HETA 92-0009-2362
October 1993
New York Telephone Company
White Plains, New York

NIOSH INVESTIGATORS:
Robert Malkin, D.D.S., Dr.P.H.
C. Eugene Moss, HP, CSS
Nancy Clark Burton, MS
Don Booher

I. SUMMARY

On October 7, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from employees of the New York Telephone Company (NYNEX) Central Office facility, White Plains, New York. These employees worked on the third floor of the building and were concerned about a perceived high incidence of cancer among employees working on that floor. Employees believed they were exposed to high levels of electromagnetic fields (EMF) that contributed to their disease. Employees were also concerned about workplace environmental conditions including indoor air quality and chemical exposures.

On December 23, 1991, an initial site visit was conducted. On July 27-29, 1992, a follow-up site visit by a NIOSH industrial hygienist, epidemiologist, and health physicist was conducted to further evaluate the building. NIOSH investigators measured EMF levels throughout the facility, assessed potential chemical exposures, and evaluated the indoor environmental quality within the building. NIOSH investigators also interviewed employees and observed work practices. In addition, NIOSH investigators evaluated EMF exposure at another NYNEX facility where older telephone switching equipment was in operation.

Twelve cases of cancer were identified by employees over the past 13 years, 6 within the last 3 years. No one form of cancer predominated in the White Plains facility. Because of this finding, the small size of the workforce at White Plains, the presence of confounders (other potential risk factors for cancer), and the inability to accurately assess the past EMF exposure due to major changes in type of equipment used in the telephone industry, a definitive epidemiologic investigation of the role played by EMF in the development of cancer at this site was not feasible.

Measurements of extremely low frequency (ELF) magnetic fields ranged from 0.1 to 2100 milligauss (mG) and measurements of very low frequency (VLF) fields ranged from 0.1 to 30 mG. Measurements of ELF electric fields ranged from 2 to 5.8 volts per meter (V/m) and VLF fields ranged from 1.8 to 300 V/m. All measurements were within the American Conference of Governmental Industrial Hygienists (ACGIH) occupational exposure standards for ELF and VLF exposure.

During the course of this evaluation, NIOSH investigators discovered that radioactive vacuum tubes had previously been in widespread use at telephone Central Office Facilities (COFs). This finding could possibly introduce a major confounder in assessing workplace exposure to carcinogens.

Industrial hygiene measurements revealed adequate ventilation of the workspace, but several areas exceeded American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) guidelines with regards to humidity. Very low chemical exposures were found while employees were soldering.

Based on environmental sample results and a detailed measurement of occupational EMF exposure, NIOSH investigators concluded the following: 1) trace levels of chemical contaminants were detected in the switching areas but, based on the short duration of the activities that produced those contaminants, the exposure should not be in excess of occupational standards 2) electrical shock potential, to both AC and DC currents, existed 3) no levels exceeded the occupational standards for either ELF or VLF electric or magnetic fields, and 4) the role of ionizing radiation (radium) needs to be considered in any study of cancer among telephone company central office employees.

Keywords: SIC 3661 (telephone and telegraph apparatus), switching equipment, EMF, radium bromide, cancers, indoor environmental quality

II. INTRODUCTION

On October 7, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request from employees of the New York Telephone Company (NYNEX), White Plains, New York. These employees worked on the third floor and were concerned about a perceived high incidence of cancer among their co-workers that they felt was related to exposure to high levels of electromagnetic fields (EMF). Of particular concern at this worksite was one of the sub-divisions of EMF known as the extremely low frequency (ELF) region, which is a frequency band from 30 to about 3000 Hertz (Hz). There was also concern about exposure to microwave radiation (frequency greater than 300 megaHz) from telephone relay systems. In addition, employees reported exposure to battery acid, fumes generated from soldering plastic-coated wires, and comfort issues in renovated office areas.

On December 23, 1991, NIOSH epidemiologists conducted an initial site visit and interviewed employees and management. During this first site visit, employees reported the following problems in the work environment:

1. Diesel exhaust entering the building through a freight elevator shaft adjacent to a truck loading/unloading area.

2. Toxic chemicals that might have been released during a major facility fire in 1976.

3. Pigeons nesting near the building air intakes.

On July 27-29, 1992, a follow-up site visit was conducted to further evaluate the building. This evaluation team consisted of a NIOSH industrial hygienist, an epidemiologist, and a health physicist. Measurements of EMF levels throughout the facility were made. Because of the general concerns about the work environment, which were reported by workers during interviews, NIOSH investigators also made selected environmental measurements at the site.

III. BACKGROUND

A. White Plains Facility

This building is a central office facility (COF) servicing thousands of telephones over a large area in the vicinity of White Plains, New York. A COF converts electrical power from commercial alternating current (AC) into a variety of AC and direct current (DC) voltages and currents to fulfill electrical requirements for various telephone communication systems. Typically, a COF may provide current levels ranging from 10^{-3} to 10^{4} amperes and voltage levels ranging from 1 to 10^{3} volts. COFs may also be equipped to furnish either AC or DC power as a substitute for commercial power during periods of failure of the commercial supply. In the past, COFs were usually equipped with 24, 48, and 130 volt battery power plants to provide power for various electro-mechanical switching systems, relay controlled devices, toll and manual switching equipment, and carrier/repeater circuits using vacuum tubes.

The NYNEX building in White Plains was built in three stages between 1906 and 1973. The building has eight stories and a basement, and approximately 500 people work over three shifts at this site. Approximately 75% of the building employees belong to the Communications Workers of America. Large areas of the building (including parts of the third, fifth, and sixth floors) were not occupied on the evaluation dates since much of the older telecommunication equipment had been replaced with new and more advanced communication equipment which requires fewer employees.

B. Ventilation System

In response to concern over indoor environmental conditions on the third floor and the renovated office areas, the ventilation system for the building was evaluated. A constant volume ventilation system was installed in 1973 and all of the former ventilation system ductwork was removed. The present system has 20 air handling units. Two filters are used in the air handling units: the pre-filter is 40% efficient and was reported to be changed approximately every two months; the primary filter is 90% efficient and replaced whenever necessary, based on visual inspection.

When equipment space was converted to office space, the ventilation system specifications were not changed. Instead, lower ceilings were installed and the ductwork extended. The entire ventilation system has never been balanced at one time. When portions of the ventilation system were refitted, that portion of the system was balanced to original specifications.

The outside air (OA) supply changes depending on the outside air temperature. The OA supply is at its minimum setting during the summer months to conserve energy. Supply air is cooled in the summer by circulating cooling water from a cooling tower to the air handling units (AHUs) and the supply air is heated by circulating heated water from a boiler to the AHUs.

An OA intake had previously been located over the loading dock. It presently was closed and another OA intake had been installed on the opposite side of the building. All of the outside louvers are screened to prevent birds from entering and roosting on portions of the air handling systems.

Smoking is not allowed in the office and equipment areas but is permitted in designated areas. Since the building houses both industrial and office areas, the temperature is regulated to protect the telephone equipment.

C. COF Job Duties

NYNEX workers on the third floor were employed as switching equipment technicians whose main responsibility was installing and servicing telephone carrier equipment. Most of the workers had worked on the N1 carrier that was used from the late 1940's to the late 1980's. This equipment allows for a single telephone line to "carry" up to 24 conversations for transmission between central offices. Five to six of these N1 carrier units, each containing five vacuum tubes, were housed in a rack. Racks were arrayed in rows approximately three feet apart throughout the length of the building floor (approximately 100 feet). All of the N1 carriers, however, have been removed from the building. These units had been replaced by the "T" carrier, which used transistors (instead of vacuum tubes) and was introduced in the 1960's. Workers also service the "L" carrier that is used to process microwave signals.

The duties of the third floor workers included maintenance, installation, and repair of telephone carrier equipment. Although their job duties required them to move throughout the floor, their time was predominantly spent in close contact with the carrier equipment. These duties, at times, included soldering wires using a lead-based solder (99% lead). According to NYNEX representatives, the present telephone systems requiring solder are to be phased out and replaced by new telephone equipment which does not require soldering.

In the past, workers had also come in contact with cross-bar switches during the course of the work day. These are a type of electromechanical switch used to connect telephone circuits to the individual user and were previously housed in the White Plains building. They have since been replaced at the White Plains facility, starting in the mid 1980's, with more modern electronic switches but were still used in a few other NYNEX facilities. These switches functioned with electronic devices known as translators which used vacuum tubes that contained radioactive material. At the time of this evaluation, there were only a few remaining telephone facilities left that used the older cross-bar switches. In a separate HHE (91-058), NIOSH investigators had previously visited an older COF in Manhattan, New York, where the older cross-bar switches were still in operation . As part of this HHE, NIOSH investigators visited another COF facility, located in Yonkers, New York, (Figure 1) where the older equipment was still in use. Measurements of representative occupational exposures were performed by NIOSH investigators at these locations to better understand the differences between EMF exposures generated by older equipment and present exposures.

There is a small microwave dish antenna located on the roof of the White Plains COF. This antenna, which is part of the DR-18 system, is mounted adjacent to a small metal frame structure (radio shack). This system, operating at a frequency of 18 GHz and at a power level of less than 1 watt, transmits and receives microwave signals. Employees in the White Plains facility are also responsible for the maintenance of this equipment. The maintenance is done only when needed but requires the employee to be in close proximity to both transmission and receiving equipment. Only several COF employees were potentially exposed to this low level of microwave radiation as part of their duties and those that were, were exposed infrequently.

Employees informed NIOSH investigators of the previous use of radioactive vacuum tubes at the White Plains facility. The Western Electric (WEC) and American Telegraph and Telephone (ATT) Companies used up to 1 microcurie (µCi) of radium bromide (RaBr) in the envelope of cold-cathode gas tubes as a stabilizing agent for many years (Cassidy, 1960). These gas tubes were originally built by WEC at their plant in Allentown, Pennsylvania in the late 1950's. Around 1960 a major effort was made by both WEC and ATT to use Krypton-85 (Kr-85) as the residual ionization sources instead of RaBr (Cassidy, 1960). The use of Kr-85 was encouraged because it would reduce the occupational radiation exposure, reduce external radiation from completed tubes, and be more efficient to manufacture. At least three groups of workers were potentially exposed to the RaBr radiation: 1) electron tube manufacturing personnel (mainly workers at Allentown, PA) 2) personnel assigned to the disposal of spent or completed tubes, and 3) workers in areas where the tubes are used (switching rooms at COFs). The possible exposure to ionizing radiation from both RaBr and Kr-85 tubes during manufacturing lead to the establishment of an extensive ionizing radiation personnel protection program by WEC. (Geller, 1961).

