U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION DETERMINATION
REPORT NO. 77-3-420

ESSEX INTERNATIONAL
KITTANING, PA
SEPTEMBER, 1977

I. TOXICITY DETERMINATION

A Health Hazard Evaluation has been conducted at Essex International, Kittaning, PA to evaluate employees' exposure to organic vapors. It was determined that exposures to organic vapors were toxic under conditions of use noted on September 30, 1976. Subsequent incidents appeared to have been the result of a fear-anxiety reaction which was potentiated by the previous conditions resulting in a hyperventilation syndrome (Respiratory Alkalosis).

These determinations are based upon review of available medical data, interviews of employees, measurement of work place air concentrations by both the insurance carrier and NIOSH representatives, inspection of the work areas and materials used, and a review of the pertinent literature.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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

Copies have been sent to:

a) Essex International, Inc., Kittaning, PA
b) Authorized Representatives of Employees, United Steel Workers of America
c) U.S. Department of Labor
d) Pennsylvania Department of Health
e) NIOSH - Region III

For the purpose of informing the approximately 200 "affected employees" the employer should promptly "post" for a period of 30 calendar days the Determination Report in a prominent place(s) where affected employees work.

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety & Health Act of 1970, 29 U.S.C. 669(a)(6), authorizes the Secretary of Health, Education and Welfare, following a written request by an employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health (NIOSH) received such a request from a representative of Essex International, Inc. concerning unexplained employee illness at the Kittaning Plant.

Requests for assistance were also received from the United Steelworkers of America, U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) and the Commonwealth of Pennsylvania Department of Health.

IV. HEALTH HAZARD EVALUATION

A. Evaluation Background/Chronology

In understanding some of the problem areas that will be discussed in this report, it is important to keep in mind the series of events that occured prior to the closing of the Kittaning production facility of Essex International, Inc. on October 7, 1976 and the subsequent request for this assistance of October 14, 1976.

9/23/76 - The nitrogen evaporation system freezes, resulting in the loss of nitrogen gas curtains and the "explosion" of sixteen hydrogen atmosphere furnaces. Ten employees were taken to the hospital for observation.

9/24/76 - Automatic sprinkling system activated without an in-plant fire.

9/28/76 - Twenty and forty-ton air conditioning systems were down for repairs in production areas.

9/30/76 - Major environmental incident occurs. Plant shut down for weekend.

10/4/76 - Production resumed.

10/7/76 - Second major incident occurs, plant shut down - production discontinued indefinitely.

This series of events in turn resulted in numerous activities by many groups. A brief chronology of some of the events is as follows:

9/13/76 U.S. Department of Labor/OSHA visits plant as a result of an employee complaint.

9/22/76 - OSHA conducts an industrial hygiene inspection.

9/23/76 - OSHA investigates the hydrogen furnaces explosion.

9/30-10/4/76 - The Liberty Mutual Insurance carrier and Essex International industrial hygienists conduct joint survey of plant.

10/8/76 - Essex International requests assistance from the Pennsylvania Department of Health.

10/9-13/76 - An epidemiological investigation was conducted by the Pennsylvania Department of Health, Division of Communicable Disease Control.

10/14/76 - Essex International requests assistance from NIOSH.

10/18/76 - A meeting of all interested parties is held at Essex International.

10/18-28/76 - NIOSH personnel conduct survey and review modifications to production areas.

10/28/76 - Limited production resumes in the printed circuit department.

12/6/76 - Full production resumes.

12/6-11/76 - NIOSH conducts evaluation of full production operations.

B. Process Description

Essex International is involved in the production of diodes and assembly of electronic door opening controls at the Kittaning plant. The plant is a one story structure and is windowless in the production area. Heating and cooling is provided by a series of roof mounted air handling units. Local exhaust ventilation is provided throughout the production area, however, adequate make up air was not provided, resulting in a general negative pressure in the plant.

Various departments and their functions are as follows:

1) Printed circuits area (P.C.); performs mechanical and hand component insertion of circuit boards, soldering of junctions, via two wave soldering machines, assembly, rework testing and packaging of automatic door opening equipment. This area also contained a major degreasing unit at the time of the first incident, which has since been removed.

2) "Clean" diode room, (so called because at one time this area was considered a "clean room") provides the heart or waffer of the diode. Waffer fabrication itself consists of a series of plating, coating, etching and cutting processes. Final testing, marking, sorting and packing of diodes are also performed in the clean diode area.

3) Diode II receives waffers from clean diode and assembles them with other component parts for firing.

4) The plating room performs tin plating and most of the degreasing for the rest of the plant.

5) Shipping and receiving handle all incoming and outgoing materials and provide a quality control check of incoming electrical parts.

Numerous heat treatment furnaces are located throughout the plant and are used for a variety of purposes. At the time of the initial plant visit, all furnaces were operating with a hydrogen atmosphere and nitrogen curtains at each end.

C. Evaluation Design

During a meeting to exchange information on October 15, 1976, conducted by the Pennsylvania Department of Health, the decision was made that NIOSH would be responsible for coordinating activities regarding the Essex incident. NIOSH would also provide industrial hygiene and medical support while the Commonwealth of Pennsylvania would provide the epidemiological air pollution and any additional back up support that might be necessary.

An initial visit was conducted by NIOSH personnel from October 18 to 28, 1976 to review equipment, chemicals, process controls, and conditions of use after an initial start-up of the plant. A second visit was made to the plant from December 6 to 11, 1976 to review conditions both medically and environmentally after the full start-up.

D. Evaluation Methods

1) Environmental Aspects

a) Inplant/Initial Visit
Direct Reading Samples

Due to the non-specific nature of the request and the need for immediate information, initial air sampling was conducted by direct reading instruments. Additional data was also obtained using approved NIOSH personal sampling techniques.

Direct reading instruments used were the Johnston Instrument Division, Gastech Halide Detector, Model 73-0025; the HNU Systems Inc., Photoionization Analyzer, Model P1-101; the Energencis Corporation Ecolizer (CO) Analyzer, Model 2400; the GCA Dust Monitor RDM-101; the J & W Oxygen Deficiency Meter; and the JW-SSP Combustible Gas Indicator*.

