California State University, Northridge

THE NEED FOR A UNIFORM METHOD OF INVESTIGATION
OF DOMESTIC CARBON MONOXIDE INCIDENTS

A thesis submitted in partial satisfaction of the
requirements for the degree of Master of Science in
Health Science
by
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The thesis of Daniel R. Esposito is approved:

________________________________________
Committee Chairman

California State University, Northridge
January, 1973
Dedicated
to
Joan
and
Our Family
Gena, Daniel, Patrice, David
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>APPROVAL PAGE</strong></td>
<td>ii</td>
</tr>
<tr>
<td></td>
<td><strong>DEDICATION</strong></td>
<td>iii</td>
</tr>
<tr>
<td></td>
<td><strong>ACKNOWLEDGEMENT PAGE</strong></td>
<td>iv</td>
</tr>
<tr>
<td></td>
<td><strong>TABLE OF CONTENTS</strong></td>
<td>v</td>
</tr>
<tr>
<td></td>
<td><strong>LIST OF TABLES</strong></td>
<td>vii</td>
</tr>
<tr>
<td></td>
<td><strong>ABSTRACT</strong></td>
<td>viii</td>
</tr>
<tr>
<td>I</td>
<td><strong>INTRODUCTION</strong></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Statement of the Problem</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Limitations of the Study</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Importance of the Study</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Definitions of Significant Terms Used in this Study</td>
<td>6</td>
</tr>
<tr>
<td>II</td>
<td><strong>REVIEW OF THE LITERATURE</strong></td>
<td>8</td>
</tr>
<tr>
<td>III</td>
<td><strong>METHOD</strong></td>
<td>22</td>
</tr>
<tr>
<td>IV</td>
<td><strong>RESULTS AND DISCUSSION</strong></td>
<td>27</td>
</tr>
<tr>
<td>V</td>
<td><strong>SUMMARY, CONCLUSIONS AND RECOMMENDATIONS</strong></td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Summary and Conclusions</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Recommendations</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td><strong>BIBLIOGRAPHY</strong></td>
<td>59</td>
</tr>
</tbody>
</table>
APPENDIX

I. Cover Letter to Local Health Departments . . 64

II. Questionnaire Form . . . . . . . . . . . . . . . . . . . . 65

III. Local Health Departments and CO
    Investigative Methods . . . . . . . . . . . . 66
LIST OF TABLES

Table                                                                 Page

I. Carbon Monoxide Incidents in Residential Units                      39

II. Carbon Monoxide Incidents and Characteristics of Gas Heaters     41

III. Carbon Monoxide Incidents and Maintenance Characteristics of Gas Appliances 43
ABSTRACT

THE NEED FOR A UNIFORM METHOD OF INVESTIGATION
OF DOMESTIC CARBON MONOXIDE INCIDENTS

by

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Master of Science in Health Science

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It was the purpose of this study to determine if there was uniformity in the methods of investigation of domestic carbon monoxide incidents conducted by local public health agencies.

Carbon monoxide poisoning, long recognized as an occupational health problem, is receiving increased attention by public health officials as a domestic health problem.

Annually in the United States, medical attention is required for approximately 10,000 persons and 1,400 persons expire as a result of exposure to carbon monoxide in the residential environment.

For this study a questionnaire survey of about one-half of the forty-six (46) local public health depart-
ments in California revealed that 67% of these agencies conduct investigations of domestic carbon monoxide incidents. Varying differences in the procedures by these agencies, for the reporting of investigative data and testing of suspected gas appliances for emission of carbon monoxide, were noted.

As a result of this study, it was recommended that: local public health departments should investigate domestic exposures to carbon monoxide; these investigations should be conducted by Environmental Management personnel; the completeness of the investigative data to be reported relating to victim, dwelling unit and gas appliance is more important than the type of investigative form on which the data is recorded; the suspected gas appliance should be subjected to testing by a direct-reading instrument that will give an almost instant reading of the approximate maximal level of carbon monoxide gas generated.
Chapter I
INTRODUCTION

Carbon monoxide or CO is a colorless, odorless, tasteless, and deadly gas. It is produced by the incomplete combustion of carbon or compounds that contain carbon. Under ideal conditions of combustion, very small amounts of the gas are produced, and these are quickly dissipated. However, if the gas is not dissipated, concentrations of 0.01 per cent or 100 parts of gas per one million parts of air inhaled for more than eight hours can produce ill effects.

Carbon monoxide is an asphyxiant gas that is dangerous to health because of its affinity for the hemoglobin of human red blood cells. This affinity is approximately 300 times that of oxygen. Expressed in another manner, a given concentration of carbon monoxide in air will compete for the hemoglobin of the blood on equal terms with 300 times its concentration of oxygen.

The ill effects of carbon monoxide upon the human body are commonly called carbon monoxide poisoning. However, the diagnosis of carbon monoxide poisoning can be difficult unless the attending physician is aware of patient exposure to the gas. Many of the symptoms associated with carbon monoxide poisoning are similar to...
symptoms of other illnesses. A person exposed to low concentrations of the gas over prolonged periods might experience headaches, dizziness, nausea, anemia, weakness, confusion, nervousness, and irritability. Many deaths and injuries occurring as a result of carbon monoxide poisoning are not being reported as such because carbon monoxide is not suspected or recognized. Thus, many carbon monoxide incidents may go undetected.

