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Case Studies

Evaluation of a Narcotic Evidence Holding Room

Dawn Tharr, Column Editor

Reported by Nancy Clark Burton

The National Institute for Occupational Safety and Health (NIOSH) received a confidential request from employees working at a State Police Division of Narcotics Enforcement for a health hazard evaluation (HHE) of the narcotics evidence holding room. The HHE requesters expressed concern over employees' exposures to degrading samples of chemicals, drugs, and plant materials collected from clandestine methamphetamine laboratories and other narcotics cases. They also reported that there were three recently diagnosed cancer cases among narcotics enforcement staff, and several employees had severe headaches while at the workplace.

Background

The evidence storage room was located in a single-story office building with other businesses on either side. There was an office area with open and individual offices in the front half of the building. The back half of the building was open warehouse space; it contained the evidence room, the employee break area, and storage. Two evidence room clerks worked in the evidence room as needed, which could be from eight to 40 hours a week. Occasionally, detectives also worked in the evidence room. Eight administrative employees also worked in the building, and field detectives frequently visited the office.

The front office area was served by two package heating, ventilating, and air-conditioning (HVAC) units on the roof. One of these HVAC units was not operating at the time of the site visit. Conditioned air was supplied to the office area through unlined ducts, and some of the air was recirculated from an open ceiling plenum. There were fire walls between the businesses. The walls of the evidence room did not go to the ceiling, and there were areas that were open to the ceiling plenum. There was no provision of supply air to the warehouse area that included the evidence room and employee break area. The evidence room had a ceiling exhaust fan that was controlled by a toggle switch outside the room. The employees kept the evidence room door open when working in the room. One of the evidence room clerks occasionally wore Tyvek™ overalls and rubber gloves to clean the evidence room with a U.S. Environmental Protection Agency (EPA)-approved biocide.

At the time of the site visit, the evidence room contained drug evidence from 1983 to the present. Evidence could only be destroyed by court order after all of the associated legal cases were completed. Some of the more unusual drugs were kept for training purposes. The agency had a contract with the local hospital to destroy the evidence using incineration. In 1998, there were approximately 370 clandestine laboratory investigations conducted by narcotics agents. There were eight individuals on the laboratory team. Personal protective equipment (PPE) used in the field to collect samples included Level A Tychem™ suits, self-contained breathing apparatus (SCBA) respirators, rubber gloves, and shoe covers. During each investigation, the investigators usually collected 8 to 10 analytical samples in plastic bottles, glass vials, or plastic bags. A hazardous waste disposal company had a contract to remove any remaining substances at the investigation site. After the analyses were completed by the police analytical laboratory, samples were returned to the evidence room for storage. Marijuana was also stored in the evidence room.

Methods

Qualitative Analysis of Volatile Organic Compounds (VOCs)

To look for volatile organic compounds (VOCs) that might be associated with clandestine drug laboratories, eight area air samples were collected, in the evidence room, break area, and office area, on thermal desorption tubes containing three beds of sorbent material. The samples were analyzed for VOCs according to NIOSH Method 2549 using a Tekmar thermal desorber interfaced directly to a gas chromatograph and a mass-selective detector (TD-GC-MSD).[1]

Ethyl Ether

Five area air samples were collected in the evidence room, break area, and office area for ethyl ether, which is used in illicit phencyclidine (PCP) laboratories. The area air samples were collected at a flow rate of 0.05 liters per minute (L/min) using charcoal tubes, and were analyzed for ethyl ether according to NIOSH Method 1310 using gas chromatography with a flame ionization detector (GC/FID).[2] For this data set, the analytical limit of detection (LOD) was 0.0005 milligrams (mg), which is equivalent to a minimum detectable concentration (MDC) of 0.007 parts per million (ppm), assuming a sample volume of 22.2 liters. The limit of quantitation (LOQ) was 0.002 mg, which is equivalent to a minimum quantifiable concentration (MQC) of 0.03 ppm, assuming a sample volume of 22.2 liters.