The Halide Detector will give useful readings for most practical ranges of halogenated hydrocarbons. Threshold Limit concentrations of carbon tetrachloride, trichloroethylene, chloroform and most other halogen containing compounds are readily determinable. Response is a function of the type and number of halogen atoms, with greatest sensitivity obtained on chlorine and fluorine compounds. A calibration curve for trichloroethylene was used

* Mention of company or product names is not to be considered as an endorsement by NIOSH.

to evaluate exposures to Freon TF since this is accurate within about two percent.

The HNU Photoionization Analyzer operated with a photon source potential of approximately 10 eV. The ionization potential of a given gas contaminant serves as a rough guide to whether or not a response is obtained, however, it does not predict what the quantitative response will be. The relative photoionization sensitivity for various gases are listed in Table XVII of the operator's manual. The relative sensitivity of chemical groups are as follows:

Chemical Grouping	Relative Sensitivity PPM	Examples
Aromatic hydrocarbons	10.0	Benzene, Toluene, Styrene
Aliphatic hydrocarbons	10.0	Diethylamine
Chlorinated Unsaturated hydrocarbons	5-9	Vinyl Chloride, Vinylidene Chloride, Trichloroethylene
Carbonyl	5-7	MEK, MIBK, Acetone, Cyclohexene
Unsaturated hydrocarbons	3-5	Acrolein, Propylene, Cyclohexene, Allyl Alcohol
Sulfide	3-5	Hydrogen Sulfide, Methyl Mercaptan
Paraffins (C_5-C_7)	1-3	Pentane, Hexane, Heptane
Ammonia	0.3	
Paraffins (C_1-C_4)	0	Methane, Ethane

The Energenics Ecolizer has a minimum detectable sensitivity for carbon monoxide of 0.5% of full scale with an accuracy of $\pm$1% full scale.

The GCA Dust Monitor operates on a ratio comparison between initial and final beta radiation counts on a polyester impaction disk. The GCA has a mass concentration measurement range of 0.2 to 50 milligrams per cubic meter depending on sampling time with an accuracy of $\pm$25% for the minimal concentration.

The J & W oxygen meter used to evaluate the work environment for oxygen deficiency operates on a 0 to 25% and 0 to 100% oxygen scales.

The JW-SSP Combustible gas indicator is a non-specific meter which will respond to any combustible gas. The SSP is equipped with two ranges: percent lower explosive limit (% LEL) and parts per million (PPM) 0 to 1,000. Readings were taken on the PPM scale for screening purposes only and no values could be assigned to the results due to lack of specific calibration.

Breathing Zone and Area Samples

Personal breathing zone and area samples were taken using 150 milligrams (mg) and 600 mg activated charcoal tubes with Sipin pumps. The pumps were operated at 50 cubic centimeters (cc) per minute for personal breathing zone samples when using 150 mg tubes, and 100 cc per minute for the 600 mg tubes. Area samples were taken using either 150 mg charcoal or silica gel tubes with pumps operating at 200 cc per minute.

Air samples were analyzed by gas chromatography for 1,1,2-trichloro - 1,2,2-trifluoroethane, toluene, acetone, ethyl acetate, sec butyl alcohol, n-butyl acetate, methyl acetate and ispropyl alcohol using NIOSH P & CAM #126 or #127[1]. The lower limit of detection was 0.1 mg per analyte per sample.

Lead fume samples were collected using MSA Model G pumps operating at a flow rate of 2.0 liters per minute on closed face 37 micron AA type filter cassettes with 0.8 micron pore size. Samples were subsequently analyzed for lead by P & CAM #155[1] using atomic absorption. The limit of detection was 0.001 ug lead per sample.

Air samples were analyzed bases on two items: 1) composition of materials used in general production, and 2) the results of environmental samples collected jointly by the Essex International and Liberty Mutual (workman's compensation) industrial hygienists.

The results of the joint environmental evaluation were provided to NIOSH during the initial plant visit and are presented as part of this report as Table II. This environmental data is being presented as received from Essex International other than for adjustments for spacing for retype.

The environmental evaluation conducted in early December again followed the same format utilizing direct reading instruments backed up with air samples analyzed in the laboratory.

b) Inplant/Follow-up Visit

Direct reading instruments used during the December visit included, Gastech Halide Detector, Ecolizer Carbon Monoxide Detector, J & W Oxygen Deficiency Meter, and the J & W SSP Combustible Gas Indicator.

Personal breathing zone and area samples obtained during the December environmental visit were collected and evaluated in the manner used during the initial visit.

Samples were collected for methyl amine in midget impingers containing 1% sulfuric acid and analyzed by gas chromatography using NIOSH P & CAM #127[1]. The lower limit of detection was reported as 0.01 ug/ul of sample. Efforts were made to analyze samples collected on silica gel for triethanol amine by gas chromatography, however, to date no successful method of analysis has been obtained for these samples.

c) External to Plant

Air quality samples were collected and evaluated by the Pennsylvania Department of Environmental Resources Bureau of Air Quality and Noise Control for potential emission sources external to the Essex facility. These samples were requested due to the odor of sulfur dioxide being detected at the time of the incidents. The area of investigation centered on emission of sulfur dioxide and fluorides from an adjacent refractory.

Air samples were collected in impingers containing 5% sodium hydroxide. Samples were subsequently evaluated gravimetrically for total sulfur oxides (as a barium precipitate) and for fluorides using a specific ion probe.

2) Medical and Epidemiology Aspects

Doctors Parkin and Beecham of the Pennsylvania Department of Health, Division of Communicable Disease Control conducted an on site epidemiological investigation from October 9 to 13 and 18 to 19, 1976. On October 11 and 12, a questionnaire was administered to 252 of 297 plant employees. Questioning was conducted by telephone utilizing plant supervisory personnel as interviewers. One hundred thirty-one emergency room records and five in-patient records of plant employees treated at Armstrong County Hospital were reviewed. Additional personal interviews were conducted with the Emergency Room Director of Armstrong County Hospital and various management and union officials at the work location. Interviews were also conducted with an eleven-man construction crew working outside the plant at the time of the second incident on October 7, 1976.