IV. EVALUATION DESIGN

A. Chemical Exposures

To measure organic components of the fume generated during soldering, two air samples were collected using thermal desorption sorbent tubes while an employee soldered two wires on the old switching rack. Gas chromatography/mass spectroscopy was used for the qualitative analysis. Two settled dust samples were collected, one from beneath a switching rack and one of loose material from the cable vault under the floor. These were analyzed for trace metal content according to NIOSH Method 7300, modified for bulk samples (NIOSH 1984). The samples were digested with a mixture of nitric and perchloric acids and analyzed by inductively coupled plasma (ICP)-atomic emission spectrometry. Because the loose material was not homogeneous, three samples were analyzed. One bulk sample was submitted for fiber analysis using polarized light microscopy.

B. Ventilation and Thermal Comfort

Real-time temperature and relative humidity (RH) measurements were made using a LCD Digital Hygrometer (Cole-Palmer Instrument Co.). Real-time carbon dioxide (CO_2) levels were measured using a Gastech Model RI-411A, portable CO_2 meter.

A questionnaire was distributed to 75 employees on the second and third floor concerning environmental conditions and building-related symptoms. The second floor was industrial space that had been remodeled into office space while the third floor contained predominantly telephone equipment.

Temperature, relative humidity (RH), and CO_2 sequential measurements were made at various locations (that represented the different types of spaces found in the building) three times on July 28, 1993. For comparison, measurements were taken outside of the building near the main entrance. The purpose for the sequential readings was to observe any fluctuations in these parameters throughout the day. The measurements were made between 7:30-9:40 a.m. (beginning of the workshift), 12:20-1:20 p.m., and 4:45-5:20 p.m. (the end of the work day).

With the assistance of maintenance personnel, four of the heating, ventilation, and air-conditioning (HVAC) units were opened and visually examined for microbial contamination, standing water, position of outside air intake dampers, general cleanliness, and particulate filter condition. Smoke powder was used to determine air flow patterns.

C. EMF Analysis and Ionizing Radiation

1. EMF Analysis

This evaluation was designed to survey occupational exposures to EMF as workers performed their various work tasks. The number of measurements taken in this evaluation were not intended to represent a complete evaluation of all possible EMF exposures at the site, but rather, were intended to approximate occupational exposure levels found on the days of measurement.

Worker exposure to the various EMF found at the White Plains facility was documented using the following equipment:

1). Holaday Industries, Inc. model HI-3602 ELF sensor, connected to a HI-3600 survey meter. This meter was used to document both the magnitude of ELF electric and magnetic fields and the electrical frequency (as well as the waveforms) produced by such fields. The electric field strength was measured in units of volts per meter (V/m) and the magnetic field strength was measured in units of milligauss (mG). Waveforms were captured by the Holaday meter and displayed on a digital oscilloscope at different locations in the building.

2). Holaday Industries, Inc. model HI-3627 3-axis ELF magnetic field meter. This meter was used to make isotropic measurements of the magnetic field in and around different workstations. The magnetic field is measured over the frequency region from 30 to 2000 Hz, and the dynamic range of the instrument is from 0.2 mG to 20 gauss.

3). Emdex® II exposure system, developed by Enertech Consultants. The EMDEX® II is a programmable data-acquisition meter which measures the orthogonal vector components of the magnetic field through its internal sensors. Measurements can be made in the instantaneous read or storage mode. The system was designed to measure, record, and analyze power frequency magnetic fields in units of mG in the frequency region from 30 to 800 Hz.

4). AMEX-3D exposure meter manufactured by Enertech Consultants. This small, lightweight three-axis magnetic field meter can be worn by a worker to monitor average, low-level, magnetic fields exposure. The AMEX-3D stores an electrical charge, proportional to the time-integral of the magnetic field, which can then be read out and converted into average magnetic field value. The AMEX-3D exposure meter is also manufactured by Enertech Consultants.

ELF electric and magnetic fields results were documented with the EMDEX ® II, AMEX, and Holaday systems on all floors of the building. At some locations measurements were made for VLF levels using the Holaday meters. Due to the vast number of measurements necessary to be taken in this evaluation, the EMDEX ® II units and the Holaday meters were used in a walk-around monitoring mode by NIOSH investigators. When operating in this mode the meters were held at chest height and slowly moved over a small area while walking at a slow pace to determine the lowest and highest levels found in a particular worksite. No attempt was made to record individual workers' time-weighted average exposure with these units when operating in this mode. The walk-around monitoring mode, however, made it possible to obtain a large amount of data quickly. When levels were recorded that appeared to be above the background range being documented, that particular area was scanned again at a slower rate to confirm the presence of a localized elevated level.

The AMEX units were positioned in several rooms on different floors to evaluate ELF levels near instrument racks. All measurements were made during the first two shifts with equipment held at waist height. All systems were calibrated either by the manufacturer or NIOSH within six months of the date of this evaluation.

A few, limited EMF measurements using some of the above equipment were made at the Yonkers COF. Selected transient waveform measurements were also performed at a Manhattan COF using equipment specially developed for that function.

2. Ionizing Radiation

The evaluation for worker exposure to ionizing radiation included a review of telephone company data, published reports, and measurement of radiation levels. A limited ionizing radiation survey was performed, both at the White Plains and Yonkers COF, to evaluate occupational exposure from present day use of radioactive tubes and possible contamination of the worksite from use of these tubes in the past.

On July 29, 1992, NIOSH investigators went to the COF facility in Yonkers, NY, and measured several RaBr and Kr-85 tubes that were still operating (Figure 2). NIOSH investigators also scanned the floor at the White Plains COF looking for residual radioactive material from tubes that were, according to employee reports, broken during the removal of equipment in the past. The measurements were made using a Mini-Con-Rad monitor manufactured by the Dosimeter Corporation. The monitor uses a Geiger-Mueller tube that is calibrated relative to Cesium-137.

D. Medical/ Epidemiological

The medical evaluation included interviews with employees, union representatives, and the company physician. It also included observation and analysis of work practices of employees.

E. Facility Safety

NIOSH investigators conducted a walkthrough tour of the facility to evaluate facility safety and to determine if there were any obvious chemical exposures. In addition, during the course of the employee interviews NIOSH investigators were informed of work practices and exposures that might be hazardous to employees. NIOSH investigators evaluated these reports to determine the extent of the problems and to be able to make recommendations for their amelioration.

V. EVALUATION CRITERIA

A. Chemical Exposure

To assess the hazards posed by workplace exposures, NIOSH investigators use a variety of environmental evaluation criteria. These criteria propose exposure levels to which most employees may be exposed for a normal working lifetime without adverse health effects. These levels do not take into consideration individual susceptibility, such as pre-existing medical conditions, or possible interactions with other agents or environmental conditions. Evaluation criteria change over time with the availability of new toxicologic data.

There are three primary sources of environmental evaluation criteria for the workplace: 1) NIOSH Recommended Exposure Limits (RELs), 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs®), and 3) the U.S. Department of Labor OSHA PELs. In July 1992, the 11th Circuit Court of Appeals vacated the 1989 Air Contaminants Standard. OSHA is currently enforcing the 1971 standards which are listed as transitional values in the current Code of Federal Regulations; however, some states operating their own OSHA approved job safety and health programs will continue to enforce the 1989 limits. NIOSH continues to encourage employers to follow the 1989 limits. The OSHA PELs may reflect the feasibility of controlling exposures in various industries where the agents are used; whereas the NIOSH RELs are based primarily on concerns related to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard and the OSHA PELs included in this report are the 1971 values.

1. Sulfuric Acid

Sulfuric acid is a severe irritant of the respiratory tract, eyes, and skin (Proctor, 1988). Exposure can also cause dental erosion. NIOSH, OSHA, and ACGIH have set an occupational exposure limit of 1 milligram per cubic meter (mg/m^3) for sulfuric acid.

2. Soldering

Based on the type of soldering done at this facility, the following compounds could be in the emissions:

a. Lead

Inhalation (breathing) of dust and fume, and ingestion (swallowing) resulting from hand-to-mouth contact with lead-contaminated food, cigarettes, clothing, or other objects are the major routes of worker exposure to lead. Once absorbed, lead accumulates in the soft tissues and bones, with the highest accumulation initially in the liver and kidneys (NIOSH, 1981). Lead is stored in the bones for decades and may cause toxic effects as it is slowly released over time. With chronic exposures, lead may be harmful to various organs, including the brain, the nerves in the arms and legs, the blood forming organs, the kidneys, and the reproductive systems of men and women. Overexposure to lead may also increase the risk of high blood pressure and stroke in men (Hernberg, 1988; Landrigan, 1985; Proctor, 1988). Lead can accumulate in the body over time and produce health effects long after exposure has stopped.

Under the OSHA standard regulating occupational exposure to inorganic lead in general industry, the PEL is 50 micrograms per cubic meter (µg/m$^{3)}$ as an 8-hour TWA (Code of Federal Regulations, 1992). In recognition of the health risks associated with exposure to lead, a goal for reducing occupational exposure was specified in *Healthy People 2000*, a recent statement of national consensus and U.S. Public Health Service policy for health promotion and disease prevention. The goal for workers exposed to lead is to eliminate, by the year 2000, all exposures that result in blood lead levels (BLLs) greater than 25 micrograms per deciliter (µg/dl) (DHHS, 1990).

b. Volatile Organic Compounds

Acetic acid is considered a severe irritant of the eyes, mucous membranes, and skin. The current NIOSH, OSHA, and ACGIH occupational exposure limit for acetic acid is 10 ppm as a time-weighted average (TWA).

Formic acid is a severe irritant of the eyes, mucous membranes, and skin. The current NIOSH, OSHA, and ACGIH occupational exposure limit for formic acid is 5 ppm as a TWA.

Toluene has been associated with central nervous system depression. Symptoms may include headache, dizziness, fatigue, confusion, and drowsiness. Exposure may also cause irritation of the eyes, respiratory tract, and skin. The current NIOSH occupational exposure limit for toluene is 100 ppm as a 10-hour TWA and the OSHA PEL is 200 ppm as an 8-hour TWA. The ACGIH TLV is 50 ppm as an 8-hour TWA.

Xylene may cause irritation of the eyes, mucous membranes, skin, and respiratory tract. The current NIOSH, OSHA, and ACGIH occupational exposure limit for xylene is 100 ppm as a TWA.

Terpene is used as an insecticide and is a naturally occurring compound in plants. There are currently no established occupational exposure limits for this compound and no known health effects from exposure.