Carbon monoxide poisonings constitute a significant public health problem. Each year in the United States, nearly 10,000 persons exposed to CO are reported to require medical care, and about 1,400 persons are diagnosed as dying from CO poisoning with 70% of the deaths occurring in the home\(^\text{(10)}\). Most deaths occur in the winter months or heating season and seem to be related to the use of gas heating equipment.

In addition to deaths resulting from carbon monoxide poisoning, there is potential hazard to humans in the daily exposure to low concentrations of CO in the home and work environment. Physical health and existing illnesses can be affected by frequent or chronic exposure to sub-lethal doses of carbon monoxide.

It has been only in recent years that public health agencies have given specific attention to carbon monoxide poisoning as a domestic health problem. Ironically in recent years the development of a safe heating fuel
(natural gas), and improvement in domestic heating, cooking, and refrigeration systems have contributed greatly to increased consumer comfort and safety.

In Southern California as well as other geographical areas of the country, natural gas, a gaseous form of petroleum is used as the heating fuel. It is predominantly methane in composition and contains no carbon monoxide. It is gradually replacing manufactured gas which is from 20% to 40% carbon monoxide in composition. It is virtually odorless, and non-toxic in its natural state, and can be inhaled for a prolonged period of time without ill effect.

However, enough incidents of CO poisoning still occur to cause public and private agencies some concern. These agencies are still called upon to investigate suspected CO poisonings. But it is becoming more evident that carbon monoxide incidents are investigated without uniformity in method by public and private agencies. The variety of investigative agencies which include the local or regional gas company which supplies the commodity of gas, and usually or occasionally the local health, fire, and building departments, may account for some of the variations.

Investigations by these agencies may vary in method or content. Their investigations may or may not include the on-site examination of the appliance, testing
the appliance for evidence of CO production, and use of an investigative form to record pertinent investigative data.

Uniformity of investigative method, coordination of investigative activities, and cooperation among all investigative agencies is needed to produce reliable data to indicate the physical causes for the appliance failure, housekeeping and environmental conditions influencing the generation of CO, and behavioral activities of the householder contributing to the CO incident.

Reliable causative data can be beneficial to the appliance manufacturers. Hazardous features can be eliminated through modification of appliance design and engineering. In this manner it is possible that the incidence of CO poisonings could be reduced.

Statement of the Problem

This study was undertaken to determine if there was a need for a uniform method of investigation of carbon monoxide incidents involving domestic gas appliances.

Limitations of the Study

This study was limited to an inquiry of twenty-five (25) of forty-six (46) local public health jurisdictions, in the State of California to determine the
method utilized for the investigation of carbon monoxide poisonings. Responses were received from twenty-one (21) of these agencies.

In some communities the local gas company, a private agency, also investigates CO incidents. Although it does not have enforcement powers, it is deeply concerned that the commodity it provides to the community be used in a manner that is not hazardous to the health and welfare of the consumer. Inquiry was made only of the Southern California Gas Company about its investigative procedure.

Limited contact was made with the Los Angeles County Building Department and the Los Angeles City Fire Department. These public agencies infrequently investigate CO incidents. Their investigations are conducted to ascertain if there has been violation of and to secure compliance of codes relating to installation and size of approved heating systems for dwelling unit floor area, and the fire safety of these heating systems.

**Importance of the Study**

The confirmation of a need for a uniform investigation of carbon monoxide poisonings could lead, through subsequent research and testing to development of an investigative method for the inspection and testing of
the suspected gas appliance, and the recording of pertinent data. In this manner the use of the information derived might prove beneficial in reducing the incidence of CO incidents, by alerting the general public to hazardous appliance characteristics and the conditions that cause CO production, and by modification of appliance design for greater consumer safety.

Definitions of Significant Terms Used in This Study

CO - Chemical symbol for carbon monoxide.

Parts Per Million (ppm) - Parts of gas or vapor per million parts of contaminated air by volume.

Occupational Health - The physiological, biological, chemical, and environmental quality of the work environment.

Direct-Reading Instrument - An air instrument which determines the concentration of toxic substances by a direct reading on a dial or by the production of a color change in a sensitive chemical. Three such instruments used for the detection of carbon monoxide are the Mine Safety Appliance, Drager, and Kita Gawa.

Flame Impingement - A condition caused by contact of a non-adjusted flame with any part of a gas appliance, thus cooling the flame below its ignition temperature of 1200°F and causing the production of carbon monoxide.
**Overgassing** - A condition caused by the supply of gas to a gas appliance at too great a volume or pressure for all of the gas to be burned completely, thus resulting in incomplete combustion and generation of carbon monoxide.

**Air Occlusion** - A condition caused by restriction of the passage of adequate combustion air through air ports of the gas appliance, thus resulting in incomplete combustion and emission of carbon monoxide.
Chapter II
REVIEW OF THE LITERATURE

Carbon monoxide does not exist in nature. It is produced by carbon containing materials that undergo incomplete combustion. These materials include coal, oil, wood, coke, and even paper. This study is concerned with that carbon monoxide gas produced by the incomplete combustion of natural gas that serves as the fuel for heating and cooking appliances.

Natural gas is about two-thirds as heavy as air, and rises rapidly when it escapes into the atmosphere. It is virtually odorless and non-asphyxiating in its natural state. An odorant is added to the gas in sufficient quantity as a safety measure for detection of escaping gas.