Cocaine Air Samples

Five area air samples for cocaine dust were collected at a flow rate of 2 L/min using 2-micrometer (μm) polytetrafluoroethylene (PTFE) filters. The filters were desorbed in methanol and analyzed for cocaine using GC/FID. Liquid standards were used by the contract analytical laboratory for comparison. The analytical LOD was 0.02 mg, which is equivalent to an MDC of 0.02 ppm, assuming a sample volume of 870 liters. The LOQ was 0.06 mg, which is equivalent to an MQC of 0.07 ppm, assuming a sample volume of 870 liters.

Cocaine Wipe Samples

A new analytical method was attempted in order to look at possible surface contamination. Seven wipe samples were collected from the shelves and computer work area in the evidence room. Mixed cellulose ester filters (0.8-μm 37-millimeter [mm]) were moistened with methanol, and a 10-cm by 10-cm area was wiped. The filters were transferred to vials in the field. Unexpectedly, at the analytical laboratory, the filters totally dissolved in the methanol. The solutions were refrigerated for three days to precipitate out insoluble material. The supernatants were decanted, and one-milliliter aliquots from each sample were placed in separate vials. These aliquots were dried, and the resultant solids were dissolved in methylene chloride. These solutions were analyzed for cocaine using GC/FID. Liquid standards were spiked onto filters for comparison. The analytical LOD and LOQ were 0.05 mg/sample and 0.2 mg/sample, respectively. The method had a low recovery level (20%) for the spiked filters, most likely due to the fact that the filters were soluble in methanol.

Inorganic Acids

Five area air samples for acids were collected in the evidence room, break area, and office area at a flow rate of 0.05 L/min using silica gel tubes. The samples were analyzed for hydrofluoric acid, hydrochloric acid, hydrobromic acid, nitric acid, phosphoric acid, and sulfuric acid, according to NIOSH Method 7903 using ion chromatography.[3] The analytical MDCs for hydrofluoric acid, hydrochloric acid, hydrobromic acid, nitric acid, phosphoric acid, and sulfuric acid were between 0.004 and 0.09 milligrams per cubic meter (mg/m^3), assuming a sample volume of 22.8 liters. The MQCs were 0.1 to 0.31 mg/m^3, assuming a sample volume of 22.8 liters. Sample concentrations were field-blank corrected.

Indoor Environmental Quality Measurements

Carbon dioxide (CO_2), temperature, and relative humidity (RH) measurements were collected using a Q-Track^{TM} Model 8550 IAQ Monitor. This portable, battery-operated instrument monitors CO_2 through nondispersive infrared absorption, with a range of 0–5,000 ppm and a sensitivity of $\pm$ 50 ppm. It also directly measures dry bulb temperature (range: 32°F–122°F) and RH (range: 5%–95%). Instrument calibration was performed prior to use. The CO_2 sensor malfunctioned during the evaluation; therefore, data was only collected for temperature and RH.

Microbial Assessment

Two bulk dust samples were collected from the shelves of the evidence room. The dust samples were submitted for culturable fungal analysis, and were processed, extracted, and inoculated on two percent malt extract agar (MEA) and dichloran glycerol (DG-18) media. The plates were incubated at 25°C, and the taxa and ranks of the organisms were identified.

Occupational Exposure to Narcotics and Other Drugs During Law Enforcement Activities

There have been some studies of occupational exposures to drugs and their components during law enforcement activities. The identified routes of exposure for workers were inhalation and skin absorption from collecting, analyzing, and packaging/repackaging the drug samples. There are no occupational exposure limits for the drugs that law enforcement officers and evidence room clerks may encounter.

A retrospective cohort study was undertaken of law enforcement chemists (journal subscribers) and clandestine laboratory investigation team members in Washington State.[4] The study had a low response rate (46/270 chemists and 13/23 team investigators). Symptoms reported were headache, as well as skin, respiratory, and mucous membrane irritation, which usually occurred during chemical analysis.