B. Ventilation and Thermal Comfort

The symptoms and health complaints reported by building occupants in previous NIOSH indoor air quality (IAQ) evaluations have been diverse and are usually not suggestive of any particular medical diagnosis or readily associated with a causative agent. A typical spectrum of symptoms has included headaches, unusual fatigue, varying degrees of itching or burning eyes, irritations of the skin, nasal congestion, dry or irritated throats, and other respiratory irritations. Typically, the workplace environment has been implicated because workers report that their symptoms lessen or resolve when they leave the building.

Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints (Kreiss, 1989; Norback, 1990). Among these factors are imprecisely defined characteristics of HVAC systems, cumulative effects of exposure to low concentrations of multiple chemical pollutants, odors, elevated concentrations of particulate matter, microbiological contamination, and physical factors such as thermal comfort, lighting, and noise (Morey, 1989; Molhave, 1986; Mendell, 1989; Robertson, 1989). Indoor environmental pollutants can arise from either outdoor or indoor sources (Levin, 1989).

There are also reports describing results which show that occupant perceptions of the indoor environment are more closely related to the occurrence of symptoms than the measurement of any indoor contaminant or condition (NIOSH, 1991). Some studies have shown relationships between psychological, social, and organizational factors in the workplace and the occurrence of symptoms and comfort complaints (Boxer, 1990; Baker, 1989). Less often, an illness may be found to be specifically related to something in the building environment. Some examples of potentially building-related illnesses are allergic rhinitis, allergic asthma, hypersensitivity pneumonitis, Legionnaires' disease, Pontiac fever, carbon monoxide poisoning, and reaction to boiler corrosion inhibitors. The first three conditions can be caused by various microorganisms or other organic material. Legionnaires' disease and Pontiac fever are caused by *Legionella* bacteria.

NIOSH, OSHA, and ACGIH have published regulatory standards or recommended limits for occupational exposures (CDC, 1992; CFR, 1991; ACGIH, 1992). With few exceptions, pollutant concentrations observed in the office work environment fall well below these published occupational standards or recommended exposure limits. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation design criteria and thermal comfort guidelines (ASHRAE, 1981 and 1989).

Ventilation measurements and comfort indicators such as CO_2, temperature, and RH are useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems. Measurement of other indoor environmental contaminants has rarely proved to be helpful, in the general case, in determining the cause of symptoms and complaints except where there are strong or unusual sources, or a proved relationship between a contaminant and a building-related illness.

The basis for environmental measurements of office areas made during this evaluation are listed below. These criteria are applicable to the occupied office areas of the building.

1. Carbon Dioxide (CO_2)

CO_2 is a normal constituent of exhaled breath and, if monitored, may be useful as a screening technique to evaluate whether adequate quantities of fresh air are being introduced into an occupied space. The American National Standards Institute (ANSI)/ASHRAE Standard 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cubic feet per minute per person (cfm/person) for *office* spaces and conference rooms, 15 cfm/person for reception areas, and 60 cfm/person for smoking lounges, and provides estimated maximum occupancy figures for each area (ASHRAE, 1990).

Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration (range 300-350 parts per million [ppm]). When indoor CO_2 concentrations exceed 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased.

2. Temperature and Relative Humidity

The perception of comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperatures. Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. ANSI/ASHRAE Standard 55-1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally comfortable (ASHRAE, 1981).

3. Birds

Exposure to pigeons and their droppngs can result in certain infectious and hypersensitvity (allergic) illnesses including, cryptococcus, histoplasmosis and hypersensitivity pneumonitis. These illnesses usually occur under certain conditions e.g. cryptococcus in immunocompromized people, histoplasmosis when old droppings are disturbed, and hypersensitvity pneumonitis in people who handle the birds.

C. EMF

At present, there is limited information from OSHA on exposure criteria for workers exposed to physical agents. Criteria for physical agents not covered by OSHA come from either ACGIH, NIOSH, or in some cases, from consensus standards promulgated by the ANSI. In this investigation, NIOSH investigators utilized criteria formulated by the ACGIH.

The ACGIH has published TLVs for sub-radiofrequency electric and magnetic fields (30 kiloHz and below) (ACGIH, 1992). The TLV for magnetic fields (B) states "routine occupational exposure should not exceed:

$$B_{TLV} \text{ in milliteslas (mT)} = 60/f$$

where f is the frequency in hertz." Conversely, the electric field (E) TLV states "occupational exposures should not exceed a field strength of 25 kilovolts per meter (kV/m) from 0 to 100 Hz. For frequencies in the range of 100 Hz to 4 kHz, the TLV is given by:

$$E_{TLV} \text{ in volts per meter (V/m)} = (2.5 \times 10^6)/f$$

where f is the frequency in Hz. A value of 625 V/m is the exposure limit for frequencies from 4 kHz to 30 kHz."

This means, for example, at 60 Hz, which is classified as ELF, the electric field intensity TLV is 25,000 V/m and the magnetic flux density TLV is 1 mT or 10,000 mG.

The basis of the ELF E-field TLV is to minimize occupational hazards arising from spark discharge and contact current situations. The H-field TLV addresses induction of magnetophosphenes in the visual system and production of induced currents in the body.

D. Ionizing Radiation

Ionizing radiations are produced naturally by the decay of radioactive elements or artificially by such devices as X-ray machines and high energy accelerators. A radioactive nucleus is one that spontaneously changes to a lower energy state, emitting particles and often gamma rays in the process. The particles commonly emitted are alpha particles and beta particles.

Alpha particles, which interact readily with matter to produce ions, usually have energies of from 4 to 8 million electron volts (Mev). They travel a few centimeters in air and up to 60 microns into tissue. The high energy and short path result in a dense tract of ionization along the path of the particles, which produces serious biologic damage in the tissues with which the particles interact. Alpha particles will not penetrate the stratum corneum of the skin and thus are not an external hazard; but if alpha-emitting elements are taken into the body by inhalation or ingestion, serious internal exposure problems may result.

Beta particles interact much less readily with matter than do alpha particles and will travel up to a few centimeters into tissue or many meters in air. Exposure to external sources of beta particles is potentially hazardous, but exposure internally is more hazardous.

Gamma rays are primarily an external hazard and their biologic effects are better known than those of any of the other ionizing radiations. Examples of gamma emitters used in industry are cobalt-60, cesium-137, and iridium-192.

Entry of radiation sources into body during occupational exposures is principally from breathing air containing particulate or gaseous radionuclides, although ingestion and skin absorption can be important.

The effect from external radiation sources depends on the penetrating ability of the particular radiation. Thus, alpha radiation is of no concern externally, and beta is stopped in the outer tissues, the depth depending on energy. Very low energy X or gamma radiation is attenuated quite rapidly.

The early experience of radiation workers (including various nuclear accidents, exposures of radium dial-painters, casualties from atomic bomb explosions) and data from research projects provide clear evidence that high levels of ionizing radiation definitely create somatic damage and may induce genetic damage. The occupational somatic effects include radiodermatitis, epilation, acute radiation syndrome, cancer, leukemia, cataracts, sterility, and life span shortening. The genetic effects resulting from occupational exposures are to a great extent still unknown. Moreover, it is important to remember that a mutation produced by radiation is similar to one effected by a mutagenic chemical or to one occurring spontaneously.

The effects from occupational exposures to ionizing radiations are usually localized, leading to erythema or radiodermatitis. Among the long term effects are an increased incidence of carcinoma, as noted in the radium dial painters and uranium miners; the embryological effects, as noted in pregnant working women; the cataractogenic effects, as seen in certain radiologists and nuclear physicist; and shortening of the life span.

The applicable ionizing radiation occupational exposure standard is given in 10 CFR part 20 and, in general, limits exposures to a annual total effective dose equivalent to 5 rems (0.05 sieverts [SV]).

VI. RESULTS

A. Chemical Exposure

1. Analysis of Soldering Fumes

At the request of the NIOSH investigators, one of the employees soldered two wires on the switching rack. Thermal desorption tubes were used to collect the generated fumes during these events to determine the levels of VOCs. The employees used lead solder and plastic coated wires to make repairs to the switching racks whenever a problem was identified.

Trace levels of acetic acid, formic acid, toluene, xylenes, some oxygen-containing compounds and terpene/terpene derivative compounds were detected from the qualitative analysis of the thermal desorption tubes. Although the compounds detected could cause acute irritation of the eyes and mucous membranes, the short duration of the activity (repairs on the switching racks whenever necessary) would unlikely lead to chronic health problems. In the past, when this was a more frequent activity due to the larger number of switching racks, exposures to organic compounds would likely have been higher than what can be measured presently.

2. Analysis of Dust and Bulk Samples

A dust sample from under the rack and a sample of loose material from the cable vault under the floor were collected and analyzed for lead content. The dust sample contained 1.04% lead. The loose material was not homogeneous; three samples were analyzed and the percentage of lead varied from 0.94 to 5.76%. This indicates that employees are potentially exposed to lead. The need for soldering, however, has decreased with the introduction of wire wraps as a method for wire connection. Presently, soldering is done for repair of equipment only.

One bulk sample was submitted for fiber analysis using polarized light microscopy. No asbestos was detected. The fibrous contents were cellulose (3-5%) of the total material, glass fibers (<1%), and synthetic fibers (1-2%).

3. Impact of 1976 Building Fire

NIOSH investigators had no way to evaluate toxic emissions produced in the facility fire in 1976, and fumes/vapors present in the work environment for the period immediately following the fire. The building has been substantially remodeled since that time and no damage from the fire was evident.

B. Ventilation and Thermal Comfort

1. Temperature, Relative Humidity and CO_2

The HVAC systems that were examined were free of visible microbiological contamination and standing water, and appeared to be well maintained.
The results of the environmental evaluation are presented in Table 1. Indoor CO_2 concentrations in the office areas ranged from 275 to 675 ppm, well below the 1000 ppm guideline suggested by ASHRAE (ASHRAE, 1990). Outdoor CO_2 concentrations ranged between 275 to 350 ppm. Temperature measurements in the equipment work spaces ranged from 63 to 73ºF and in the office spaces from 71 to 75ºF. Relative humidities ranged from 53 to 77% (equipment areas) and 58 to 69% (office). According to ASHRAE guidelines, acceptable summer temperature and RHs for office areas are 72.5ºF-79.5ºF at 30-60% RH. Temperatures in the office areas were within accepted levels but the RHs were at or above current guidelines.

2. Questionnaires

Twenty-seven out of 75 questionnaires (36%) were returned and analyzed. The most common environmental concerns were lack of air circulation (eight [30%]), temperature extremes (11 [41%]), and fumes (three [11%]). The four most frequently reported symptoms were eye problems (12 [44%]), fatigue (seven [26%]), headache (five [19%]), and sinus congestion (four [15%]). Nine respondents reported no problems or symptoms.