The threat of carbon monoxide poisoning is not confined to the home. It is present on the highway, in the garage, in the industrial environment, and any place where fuel burning equipment is used. Since there are many possible sources of carbon monoxide, the total environment should be considered in evaluating the public health problems associated with this gas.

The detrimental effects of CO, in sufficient quantities to affect the physical health of the individual
in a working environment has been recognized as an occupational health problem for many years. However, only recently has carbon monoxide poisoning been given much attention as a domestic health problem.

Public health authorities now recognize the problem of carbon monoxide poisoning as a potential health hazard in the home environment. In the dwelling unit, today's living style requires the use of gas-fired appliances. These appliances include heaters, cooking appliances, water heaters and gas dryers. Each appliance must be considered potentially hazardous as a source of carbon monoxide.

Whenever there is a flame or combustion, deadly carbon monoxide gas is produced. The production of the toxic gas is increased if the following conditions are prevalent: 1. improper fuel-air mixture; 2. insufficient ventilation of combustion gases; 3. insufficient fresh air intake. There is little danger of CO poisoning if none of these conditions exist during the combustion process. Under ideal conditions of combustion, minute amounts of CO are produced and these are quickly dissipated.

Carbon monoxide poisoning is a recognized public health problem in metropolitan Los Angeles. Lavers reported that the Los Angeles County Health Department investigated eighteen (18) deaths and fifty (50)
illnesses from carbon monoxide poisoning during the fiscal year 1968-1969. These incidents were attributable to the use of unvented gas heaters or inadequately maintained gas appliances.

Imus(15) called attention to the reservoir of potentially hazardous gas heaters in the metropolitan Los Angeles area and the spectre of carbon monoxide poisoning. In this community it is estimated that there are between 100,000 and 200,000 unvented gas heaters. The great majority of these are in use in private dwellings and a large percentage of these are of the type unapproved by a nationally recognized testing agency.

In the course of his treatment of a family of six persons in reoccurrences of acute carbon monoxide poisonings, Anderson(1) concluded that the carbon monoxide generated by the gas heater in the victims' home was caused by the greedy characteristic of the natural gas heating fuel for oxygen. This conclusion was refuted by Griffiths(14) who stated that natural gas requires only 10% more oxygen than manufactured gas for perfect combustion and was not the causative agent for the carbon monoxide episodes. He further noted that the gas appliance implicated had been installed in such a manner that it could not be properly vented.

The importance of an adequate supply of oxygen for the proper combustion of gas appliances was demonstrated
in a study by Kent(16). The hazard from products of combustion were demonstrated by laboratory tests. When unvented gas appliances are used in a confined space, adequate ventilation needs to be maintained to insure the proper fuel to air ratio and provide adequate secondary air for combustion. In this manner, freedom from the toxic products of combustion may be insured.

In order to establish more clearly the carbon monoxide problem in the home, the Memphis and Shelby County Health Department in Tennessee in cooperation with the U.S. Public Health Service Division of Accident Prevention conducted a preliminary study of carbon monoxide gas in the home environment during the 1964-1965 heating season(27). The study included investigation of one hundred and fifty CO incidents, and the testing of one thousand and sixty-one combustion appliances in three hundred and seventy-two residential units. Forty per cent of the units investigated had appliances that emitted carbon monoxide, twenty-five per cent of all tested appliances were discharging CO into the room atmosphere, and twenty-four per cent of the appliances that tested positive were emitting CO in the range of 200 ppm. Forty per cent of the residents in units that tested positive for CO gave clinical histories similar to those of carbon monoxide poisoning.

The difficulty encountered sometimes in accurately
diagnosing CO poisoning was pointed out by Tetreault. He recounted an incident in which three members of a family were found dead and four other members unconscious in their car while enroute from Arkansas to California. Clinical symptoms observed were similar to those of food poisoning, but a subsequent autopsy revealed findings compatible with carbon monoxide poisoning. These findings were confirmed when an investigation of the car demonstrated that lethal amounts of carbon monoxide were generated when the car was driven at a speed of fifty miles per hour with the windows open.

Moore and Finestone presented a case to demonstrate the strange way that CO presents itself to the physician. A female patient was hospitalized after suffering constant headaches for three weeks. After a few hours in the hospital the headaches vanished. Except for a flushed red face, the physical examination was unremarkable. Several days after her discharge, both the woman and her husband were hospitalized after suffering fainting spells. The husband was red faced. Investigation of the patients' home revealed that the house chimney was blocked causing carbon monoxide to collect within the premises.

The issue of chronic carbon monoxide poisoning as a disease entity is a controversial one. It is a fact...
that carbon monoxide is so toxic that 1.3 per cent of the gas in the inhaled air can cause death in one to three minutes\(^{(7)}\). The average concentration of CO in automobile exhaust is 3.8 per cent. However, among the authorities who recognize chronic carbon monoxide poisoning as a disease entity there is little agreement that long exposures to low concentrations of the gas is permanently harmful to health. Some authorities contend that in pure air, the small amount of gas absorbed in the blood from long-term exposure is entirely eliminated from the body.