NIOSH conducted HHEs in the mid-1980s to evaluate potential occupational health hazards associated with the seizure of clandestine drug laboratories by the Drug Enforcement Administration (DEA).[5] Five of eight forensic chemists reported headaches when working on clandestine laboratory evaluations. Also, four narcotics agents reported headaches when investigating clandestine laboratories in the field. The NIOSH researchers recommended that PPE including chemical protective suits and SCBA be worn for all situations. Training on the hazards associated with the wide range of chemicals that can be found in clandestine laboratories was also stressed. An evaluation of the Hazardous Substances Emergency Events Surveillance (HSEES) system maintained by the Agency for Toxic Substances and Disease Registry (ATSDR) found that from 1996 to 1999, 112 reported events were associated with methamphetamine (0.5% of total reported).[6] Fifty-three percent of the events resulted in "injuries" to the first responders. Injuries reported included respiratory irritation, eye irritation, nausea and vomiting, dizziness/central nervous system symptoms, shortness of breath, and chemical burns. Police officers were most likely to report these problems. Recommendations included the increased use of PPE, training on the hazards associated with methamphetamine laboratories, and establishing decontamination processes.

One study evaluated exposures to cocaine from handling crime scene evidence.[7] The investigators were responsible for inspecting, fingerprinting, and analyzing the cocaine samples, and reportedly wore latex gloves during this work. Urine samples were collected and analyzed for cocaine and benzoylecgonine (a metabolite). Two investigators had detectable levels of cocaine and benzoylecgonine in their urine after analyzing evidence. These two compounds were not detected in urine samples collected at the beginning of the workday. Laboratory managers, who were used as controls, had no detectable urine concentrations of the two chemicals.

In one instance, three individuals died as a result of phosphine gas exposure while making methamphetamine in a motel room.[8] Officers entered the room without PPE and determined the individuals were dead. Follow-up assistance from a clandestine laboratory task force and a hazardous materials team found levels of phosphine gas greater than 0.3 ppm in the area of the apparatus. This level exceeded the current NIOSH, Occupational Safety and Health Administration (OSHA), and American Conference of Governmental Industrial Hygienists (ACGIH®) full-shift time-weighted average (TWA) exposure limits of 0.3 ppm, but not the NIOSH short-term exposure limit (STEL) of 1 ppm.

Another investigation looked at exposures to PCP while handling investigative samples.[9] The investigators found that one police department chemist had detectable concentrations of PCP in his/her blood six months after the last known exposure, and another chemist had detectable concentrations of PCP in his/her blood despite the use of a laboratory hood for sample processing. The issue of recreational usage was not addressed.

Chemical Hazards from Drug Storage

There are no published articles that specifically address the storage of drugs and chemicals in evidence rooms. Clandestine laboratories use several different methods to manufacture drugs; therefore, it is difficult to predict the chemical hazards that will be encountered during the initial investigation. Most of the small clandestine laboratories in the Midwest manufacture methamphetamine using the sodium ammonia or "Nazi" method. The Nazi formula of methamphetamine production utilizes ephedrine/pseudoephedrine reduction, as well as sodium or lithium metal and other dangerous chemicals such as anhydrous ammonia, hydrochloric acid, sulfuric acid, sodium hydroxide, antifreeze (ethylene glycol), or drain cleaner (sodium hydroxide) in the process. Sodium metal is a fire hazard and will ignite upon contact with water. This production technique has spread throughout the Midwest since anhydrous ammonia is readily available because of its widespread use as an agricultural fertilizer. Another common production method uses red phosphorus instead of anhydrous ammonia. A more detailed list of the potential chemicals that can be used in methamphetamine laboratories and stored in the evidence room is provided in Appendix A.[10]

For cocaine laboratories, potential chemical hazards include allyl benzene, calcium oxide, ethanol, hydrochloric acid, petroleum ether, and sodium metal. For PCP, potential chemical hazards include benzene, ethanol, piperidine, cyclohexanone, ethyl ether, sodium bisulfite, hydrochloric acid, iodine, sodium cyanide, bromobenzene, and magnesium metal.

