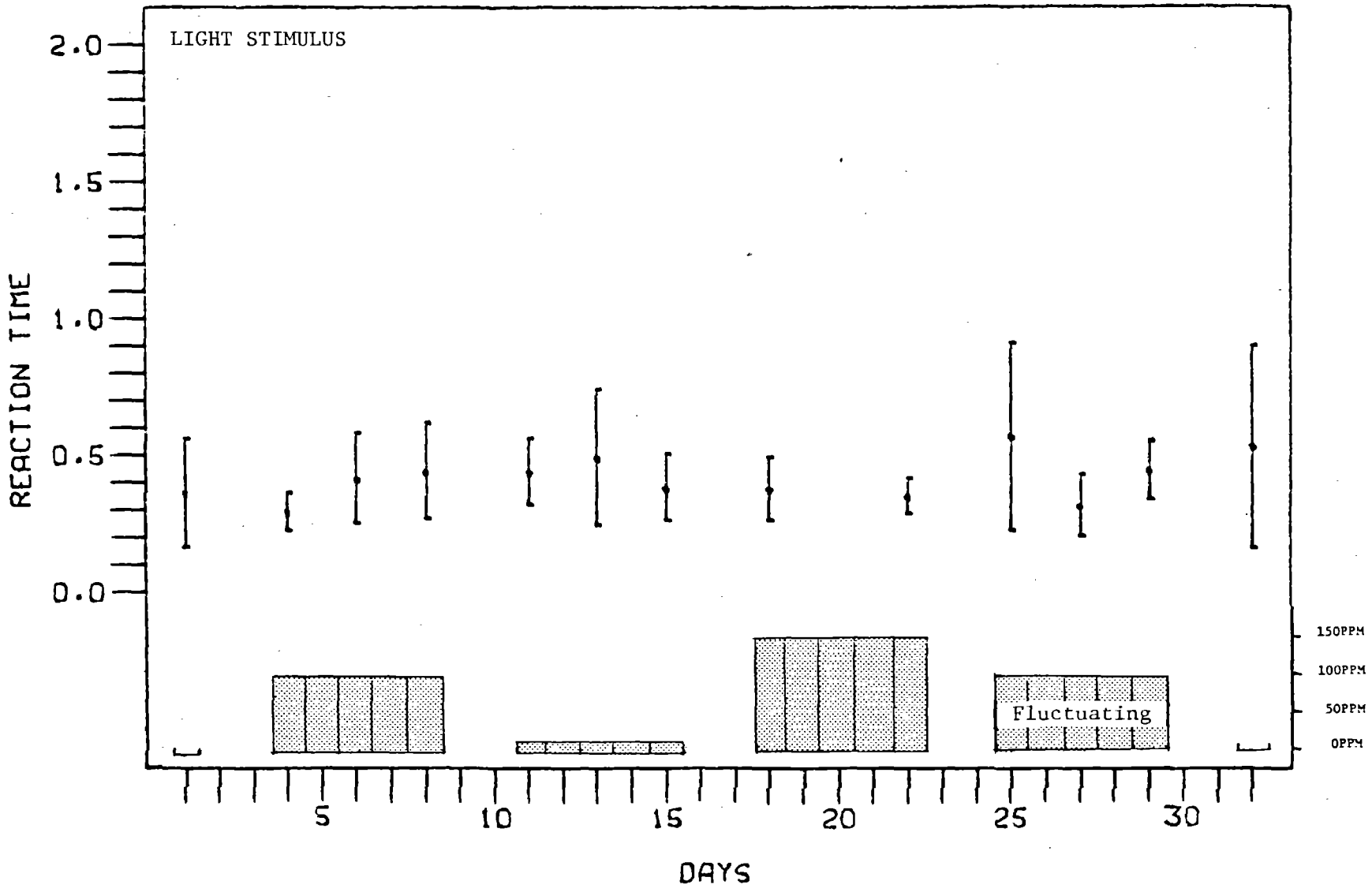


FIGURE 28

The Effect of Exposure (3 Hr/Day)