Medical and epidemiological information was reviewed and analyzed with the chief of NIOSH, Medical Section, HETAB during the meetings of October 18 and 19. Following the data analysis, and a review of findings with Essex, a partial restart of the plant was scheduled. On December 6, 1976, the NIOSH medical team returned to the plant to monitor the first three days of full production. The NIOSH investigators roamed freely to all areas of the plant discussing problems, symptoms and getting first hand worker information as to what happened during the September 30 and October 4 incidents.

E. Evaluation Criteria

1) Occupational

Airborne exposure limits intended to protect the health of workers have been recommended or promulgated by several sources. These limits are established at levels designed to protect workers occupationally exposed to a substance on an 8-hour per day, 40-hour per week basis over a normal working lifetime. For this investigation, the criteria used to assess the degree of health hazards to workers were selected from the following sources:

a) NIOSH Recommended Standards - airborne exposure limits which NIOSH has recommended to OSHA for occupational health standards.

b) OSHA Standards - the air contaminants standards enforced by the U.S. Department of Labor as found in Federal Register, Vol. 39, 23540-23543, June 27, 1974.

c) ACGIH Threshold Limit Value and supporting documentation.

During this evaluation, levels of exposure within the recognized occupational limits, but detectable due to their odors, caused considerable worker concern. For this reason, general levels of odor detection for solvents evaluated have been listed for comparison purposes with the exposure criteria. These levels are as follows:

Substance	8-hour time Weighted Average Concentration	Standard Source	Odor detection Threshold PPM(a)	Odor Source
Ethyl Alcohol	1,000 ppm(a)	OSHA Standard[2]	2	Handbook[5]
n-Butyl Acetate	150 ppm	OSHA Standard	0.006	Journal[6]
Isopropyl Alcohol	400 ppm	NIOSH Crit. Doc.[3]	3.2	Journal
Methyl Acetate	200 ppm	NIOSH Crit. Doc.	200	Handbook
Toluene	100 ppm	" " "	0.17	Journal
Acetone	1,000 ppm	OSHA Standard	20	Journal
Ethyl Acetate	400 ppm	" "	6.3	Journal
Sec Butyl Alcohol	150 ppm	" "	0.12	Journal
Trichloroethylene	100 ppm	NIOSH Crit. Doc.	100	Handbook
1,1,2-trichloro-1,2,2-trifluoroethane	1,000 ppm	OSHA Standard	--	--
Methyl Alcohol	200 ppm	NIOSH Crit. Doc.	426	Journal
Methyl Amine	10 ppm	OSHA Standard	--	--
Triethanol Amine	*4	*	--	--
Lead	0.1 mg/M^3	NIOSH Testimony at lead Hearings	-	--
Inert Dust	10 mg/M^3(b)	ACGIH Standard	--	--

a) PPM denotes parts of contaminant per million parts of air.
b) mg/M^3 denotes milligrams of contaminant per cubic meter of air.
*) No established limit for Triethanol Amine

2) Environmental

Air Quality standards used in this evaluation are covered in Chapter 123.21, Rules and Regulations Department of Environmental Resources, Commonwealth of Pennsylvania.

	Stack	Ambient
Sulfur Oxides	500 ppm	0.14 ppm/24 hrs.
Fluorides	5mg/M^3	

3) Toxic Effects

A review of current literature concerning health hazard associated with this evaluation indicated that most materials were capable of causing narcosis and mucous membrane irritation. More specific information on each follows:

Acetone (TLV 1,000 ppm)- causes slight eye, nose, and throat irritation at levels less than 1,000 ppm during intermittent exposure. Beginning evidence of narcosis, such as dulled sensiblities with increased accident proneness also occurs at this level.

n-Butyl acetate (TLV 150 ppm)- characteristic fruity odor at lower concentrations but disagreeable at higher concentrations. Throat irritation at 200 ppm, becoming severe at 300 ppm. Narcosis may be experienced at higher concentrations.

n-Butyl alcohol/sec Butyl alcohol (TLV) 150 ppm)- eye irritation at 200 ppm with narcotic effects at higher concentrations for n-Butyl alcohol while limit for sec-Butyl alcohol is based primarily on its anology with n-Butyl alcohol.

Ethyl acetate (TLV 400 ppm)- eye, nose and throat irritation at 400 ppm has mild narcosic action. Workers unaccustomed to exposure may find levels less than 400 ppm mildly irritating.

Ethyl alcohol (ethanol) (TLV 1,000 ppm)- some eye irritation at above 1,000 ppm. Vapors may be anesthetic and narcotic.

Isopropyl alcohol (TLV 400 ppm)- mild irritation of the eyes, nose and throat at 400 ppm. Narcotic at higher concentrations.

Lead (TLV 0.1 mg/M^3)- acute forms of lead poisoning are rarely seen in industry. Chronic poisoning may include the symptoms of metallic taste in their mouth, loss of appetite, indigestion, nausea, vomiting, constipation, abdominal cramps, nervousness and insomnia.

Methyl acetate (TLV 200 ppm)- irritation to mucous membranes of eye, upper and lower respiratory passages. Narcotic above 400 ppm.

Methyl amine (TLV 10 ppm)- general irritation of eyes, respiratory tract and skin. Limit also based on analogy with ethyl and butyl amine and characterized by a fish like odor.

Methyl alcohol (Methanol) (TLV 200 ppm)- concentrations in excess of 200 ppm may lead to persistently recurring headaches. Higher concentrations may result in mucous membrane irritation and narcosis.

Trichloroethylene (TLV 100 ppm)- headache, nausea and dizziness may occur above 100 ppm. Narcotic action appears with exposure between 3,000 and 10,000 ppm.

Toluene (TLV 100 ppm)- fatigue, weakness and confusion may occur at 200 ppm. Irritation of mucous membranes at 400 ppm. High exposure causes narcosis.