In a study of industrial CO exposure in coke and metallurgical plants by Zorn and Kruger\(^{(29)}\), the conclusion was reached that chronic CO poisoning in the true sense was non-existent. What some persons might consider to be chronic monoxide poisonings were identified as light, reoccurring carbon monoxide poisoning.

Breyesse\(^{(5)}\) reported that the question of chronic CO poisoning has received much discussion but is yet not resolved. According to Breyesse, what has been termed chronic CO poisoning, in some instances, is really only repeated episodes of acute poisoning, and that chronic poisoning should be considered as chronic exposure.

Pfrender\(^{(21)}\) concluded in his critical resume that although considerable work has been done, no definite
conclusions can be reached regarding the existence of chronic carbon monoxide poisoning. More research is needed in this field, especially in the areas of carbon monoxide combinations with other substances, pathological effects attributable to carbon monoxide, and consideration of acclimatization to the gas. Until this research has been accomplished, the existence of chronic CO poisoning remains a matter of personal opinion.

Carbon monoxide is widely recognized as a major pollutant of the urban environment. A study by Yocom et al. (28) described the effects of four pollutants including CO on the quality of air inside and outside of three pairs of structures during different seasons of the year. The structures surveyed were public buildings, office buildings and private dwellings. The results showed that daily outdoor activity greatly influenced urban carbon monoxide levels, and also affected interior concentrations in some of the structures sampled. It was shown that in homes with gas heating and cooking facilities, the gas stove had a more significant effect than the heater on indoor CO levels. The study also revealed that carbon monoxide in the outside air readily penetrated all structures.

The risk of CO exposure in the home environment by faulty domestic appliances is increased by the operation of the automobile engine in the garage. Although
the public has been warned repeatedly as to the danger of operating automobiles in a closed garage, accidents continue to happen from this practice. The garage atmosphere will become very hazardous after running an automobile for only two or three minutes\(^4\). In cold weather, the practice is even more hazardous if the choke is used in starting the engine, as more CO will be produced than when the engine is warmed up. The ignition should not be turned on unless the garage doors are opened wide.

Goldstein\(^{13}\) has emphasized the danger of running an automobile engine in an enclosed garage as an increasingly common cause of accidental and suicidal death. In 1964 more than 2000 deaths by suicide in the United States were attributable to carbon monoxide, and more than two-thirds of these were caused by the exhaust of a motor vehicle.

A study by Sloan and Amiro\(^{24}\) outlined the techniques and results of tests for the presence of carbon monoxide on school buses in Talladega County, Alabama. The data from this study established a correlation between a defective engine exhaust system and the presence of CO in the atmosphere of the buses tested. One hundred and ninety-one (191) buses were tested and ninety-nine (99) tested positive for carbon monoxide. The concentration of CO emitted ranged from 25 ppm to
800 ppm. The exposure time varied from 20 minutes to 120 minutes with an average exposure time of 56 minutes. It was found that ninety-eight (98) buses had visibly defective exhaust systems beyond the engine manifold area. Seventy-nine (79) buses had defects in the engine manifold area and/or visible openings in the cab fire-wall or floor board near the driver. It was recommended in the study that additional investigations of this problem were needed to determine the optimum point of discharge for exhaust gases from school buses.

The widespread exposures to carbon monoxide have been discussed in a report by Goldsmith and Landau\(^{(12)}\). Cigarette smoking is probably the most important source of CO in the urban population of the United States followed by motor vehicle exhaust, occupational services, and domestic heating and cooking appliances. Air pollution may produce levels of CO in nonsmokers similar to those observed in smokers. A possible role of CO in motor vehicle accidents has been suggested by data which show higher levels of CO in drivers involved in accidents than in populations of other occupational exposures.

The properties of carbon monoxide as a toxic gas and air pollutant have been well studied. The most important source of CO in the environment is the incomplete combustion of gasoline in the automotive
engine.

In 1968 in the District of Columbia, the CO production was estimated as 1.26 tons per year, and 99% of this amount of the pollutant was believed to have come from the automotive vehicles\(^{(23)}\). In an area such as Philadelphia, which has more industrial sources, about 59% of the CO was produced by automobiles. Stringent federal standards for control of automobile emissions, it is projected, will reduce the level of CO by 50% before the year 1975. With the application of more restrictive standards, already legislated, a further reduction of 65% is projected. In communities where CO production is caused only by the automobile, changes in vehicular design would result in major reduction in the CO level.

A report by Cook\(^{(9)}\) on the carbon monoxide concentrations in the City of Detroit indicated that traffic conditions do not produce enough CO to constitute a hazard to drivers. However, statistical treatment of the findings suggested that a combination of increased traffic and weather conditions favoring accumulation of exhaust gas might result in excessive concentrations of carbon monoxide. Thus, the occupational carbon monoxide hazard of commercial vehicle drivers under present traffic conditions has been determined, and may be estimated for future conditions by analysis of the
study data.

The effects of pollutants on human behavior should be considered in establishing improved standards of air quality. Taking this into account, the effects of CO exposure were studied on a group of young adults. As reported by Beard and Wertheim (2), deterioration of performance was observed. This occurred after 90 minutes at 50 ppm and at shorter periods of time after exposures to higher concentrations up to 250 ppm. Experiments with rats showed interference with the ability to judge time with a significant decrement occurring after 11 minutes of exposure to 100 ppm. The authors suggested that the use of methods in experimental psychology might contribute substantially to the understanding of CO as an air pollutant, and thereby aid in the promulgation of standards of air quality.