to p-Xylene on the Arithmetic Test

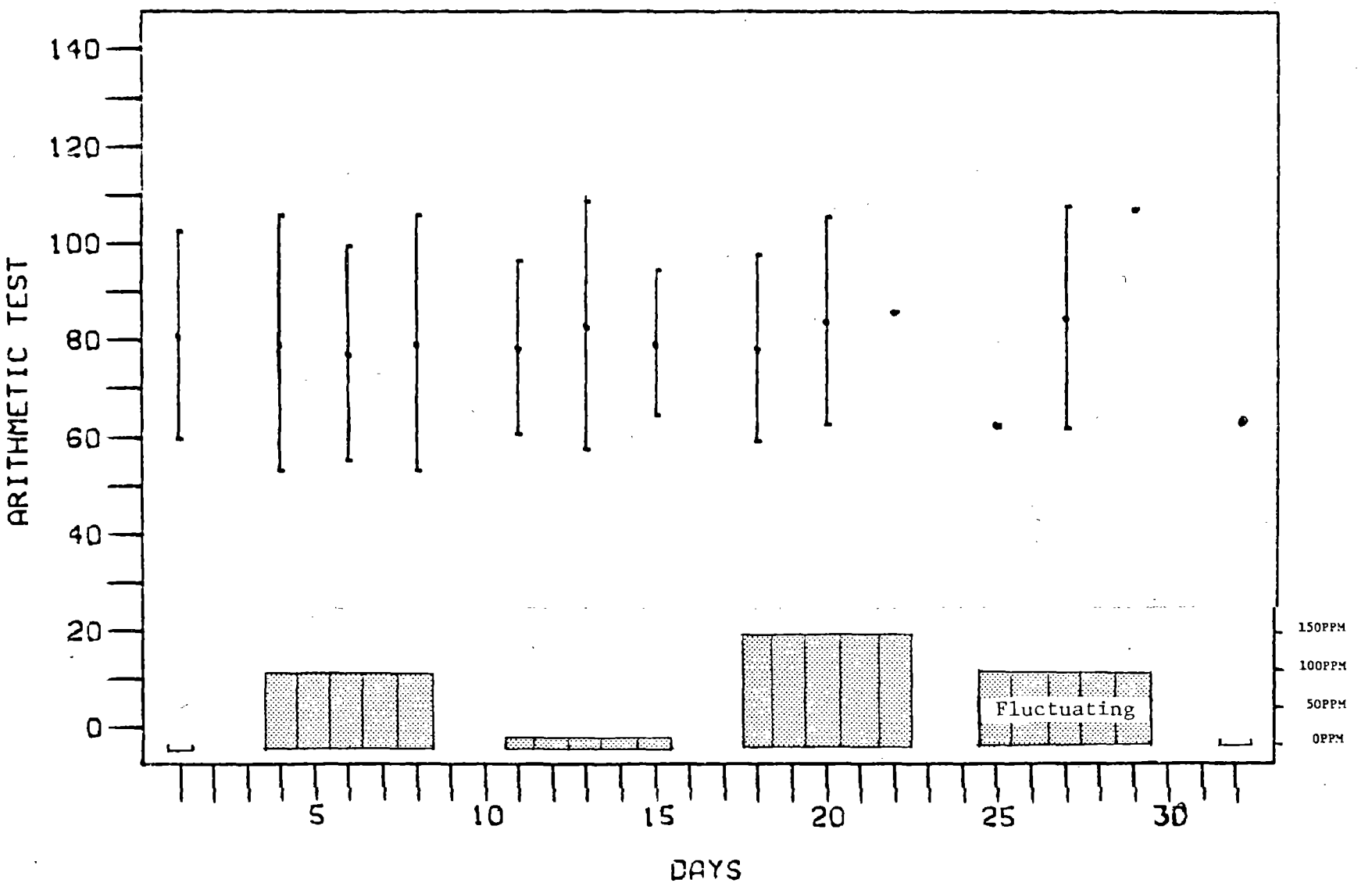


FIGURE 29

The Effect of Exposure (3 Hr/Day)