1,1,2-trichloro - 1,2,2-trifluoroethane (TLV 1,000 ppm)- depression of the central nervous system and irritation of the respiratory tract at higher concentrations.

Triethanol amine - acute symptoms of mucous membrane irritation appear to be related to its alkalinity.

F. Results

1) Epidemiological/Medical

a) The Outbreak

At 10 p.m. on Tuesday, September 28, a female employee was given oxygen in the first aid room and sent home. During the first shift on Wednesday, September 29, there were approximately 10-15 employees in the PC area who visited the first aid room and received acetaminophen for complaints of headache.

By 8 a.m., (after one hour of work) on Thursday, September 30, approximately 12 PC area employees had symptoms of headache, mucous membrane irritation, weakness, drowsiness, dizziness, chest discomfort, nausea, and nervousness. At 9 a.m. all of the 55 employees in the PC area were sent home or to the hospital. By 11:30 a.m. because of additional illness the plant was closed. Air samples were collected at this point by the insurance carrier's industrial hygienist.

At 1 p.m., September 30 the air handling unit for the PC area and diode II area was turned on after having been down for repairs. Because of a subjective sense of increased air "freshness" management chose to call in the evening shift. Again at 5:15 p.m. people were noted to be ill, immediately the plant closed and people were sent to the emergency room.

Over the next several days, the plant made modifications in the ventilation systems and reopened on Tuesday, October 5. On Thursday, October 7 at 9 a.m., three PC area employees complained of a "pain in the neck", at 10 a.m. a "dead fish" odor was noted around one of the hydrogen furnaces, and by 1 p.m. again the plant was closed and people sent to the hospital with symptoms of headache, eye irritation, weakness, and dizziness.

Seventy-eight (78) plant employees were evaluated in the local hospital emergency room as a result of the September 30 outbreak; and forty-nine (49) as a result of the October 7th incident.

Results of the epidemiological questionnaire issued by Pennsylvania Department of Health indicated that of the 235 employees present on September 30, 103 became ill for an overall attack rate of 44% for the first date. A breakdown by shift workers reveals a similar attack rate of 42% on the first shift (78 of 185) and 50% on the second shift (25 of 50). One week later on October 7, of the 188 employees present, 94 became ill for an attack rate of 48%. The plant then closed down operations before the second shift reported for work.

Most cases had onset of illness on Thursday, September 30 1976 and Thursday October 7, 1976. However, some of the employees working in the printed circuit area had experienced symptoms on other days. For example, 21 of 56 (38%) PC area employees working on September 29 complained of symptoms on that day, and 11 of 42 (26%) PC area employees experienced symptoms on October 6.

Employees generally experienced symptoms within 4 hours of reporting to work.

The employee medication list is a record of the number of employees seen in the first aid room by day. This record reveals a baseline average of 5 employees seen per day until September 29 when 21 were treated. This recording system became inaccurate on September 30 and October 7, when as a result of generalized confusion, names were not recorded.

b) Clinical Picture

A review of the data indicates employees developed one or more of the following symptoms: headache, mucous membrane irritation; weakness; drowsiness; dizziness; chest discomfort; nausea; nervousness; numbness and/or tingling of the arms or legs; muscle aches; blurred vision; or abdominal pain. Most of the symptoms resolved within 24 hours.

A review of 131 emergency room records revealed that four patients had signs of muscular spasm, two having frank carpo-pedal syndrome in the presence of the emergency room physician. Tachypnea was not usually present and five arterial blood gases revealed five patients with significant blood alkalosis (ph > 7.45). Blood counts, urinalysis, liver and renal function tests, chest x-rays, and electrocardiograms were normal. A review of the records of five patients admitted to the hospital revealed no detectable signs of visceral organ damage, or central or peripheral nervous system impairment.

Symptoms Experienced by Plant Employees
Kittaning, Pennsylvania
9/30/76 and 10/7/76

Symptom	Percentage Present
Headache	90%
Mucous Membrane Irritation	62%
Weakness	60%
Drowsiness	60%
Dizziness	59%
Chest Discomfort	53%
Nausea	52%
Nervousness	52%
Numbness, Tingling of arms and/or legs	39%
Muscle Aches	37%
Blurred Vision	23%
"Stomach" Pain	19%
Vomiting	6%

The frequency of symptoms and their distribution were essentially the same for all three major episodes of illness, i.e., September 30, first and second shifts, and October 7, first shift.

c) Work Location and Illness

Risk of illness was related to work location in the plant, (See Table I). Working in the PC area was associated ($p < .001$) with a higher risk of illness when compared to other work locations. The clean diode room, which is a walled-off work area adjacent to the PC area, with its own air handling unit, appeared to offer protection from the illness ($.02 < p < .01$).

d) Work Location and the Ventilation System

Risk of illness was also related to proximity of the employee's job station to the overhead air intake and air outlet vents. Being within a ten foot radius of any air intake or air outlet vent provided protection against illness. This trend was seen throughout the plant, ($.02 < p < .01$) but was particularly evident in the PC area and contiguous diode II area ($p < .001$). See Table I.

e) Age, Sex, Salary Factors

As previously indicated, 252 of 297 employees (85%) completed a questionnaire. The median age of all respondents was 24.8 years. There were 204 females and 48 males. Sixty percent (29/84) of the males were salaried employees, i.e. supervisory personnel. While 2.5% (5/204) females were salaried employees.

Risk of illness was related to employment status and sex, with hourly female employees at greater risk ($p < .01$) of developing illness.

There was no difference in attack rates between different age groups; or between smokers and nonsmokers.

2) Environmental

Occupational air samples collected over the period of September 30 until December 8, 1976, resulted in two distinctly separate sets of data. 1) Those prior to October, 1976, which are presented as the first part of Table II, and 2) those on and after October 2, 1976, which are presented as the remainder of Table II and Tables III, IV and V.

The joint report prepared by G. W. Lancour, Industrial Hygienist, Essex International, Inc. and S. M. Wilner, Industrial Hygienist, Liberty Mutual Insurance Company provides several indications as to conditions present at the time of the first incident.