3. Environmental Observations

During the walk-through, NIOSH investigators noticed small holes in the netting surrounding the ventilation system which allowed pigeons to roost in portions of the ventilation system. This creates the opportunity for organisms associated with the birds and their droppings to enter the ventilation system.

On the third floor, cables were located over the racks between the employees and the supply and exhaust diffusers. This arrangement blocked the movement of air.

Sulfuric acid leaks from the explosion proof caps of the batteries in the power room located on the fourth floor and is cleaned up about every six months. The employee used rubber gloves and neutralized the sulfuric acid with a mixture of baking soda and water. Figure 3 shows a worker performing cleaning procedures on the batteries.

Tobacco smoke from the second floor smoking area was observed flowing into the hallway and subsequently into the office spaces. Smoke tube testing documented that air flowed from the loading dock area up the two adjacent elevator shafts, which open on each floor. These shafts would provide a route for diesel exhaust to enter the building from the nearby loading dock.

C. EMF and Ionizing Radiation

At the opening conference, employees and union officials requested that, since little was known about EMF exposure levels at COFs, NIOSH investigators should obtain measurements throughout the COF. Results for the EMF phase of the evaluation were obtained from measurements made in the switching equipment room, general office locations, cable vault room, and near the microwave system operation. In addition, observations were noted from walk-through assessments on every floor of the facility.

1. EMF Assessment by Floors

Levels of ELF electric and magnetic fields were measured in general office areas as well as at non-office areas. The non-office areas could include switching (both new and old) and power rooms, cable vault areas, roof top locations, and various telephone equipment bins and racks. In evaluating the data collected, it should be noted that switching rooms, in various phases of activity, were located on the third, fourth, fifth, sixth, seventh, and eighth floors. The seventh and eighth floors contained the newest telephone exchange equipment. The differences between the old and new telephone equipment relates to the presence of a large number of electromechanical switching elements in the old equipment. All of the new telephone switching equipment was fabricated from solid state components that occupied less space and operated more efficiency. Power rooms were located on the fourth and eighth floors.

All data related to EMF levels by floor are summarized in Table 2 unless otherwise specified.

Waveforms were evaluated on every floor in the facility. All waveforms collected in typical office areas were of the normal sinusoidal varying 60 Hz type. However, waveforms captured in the switching room varied in frequency and complexity and consisted of 60 and 180 Hz fields superimposed with non-sinusoidal random pulses of 5 to 50 milliseconds (ms) in duration. Some typical waveforms from switching equipment used by the telephone company were obtained by NIOSH investigators at the Manhattan COF and are shown in Figures 4-5. While these results are not from White Plains, the equipment was similar, therefore these results are probably typical of what would have been measured had the values been recorded at White Plains COF.

a. Cable Vault Area Measurements

Measurements were performed in both the new and old basement area that housed the telephone cables that enter and exit the White Plains facility. The Holaday ELF E-field probe gave levels of which 7 ranged from 1.8 to 4 V/m and the 3-axis Holaday meter levels ranged from 0.2 to 7.3 mG along the main walkway in the vault. The NIOSH investigators were told that few telephone workers ever came into this area and it would be considered an area of low and infrequent occupancy.

b. First Floor Measurements

Limited measurements in office environments were performed on the first floor. The ELF electric field levels ranged from 1.8 to 4.8 V/m and the magnetic field levels ranged from 0.3 to 8.9 mG.

c. Second Floor Measurements

The ELF electric and magnetic fields on the 2nd floor were documented using a walk-through mode. The levels measured ranged from 1.8 to 15.5 V/m and 0.2 to 100 mG respectively. The following sources of ELF radiation were noted at second floor office locations on the evaluation dates:

- electric fans (different types)
- video display terminals
- power strips
- AM/FM radio/stereo systems
- wall and desk (alarm) clocks
- wall and space heaters
- television set with VCR
- computer modems
- illuminated signs
- photocopy machines
- FAX units
- pencil sharpeners
- desk lamps
- small refrigerator
- small hot plate
- microwave oven
- computer printers

d. Third Floor Measurements

Measurements on this floor were made in the MDF 1901, CO Equipment 1925, CO Equipment 1906, Toll Administration 1971, and Central Toll SSC 1973 areas. Measurements were performed in these areas over two shifts.

Fourteen AMEX dosimeters were placed either on or next to various telephone electronic components in the high bay switching areas. The placement of the dosimeters was chosen to simulate locations where workers were seen working by the NIOSH investigators (Figure 6). The mean magnetic field levels obtained from these dosimeters after a minimum of 1.5 hours exposure time ranged from 0.3 to 9.2 mG.

A NIOSH investigator wore a EMDEX ® II unit for 1.5 hours while performing measurement tasks on portions of the third floor. During this time period, magnetic field intensity levels ranged from 0.3 to 12.1 mG, with a median level of 1.8 mG. Table 3 gives further information on these EMDEX II measurements.

The Holaday ELF electric field meter values recorded on this floor ranged from 1.8 to 300 V/m. The high value was recorded near a soldering iron located on a moveable ladder (Figure 7). Measurements were also made with a VLF magnetic meter at close distances (about two inches) from various rack mounted equipment. These levels ranged from 0.1 to 2.3 mG.

The 3-axis Holaday magnetic field probe was used to document area levels found in the aisleway and near surfaces of electronic equipment. Levels ranged from 0.2 to 400 mG. The highest value was obtained on a EDS multiplex unit.

e. Fourth Floor Measurements

Measurements on this floor were made in the CO Equipment 1XBar 1925, Central/SO EM-SCC 1970, PVT Line Test Center 1956, and Power Room 1951 areas.

Fourteen AMEX dosimeters were placed either on or next to various telephone electronic components in the PVT Line Test Center 1956 area. The average magnetic field levels obtained from these dosimeters after 2.3 hours of exposure time ranged from 0.1 to 61.3 mG.

Four EMDEX ® II units were worn by NIOSH investigators, a union representative, and the corporate health and safety representative while positioned in the CO equipment 1X Bar 1925 and Power Room 1951 areas for about 2.3 hours. The levels recorded from these four units ranged from 1.94 to 291.3 mG (Table 3).

The 3-axis magnetic field probe was used to assess exposure in large segments of the Power Room 1951 and Central/SO EM-SCC 1970 areas (Figure 8). The highest magnetic field level measured in these areas, 100 mG, was found near a desk located immediately in front of the Power Room wall, and was probably from the Power Room. There were many office-related ELF-producing sources in these areas as well.

The Power Room area contains batteries and various AC power supplies for operating portions of the While Plains facility. Only one worker was in the Power Room. Levels of ELF electric and magnetic fields ranged from 5 to 15 V/m and from 0.2 to 2100 mG, respectively. The highest magnetic field reading occurred near a rectifier.

f. Fifth Floor Measurements

The #4ESS area was the only location evaluated on this floor. This air-conditioned area contained 13 racks of new electronic telephone equipment, which operated at 5 volts, DC (Figure 9). Using the walk-around area measurement approach for ELF fields, levels ranging from 1.8 to 5.3 V/m, and 0.2 to 200 mG, were measured. The 200 mG level was measured in a ring current circuit. This appeared to be an area of infrequent occupancy; since during measurement period only three workers were seen in this area doing repair work.

g. Sixth Floor Measurements

Measurements on this floor were made in the CO equipment IESS 1929, MDF 1963, MDF 1901, and CO equipment 4AToll 1915 areas.

Three EMDEX® II units were worn by NIOSH investigators and observers for different time periods while working on the floor. The magnetic field levels measured by the three EMDEX® II units ranged from 0.2 to 1313 mG. Table 3 gives further information on these EMDEX® II measurements.

Fourteen AMEX dosimeters were placed either on or next to electromechanical switching components in the CO Equipment IESS 1929 area (Figure 10). The average magnetic field level obtained from these dosimeters ranged from 0.56 to 7.25 mG.

The 3-axis Holaday probe was used to make walk-around measurements in the aisle of equipment racks and next to various electronic equipment. Magnetic field levels on this floor ranged from 0.2 to 6 mG. Some limited measurements were performed next to switching equipment with the Holaday VLF meters which gave values from 2 to 5.8 V/m and up to 30 mG. However, the dimensions of the meter prevented collection of data at locations close to the electronic components.

h. Seventh Floor Measurements

Measurements on this floor were performed in the DMS 100/200 area using the Holaday 3-axis probe. This area contained the newest state-of-the-art telephone switching equipment and operated at 48 volts. Using a walk-around approach, measured levels ranging from 0.2 to 20 mG were documented around the equipment and in the aisle. During the evaluation of this area, four workers were in the area pulling wire and connecting equipment. Electric field levels at the locations where the employees were working ranged from 2 to 6 V/m at waist levels.

i. Eighth Floor Measurements

Measurements on this floor were made in the Power Room and in the computer room next to the Power Room. The highest level measured in the Power Room was 2,000 mG next to a step down transformer while the maximum level found in the computer room was 20 mG. Both of these areas were assessed using a walk-around technique.

j. Roof

The ELF levels on the roof were 2 to 3 V/m and 1-3 mG. As noted previously, a microwave dish antenna, part of the DR-18 (Digital Radio-18 GHz) system used to receive and transmit signals at less than one watt, was mounted to a small structure on the roof. NIOSH investigators did not have a detector available on the days of the evaluation to perform microwave measurements.

2. Personal EMF Dosimetry

Table 3 summarizes the results obtained from eight workers, on three floors, using EMDEX® II dosimeters. The mean results from three floors ranged from 1.90 to 6.73 mG. Figure 11 shows a typical time-intensity distribution for one of these dosimeters. It is quite apparent from Figure 11 that workers undergo a change of exposure with time as they move in and out of proximity to various AC electrical devices. Exposure levels (grouped by floors in Table 3) show very little difference in mean and median values; however, the maximum levels can vary substantially depending on location.

3. Ionizing Radiation

Since large banks of RaBr tubes were no longer available, company data was used to review previous exposure. An estimate of the relative radiation intensity that could be achieved from a array of tubes containing radium versus the replacement tube with Kr-85 is shown in Table 4.