Ethyl ether. Ethyl ether is used in illicit PCP manufacturing. It is also used as an anesthetic, and as a solvent in the production of dyes, plastics, and rayon. It can cause eye and respiratory irritation. At high concentrations, it can cause central nervous depression, which can include headache, nausea, vomiting, drowsiness, dizziness, and narcosis. Ethyl ether is considered a mild skin irritant. The OSHA Permissible Exposure Limit (PEL) and ACGIH Threshold Limit Value (TLV®) for ethyl ether are both 400 ppm as an 8-hour TWA over the work shift.[11,12] ACGIH® has also established an STEL of 500 ppm.[11] NIOSH does not have an occupational exposure limit for ethyl ether.[13]

Sulfuric acid. Sulfuric acid can be used in clandestine methamphetamine laboratories. It is a primary irritant, and is corrosive in high concentrations.[14,15] It will cause chemical burns when in contact with the skin and mucous membranes, and is particularly hazardous to the eyes. Ingestion of sulfuric acid will result in severe throat and stomach destruction.[14] The NIOSH REL, OSHA PEL, and ACGIH TLV for sulfuric acid are all 1 mg/m^3 as a TWA over the work shift.[11–13]

Hydrochloric acid. Hydrochloric acid can be used in the production of methamphetamine, cocaine, and PCP. It is an irritant of the eyes, mucous membranes, and skin. NIOSH, OSHA, and ACGIH® have all established a 5-ppm ceiling limit for exposure to hydrochloric acid.[11–13]

Indoor Environmental Quality

Scientists investigating indoor environmental problems believe that there are multiple factors contributing to building-related occupant complaints.[16,17] 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.[16–18]

With few exceptions, pollutant concentrations observed in the indoor work environment fall well below the NIOSH, OSHA, and ACGIH published occupational standards or recommended exposure limits. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building ventilation and thermal comfort guidelines.[19,20] ACGIH® has also developed a manual of guidelines for approaching investigations of building-related symptoms that might be caused by airborne living organisms or their effluents.[21] Measuring ventilation and comfort indicators such as CO_2, temperature, and RH is useful in the early stages of an investigation in providing information relative to the proper functioning and control of HVAC systems.

ASHRAE's most recently published ventilation standard, ASHRAE 62-1999, *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 15 cfm/person for reception areas, classrooms, libraries, auditoriums, and corridors.[20] The American National Standards Institute (ANSI)/ASHRAE Standard 55-1992 specifies conditions in which 80 percent or more of the occupants would be expected to find the environment thermally acceptable.[19] Assuming slow air movement and 50 percent RH, the operative temperatures recommended by ASHRAE range from 68°F to 74°F in the winter, and from 73°F to 79°F in the summer. The difference between the two is largely due to seasonal clothing selection. ASHRAE also recommends that RH be maintained between 30 and 60 percent.[19] Excessive humidities can support the growth of microorganisms, some of which may be pathogenic or allergenic.

Cancer Clusters

Cancer is a group of different diseases that have the same feature—the uncontrolled growth and spread of abnormal cells. Each type of cancer may have its own set of causes. Many factors play a role in the development of cancer. The importance of these factors is different for different types of cancer. Most cancers are caused by a combination of factors that interact in ways that are not fully understood. Some of the factors include: (a) personal characteristics such as age, sex, and race; (b) family history of cancer; (c) diet; (d) personal habits such as cigarette smoking and alcohol consumption; (e) the presence of certain medical conditions; (f) exposure to cancer-causing agents in the environment; and (g) exposure to cancer-causing agents in the workplace. In many cases, these factors may act together or in sequence to cause cancer. Although some causes of some types of cancer are known, we certainly do not know everything about the causes of cancer. This can be frustrating to researchers and to people whose lives have been affected by it.

Cancers often appear to occur in clusters, which scientists define as an unusual concentration of cancer cases in a defined area or time. A cluster also occurs when the cancers are found among workers of a different age or sex group. The cases of cancer may have a common cause, or may be the coincidental occurrence of unrelated causes. The number of cases may seem high, particularly among the small group of people who have something in common with the cases, such as working in the same building. In many workplaces, the number of cases is small. This makes it difficult to detect whether the cases have a common cause, especially when there are no apparent cancer-causing exposures.

When cancer in a workplace is described, it is important to learn whether the reported location of a cancer in the body represents the primary site or a metastasis (spread of the primary cancer into other organs). For occupational cancer investigations, the primary site is used for looking further into specific types of cancer. To assess whether the cancers among employees could be related to occupational exposures, the number of cancer cases, the types of cancer, the likelihood of exposure to potential cancer-causing agents, and the timing of the diagnosis of cancer in relation to the exposure should be considered.