"The 20 and 40 ton air conditioning systems were down for repairs, prior to the incident. During this period, weather conditions were overcast, humid and raining, resulting in an inversion condition. In addition local exhaust ventilation stacks located on the roof were positioned in close proximity and below the intakes of the air conditioning unit. It is highly probable that with the start-up of the air conditioning unit, emissions were re-entrained into the P/C area. (This was proven with smoke tests conducted on 10/2/76).

Upon arrival on 9/30, 10/1 it was determined that the local exhaust

ventilation in the P/C area was inadequate. This was exhibited in insufficient capture velocities, poor ventilation design, construction, and numerous leaks in the system.

The degreasing operation and still were not designed to function together. The still was not sealed properly and was vented to room air. The glue drying oven was located approximately 25 feet from the gluing hood and was vented to room air. It was also pointed out that in the general time frame leading up to the incident, production in the area had been increased.

As a result of all the above mentioned conditions, there was a build-up of air contaminants in the P/C area."

When two or more substances are present, their combined effects rather than individual effects are given primary consideration and are considered additive unless information to the contrary is available. That is if the sum of the fractions

$$\frac{C_1}{T_1} + \frac{C_2}{T_2} + \ldots \frac{C_n}{T_n}$$

where C_1 is the observed air concentration and T_1 the corresponding threshold limit exceeds 1.0 then the threshold limit for the mixture should be considered as being exceeded.

Results of air samples collected by Liberty Mutual for September 30, 1976, although collected after production had been shut down and after both air conditioning units were brought into service, resulted in exposure fractions ($\frac{C_1}{T_1} + \frac{C_2}{T_2} \ldots$) that ranged from two to six times in excess of unity (i.e.: the threshold limit).

After engineering modifications were made to problems previously noted, air samples collected on 10/2 and 10/5/76 indicated that exposure fractions were well within established limits.

Although outside ambient atmospheric conditions were again comparable at the time of the second incident on October 7, it appears from environmental data gathered during the period October 4 to 6, (Table II), October 17 to 20, (Table III), and again December 5 to 8, (Table IV), that this incident was not the result of excessive exposures to organic solvents.

Data gained from direct reading instruments yielded no significant results during the NIOSH October visit relating to employee exposures. Only samples designed to test meters yielded significant responses.

Air samples collected by the Pennsylvania Department of Environmental Resources Bureau of Air Quality to evaluate pollution sources external to the plant property resulted in the following values:

Periodic Kiln	Sulfur Oxides	Fluorides
Stack Sample	6.5 ppm	0.34 ppm
Tunnel Shuttle Kiln	3.1 ppm	0.35 ppm
Stack Sample	0.17 ppm	0.17 ppm

Samples were collected over a period of time ranging from 9 to 27 hours and varied temperatures. Although this facility has a number of emission sources, they do not in total (or individually) result in an excessive emission.

V. CONCLUSION

In conclusion, a number of separate outbreaks of an occupational illness characterized by nonspecific symptoms occured at the Essex International, Kittaning facility between late September and early October, 1976. The major incident occuring on September 30, 1976 appears to have resulted from accumulation of concentrations of organic vapors that when added together exceeded a level at which one might expect symptoms.

Although engineering controls present were modified to correct the excessive conditions and levels documented to insure safe levels (Tables III & IV), a great amount of anxiety and fear continued. It must be remembered that this incident was only one in a series of events including the "explosion" of 16 hydrogen furnaces, the activation of the automatic sprinklers and the breakdown of the normally present air conditioning system during a very hot and humid period.

When production was resumed after September 30, environmental data indicated the problem had been corrected and that exposures were not in excess of the environmental criteria or any recognized effect level. This does not mean, however, that the production areas were without odors. As previously noted in the criteria section of this report, odors are quite often detectable below the threshold limit and would not present a health hazard.

In the situation of the incident on October 7, it is believed that two factors, anxiety-fear and detectable odors resulted in a very real condition.

The occurence of an odor in the work area may have acted as the triggering mechanism to recreate the effects that were present during the initial incident. Because the workers were unaware of what they were working with and the potential hazards that these chemicals could produce the anxiety and fear continued to mount. The anxiety and fear may have in turn led to hyperventilation resulting in respiratory alkalosis and leading to the development of numbness and tingling of the arms and legs, heavy feelings in the arms and legs, nausea, light headedness, carpal-pedal spasm and other signs that were noted.

As previously noted those employees admitted to the hospital showed no detectable signs of visceral organ damage or central or peripheral nervous system impairment. The subsequent review of medical and environmental data provides no reason to anticipate any chronic or long term health problems.

Provided operational controls continue as noted during the re-evaluation of working conditions in December, no significant acute or chronic problems related to the accumulation of organic vapors is expected in the future.

VI. RECOMMENDATIONS

1) It is essential that good work practices as well as employee-employer education as to the chemicals and their hazards in use in this plant be initiated.

2) Periodic monitoring should be conducted to provide continuing assurances that controls meet recognized engineering criteria as necessary to maintain organic vapors below the recommended environmental criteria.

VII. REFERENCES

1) P & CA Mehtods #126, 127, 155, NIOSH Manual of Analytical Methods, HEW Publication No. (NIOSH) 75-121, 1974.

2) U.S. Department of Labor - OSHA, Federal Register, July 1, 1975, Volume 39, Title 29, Part 1910, Subpart 2, Section 1000.

3) Criteria for a Recommended Standard...Occupational Exposure to:

Isopropyl Alcohol	HEW	Publication	No.	(NIOSH)	76-142
Methyl Acetate	"	"	"	"	
Toluene	"	"	"	"	73-11023
Trichloroethylene	"	"	"	"	73-11025
Methyl Alcohol	"	"	"	"	76-148
Lead (revised)	"	"	"	"	

4) Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes for 1976, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio, 1976.

5) Handbook of Organic Industrial Solvents, Second Edition, National Association of Mutual Casualty Companies, Chicago, Illinois.

6) Hellman, T.M., Small, F.H., Characterization of Odor Properties of 101 Petrochemicals Using Sensory Methods, Journal of the Air Pollution Control Association, Vol. 24, No. 10, October, 1974.