to p-Xylene on the Coordination Test

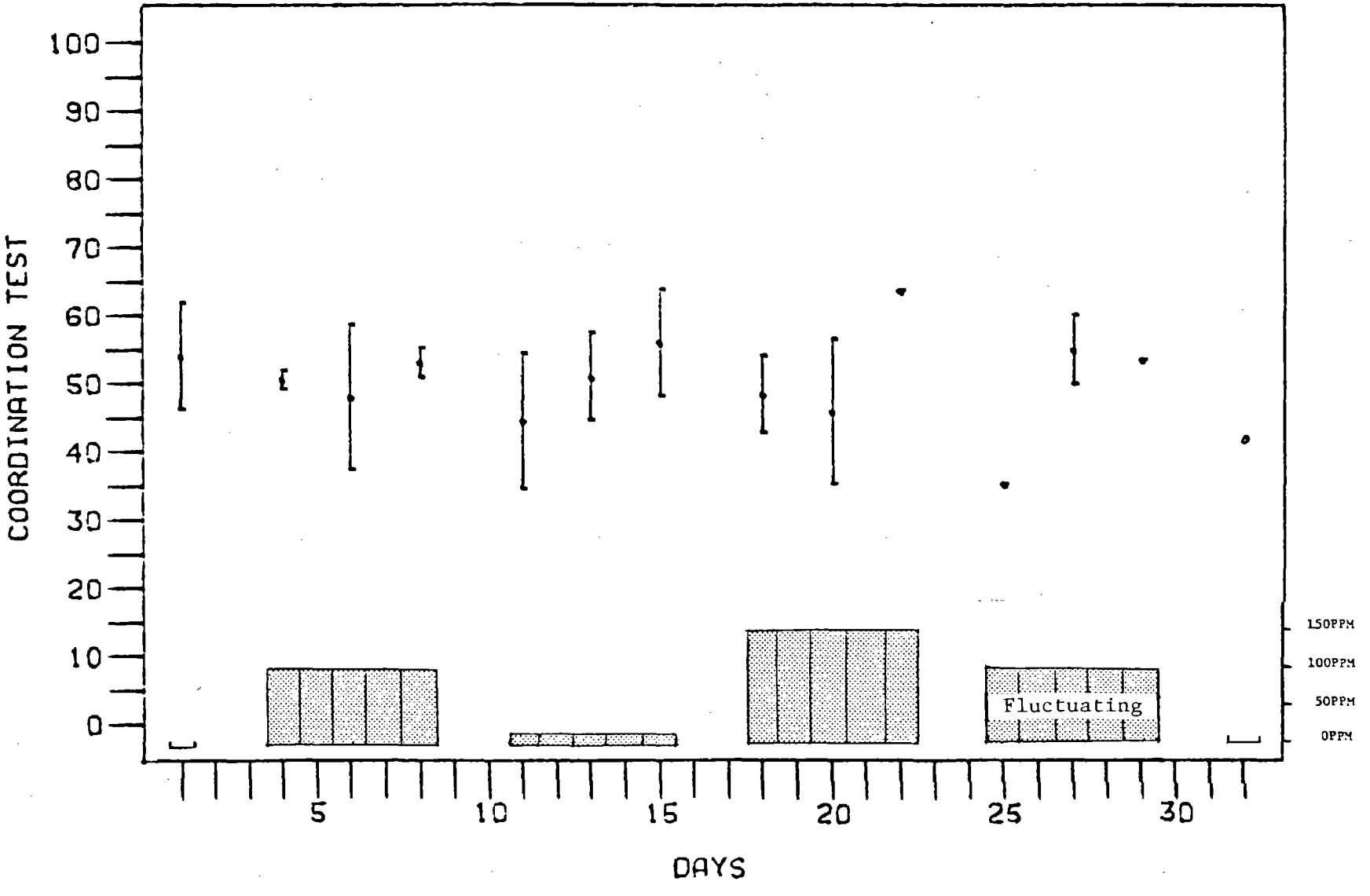


FIGURE 30

The Effect of Exposure (3 Hr/Day)