The importance of epidemiologic evaluations of the effect of various environmental agents such as CO in a constantly changing environment was discussed in a report by Goldsmith (11). Environmental epidemiology offers strategies for preventing and abating health impairment due to environmental exposure. These strategies include collection and presentation of quantitative data on human exposures and effects which are of sufficient predictive validity to be used as bases for public health regulations. In the absence of such information,
data for exposures of greater intensity and duration than normally occur, can be collected.

The problem of carbon monoxide, an element of the air pollution that has plagued Los Angeles for several decades has been discussed by Bengelsdorf\(^3\). He pointed out that in 1967, there were 3.75 million automobiles registered in Los Angeles County. These vehicles burned 7.75 million gallons of gasoline per day. Out of the exhaust tailpipes of these vehicles poured 20 million pounds of carbon monoxide daily. The amount of pollutants emitted when each car moved at a speed of 25 miles per hour was one-sixth pound per mile traveled.

Carbon monoxide is one of the important target hazards in the industrial environment, the control of which has been given priority by the National Institute of Occupational and Safety Health.

In the field of occupational health, carbon monoxide is recognized as the gas which is responsible for more incidents than any other. Carbon monoxide was also the gas responsible for the greatest number of cases of fatal asphyxiation\(^20\). Cases of asphyxiation have commonly occurred over the years on Monday mornings after a weekend shut down where cold systems such as furnaces were being heated with natural gas. The impingement of the burning gas on cold surfaces resulted in incomplete combustion and monoxide production.
The findings related to occupational exposure to carbon monoxide are described in a report by Sievers et al. (22). The Public Health Service and the Bureau of Mines recently made a series of clinical and laboratory examinations which may prove useful in defining the region of safe exposure to carbon monoxide. Examination of a group of one hundred and fifty-six Holland Tunnel traffic officers exposed throughout a period of thirteen years to an occupational carbon monoxide exposure averaging 70 ppm of carbon monoxide did not reveal any evidence of injury to health that could be attributed to CO exposure. These findings are important because this CO exposure is about as great as has so far been observed in the breathing zone of workers in most shops and mills. In situations where internal combustion engines are operated in enclosed spaces exposing workers to CO, it has been recommended that the control methods developed during the planning and operation of the Holland Tunnel be extended.

Carbon monoxide incidents, both fatal and nonfatal, are more prevalent than are generally recognized. Morbidity data for carbon monoxide poisoning is collected from death certificates and reported annually by the National Center For Health Statistics (18). Total accidental deaths attributed to CO in 1966 were about 1,500. Of these, almost 900 were in dwellings, more
than 100 were in industrial establishments, and less than 200 were reported to have occurred on streets or highways, presumably from inhalation of motor vehicle exhaust. Application of data existing about the installation and maintenance of domestic heating systems would save 800 to 900 people from death each year.

Accidental CO poisoning in the residential environment could be almost totally controlled if existing standards were improved, if effective codes were enforced, and if the public were better educated as to how to avoid the CO hazard.
Chapter III
METHOD

PUBLIC HEALTH AGENCIES

For this study, it was determined that local health departments in California should be contacted to determine if any of these agencies conducted an ongoing program for the investigation of domestic carbon monoxide incidents.

In conjunction with this, an assessment was made of the depth of the investigating roles of other public and private agencies primarily interested in CO poisonings. Included among these agencies was the local gas utility in Los Angeles County which conducts its own investigation of each CO incident, and other involved regulatory agencies such as the local building and fire departments.

A survey of the investigative program used by the Southern California Gas Company was conducted through personal communication with selected members of the company. The author has collaborated in the investigation of numerous CO incidents with investigative personnel of the Gas Company. The information that has been gleaned from these past experiences was reinforced and augmented by conversations with Gas Company per-
sonnel employed in the Customer Service and Claims Divisions.

Personal conversations were held with officials of the Los Angeles County Department of Building and Safety and the Los Angeles City Fire Department. These conversations were invaluable in that they outlined the responsibilities of these agencies in CO investigations as defined by legal mandate.

The questionnaire method was used to survey the local health departments. A brief questionnaire was developed consisting of three questions designed to elicit the relevant information about CO investigative methods. The local health agencies were asked: (1) if the domestic carbon monoxide incidents occurring within their jurisdiction were investigated; (2) if an investigative form for recording of data was used in the course of the investigation; (3) if the suspected gas appliances were tested for confirmation of CO emission.

Questionnaires were mailed to the Directors of Sanitation of twenty-five (25) of the forty-six (46) local health departments. Included among the agencies surveyed were twenty-four county agencies and one city agency. In addition to this survey the ongoing investigative program and records of the Los Angeles County Health Department were reviewed.

The public health agencies to whom questionnaires
were sent were not selected by a scientific, random sampling method. The health agencies were surveyed because of their comparatively larger staffs, the larger populations served, and the more comprehensive environmental services provided by these organizations. No attempt was made to contact the California State Department of Public Health which provides contract services to those counties which do not have health departments.

Of the questionnaires mailed to the twenty-five (25) local health departments, twenty-one (21) were returned. Review of the questionnaires returned revealed that carbon monoxide incidents were investigated by fourteen (14) local health agencies. One health department reported that all incidents reported to it were referred to the local gas company for investigation.