This information is the only published data that was found concerning radiation levels produced by these WEC manufactured tubes. If one uses the above data under the worst possible condition (i.e., body in contact with an array of RaBr tubes), the body would be exposed to 160 milliroentgens (mR) in a 40-hour week (4 mR/hr x 40 hrs). This potential exposure level exceeds the ionizing radiation safety regulations in effect in 1960. For example 160 mR/wk x 13 wks = 2080 mR or 2.08 rems. The maximum permissible external exposure for the whole body permitted in 1960 was 1.25 Rems/quarter (13 wks). In making these assumptions several things should be noted: a) exposure to whole body could have reached 3 rem in a given quarter provided the accumulated dose did not exceed 5(n-18) rems where n stands for individual age in years, b) ionizing records are maintained, c) personnel were near these tube arrays only part of the time. If workers were in contact with these RaBr tube arrays for only 60% of their work time, they would still have exceeded the applicable radiation exposure standard. NIOSH investigators believe that actual exposure times to the RaBr tubes was probably less than in either of the above senarios. However, management and union officials informed NIOSH investigators that, in the past, it was possible that employees carried RaBr tubes in their shirt pocket. If that did occur, contact with the chest would be constant.

Radium emits 75% of its total energy as alpha particles, 17% as beta radiation, and 8% as gamma radiation. The alpha particle contribution may be disregarded when considering sources <u>inside a tube</u> since they do not penetrate the tube wall. This is a very important point if workers would ever have to work around a tube(s) that are broken. Worker and union officials both reported poor hygiene practices employed when dismantling old phone equipment containing these tubes, with numerous tubes being broken during their removal. Representatives from the NYNEX Health and Safety Office informed the NIOSH investigators that on two different occasions in 1987 tubes of this type have broken and caused local exposure concerns.

NIOSH investigators evaluated the worksite for possible ionizing radiation contamination at several locations in the White Plains COF, where workers informed us that radioactive tubes previously were used, to determine if a radiation risk from possible broken tubes in the past existed at the worksite. There was no evidence of radioactive material on the floor at either the White Plains or Yonkers facility or on the racks at the Yonkers COF that had contained the tubes.

While a major effort was expended in the 60's to replace the RaBr tubes, the NIOSH investigators found these tubes in use at a NYNEX facility as late as 1992. NIOSH investigators measured the few remaining radioactive tubes present in the Yonkers COF (Table 5). While the absolute value of the measurements made in Table 4 and 5 are different, these results do clearly demonstrate three points. First, the specially marked RaBr tubes gave much higher radiation levels than the Kr-85 tubes. Second, the drop-off in radiation activity is quite similar to that reported in the telephone company report. Third, RaBr tubes were in use in 1992 in at least one COF. While it is true that the exposure to radium bromide tubes at the White Plains facility can only be hypothesized since no tubes were seen there on the days of evaluation, it is likely that some ionizing radiation exposure occurred at all COFs where the cross-bar switches were present from the large banks of tubes (i.e. 5 rows of 12 tubes = 60 tubes per array per rack) associated with this equipment.

In summary, the NIOSH investigators conclude that exposure to ionizing radiation from RaBr tubes could have occurred from carrying tubes in clothing, broken tubes, and working near tubes arrayed in racks. The contribution to total exposure from each of these routes is not known. However, it seems apparent from observations, interviews with employees, and discussion with past and present company officials that workers could have been exposed to radiation, at some level, from one or all of the above routes.

4. Medical Evaluation

Present employees identified 12 cases of cancer that were diagnosed since 1978 among workers on the third floor. No cancer type predominated. Reported cancers diagnoses included testicular, male breast, stomach, leukemia, female breast, female breast and cervix (same patient), cervical, melanoma, two colon cancers, stomach, and a dermatofibrosarcoma. These cases were identified by the requestors and other employees. In addition, there was one worker who reported the removal of "atypical" cells from her colon. The case of male breast cancer was diagnosed in a worker in 1978. Of the 12 cancer cases, two new cases of cancer were diagnosed in 1991 and there were two fatalities during 1991.

The NYNEX physician reported that he had no records of employee cancers in the past, since those records were sent directly to AT&T. He was unaware of any unusual clusters of cancer at the other facilities in the company.

The number of employees on the floor has steadily fallen from a high of about 100 in the mid-1980s to about 30 at the time of the site visit. The workers have felt that there is a concentration of cancers at this location, and the Union informed the investigators that this increase is not being reported at other telephone central office locations. However, the union could provide no specific data about cancer incidence at other sites.

D. Facility Safety and Ergonomics

1. Electrical Shock

Employees who performed cable wiring functions at the COF reported many incidents of electrical shock, sometimes involving high voltage, as a result of their work. Employees reported that current was high enough to "melt" screwdrivers if they touched the wrong wires, particularly in the vicinity of transformers used in telephone equipment.

The ceiling cables carrying the current to the equipment racks were previously maintained either by AT&T or Western Electric before 1984, and by an outside contractor from 1984-1992. Installation and maintenance of these cables were switched to NYNEX employees starting in 1992. During interviews, employees reported they had not received adequate training for this particular job function since training was done on the basis of seniority and the least senior employees had received no formal training.

Workers told NIOSH investigators that they cannot wear electrical insulated gloves since they reduce dexterity and increase hand sweating. They do wear company issued half-gloves (finger tips cut off), which means they can be in contact with small electrical currents. In the course of their work, some telephone employees were required to handle and connect current carrying telephone cables to various switches and devices. Figure 12 shows a typical setup of the worker's hand making connection to a board with the tip of the right index finger. As mentioned earlier, the voltage impressed on the telephone cable is mainly 48 volt DC, but there are other voltages found in the COF that are higher than 48 volts, and the telephone cables can carry varying amounts of current. Using a Fluke model 8060A digital multimeter, NIOSH measured the current in cables that workers connected to frames and found levels in the range of 1 to 10 milliamperes (mA). The foreman of that area stated that cable current levels around 1 mA DC could be typical for that type of work.

2. Microscope Use

While making ELF measurements in the #4ESS area, located on the 5th floor, NIOSH investigators observed a worker performing repair/refurbish functions using a microscope, shown in Figure 13. The worker had to use a microscope in order to better visualize the work task. It should be noted that this particular work area does not house any of the older switching equipment, but rather, contains the latest state-of-the-art telephone equipment. This observation suggests the need for Health and Safety personnel to be aware that such work practices are being performed, and that its continued use may warrant further study for possible ergo-ophthalmological issues such as visual fatigue, restricted work movements, and possible neck/arm pain.

3. Use of Ladders

Around the telephone wiring racks, workers were observed carrying equipment while standing on ladders that moved along rail racks. No chocks (to prevent movement of ladders when employees were climbing on them) were evident although management reported that they were available. In addition, active soldering irons were mounted on the ladders since they were used by employees to do extensive soldering with lead solder as part of their duties. In recent years, the use of solder on the "frames" has largely been superseded by the use of frame "wire wrap connectors" which connect the line to a junction terminal using special tools and the continuing use of soldering may be a questionable work practice. In addition, the presence of soldering irons mounted on the ladders raises concerns about trip and burn hazards.

4. Availability of Material Safety Data Sheets

During the course of this evaluation several workers indicated to the NIOSH representatives that they knew Material Safety Data Sheets (MSDSs) existed but they were unaware of their location.

VII. DISCUSSION

A. Ventilation and Thermal Comfort

While the CO_2 measurements suggested that the office work areas were receiving adequate amounts of outside air on the day of the survey, due to the low occupancy of the equipment areas, CO_2 is probably not a good indicator for acceptable ventilation. The majority of the temperature and RH pairings in the equipment areas were outside the ASHRAE comfort ranges for operative temperature and humidity. The areas that were outside the ASHRAE thermal comfort range generally had low temperatures. The temperatures in these areas were kept low for the benefit of the telephone equipment. In the office areas, temperatures were within accepted levels but the RHs were at or above current guidelines. The higher RH conditions could contribute to the perception by employees of the environment being "too hot" or "too stuffy".

The lead content in the loose material and dust from the vicinity of the soldered rack suggests that there is a potential exposure to lead via inhalation and ingestion. Trace amounts of chemicals associated with soldering were found but were unlikely to be in violation of occupational standards because of the short duration of the exposure.

B. EMF Exposures at White Plains COF

1. Exposure

Table 2 summarizes all 42,991 EMF measurements made at the White Plains Facility by instrument and building location. Within the ELF region the electric field measurements ranged from 1.8 to 300 V/m and the magnetic field measurements ranged from 0.1 to 2100 mG. In the VLF region the corresponding levels were 2 to 5.8 V/m and 0.1 to 30 mG. All documented values are below present applicable occupational exposure limits.

It has been shown in a previous study that telecommunication (i.e., telephone) workers tend to work in a variety of different environments that have different ELF exposures associated with them (Rainier, 1992). That study collected more than 1200 hours of monitoring data from 249 workers in nine states over a six month period. Based on the 1.5×10^6 data points collected by using a EMDEX C magnetic monitor, the mean exposures and standard errors were determined for a variety of telephone company work environments (Table 6). The mean value of 2.23 mG given for the Central Office in Table 6 can be compared with mean levels ranging from 1.90 to 6.73 mG found in Table 3 of this evaluation.

In this evaluation, two major groups of workers were occupationally exposed to ELF. The first group included office workers who received their exposure from close proximity to electrical equipment/devices found in office work (i.e., video display terminals, electric typewriters, etc.). Exposure to these office sources, at frequencies near 60 hertz (Hz), are usually at a distance of 1 to 2 feet and occur throughout the workday. Exposure to these types of office sources is almost impossible to prevent since the equipment that produces such fields is universally used. However, as shown on page 19, not all of these office sources found at White Plains would be considered "work-essential" by the NIOSH investigators. The presence of non "work-essential" sources, or at least the reason for their use, should be re-evaluated by all parties concerned about overall potential exposure to electric and magnetic fields. Prior to the 1960's, most of these office sources were not in general use.

The second major group of workers receiving potential ELF exposure were those employees having job tasks requiring them to be near, or come into contact with, old/new electronic equipment/devices found in switching and power rooms. Figures 14-18 clearly shows the diverse nature, positioning, and location of these sources. Exposure to these sources are generally restricted to three foot wide racks located on both sides of walkways. In the past, exposure to these types of sources may have been higher or more frequent because of the need for connecting, wiring, and repairing large numbers of them. However, occupational exposure today is generally limited to short time periods for two reasons: a) little maintenance is required for the operating systems, and b) built-in system redundancy for switching components permits circuits to complete "electrical paths" without the need for worker intervention. Major changes in equipment design and power consumptions, a decreased number of workers in the area, and greater use of electrical switching components are but some of the reasons why present day exposure levels may differ from those of the past. An example of this different exposure pattern was observed by the NIOSH investigators during the visit to an older telephone COF in Yonkers, N.Y. One of the workers at White Plains recalled that, in the past, a small step-up transformer was mounted over some of the D1 Carrier equipment racks. However, such a transformer was not seen over the D1 Carrier racks at White Plains but was found at the Yonkers COF. Measurements of the magnetic field levels from this transformer at several locations indicated that at close distances to the transformer, levels of 10 mG and higher were documented.