to p-Xylene on the Inspection Test

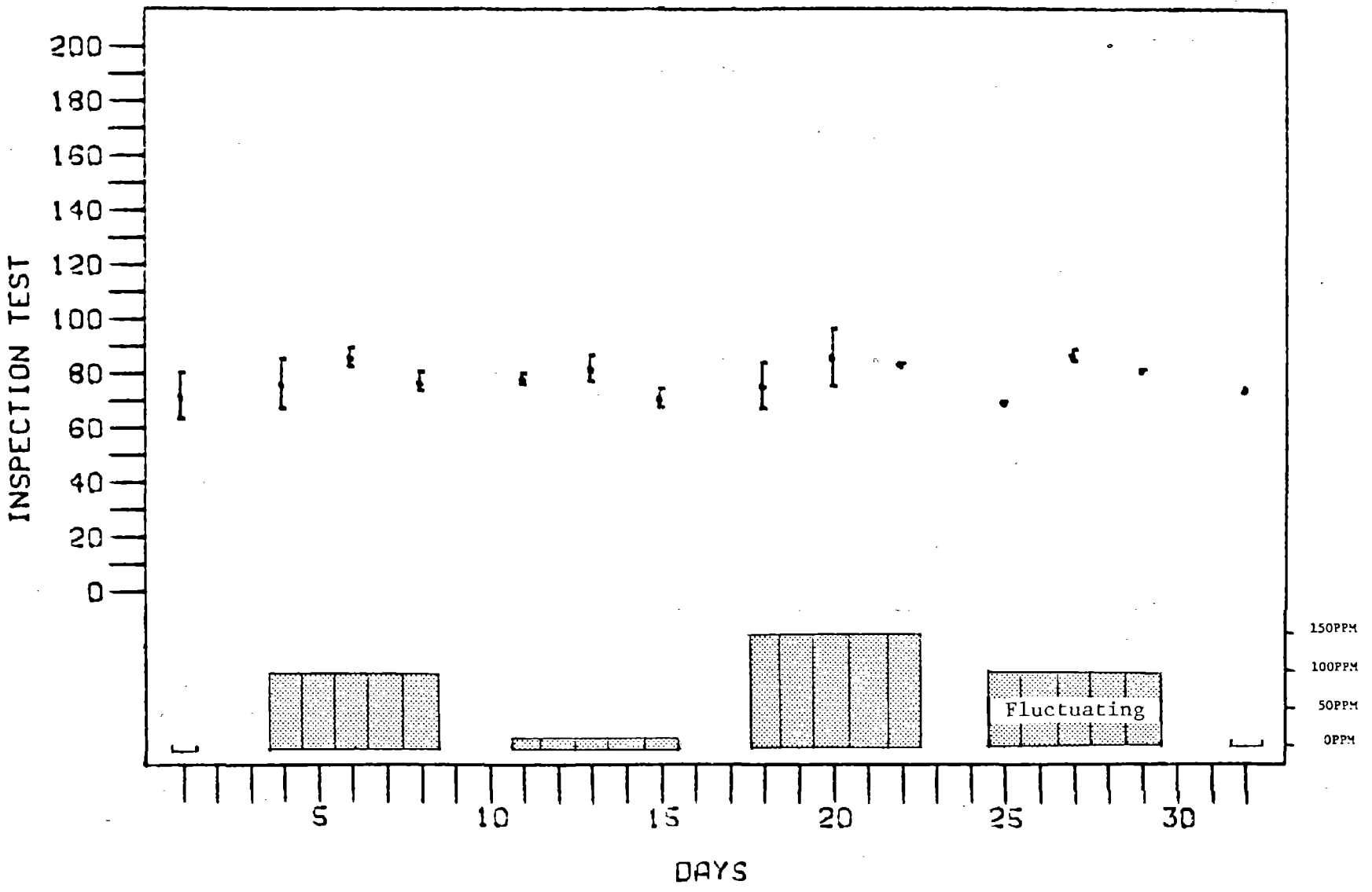


FIGURE 31

The Effect on Test Performance During Five Days

(7-1/2 Hr/Day) Exposure to p-Xylene

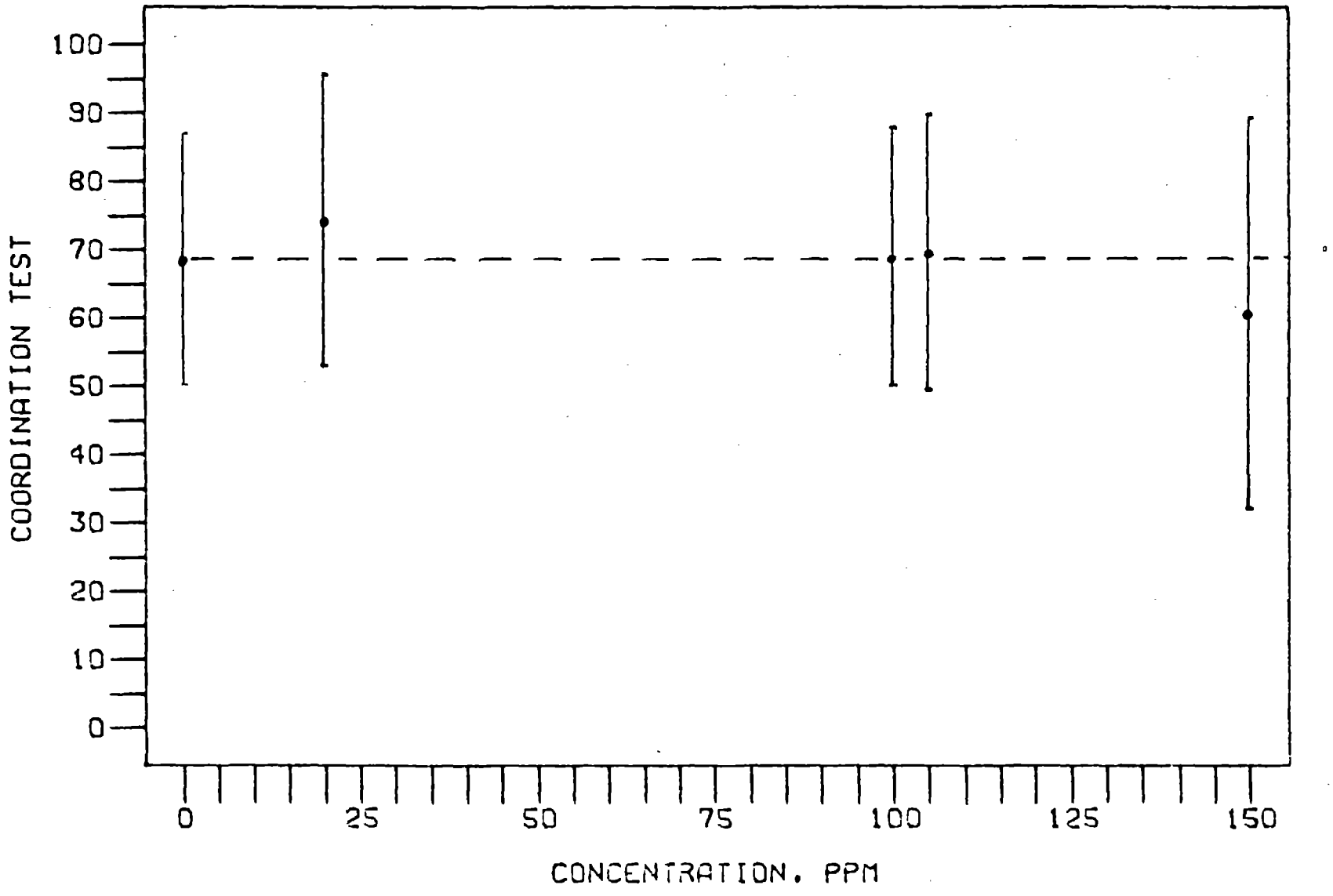


FIGURE 32

The Effect of Exposure to p-Xylene