The questionnaire data that was received from eleven (11) of the local health agencies was inconclusive. These agencies were subsequently contacted by telephone, through the cooperation of the California State Department of Public Health, and more complete data relating to their investigative methods was submitted by them.

The scope of the domestic health problem in the Los Angeles metropolitan area was confirmed by review of the investigative records of such incidents maintained by the Los Angeles County Health Department. Records of
these investigations have been kept by the Health Department since fiscal year 1953-1954. The author of this thesis has participated in the investigation of some of these CO incidents while a member of the investigating Housing and Institutions Section. Over a period of seventeen (17) years since 1953-1954, three hundred fifty-five (355) cases of carbon monoxide poisoning were reported to and investigated by the Los Angeles County Health Department.

Excluded from this study were those incidents that were determined to be suicidal in nature, and those occurring in a non-residential setting and involving non-domestic gas appliances.

The date of July 1, 1964 is significant and should be noted. This was the date when the Health Departments of the City and County of Los Angeles were consolidated into the present Los Angeles County Health Department. With consolidation, the geographic area under the jurisdiction of the County Health Department increased, as did the population, by a number in excess of two million residents.

In the eleven year interval between 1953 and 1964, one hundred and three (103) cases of CO poisoning were reported to and investigated by the County Health Department. In the seven year interval between 1964 and 1971, after consolidation, two hundred fifty-two (252)
cases were reported and investigated.

LOCAL GAS UTILITY

It has been the experience of the author while participating in the investigation of CO incidents that the local gas utility is deeply committed to the prevention and reduction of CO cases in dwelling units through very comprehensive and far-reaching educational and public-service programs.

OTHER PUBLIC AGENCIES

Personal communication was established with officials of the Los Angeles County Department of Building and Safety, and the Los Angeles Fire Department. These conversations provided the necessary information about the depth of ongoing CO investigative programs conducted by these public agencies.
Chapter IV
RESULTS AND DISCUSSION.

PUBLIC HEALTH AGENCIES

Twenty-five (25) local health departments in California were sampled by a questionnaire method to determine if these agencies had ongoing programs for the investigation of reported domestic CO incidents. Twenty-one (21) of the twenty-five (25) questionnaires mailed to those agencies were returned. These returns revealed that carbon monoxide poisonings were investigated by fourteen (14) local health agencies.

Seven (7) agencies reported that they did not investigate CO incidents. One of these departments indicated that CO cases reported to it were referred to the local Gas Company for investigation.

Of the fourteen (14) local health agencies that conduct CO investigations, twelve (12) of these prepare a report of their findings. Ten (10) departments prepare detailed comprehensive narrative reports of their field investigations. The information required by departmental guidelines in the narrative report includes the date of incident, number of victims, each victim's identity, age and sex, number of deaths or illnesses, type and physical characteristics of the
dwelling unit, the type, characteristics, and maintenance condition of the suspected gas appliance. One department prepared a narrative report which was not as detailed in content as the narrative reports previously mentioned.

One public health agency completed a Housing Evaluation Form during the course of its investigation. One brief section of this form is concerned with descriptive information about the victim, nature of the incident, maintenance condition of the appliance, and does not include gas refrigerators and clothes dryers among the gas appliances listed.

The investigative personnel of one department completed a detailed investigative form during the course of the field investigation. This form when completed in the field includes pertinent information about the victim, the CO incident, the dwelling unit, and the maintenance condition of the gas appliance.

Two agencies did not prepare an investigative form of any kind during the course of its investigations of CO poisonings.

Eight (8) of the reporting fourteen (14) agencies indicated that their Environmental Health personnel tested suspected gas appliances for emission of carbon monoxide. The testing devices used were the Mine Safety Appliance, the Drager, and Kita Gawa. These
are direct-reading, screening instruments. The instruments all produce a color change in a sensitive chemical in a glass indicator tube through which the air to be tested is drawn. The intensity of the color is a measure of the amount of CO contaminant present in the air sample.

One agency reported that it used a "grab" disc to ascertain if the suspected gas appliance emitted measurable amounts of carbon monoxide. This disc will change in color upon exposure to carbon monoxide. After use in the field, it is returned to the laboratory for analysis.

One agency indicated that the testing of suspected gas appliances was done by its Occupational Health personnel.

Three local health departments did not have the instruments to test the suspected gas appliances. Two of these departments referred this testing procedure to the local gas company; the other referred the procedure to the local Bureau of Public Works.

In Los Angeles County, the field investigations of domestic CO incidents were usually conducted by Senior Public Health Sanitarians of the Housing and Institutions Section of the Los Angeles County Health Department. On occasion the initial investigation may have been started by a Senior Public Health Sanitarian
of the Food and Drug Section inasmuch as the incident may have been reported, because of the similarity of symptoms, as a food-borne illness.

The investigating Sanitarians have gained their technical skills and competency in this field from comprehensive "on-the-job" training provided by experienced associates. This training is supplemented periodically by training programs conducted by the local gas company.

Each CO incident is investigated as quickly as possible after the report of the incident has been received. On his arrival on the scene the investigator examines and fires up the suspected gas appliance. The physical and maintenance conditions of the appliance are assessed to ascertain how these contributed to the generation of carbon monoxide. The investigator is very cognizant of those circumstances under which incomplete combustion of the natural fuel occurs.