In another HHE (91-058), NIOSH investigators obtained frequency and waveform information on electromechanical switching equipment that was still in use at a Manhattan COF, and probably representative of past exposure at White Plains. While the complete results of that study are not yet available, some preliminary information has been obtained that shows that such transient ELF fields can and do occur from these switches. The magnitude, frequency, polarization, and initiation of these transient magnetic fields produced by the older electromagnetic switching units are complex and difficult to evaluate. All measurements were made with appropriate wave form capture equipment with sensors in close proximity (1-2 inches) to the switches. Most of the peak frequency components were with non-sinusoidal random pulses of 5 to 50 milliseconds duration with a magnitude up to 250 mg. Whether exposure to these frequencies, at this magnitude and duration, is of biological significance has yet to be determined. It should be noted that in many cases, the magnetic fields had the highest intensity levels at frequency values less than 30 Hz. This suggests that using the EMDEX ® II dosimeter to measure these fields would underreport the magnetic field magnitude since these meters do not respond below 30 Hz. A more complete evaluation of these so-called transient fields will be given in the NIOSH HHE report of this project (91-058).

In a letter published in Lancet, Matanoski (1991) reported that men who worked in telephone central office switching environments were subject to a different pattern of ELF exposure, characterized by transients, than other types of telephone workers. The letter further states that "the rapid on and off switching of this machinery produced a complex field environment". She also stated "...the excesses of male breast cancer which have been observed in workers potentially exposed to EMF may fit theories that EMF exposures can change melatonin diurnal rhythms and thus lead to changes in the incidence of specific cancers." No further information was presented about this hypothesis. Although NIOSH investigators did document these transient fields in the Manhattan HHE, the presence of ionizing radiation at COFs and the possibility that workers carried the radioactive tubes in their shirt pocket, might possibly confound any hypothesis relating transient exposure to cancer, since the radioactive tubes were used along with the electromechanical switches.

2. Cancer and EMF Exposure

The cancers reported at New York Telephone are some of the more common types, particularly female breast, colon, and leukemia as well as some less common types such as dermatofibrosarcoma, melanoma, and male breast cancers. One possible explanation is that the finding of these cancers at the telephone company is a chance occurrence and not due to any workplace exposure at all. Some of these types of cancers, however, have been linked by studies to occupations in which EMF exposure is presumed to have occurred. These include telecommunication workers, electric utility workers, electricians, and the electronics industry workers, although the data are, in many cases, contradictory and inconclusive. Specifically, research has shown relationships between the following occupations and cancer: melanoma in telecommunication workers (Vagero, 1985, DeGuire 1988), male breast cancer in telephone workers and electricians (Matanoski, 1989), telephone linemen and communication workers (Demers et al, 1991), leukemia in electricians (Stern, 1986), and brain cancer in electrical engineers and telephone workers (Loomis, 1990). Negative associations were reported for leukemia and brain cancer among all studied electrical workers in Sweden (although certain subgroups of electrical workers did have statistically significantly increased standardized mortality ratios) (Tornqvist, 1991) and for leukemia among U.S. Navy personnel possibly exposed to EMF (Garland, 1990). In most studies, EMF exposure is presumed to have occurred based on the nature of the work performed by the studied population, without measurement of actual exposure. In addition, some studies can be faulted due to the small numbers in some of the cohorts and improper identification of jobs performed by individuals in the studied groups. In the three earliest studies, EMF is not even mentioned as a possible etiology for the cancers, and only in later analyses is EMF exposure presumed.

Although NIOSH investigators have conducted measurements of present- day levels of EMF at the White Plains COF, EMF exposure may have changed markedly with the introduction of the new solid-state equipment in the 1980's, which replaced equipment utilizing vacuum tubes, and the elimination of the crossbar switching technology. NIOSH investigators attempted to find worksites utilizing the older, tube type, carrier equipment but were unable to do so. Therefore, it was impossible to assess the past EMF exposures that would have been relevant to recent cases of cancer (the period between exposure and diagnosis is typically 10-20 years for most cases).

Besides the unavailability of past exposure data, a definitive epidemiologic study at this site is precluded for other reasons. First, defining the population at risk and identifying cases are particularly difficult in this worker group because the work force has shrunk dramatically with the introduction of the newer solid-state equipment and many employees have either been transferred or retired. Second, neither the union nor NYNEX management has records of employees that are specific for a given floor or job duty.

The role of EMF in the development of cancer cannot be studied in a relatively small workforce, such as a single Central Office. The choice of the study and its design should reflect what is known about the problems with existing studies of EMF. Specifically, a study of EMF should involve a well defined cohort of workers with a quantifiable exposure, obtainable employment records and with a cohort size that is large enough so the study has sufficient statistical power to detect increases in incidence of cancers that are common in the population (such as colon, female breast, and leukemia).

C. Ionizing Radiation and Leukemia

While NIOSH investigators have no way to reliably quantify past exposure to ionizing radiation from radium or krypton tubes, it is possible that the presence of ionizing radiation would confound any study of EMF and cancer that included COF employees. This awareness that RaBr existed at all COFs, including White Plains, has direct bearing on previous studies of COF employees. A paper by Matanoski et. al (1993), reported a possibly elevated rate of leukemia among telephone linemen, including central office workers, and reported that there were "no important exposures to potentially leukemogenic agents in this population." The findings of RaBr tubes raises doubts as to the validity of the above statement. Ionizing radiation is a well-established leukemogen and a known human carcinogen.

D. Facility Safety Observations

1. Electric Shock

Contact with live electric wires was found to be a regular part of the job of persons working with equipment at the telephone company. As noted in the results section, this exposure may be to both high voltage and low voltage current. Apparently, many years ago the telephone company attempted to reduce this problem of electric shocks by installing plastic covers around the various cable cabinets, but this method of control was ended since work could not be properly performed with the plastic covers in place (Figure 19).

The usual entry of electrical current into the body is through the skin. The resistance of the skin varies with its thickness and condition at site of contact, i.e., wet or dry conditions. A well-calloused, dry hand can have a resistance of 1 million ohms (Megohm), while a moist hand's resistance may be as low as 1000 ohms (Booney, 1978).

A limitless number of human electrical sensation thresholds can be defined depending upon the location selected on the body and the nature of the contacts made with the body location. No thresholds can be said to apply to all individuals. The tongue, for example, can detect as low as 4 microamperes (μA) of direct current (Keeney, 1970). Cuts or even needle punctures on hands or fingers significantly decrease the current required for perception, and currents almost too small to measure can often cause pronounced pain when they flow in an open cut or wound. The realistic evaluation of what constitutes a safe human threshold for electrical stimulation requires data on the minimal amount of electric current that is just strong enough to produce some type of measurable physiological response. The information that does exist on this topic originates from sources such as the perception of electric current flow, uncontrollable muscular contraction, and death. Most of this type of biological information is based on acute exposure scenarios, such as stimulation of nerve, skeletal muscle, and cardiac muscle. Adequate quantitative data for other responses, such as might occur in chronic, low current or low voltage exposure situations, are not available.

Dalziel reported that a value of less than 1 mA DC produces no sensations on hands of males. He also reported that the human (male) perception threshold for DC current is 5.2 mA. (Dalziel, 1956). Therefore, based on these values and the limited human current levels measured by NIOSH, it is reasonable to expect that some workers may not might perceive electricity while others may.

Under present OSHA standards, as described in Section 1910.303, live parts of electrical equipment operating below 50 volts are not required to be guarded against possible contact by workers during their job.
However, the standard is based on the applied voltage and not on the magnitude of electrical current passing through the body. In this evaluation, the dominant voltage that workers contact is 48 volts DC, and such exposure would not fall under OSHA coverage. However, 48 volt DC is not the only voltage present in telephone circuits and some voltages can be much greater.

VIII. CONCLUSIONS

The results of this HHE revealed that present-day occupational exposure to ELF and VLF electric and magnetic fields were maintained below occupational standards. Based on previous research by NIOSH investigators of older telephone equipment and the similarities to the equipment found at White Plains, transient electric fields are likely to be found at close distances from older telephone equipment, still in existence, that utilizes electromechanical switches. The presence of tubes containing radium bromide was documented in COF facilities and it was possible that workers at COFs were exposed to ionizing radiation. These tubes are no longer found in the White Plains COF. There was a constant risk of shocks from 48-volt currents and workers reported occasional shocks from higher voltage equipment.

Only trace levels of chemicals were found during the soldering procedure, and ventilation in occupied office areas was found to be adequate, based on studies of CO_2 levels in the worksite.

While there were reported cases of cancer at the White Plains facility, a definitive epidemiologic investigation of cancer COF workers would require a larger group of workers in the study than what is found at White Plains (and any other single facility) and consideration of ionizing radiation as a potential causative exposure. Such a study is beyond the scope of the NIOSH HHE program.

IX. RECOMMENDATIONS

The following recommendations are offered to reduce potentially significant occupational exposures and safety risks at the White Plains facility of NYNEX:

1. NIOSH investigators were informed that almost all equipment utilizing radioactive vacuum tubes have been replaced, or are scheduled to be replaced, with more modern equipment. Until such time that the replacement is complete, all existing RaBr tubes in the phone company should be eliminated immediately and replaced with the less radioactive krypton tubes.

2. Management should minimize the exposure of employees to microwave radio transmission. While it is not likely that the system at the phone company would represent a major occupational exposure concern, it is recommended that the NYNEX Health and Safety office determine the levels of microwave emission and notify NIOSH investigators, the union, and applicable workers as to their findings. Until exposure levels are determined, NIOSH investigators recommend that the microwave systems should not be transmitting when employees are on the roof near the transmitters.

3. Greater emphasis should be placed on worker safety, particularly when new job duties or equipment are introduced. Chocks should be available on ladders. Wires containing higher voltages should be labelled to prevent workers from mistaking them from lower voltage telephone wires.

4. The potential for electrical shock can be real and needs to be evaluated particularly for higher voltage situations. Training programs that deal with electrical hazards should be enhanced.

5. Hazard communication training should be improved in the area of EMF. Employees should be aware of the existence and location of MSDSs as required by OSHA.

6. The holes in the net covering the ventilation system intakes should be repaired to prevent birds from entering the system.

7. The areas near the outside air intakes for the office building should be kept clear of potential sources of contaminants such as bird droppings, dead birds, and feathers. If future cleaning of these areas is required, the waste products and other bird debris should first be disinfected prior to removal. Wetting this debris with a 10% hypochlorite (chlorine) in water solution should provide acceptable disinfection. Employees removing this debris should wear NIOSH approved air purifying respirators equipped with high efficiency particulate air (HEPA) cartridges. To avoid contamination of the duct work and air handling units, the HVAC systems should not be operated while these contaminated areas are disinfected and cleaned.