(7-1/2 Hr/Day) on the Fifth Day of Exposure

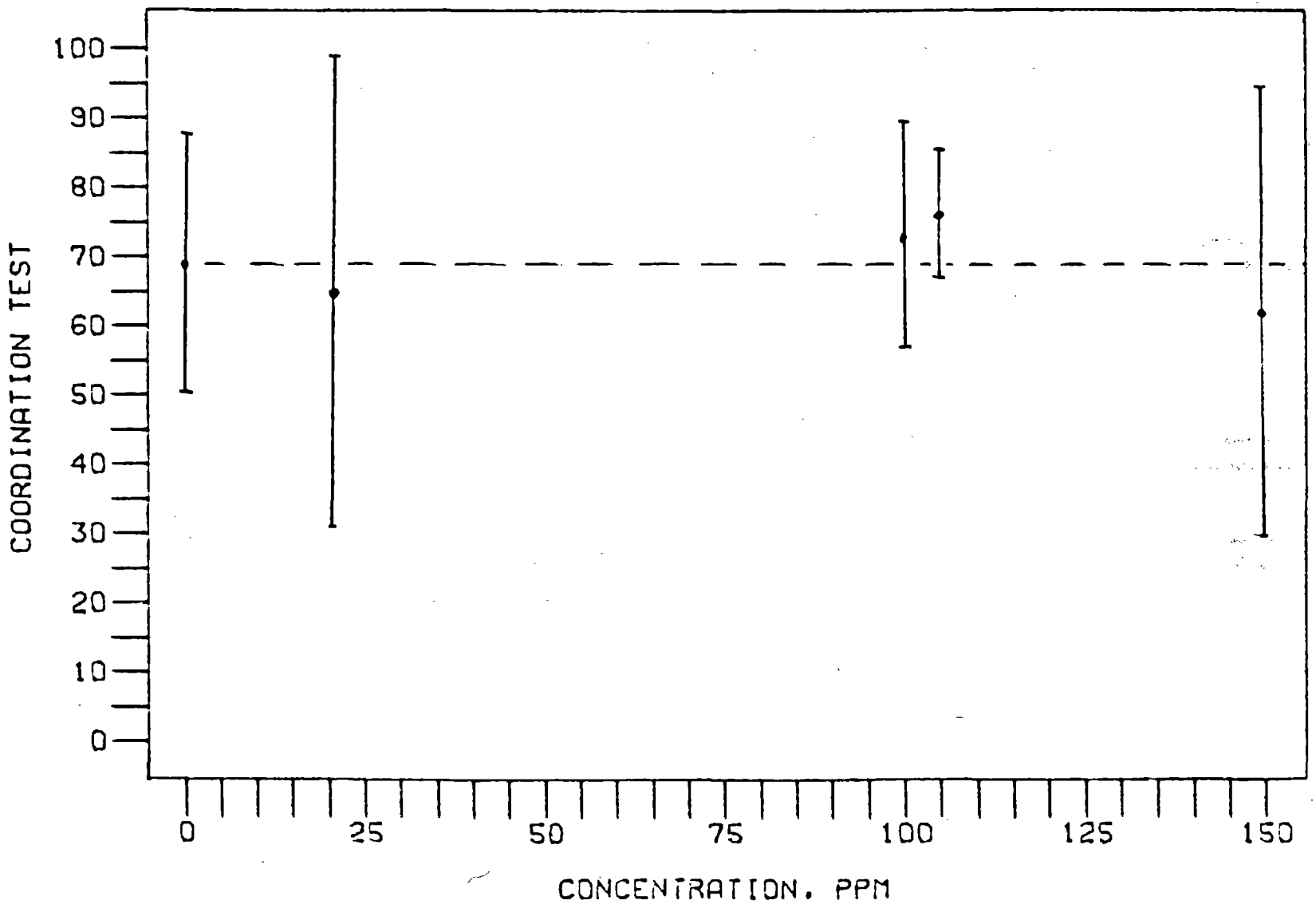


FIGURE 33

MEANS AND RANGES OF POST EXPOSURE BREATH LEVELS FROM FOUR SUBJECTS EXPOSED FIVE DAYS PER WEEK, 7½ HOURS PER DAY, TO THREE CONCENTRATIONS OF p-XYLENE VAPOR