The following statements describe field procedures pursued by the investigator, and field conditions of which he is cognizant, that are conducive to the generation of carbon monoxide.

Of great importance to the safety of the consumer who uses a gas appliance is proper adjustment of the flame or burner of the appliance. The characteristic of the burner flame is observed to ascertain if it is
in proper adjustment.

The color of the properly adjusted burner flame is blue. If the flame is not in adjustment it turns yellow in color, and becomes potentially hazardous. The yellow flame indicates that the fuel is undergoing incomplete combustion.

The conditions causing this type of yellow flame must be determined by the investigator. These conditions would include an insufficient supply of combustion air, improper fuel-air mixture, and insufficient ventilation of products of combustion.

The non-adjusted yellow, potentially dangerous flame will become elongated and flicker. It becomes dependent on the air surrounding it for combustion rather than on the air supplied through the burner's primary air openings, which may have become obstructed. Impingement of the yellow, flickering flame on any surface of the gas appliance will cool the flame to below its ignition temperature of approximately 1200°F and cause generation of carbon monoxide.

The hazardous condition of over-gassing may be obvious during examination of the appliance. Over-gassing occurs when too much gas or gas at too great a pressure is supplied to the burner. Portions of the partially burned gas are blown through and out of the flame, and parts of the incompletely burned gas are
given off as carbon monoxide. This condition can be confirmed when it is observed that the flame is abnormally high and out of its normal zone, and a blowing sound is audible. This condition can be created if the appliance does not have a pressure regulator and is physically modified so that more gas can be supplied to the burner.

The investigator examines the flue and vent pipe of the gas appliance. Any obstructing material lodged in these areas will cause the products of combustion such as water, carbon dioxide, and heat to not be discharged to the outer air. Any monoxide gas emitted will not be ventilated to the outer air. Instead the toxic gas will be circulated back into the room.

Deposits of smoke and soot within and on the gas appliance and on the surfaces surrounding it indicate to the investigator that the appliance flame is maladjusted and potentially hazardous. This carbonizing effect occurs when the yellow flame impinges on any surface of the appliance and is subsequently cooled to below its ignition temperature. Carbon monoxide emission results.

The investigator is aware that the efficiency of the gas appliance is directly related to its maintenance condition. He knows that inadequate housekeeping
will cause the burner air holes to become clogged with
dirt and lint, and restrict the intake of primary air
necessary for combustion. Improper workmanship in the
installation of wall heaters could cause the burner
component to become misaligned with the flue and
venting system, and create a hazardous condition.

Installation of unvented space heaters by incom-
petent or unqualified persons in a manner that would
occlude or restrict the intake of primary air could
be detrimental to the health of its users. The phys-
ical altering of a gas heater in the hope of making
its operation more efficient can be a very dangerous
business. Cracked, "burned-out", and otherwise de-
teriorated burner components are extremely hazardous
to continue in operation, and should be repaired or
replaced by qualified service personnel.

Provision of routine housekeeping and maintenance
attention to gas appliances is important to deter
those conditions that would cause the flame to go out
of adjustment and generate carbon monoxide.

The inspection of potentially hazardous gas ovens
which have been used for heating purposes can occasion-
ally be difficult. Often the gas burner can not be
observed. If it is not in proper adjustment, flame
impingement can occur.

The flame of the top burners of the domestic gas
range can be potentially hazardous if not kept in proper adjustment. Contact of the maladjusted yellow flame over long periods of time with domestic cooking utensils can result in toxic quantities of monoxide gas being generated.

It is important that gas appliances such as water heaters and gas-fired refrigerators be installed in areas where fresh air can be adequately supplied for the safe burning of the fuel. The housekeeping in areas in which these appliances are located should not be neglected. Otherwise if the primary air supply to the appliance is restricted because of an inadequate supply of fresh air or clogged, linted air holes, the flame will go out of adjustment and carbon monoxide might be generated.

If the gas appliance is still connected to the gas supply and operable, the investigating Sanitarian will test it with appropriate testing apparatus. Either of two testing devices is available; these are the Mine Safety Appliance and the Drager Testing Appliance.

Each of these instruments is designed to detect the presence of carbon monoxide by means of a direct-reading colorimetric test. The testing instrument contains a yellow silica gel which undergoes distinctive changes in color, proportionate to the percentage concentration of monoxide emitted by the gas appliance. As
it passes into the testing instrument, the carbon monoxide causes the color of the silica gel to change from a basic yellow color through deep shades of green and subsequently blue colors at higher concentrations of the gas. This field test will confirm the presence of carbon monoxide and measure the quantity of the gas in parts per million.

The Sanitarian records all pertinent data collected from the examination and testing of the gas appliance as it relates to the physical condition of the heater and flame, on a special CO inspection form. This serves as the permanent record of investigation. Records of carbon monoxide incidents have been maintained by the Los Angeles County Health Department since fiscal year 1953-1954. This inspection form has been modified and simplified since its original design to eliminate the need for collection of unnecessary information about the physical characteristics of the dwelling unit involved.

The data that the Sanitarian records on the inspection form is that descriptive information related to the identity of the victim, and characteristics of the suspected gas appliance and dwelling unit. The victim's name, address, age, and sex are determined. The type of dwelling unit involved is recorded, whether it be a dwelling, apartment house, hotel, motel, trailer
coach or mobile home.