VIII. AUTHORSHIPS AND ACKNOWLEDGMENTS

Report Prepared by:

Wesley E. Straub
Regional Industrial Hygienist
Region III, Philadelphia, PA

Channing Meyer, M.D.
Chief, Medical Section
Hazard Evaluation and
Technical Assistance Branch

Originating Office:	Jerome P. Flesch Chief Hazard Evaluation & Technical Assistance Branch Cincinnati, Ohio
Industrial Hygiene Section:	Bruce A. Hollett James H. Price Guy F. Burroughs Industrial Hygienists
Medical Section:	Bonnie Nelson Physician's Assistant
Laboratory Anaylsis:	Steven Hudson Gordon Gibson James Snarr Charles Runkle Chemists Utah Biomedical Test Laboratory Salt Lake City, Utah
Epidemiology:	H. James Beecham, M.D. William Parkin, Ph.D. Division of Communicable Disease Control Commonwealth of Pennsylvania

The authors of this report wish to express their thanks to the following personnel and all others for their assistance in completing this report.

J. Knauber, Director	Bureau of Occupational Health Department of Environmental Resources Commonwealth of Pennsylvania
M. Smith, Ph.D., Section Chief	Motivation and Stress Research Section NIOSH, Cincinnati, Ohio
E. Baker, M.D., Acting Chief	Environmental Hazards Activity Cancer & Birth Defects Division Bureau of Epidemiology Center for Disease Control
W. Lloyd, Ph.D., Epidemiologist	United Steel Workers of America Washington, D.C.
G. Lancour, Director	Health & Safety Essex, International Fort Wayne, Indiana
S. Wilner, Industrial Hygienist	Liberty Mutual Insurance Co. Pittsburgh, PA

ESSEX INTERNATIONAL, INC.
Kittanning, Pennsylvania
Health Hazard Evaluation 77-3
Table I
Work Location and Attack Rates

	9/30 1st Shift		9/30 2nd Shift		10/7 1st Shift		Total	
Office	30%	3/10	0	0/0	11%	1/9	21%	4/9
Printed Circuit Area	56%	34/61	56%	22/39	66%	42/64	60%	98/164
Diode II	48%	12/52	0	0/1	50%	13/26	48%	25/52
Clean Diode	30%	14/47	50%	1/2	31%	15/48	30%	30/97
Shipping and Receiving	50%	6/12	33%	2/6	75%	9/12	57%	17/30
Electrostatic	100%	1/1	0	0/0	100%	1/1	100%	2/2
Plating	50%	1/2	0	0/0	0	0/1	33%	1/3
Mobile	28%	7/25	0	0/1	30%	8/27	28%	15/23

ESSEX INTERNATIONAL, INC.
KITTANNING, PENNSYLVANIA
HEALTH HAZARD EVALUATION 77-3
TABLE II
LIBERTY MUTUAL SOLVENT VAPOR CONCENTRATIONS PPM