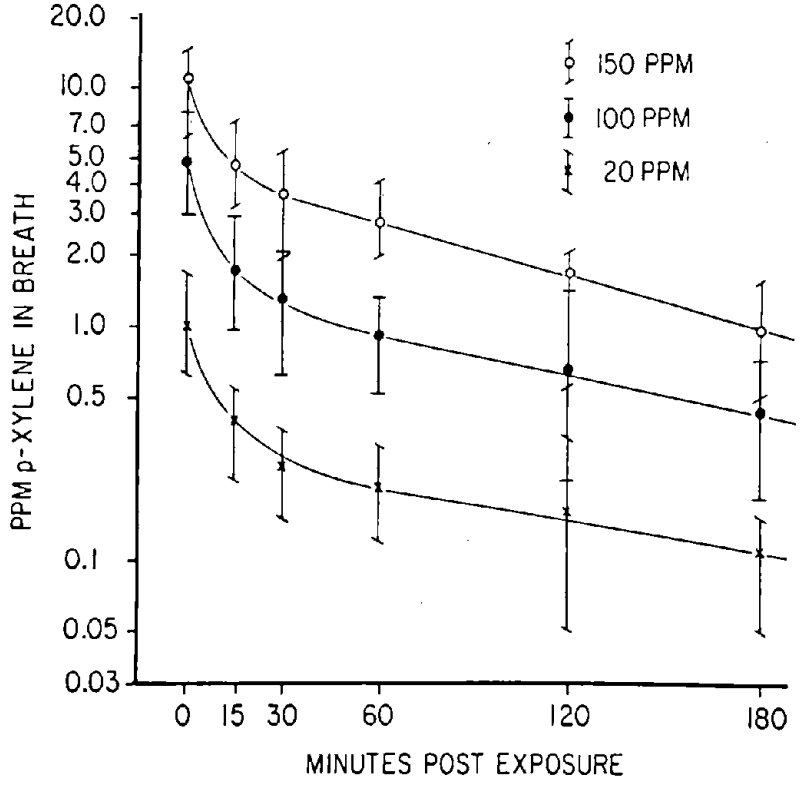


FIGURE 34

MEANS AND RANGES OF
p-XYLENE BREATH LEVELS AFTER
REPEATED VAPOR EXPOSURES