Results/Discussion

Volatile Organic Compounds (VOCs)

All of the air samples contained low levels of similar compounds. The major identified compounds include toluene, siloxanes, heptanes, perchloroethylene, a mixture of C_9–C_{12} aliphatic hydrocarbons and alkyl benzenes, trichloroethylene, methyl propanoic acid esters, ethylene glycol, propylene glycol, butanol, butyl cellosolve, limonene, methanol, 1,1,1,-trichloroethane, and isopropanol. Some of these chemicals have been associated with clandestine laboratories (toluene and ethylene glycol); however, they have other sources, and have been found in the air in nonindustrial buildings. Others could be substances that were created during the manufacturing process.

Ethyl Ether

The area air sampling results for ethyl ether were all nondetected. Ethyl ether was not detected in the area air samples at an MDC of 0.007 ppm.

Cocaine Area Air Samples

The area air sampling results for cocaine were nondetected. Cocaine was not detected in the area air samples at an MDC of 0.02 mg/m^3.

Cocaine Wipe Samples

Cocaine was not detected in any of the seven wipe samples that were collected at an LOQ of 0.05 mg/sample. It is difficult to interpret these data since the analytical method, which was used for the first time, had a very low recovery rate (20%).

Inorganic Acids

Low levels of hydrofluoric acid (up to 0.04 ppm), hydrochloric acid (trace levels), and sulfuric acid (up to 0.11 ppm) were found on the day of the survey. Hydrobromic acid, nitric acid, and phosphoric acid were not detected in the samples at MDCs of 0.004 mg/m^3, 0.004 mg/m^3, and 0.09 mg/m^3, respectively.

Bulk Dust Samples

The fungal species identified from the loose material on the shelves in the evidence room were *Eurotium (Aspergillus) repens, Eurotium (Aspergillus) rubrum, Aspergillus versicolor*, and *Cladosporium cladosporioides.* Total fungal counts ranged from 1.4×10^3 to 8.2×10^3 colony-forming units per gram. The counts of these organisms were low, and all of the fungi are commonly found in indoor environments. The *Eurotium* species are associated with household dust; *Aspergillus versicolor* organisms are associated with wet indoor environments; and *Cladosporium* species are very common in moist outdoor and indoor environments.

Observations

There was a strong odor of organic material in the evidence room and surrounding office areas. Some of the evidence in powder form was stored in heat-sealed plastic bags within manila envelopes. Some of these bags were coming open during storage. The evidence room clerks reported that mice chew holes in the bags of marijuana. A dead mouse was observed on a shelf during the survey. Some of the aisles were blocked, creating a trip hazard.

Smoke tube patterns showed that there was no air movement in the back areas of the evidence room (away from the exhaust fan). Some of the individuals who worked in the evidence room reported developing headaches while working in that area. Inside the evidence room, and in the break area, the morning temperature was 79°F, and the RH was 61 percent. The outside temperature was 82°F, and the RH was 79 percent. The inside temperature measurement was at the top of the suggested range of 73–79°F in the summer, and the inside RH measurement exceeded the ASHRAE guidelines of relative humidity of 30 and 60 percent RH.(19)

Cancer

Three cases of cancer were reported during the site visit (one breast and two non–Hodgkins lymphoma). Two of the three individuals worked in the narcotics department for less than two years. The other individual had worked more than 10 years as a field investigator.

Cancer is common in the United States, and occurs among people at any workplace. One in two men and one in three women will develop some type of cancer in their lifetimes. One of every four deaths in the United States is from cancer. These figures show the unfortunate reality that cancer occurs more often than many people realize. When several cases of cancer occur in a workplace, they may be part of a true cluster (when the number is greater than we expect compared to other groups of similar people with regard to age, sex, and race). While comparing the expected number of people with cancer with the observed number is sometimes done to assess whether the occurrence of cancer in a particular group is unusual, such a comparison is often not very informative, particularly in the early phases of a cluster investigation. Cancer rates are extremely variable in small populations and rarely match the overall rate for a larger area (i.e., the state), so that, for any given time period, some groups of people have cancer rates above the overall rate, and others have rates below the overall rate. So, even when there is an excess, this may be completely consistent with the expected random variability in cancer rates. Focusing on other aspects of the perceived cluster, as described below, is usually more helpful. These considerations address more directly the possibility of a link between the reported cancers and the work environment.