SAMPLE NO.	TIME	LOCATION	FREON TF	ETHYL ALCOHOL	TOLUENE	N-BUTYL ACETATE	N-BUTYL ALCOHOL	ISOPROPYL ALCOHOL	TRICHLORO-ETHYLENE	S-BUTYL ALCOHOL	FAP 1-X
/30											
1	2:00 P.M.	Inside trans/rec test cage #1, floor level	16	55	20	103	180	-(a)	-	-	2.76
2	2:01 P.M.	" "	1	67	11	130	110	-	-	-	2.1-
3	2:02 P.M.	" "	1	79	8	90	140	-	-	-	2.16
4	2.03 P.M.	" "	1	95	8	108	150	-	-	-	2.43
5	2:04 P.M.	" "	1	95	7	117	170	-	-	-	2.65
6	2:05 P.M.	" "	1	155	1	115	190	-	-	-	2.83
7	2:06 P.M.	Operator's breathing zone (OBZ) - trans/rec test cage #1	1	78	29	108	120	-	-	-	2.29
8	2:07 P.M.	" "	1	85	16	110	130	-	-	-	2.28
9(b)	2:08 P.M.	" "	1	130	19	160	130	-	-	-	2.69
0(b)	2:09 P.M.	" "	1	140	1	140	130	-	-	-	2.38
.1(b)	2:10 P.M.	" "	1	140	1	160	180	-	-	-	3.02
.2	2:11 P.M.	Around degreaser and still, floor level	1	120	8	300	140	-	-	-	3.63
.3	2:12 P.M.	" "	1	100	24	140	160	-	-	-	2.87
.4	2:13 P.M.	" "	1	160	1	220	190	-	-	-	3.54
15	2:14 P.M.	" "	1	160	1	330	170	-	-	-	4.07
16	2 15 P.M.	" "	28	240	1	262	410	-	-	-	6.12
17	2:16 P.M.	" "	1	210	36	180	190	-	-	-	3.67
10/2											
18	1:20 P.M.	(OBZ) - P/C degreaser	41	23	-	-	-	8	19	13	0.26
19	1:21 P.M.	"	40	1	-	-	-	3	9	5	0.17
20	1:22 P.M.	"	43	17	-	-	-	1	11	5	0.2-
21	1:23 P.M.	(OBZ) - trans/rec test cage #1	36	14	-	-	-	1	8	3	0.15
22	1:24 P.M.	" "	99	25	-	-	-	3	10	4	0.26
23	1 25 P.M.	" "	66	20	-	-	-	5	8	3	0.20
24	1:26 P.M.	Around P/C degreaser and still, floor level	46	26	-	-	-	15	20	18	0.43
25	1:27 P.M.	" "	110	25	-	-	-	14	19	19	0.49
26	1:28 P.M.	" "	35	15	-	-	-	8	10	7	0.22
27	1:29 P.M.	(OBZ) - trans/rec assembly table, end position	25	14	-	-	-	10	9	5	0.19
28	1:30 P.M.	" "	22	5	-	-	-	1	4	2	0.69
29	1:31 P.M.	" "	15	4	-	-	-	1	3	1	0.60
30	1:32 P.M.	(OBZ) - trans/rec wave solder machine	15	19	-	-	-	11	20	16	0.37
31	1:33 P.M.	" "	26	11	-	-	-	10	9	8	0.21
32	1:34 P.M.	" "	27	12	-	-	-	9	8	3	0.16
33	1:35 P.M.	(OBZ) - I.E. wave solder machine	25	7	-	-	-	8	7	2	0.14
34	1.36 P.M.	" "	19	3	-	-	-	1	3	1	0.60
10/3 - 1st Shift											
35	1.06 P.M.	(OBZ) - trans/rec assembly table, end position	5	1	-	-	-	1	2	6	0.07
36	1:07 P.M.	" "	4	1	-	-	-	1	2	1	0.03
37	1:08 P.M.	" "	4	1	-	-	-	1	1	1	0.02
38	1:09 P M.	(OBZ) - trans/rec wave solder machine, feed position	3	1	-	-	-	1	1	1	0.02
39	1:10 P.M.	" "	3	1	-	-	-	1	1	1	0.02
40	1:11 P.M.	" "	4	1	-	-	-	1	2	1	0.03
41	1:12 P.M.	(OBZ) - trans/rec wave solder machine, take off position	5	1	-	-	-	1	2	4	0.06
42	1:13 P M	" "	5	1	-	-	-	1	1	1	0.03
43	1:14 P.M.	" "	4	1	-	-	-	1	1	1	0.02
44	1:15 P.M.	(OBZ) - gluing hood	3	1	-	-	-	1	1	1	0.02
45	1:16 P.M.	"	5	1	-	-	-	1	1	1	0.03
46	1:17 P.M.	"	5	1	-	-	-	1	1	2	0.03
47	1:18 P.M.	(OBZ) - P/C heat swage operation	5	1	-	-	-	1	1	3	0.04
48	1:19 P.M.	" "	5	1	-	-	-	1	1	2	0.03
49	1.20 P.M.	P/C area near lunch room entrance	4	1	-	-	-	1	1	1	0.02
50	1:21 P.M.	" "	6	1	-	-	-	1	1	1	0.03
51	1:22 P.M.	" "	4	1	-	-	-	1	1	1	0.02
10/3 - 2nd Shift											
52	2.45 P.M.	(OBZ) - trans/rec assembly table, end position	5	1	-	-	-	1	1	4	0.05
53	2 46 P.M.	" "	5	1	-	-	-	1	1	1	0.03
54	2:47 P.M.	" "	1	1	-	-	-	1	1	1	0.02
55	2:48 P.M.	(OBZ) - test cage 265	2	1	-	-	-	1	1	1	0.02
56	2:49 P.M.	"	2	1	-	-	-	1	1	1	0.02
57	2:50 P.M.	"	2	1	-	-	-	1	1	1	0.02
58	2:51 P.M.	(OBZ) - trans/rec wave solder machine, feed end	1	1	-	-	-	1	1	1	0.03
59	2:52 P.M.	" "	2	1	-	-	-	1	1	1	0.02
60	2 53 P.M.	" "	3	1	-	-	-	1	1	1	0.02
61	2:54 P.M.	(OBZ) - gluing hood	2	1	-	-	-	1	1	1	0.02
62	2:55 P.M.	" "	3	1	-	-	-	1	1	1	0.02
63	2:56 P.M.	" "	3	1	-	-	-	1	1	1	0.02
64	2:57 P.M.	(OBZ) - trans/rec wage solder machine, take off position	3	1	-	-	-	1	1	3	0.04
65	2:58 P.M.	" "	3	1	-	-	-	1	1	2	0.03
66	2:59 P.M.	" "	3	1	-	-	-	1	1	1	0.02
67	3:00 P.M.	" "	3	1	-	-	-	1	1	1	0.02
68	3:01 P.M.	" "	3	1	-	-	-	1	1	1	0.02

(a) Denotes not detected
(b) One component of this complex mixture could not be identified or quantitated in these samples.

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Table III
Solvent Vapor Concentrations PPM[a]

Location	Sample Number	Date	n-Butyl acetate	Methyl acetate	Toluene	Acetone	Etnyl acetate	sec-Butyl alcohol	1,1,2-Trichloro 1,2,2-trifluoroethane	Comments
Printed Circuits	CT-F1	10-18-76	--	--	--	--	--	--	0.4[c]	Worker's exposure;[d] cleaning boards in hood
	CT-F2	"	--	--	--	--	--	--	0.8	
	CT-1	"	--	--	--	--	--	--	0.6	
	CT-2	"	--	--	--	--	--	--	0.4	
	CT-F3	"	<0.1[b]	<0.2	<0.2	<0.3	<0.2	<0.2	--	Worker's exposure, gluing coils to boards in hood
	CT-F4	"	<0.2	<0.3	<0.2	<0.3	<0.2	<0.2	--	
	CT-13	"	<0.1	<0.2	<0.2	<0.3	<0.2	<0.2	--	
	CT-20	"	<0.4	<0.65	<0.5	<0.8	<0.6	<0.6	--	
	CT-3,CT-12	"	<0.4	<0.6	<0.5	<0.8	<0.6	<0.6	0.4	Worker's exposure, cleaning board and gluing coils in hood
	CT-4,CT-21	"	<0.4	<0.7	<0.5	<0.8	<0.6	<0.6	0.3	
	CT-5	"	<0.2	--	--	--	--	<0.3	--	Worker's exposure, tending illuminated entry timer: wave soldering equipment
	CT-6	"	<0.2	--	--	--	--	<0.4	--	
	CT-9	"	<0.05	<0.05	<0.04	<0.06	<0.04	<0.04	--	General air, hand parts insertion for illuminated entry timer
	SG-1	"	--	--	<0.04	<0.06	<0.04	<0.05	<0.1	
	CT-6	"	<0.4	--	--	--	--	<0.2	--	Worker's exposure, tending receiver wave solder equipment
	CT-15	"	<0.4	--	--	--	--	<0.3	--	
	CT-10	"	<0.05	<0.05	<0.04	<0.06	<0.04	<0.04	--	General air, near receiver wave solder equipment
	CT-11	"	<0.05	--	--	--	--	<0.04	--	
	SG-2	"	--	--	--	<0.07	<0.05	<0.06	<0.2	
	CT-8	"	<0.4	--	--	--	--	<0.3	--	Worker's exposure, soldering coil-tips
	CT-14	"	<0.5	--	--	--	--	<0.3	--	
Exposure Limit	--	"	150	200	100	1,000	400	150	1,000	

a) PPM denotes, parts of solvent per million parts of air.
b) < denotes, less than.
c) Minimum concentration for this sample, since amounts were found in the back-up portion of the charcoal tube.
d) Samples were approximately 6 to 7.5 hours in duration.