IMMEDIATELY POST EXPOSURE

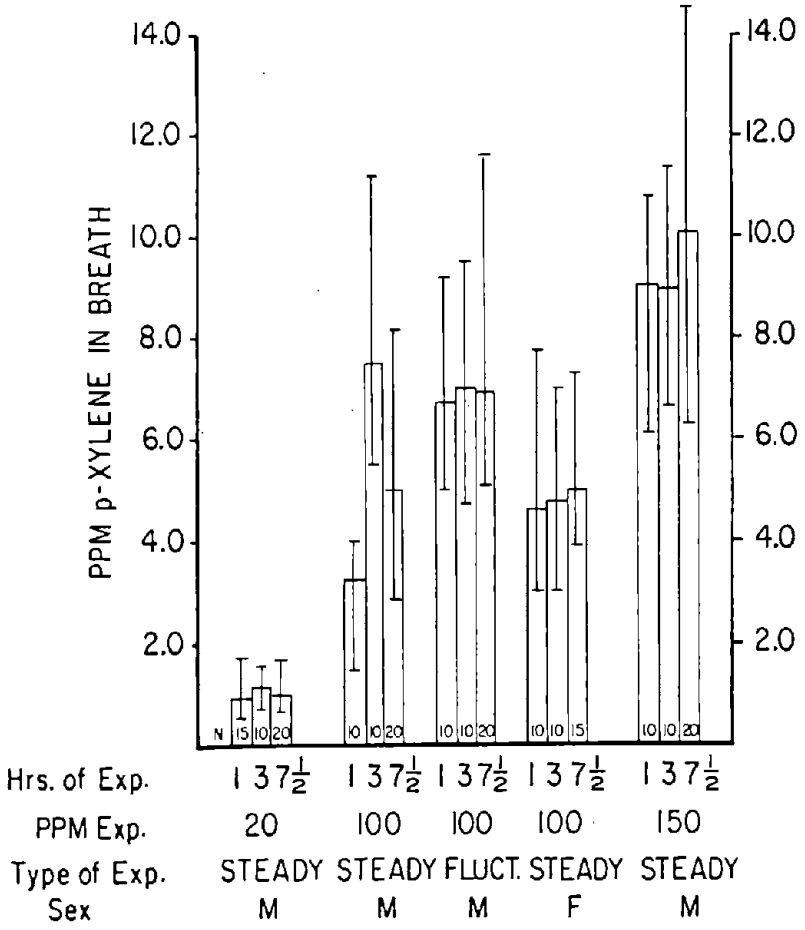
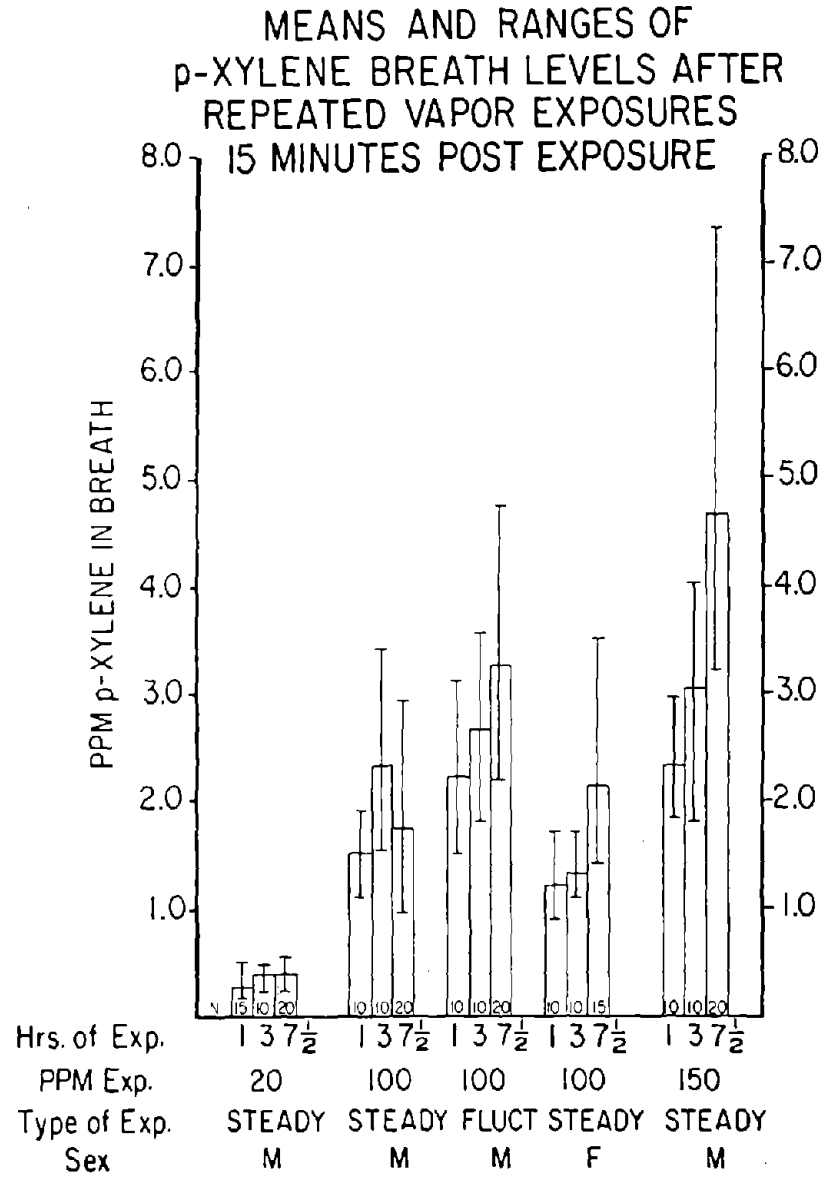