8. Smoking should not be allowed in the work environment. If this approach is not implemented, a separate smoking area should be designed to meet the current ASHRAE guidelines of negative pressure to the rest of the building, 60 cfm of supply air per person, and direct exhaust to the outside to prevent smoke from entering the ventilation system (ASHRAE, 1990). Suggestions to eliminate or restrict smoking in the workplace are found in the NIOSH "Current Intelligence Bulletin 54: Environmental Tobacco Smoke in the Workplace: Lung Cancer and Other Health Effects"(NIOSH, 1991).

9. The loading dock area should be separated from the freight elevators by a barricade, such as swinging doors, to prevent the migration of vehicle exhaust up the elevator shafts. Engines should be shut off at the loading dock.

10. To reduce lead exposure, employees should use good personal hygiene techniques, such as no eating, smoking, or drinking until washing their hands.

X. REFERENCES

ACGIH [1992]. 1992-1993 Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

. ACGIH [1989]. Guidelines for the assessment of bioaerosols in the indoor environment. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.

ASHRAE [1990]. Ventilation for acceptable indoor air quality. Atlanta, GA: American Society of Heating, Refrigerating, and Air-conditioning Engineers. ANSI/ASHRAE Standard 62-1989.

ASHRAE [1981]. Thermal environmental conditions for human occupancy. Atlanta, GA: American Society for Heating, Refrigerating, and Air-conditioning Engineers. ANSI/ASHRAE Standard 55-1981.

Anderson K, Walker A, Boyd G [1989]. The long-term effect of a positive pressure respirator on the specific antibody response in pigeon breeders. Clinical and Experimental Allergy 19(1):45-49.

ATSDR [1990]. Toxicological profile for lead. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, DHHS (ATSDR) Publication No. TP-88/17.

Baker DB [1989]. Social and organizational factors in office building-associated illness. Occupational Medicine: State of the Art Reviews 4(4):607-624.

Bonney SC [1978]. Electrical injuries. Occupational Safety and Health Symposia, U.S. Department of Health, Education and Welfare, Cincinnati, Ohio, DHEW (NIOSH) Publication No. 78-169, pp 236-247.

Bourke SJ, Banham SW, Carter R, Lynch P, Boyd G [1989]. Longitudinal course of extrinsic allergic alveolitis in pigeon breeders. Thorax 44(5):415-418.

Boxer PA [1990]. Indoor air quality: a psychosocial perspective. J Occup Med 32(5):425-428.

Burge HA [1989]. Indoor air and infectious disease. Occupational Medicine: State of the Art Reviews 4(4):713-722.

Burge S, Hedge A, Wilson S, Bass JH, Robertson A [1987]. Sick building syndrome: a study of 4373 office workers. Ann Occup Hyg 31:493-504.

Cassidy G [1960]. Radioactive krypton in cold cathode tubes. The Western Electric Engineer 4:29-31.

CDC [1992]. NIOSH recommendations for occupational safety and health: Compendium of policy documents and statements. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 92-100.

Code of Federal Regulations [1989]. OSHA Table Z-1-A. 29 CFR 1910.1000. Washington, DC: U.S. Government Printing Office, Federal Register.

Code of Federal Regulations [1992]. OSHA lead standard. 29 CFR, Part 1910.1025. Washington, DC: U.S. Government Printing Office, Federal Register.

Dalziel CF [1956]. The effects of electrical shocks on man. IRE Transactions on Medical Electronics (PGME-5).

De Guire L, Theriault G, Iturra H, Provencher S, Cyr D, Case BW [1988]. Increased incidence of malignant melanoma of the skin in workers in a telecommunications industry. Br J Ind Med 45:824-828.

Demers PA, Thomas DB, Rosenblatt KA, Jimenez LM [1991]. Occupational exposure to electromagnetic fields and breast cancer in men. Am J Epdemiol 134(4):340-7.

DHHS [1990]. Healthy people 2000: national health promotion and disease objectives. Washington, DC: U.S. Department of Health and Human Services, Public Health Service, DHHS Publication No. (PHS) 91-50212.

Fanger PO [1989]. The new comfort equation for indoor air quality. ASHRAE J 31(10):33-38.

Gammage RR, Kaye SV, eds [1985]. Indoor air and human health: Proceedings of the Seventh Life Sciences Symposium. Chelsea, MI: Lewis Publishers, Inc.

Garland FC, Shaw E, Gorham ED, Garland CF [1990]. Incidence of leukemia in occupations with potential electromagnetic field exposure in United States Navy personnel. Am J Epidemiol 132(2):293-303.

Geller EI, Worden FX, Cassidy G, Bartholomew CY [1961]. Personnel Protection Program for Industrial Use of Krypton-85. Am Ind Hyg Assoc J 22(5):403-408.

Haghighat F, Donnini G, D'Addario R [1992]. Relationship between occupant discomfort as perceived and as measured objectively. Indoor Environ 1:112-118.

Hathaway GJ, Proctor NH, Hughes JP, Fischman ML [1991]. Chemical Hazards of the workplace. 3rd. Edition. New York; Van Nostrand Rinehold.

Hernberg S, Dodson WN, Zenz C [1988]. Lead and its compounds. In: Zenz C., Occupational Medicine: 2nd Ed., Chicago, IL: Year Book Medical Publishers, pp. 547-582.

Hernberg S, et al [1988]. Lead and its compounds. In: Occupational medicine. 2nd ed. Chicago, IL: Year Book Medical Publishers.

Keeney JC, Letcher FS [1970]. Human thresholds of electric shock at power transmission frequencies. Arch Env Hlth 1(7):547-552.

Kreiss K [1989]. The epidemiology of building-related complaints and illness. Occupational Medicine: State of the Art Reviews 4(4):575-592.

Kreiss KK, Hodgson MJ [1984]. Building associated epidemics. In: Walsh PJ, Dudney CS, Copenhaver ED, eds. Indoor air quality. Boca Raton, FL: CRC Press, pp. 87-108.

Landrigan PJ, et al [1985]. Body lead burden: summary of epidemiological data on its relation to environmental sources and toxic effects. In: Dietary and environmental lead: human health effects. Amsterdam: Elsevier Science Publishers.

Loomis DP, Savitz DA [1990]. Mortality from brain cancer and leukemia among electrical workers. Br J Ind Med 47(9):633-8.

Matanoski, G [1989]. The Hopkins Telephone worker study. Health and Safety Report 7:3-4.

Matanoski GM, Breysse PN, Elliott EA [1991]. Electromagnetic field exposure and male breast cancer. Lancet 337:737.

Matanoski GM, Elliott EA, Breysse PN, Lynberg MC [1993]. Leukemia in telephone linemen. Am J Epi 137(4):609-619.

Mendell MJ, Smith AH [1990]. Consistent pattern of elevated symptoms in air-conditioned office buildings: a reanalysis of epidemiologic studies. Am J Public Health 80(10):1193-1199.

Molhave L, Bach B, Pedersen OF [1986]. Human reactions during controlled exposures to low concentrations of organic gases and vapours known as normal indoor air pollutants. Environ Int 12:167-175.

Morey PR, Shattuck DE [1989]. Role of ventilation in the causation of building-associated illnesses. Occupational Medicine: State of the Art Reviews 4(4):625-642.

NIOSH [1978]. Occupational exposure to inorganic lead. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHEW (NIOSH) Publication No. 78-158.

NIOSH [1981]. Occupational health guidelines for chemical hazards. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 81-123, and supplements 88-118, 89-104.

NIOSH [1984]. Elements (ICP): method no. 7300. In: Eller, PM, ed. NIOSH manual of analytical methods. 3rd Rev. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 84-100.

NIOSH [1986]. Occupational respiratory diseases. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 86-102.

NIOSH [1991]. Hazard evaluation and technical assistance report: Library of Congress Madison Building, Washington, D.C. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Report No. HETA 88-364-2104 - Vol. III.

NIOSH [1991]. Building air quality: a guide for building owners and facility managers. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 91-114.

NIOSH [1991]. Current intelligence bulletin 54: environmental tobacco smoke in the workplace: lung cancer and other health effects. Cincinnati, Ohio: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication 91-108.

Norbäck D, Michel I, Widstrom J [1990]. Indoor air quality and personal factors related to the sick building syndrome. Scan J Work Environ Health 16:121-128.

Schulte PA, Ehrenberg RL, Singal M [1987]. Investigation of occupational cancer clusters: theory and practice. AJPH 77(1):52-56.

Pollack H [1983]. Medical aspects of exposure to radiofrequency radiation including microwaves. S Med J 76(6):759-765.

Ranier D, et al [1992]. An electromagnetic field exposure measurement study for the telecommunications industry. Bell communications Research (Bellcore), Research Study #SR-TSV-002341.

Richerson HB, Bernstein IL, Fink JN, Hunnunghake GW, Novey HS, Reed CE, Salvaggio JE, Schuyler MR, Schwartz HJ, Stechschulte DJ [1989]. Guidelines for the clinical evaluation of hypersensitivity pneumonitis. Journal of Allergy and Clinical Immunology 84(5):839-844.

Robertson AS, McInnes M, Glass D, Dalton G, Burge PS [1989]. Building sickness, are symptoms related to the office lighting? Ann Occup Hyg 33(1):47-59.

Skov P, Valbjørn O, Pedersen BV [1989]. Influence of personal characteristics, job-related factors, and psychosocial factors on the sick building syndrome. Scand J Work Environ Health 15:286-295.

Skov P, Valbjorn O [1987]. Danish indoor climate study group. The "sick" building syndrome in the office environment: the Danish town hall study. Environ Int 13:399-349.

Slonim NB [1988]. Occupational asthma. Journal of Asthma 25(5):293-299.

Stern FB, Waxweiler RA, Beaumont JJ [1986]. A case-control study of leukemia at a naval nuclear shipyard. Am J Epidemiol 123:980-992.

Theriault GP [1991]. Health effects of electromagnetic radiation on workers: epidemiologic studies. Proceedings of the Scientific Workshop on the Health Effects of Electric and Magnetic Fields on Workers January 30-31, 1991: U.S. Department of Health, Education, and Welfare, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, NIOSH Publication No. 91-111, NTIS PB-91-173-351/A13.

Tornqvist S, Knave B, Ahlbom A, Persson T [1991]. Incidence of leukemia and brain tumors in some "electrical" occupations. Br J Ind Med 48(9):597-603.