The time between first exposure to a cancer-causing agent and clinical recognition of the disease is called the latency period. Latency periods vary by cancer type, but are usually 15 to 20 years. In some instances, the latency period may be shorter, but it is rarely less than 10 years. Because of this, past exposures are more relevant than current exposures as potential causes of cancers occurring in workers today. Often, these exposures are difficult to document.

Cancer clusters thought to be related to a workplace exposure usually consist of the same types of cancer. When several cases of the same type of cancer occur in a workforce, and that type is not common in the general population, it is more likely that an occupational exposure is involved. When the cluster consists of multiple types of cancer, without one type predominating, then an occupational cause of the cluster is less likely.

The relationships between some agents and certain cancers have been well established. For other agents and cancers, there is suspicion, but no definitive evidence. When a known or suspected cancer-causing agent has been present, and the types of cancer occurring have been linked with these exposures in other settings, the connection between cancer and a workplace exposure is more likely. This was not the case at this facility.

Conclusions

The ventilation for the evidence room is inadequate. There is no provision of outside air to the evidence room or back warehouse area where the employee break area is located, and the smoke tube tests showed no air movement in the back portion of the evidence room. In addition, one of the HVAC units for the front office area was not working at the time of the site visit. Openings near the ceiling of the evidence room resulted in air mixing with the open ceiling plenum, which serves the front office area. Odors from the evidence room were also prevalent in the office areas. No hazardous exposures to chemicals or fungi were found. The reported health symptoms could be related to the odors or the inadequate ventilation. The occurrence of three cases of two different types of cancer over a period of three years (in two cases within two years of starting work) is not suggestive of an occupational origin.

Recommendations

1. Mechanical ventilation should be provided to the warehouse area to afford employees with comfortable working conditions.(19) ASHRAE recommends a minimum of 20 cubic feet per minute per person of outside air.(20)
2. There are no ventilation guidelines specifically for evidence rooms. Based on general laboratory recommendations developed for the use and storage of chemicals, the evidence room should have a dedicated HVAC unit that maintains the room at negative pressure and provides approximately six air changes per hour (ACH), a portion of which should be outside air.(22) The air should be exhausted directly to the outside, away from occupied areas. Ideally, the air should be supplied in two

locations at either end of the room and exhausted from the center.

3. The HVAC unit for the front office area should be repaired, and a comprehensive preventive maintenance program should be developed to ensure that the ventilation systems work properly.
4. The evidence room should be sealed to minimize air mixing between the evidence room and the office areas.
5. The evidence room should be cleaned and organized to eliminate trip hazards from boxes in the walkways.
6. Liquid chemicals should be stored in appropriate commercially available chemical storage cabinets.
7. Employees should continue to report any adverse health symptoms to their supervisors when they occur, and seek appropriate medical attention if symptoms persist.
8. All evidence should be appropriately sealed and protected from rodents, in order to avoid surface contamination and potential employee exposures.

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Appendix A

Chemicals Associated with Methamphetamine Laboratories[13]

Acetaldehyde
Acetic Acid
Acetic Anhydride
Barium Sulfate
Benzaldehyde
Benzyl Chloride
Carbon Disulfide
Ethyl Aldehyde
Formamide
Formic Acid
Hydrogen Gas
Hydrogen Iodide
Hydrogen Peroxide
Lithium Aluminum Anhydride
Magnesium Metal
Mercuric Chloride
Methylamine
Palladium Metal
Perchloric Acid
Phenylacetic Acid
Phenyl-2-Propanone
Phosphorus Pentachloride
Pyridine
Sodium Cyanotrihydroborate
Thionyl Chloride

EDITORIAL NOTE: Nancy Clark Burton is with the Division of Surveillance, Hazard Evaluations, and Field Studies of NIOSH. More detailed information on this evaluation is contained in Health Hazard Evaluation Report No. 99–0252–2831, available through NIOSH, Hazard Evaluation and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, OH 45226; telephone: (800) 35–NIOSH; fax: (513) 533–8573.