FIGURE 35


MEANS AND RANGES OF
p-XYLENE BREATH LEVELS AFTER
REPEATED VAPOR EXPOSURES
15 MINUTES POST EXPOSURE
PPM p-XYLENE IN BREATH
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
N 15 10 20
10 10 20
10 10 20
10 10 15
10 10 20
Hrs. of Exp. 1 3 7½ 1 3 7½ 1 3 7½ 1 3 7½ 1 3 7½
PPM Exp. 20 100 100 100 150
Type of Exp. STEADY STEADY FLUCT STEADY STEADY
Sex M M M F M

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15. Supplementary Notes

16. Abstracts Adults of both sexes were exposed to p-xylene (1330207) vapor concentrations of 0, 20, 100, and 150ppm for periods of 1, 3, and 7.5 hours in a controlled environment chamber for two purposes: 1) to develop a practical biologic test which could be used to limit the magnitude of an industrial exposure; and 2) to monitor the physiological response of healthy, sedentary adults to different vapor concentrations and durations of exposure. Repetitive vapor exposure to the current threshold limit value of 100ppm produced no serious subjective or objective health response in the 16 subjects, nor in eight male subjects who were exposed for 5 days to 150ppm p-xylene vapor. There was indication of the saturation of metabolic pathways of p-xylene when 4 subjects exercised briefly while breathing 150ppm; however, the certainty and nature of this response requires confirmation. Analysis of methyl hippuric acid (495692) metabolite in 24 hr urine samples, and of p-xylene in postexposure blood, saliva, and breath samples all revealed the certainty of exposure to p-xylene vapor. For greatest practicality in routine biologic monitoring, and for establishing limits to p-xylene exposures in workers it is recommended that breath sampling be carried out. An alveolar sample obtained 15 minutes after p-xylene exposure, should have p-xylene concentrations no greater than 4.5ppm in males or 3.5ppm in females. Concentrations below these limits indicate that workers had not been exposed to deleterious concentrations of p-xylene during the previous 8 hours.

17. Key Words and Document Analysis. 17a. Descriptors

17b. ~~Identifiers/Open-Ended Terms~~
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