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Table IV
Solvent Vapor Concentrations PPM[a]

Location	Sample Number	Date	Ethanol	n-Butyl acetate	Methyl acetate	Toluene	Acetone	Ethyl acetate	sec-Butyl alcohol	Trichloro-ethylene	1,1,2 Trichloro 1,2,2 trifluoroethane	Methanol	Comments
Printed Circuits	CT-1	12-6-76	<0.5[b]	<0.2	<0.3	<0.3	<0.4	<0.3	<0.3	<0.2	<0.1	<0.4	Operator's exposure[d], cleaning and gluing coil on inserts circuit boards
	SG-1	12-6-76											
	CT-12	12-7-76	<0.3	<0.1	<0.1	<0.1	<0.15	<0.1	<0.1	<0.1	<0.1	<0.3	
	SG-8	12-7-76											
	CT-16	12-8-76	<0.2	<0.1	<0.1	<0.1	<0.15	<0.1	<0.1	<0.1	<0.1	1.0	
	SG-13	12-8-76											
	CT-20	12-8-76	<0.007	<0.003	<0.005	0.03	<0.006	<0.004	<0.005	0.07	3.8[c]	--	General air, outside gluing hood
	CT-2	12-6-76	<0.4	<0.1	<0.2	<0.2	<0.3	<0.2	<0.2	<0.1	11.3	1.0	Operator's exposure, tending wave soldering/cleaning circuit boards
	SG-2	12-6-76											
	CT-7	12-7-76	<0.3	<0.1	<0.2	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.3	
	SG-7	12-7-76											
	CT-17	12-8-76	<0.25	<0.1	<0.1	<0.1	<0.15	<0.1	<0.1	<0.1	10.0	0.6	
	SG-12	12-8-76											
	CT-3	12-6-76	<0.5	<0.15	<0.25	<0.2	<0.3	<0.2	<0.2	<0.1	<0.1	<0.5	Operator's exposure, hand insertion
	SG-3	12-6-76											
	CT-15	12-7-76	<0.3	<0.1	<0.15	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.4	
	SG-9	12-7-76											
	CT-14	12-7-76	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.5	
	SG-10	12-7-76											
	CT-4	12-6-76	<0.5	<0.15	<0.25	<0.2	<0.3	<0.2	<0.2	<0.1	<0.1	<0.7	Worker's exposure, group leader, hand insertion
	SG-4	12-6-76											
Chryler Button	CT-5	12-6-76	<0.55	<0.2	<0.3	<0.2	<0.3	<0.2	<0.2	<0.1	<0.1	--	Worker's exposure, "button" & heat sink cleaning
	CT-6	12-6-76	<0.5	<0.15	<0.25	<0.2	<0.3	<0.2	<0.3	<0.1	<0.1	--	
	CT-8	12-7-76	<0.5	<0.1	<0.2	<0.2	<0.3	<0.2	<0.2	<0.1	<0.1	--	"Button" assembly
	CT-9	12-7-76	<0.5	<0.1	<0.2	<0.2	<0.3	<0.2	<0.2	<0.1	<0.1	--	Junction coating
	CT-19	12-8-76	<0.4	<0.1	<0.2	<0.2	<0.3	<0.2	<0.[illegible]	<0.1	90.8	--	Cleaning dye with ultra-sonic unit
	CT-21	12-8-76	<0.3	<0.1	<0.15	1.7	<0.2	<0.1	<0.1	4.3	139[c]	--	General air, by Ultra-sonic cleaner
Plating Room	CT-11	12-7-76	<0.25	<0.1	<0.1	<0.1	4.6	<0.1	<0.1	<0.1	13.1	--	Worker's exposure, general surface preparation & treatment
	CT-20	12-7-76	-Sample lost in Analysis-										
	CT-13	12-7-76	<0.4	<0.1	<0.2	<0.2	<0.3	<0.2	<0.2	<0.1	8.9	--	
	CT-18	12-8-76	<0.3	<0.1	<0.15	<0.1	5.9	<0.1	<0.1	<0.1	17.2	--	
	CT-22	12-8-76	<0.007	<0.003	<0.005	0.06	<0.006	<0.004	<0.005	0.3	4.0[c]	--	General air in Plating room
Exposure Limit			1,000	150	200	100	1,000	400	150	100	1,000	200	

a) PPM denotes, parts per million.
b) < denotes, less than.
c) Minimum concentrations, since amounts were found in the back-up portion of the charcoal tube.
d) Samples were approximately 6 to 7.5 hours in duration.

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Table V
Solvent Vapor Concentrations PPM[a]

Location	Sample Number	Date	Ethyl alcohol (Ethanol)	Isopropyl alcohol	Methyl alcohol (Methanol)	Comments
Printed Circuits	SG-2	10-18-76	<0.09[b]	--	<0.1	General air, receiver line hand insertion area
	SG-1	--	<0.09	--	<0.1	General air, illuminated entry timer hand insertion area
	CT-17	--	--	<0.2	--	Worker's exposure
	CT-18	--	--	<0.6	--	touch-up solder line
	CT-19	--	--	<0.1	--	General air touch-up line
Exposure Limit	--	--	1,000	400	200	

a) PPM denotes, parts of solvent per million parts of air.
b) < denotes, less than.
c) Samples were approximately 6 to 7.5 hours in duration.