Vagero D, Ahlbom A, Olin R, Sahlsten S [1985]. Cancer morbidity among workers in the telecommunications industry. Br J Ind Med 42:191-195.

Wallace LA, Nelson CJ, Dunteman G [1991]. Workplace characteristics associated with health and comfort concerns in three office buildings in Washington, D.C. In: Geshwiler M, Montgomery L, and Moran M, eds. Healthy buildings. Proceedings of the ASHRAE/ICBRSD conference IAQ'91. Atlanta, GA: The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.

Woods JE, Drewry GM, Morey PR [1987]. Office worker perceptions of indoor air quality effects on discomfort and performance. In: Seifert B, Esdorn H, Fischer M, et al, eds. Indoor air '87, Proceedings of the 4th International Conference on Indoor Air Quality and Climate. Berlin Institute for Water, Soil and Air Hygiene.

XI. AUTHORSHIP AND ACKNOWLEDGEMENTS

Report Prepared by:	Robert Malkin Supervisory Epidemiologist Medical Section Nancy Clark-Burton Industrial Hygienist Industrial Hygiene Section C. Eugene Moss Health Physicist Industrial Hygiene Section Hazard Evaluation and Technical Assistance Branch Divison of Surveillance, Hazard Evaluations and Field Studies
Analytical Support:	Division of Physical Sciences and Engineering
Technical Support:	Don Booher Industrywide Studies Branch Division of Surveillance, Hazard Evaluations and Field Studies
Originating Office:	Hazard Evaluations and Technical Assistance Branch
Report Typed by:	Ellen E. Blythe Tamme Ottlinger Office Automation Assistants

XII. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report may be freely reproduced and are not copyrighted. Single copies of this report will be available for a period of 90 days from the date of this report from the NIOSH Publications Office, 4676 Columbia Parkway, Cincinnati, Ohio 45226. To expedite your request, include a self-addressed mailing label along with your written request. After this time, copies may be purchased from the National Technical Information Service (NTIS), 5285 Port Royal Rd., Springfield, VA 22161. Information regarding the NTIS stock number may be obtained from the NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. New York Telephone Company
2. Union
3. OSHA, Region II
4. Confidential Employee Requestors

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

Table 1
Indoor Air Quality Data
New York Telephone Company
White Plains, New York
July 27-29, 1992
HETA 92-0009

Location	Time (ppm)	CO_2 (°F)	Temp (%)	RH	No. of Occupants	Comments
			Second Floor			
Office Area- Inquiries- Central Area	9:17	575	73.3	59.5	2	
	1:12	425	72.8	59.9	2	
	4:45	---	72.1	60.9	0	
Office Area- Inquiries- Toward Windows	9:19	675	73.2	59.0	5	man-cooling fans on each desk
	1:14	375	72.9	58.6	5	
	4:47	---	72.7	59.2	0	
Office Area- Inquiries- Rear Wall	9:23	575	74.6	58.2	4	
	1:16	400	73.8	58.2	4	
	4:49	---	73.0	58.9	0	
Office Area- Digital Services	9:26	525	73.4	59.6	0	
	1:10	425	71.9	62.7	2	
	4:53	---	73.5	59.3	0	
Office Area- Digital Services	9:31	525	72.9	62.1	0	
	1:10	425	72.3	61.5	5	
	4:53	---	72.9	60.6	0	
Outside	9:40	300				
	1:18	275	77.5	66.0		
			Third Floor			
Open Area- Desks	7:36	625	67.7	60.0	1	
	12:47	325	67.7	60.6	1	
	4:59	350	68.1	58.7	0	
Soldered Rack Area-Rear Wall	7:40	425	67.1	75.3	0	
	12:50	300	67.6	73.8	0	
	5:01	---	67.1	73.4	0	
Soldered Rack- Center Area Between Racks	7:41	425	67.9	77.0	0	
	12:52	300	67.1	73.7	0	
	5:02	---	67.0	73.4	0	
Soldered Rack- End Area Between Racks	7:45	425	67.0	72	0	
	12:54	275	66.5	69.3	0	
	5:03	---	66.4	68.1	0	
Electronic Switch Racks (390-392)	7:59	325	66.6	64.5	0	
	12:55	275	66.9	64.3	0	
	5:04	---	65.9	64.9	0	

Table 1-Continued

Electronic Switch Racks (318)	8:04	325	68.0	64.6	0
	1:01	300	70.4	59.8	0
	5:06	---	68.7	65.2	0

Electronic Switch Racks (394A)	8:07	325	73.2	58.3	0	ceiling covered by cables
	1:05	325	71.6	60.6	0	
	5:09	---	74.2	55.0	0	
Electronic Switch Racks (3014)	8:10	300	74.4	53.0	0	man-cooling fan
	12:58	325	71.8	60.0	0	
	5:07	---	70.0	58.0	0	
Fourth Floor						
Equipment Power Room	8:39	300	64.3	58.8	0	temperature controlled for equipment
	12:26	350	63.0	62.0	0	
	LOCKED					
Battery Power Room	8:45	300	68.7	64.0	0	
	12:22	350	68.6	66.3	0	
	5:12	---	70.4	61.0	0	
Fifth Floor						
Switch-Open Area	8:50	300	70.0	70.2	1	
	12:31	300	68.5	72.6	0	
	5:15	---	68.1	71.4	0	
Sixth Floor						
Clicking Switch-Central Area	8:57	325	69.8	63.4	1	
	12:35	325	69.6	60.0	0	
	5:18	---	67.9	63.0	0	
Clicking Switch-Central Work Area	9:01	300	70.3	60.3	2	
	12:37	300	68.7	63.3	0	
	5:20	---	68.7	62.1	0	
Clicking Switch-Rear Work Area	9:05	300	72.0	57.3	1	
	12:39	300	70.8	58.6	0	
	5:21	---	69.3	59.4	0	
Renovated District Office	9:10	300	72.7	65.0	3	window open
	12:41	325	70.4	69.3	0	
	5:21	---	71.4	66.3	0	

Table 2
Summary of All EMF Measurements Recorded with Different Equipment
New York Telephone Company
White Plains, New York
July 27-29, 1993
HETA 92-0009

Location	Holaday ELF		Holaday VLF		Holaday ELF (mG)	Amex (avg) (mG)	EMDEX ® II (logged) (mG)	EMDEX ® II (monitor) (mG)
	V/m	mG	V/m	mG				
Vault Area	1.8-4(7)				0.2-7.3(8)			0.3-6.2(7)
1st floor	1.8-4.8(3)				0.3-8.9(25)			0.8-15.4(20)
2nd floor	1.8-15.5(10)	3-35(15)			0.2-100(77)			0.4-80(32)
3rd floor	1.8-300(10)			0.1-2.3(33)	0.2-400(230)	0.3-9.2(14)	0.3-12.1 (3154)	0.3-300(20)
4th floor	5-15(7)				0.2-100(150)	0.1-61.3(14)	0.2-291.3 (23514)	0.2-2100(55)
5th floor	1.8-5.3(7)				0.2-200(33)			0.3-100(8)
6th floor			2-5.8(4)	0.1-30(10)	0.2-6(220)	0.6-7.3(14)	0.2-1313 (15161)	0.6-222(45)
7th floor	2.0-6.0(6)				0.2-20(31)			0.4-17(12)
8th floor					0.3-880(6)			0.2-2000(15)
Roof	2.0-3.0(3)							1.0-3.0(10)
Totals	1.8-300(53)	3-35(15)	2-5.8(4)	0.1-30(43)	0.2-880(780)	0.1-61.3(42)	0.2-1313 (41829)	0.2-2100 (225)

mG = milligauss V/m = volts per meter

TOTAL MEASUREMENTS 42,991
Range: **VLF** Electric (E) field: 1.8 - 300 V/m **ELF** E field: 2 - 5.8 V/m
Magnetic (H) field: 0.1 - 30 mG H field: 0.1 - 2100 mG

Table 3
EMDEX ® II Dosimeter Results
New York Telephone Company
White Plains, New York
July 27-29, 1992
HETA 92-0009

Dosimeter Measure	Location (Floor)	Minimum (mG)	Median (mG)	Mean & Std. Deviation (mG)	Maximum (mG)	Geo.Mean & Geo.Std Deviation (mG)	Data Points (N)	Fraction exceeding		
								2 mG	4 mG	10 mG
1	3	0.3	1.8	1.90±1.37	12.1	1.41±2.40	3154	.450	.054	.004
2	4	0.2	1.9	3.12±4.08	47.3	1.70±3.07	5847	.471	.246	.055
3	4	0.2	0.6	1.94±5.97	140.7	0.97±2.65	5890	.282	.079	.011
4	4	0.2	0.8	4.32±14.63	291.3	1.14±4.18	5865	.335	.199	.083
5	4	0.2	1.3	5.17±20.43	281.7	1.31±3.67	5912	.345	.143	.057
6	6	0.2	2.2	3.17±3.82	37.1	2.35±1.97	4747	.624	.126	.058
7	6	0.2	2.5	2.35±0.73	5.9	2.16±1.62	1954	.873	.024	.000
8	6	0.2	0.6	6.73±61.67	1313	0.77±2.80	8460	.118	.070	.030

mG = milliguass

TABLE 4
RADIATION LEVEL FROM RaBr and Kr85 TUBES AT DIFFERENT DISTANCES
American Telephone and Telegraph Data
New York Telephone Company
White Plains, New York
July 27-29, 1993
HETA 92-0009

Distance from Array (inches)	Milliroentgen Per Hour	
	RaBr	Kr-85
0 (contact)	4.0	0.15
2	2.5	0.10
4	0.7	0.03

(Cassidy, 1960)

TABLE 5
RADIATION LEVEL FROM RaBr and Kr85 TUBES AT DIFFERENT DISTANCES
NIOSH Data
New York Telephone Company
White Plains, New York
July 27-29, 1993
HETA 92-0009

Distance from Array (inches))	Milliroentgen Per Hour	
	RaBr	Kr-85
contact	66.7	1.2
3	7.6	0.35
6	3.3	0.1

TABLE 6
MEAN EXPOSURE AND STANDARD ERRORS (mG) FOR VARIOUS WORK ENVIRONMENTS
AT&T MEASUREMENTS
New York Telephone Company
White Plains, New York
July 27-29, 1993
HETA 92-0009

Work Environment	Mean	Standard Error
Telecommunication Vault	8.21	1.23
Shared Pole	4.65	0.59
Residence Premises	2.30	0.15
Business Premises	3.27	0.48
Central Office	2.23	0.23
Work Center	1.66	0.15
Work Area Setup	3.24	0.18
Travel	2.26	0.09
Lunch/Break	1.82	0.13

(Rainier, 1992)

mG = milliguassn