The design of the original inspection form was such that information regarding the floor plan of the dwelling, room sizes, and air-tightness of the structure was recorded. This information is no longer considered vital to the investigation.

To reiterate, during the field inspection the Sanitarian will test and examine the appliance thoroughly. The examination consists of visually inspecting the burner component, shell or casing of the appliance, and the flue and venting assembly if there is one attached to the appliance.

The maintenance condition of the appliance is assessed for conditions that could contribute to or cause the flame to go out of adjustment, and result in incomplete combustion of the fuel.

Visible evidence of appliance malfunction might be evident in the form of soot, grime, and smoke deposits on the appliance and surfaces surrounding it. Obstructions in the flue and venting assembly are searched for as well as any physical condition that might restrict the venting of the products of combustion to the outer air.

If the investigating Sanitarian detects a measurable quantity of carbon monoxide or if the gas appliance is not in good repair, an official notice is
issued to the responsible party to restore the appliance to good repair and efficient operation. If the appliance is illegal to use because it is of the unapproved type or unvented, an official notice is issued to remove the appliance.

Of the three hundred fifty-five (355) cases of carbon monoxide poisoning reported to the Los Angeles County Health Department, in the period of time between fiscal years 1953-1970, emission of CO by gas appliances was confirmed in about 46% or one hundred sixty-six (166) cases. Measureable quantities of CO in these cases were detected by the use of direct-testing, field instruments.

In most of the other 54% of the reported incidents there were several reasons why the emission of carbon monoxide by a domestic gas appliance could not be confirmed. The field investigations revealed: that the suspected gas appliance did not emit measureable amounts of CO; that the gas supply to the suspected gas appliance had been discontinued preventing inspection and testing of the appliance; that entry to the dwelling unit could not be gained.

As a result of these incidents, one hundred thirteen (113) individuals lost their lives, and three hundred forty-three (343) persons were made ill. The victims included two hundred twenty-six (226) of the
female sex and one hundred ninety-six (196) of the male sex.

There was a total of one hundred thirty-seven (137) gas heaters implicated. Of these, seventy-nine (79) were unvented and fifty-eight (58) were vented heaters. Eighty-one (81) heaters were types approved by a nationally recognized testing agency, and fifty-six (56) heaters were non-approved types. A total of thirty (30) gas appliances other than heaters were implicated, including sixteen (16) gas ranges, eleven (11) gas-fired refrigerators, two (2) water heaters, and one (1) hot plate.

The investigators reported that the condition of flame impingement was observed in seventy-five (75) heaters, the condition of overgassing in fifty-one (51) heaters, and the condition of occlusion of air ports in three (3) heaters. Fourteen (14) heaters were reported to be in poor repair, and flue-vent obstructions were observed in eleven (11) heaters.

The residential structures in which these CO incidents occurred included one hundred (100) dwellings, forty-five (45) apartment houses, eleven (11) hotels, five (5) trailer coaches, and three (3) motels.
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(1 Refrigerator 1 Range 1 Refrigerator 1 Hot Plate 1 Water Heater)
### TABLE II (CONTINUED)

**Carbon Monoxide Incidents and Characteristics of Gas Heaters**

 *(Los Angeles County Health Department Records)*

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- Range
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- Ranges
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* Impingement - Fuel not completely burned.
* Overfired - More gas than can be burned.
The local gas company has demonstrated a deep commitment to the prevention and reduction of CO cases in dwelling units through its very comprehensive and far-reaching educational and public-service programs.

In the Los Angeles County area, the Southern California Gas Company maintains an extensive service division that will, upon request or complaint, inspect and adjust gas-fired appliances without a service fee. If the appliance requires more substantial repair, the responsible party is informed of its condition with the recommendation that it be repaired.

As the gas company does not have law enforcement powers, it cannot require that the malfunctioning appliance be repaired. Under some circumstances if the appliance is in poor repair and potentially hazardous, the gas supply to it can be discontinued by the service-man.

Educational programs and classes, including demonstrations and lectures are conducted by the gas company for individuals and organizations interested in the use and characteristics of natural gas. Educational programs of this type have been conducted on several occasions in past years for environmental health personnel of the Los Angeles County Health Department.

The Southern California Gas Company is deeply
committed to the investigation of carbon monoxide incidents. Investigative personnel from the Claim Section respond immediately to incidents reported directly to them or by referral from the Health Department or other public agencies. Many CO incidents have been jointly investigated, by investigative personnel of the gas company and Health Department. Such investigations have proven mutually educational and beneficial.

The gas company investigators have an extensive background of gas appliance service experience, and intimate knowledge about the physical characteristics of gas appliances and conditions conducive to generation of carbon monoxide.

In the normal course of the field examination of the gas appliance the investigator is usually able to discern its maintenance condition, the characteristics of the flame, and the circumstances under which the incident occurred. The investigator has the complete backup support of laboratory facilities and technicians in making a determination for appliance failure and monoxide production.

The investigative data compiled from CO investigations can prove helpful when consideration is given to the modification and upgrading of construction and performance standards for gas heaters.

Standards for the proper construction and safe
performance of gas heaters are established by the American Standards Institute, Incorporated. Standards have been established for both unvented room heaters and for vented heating systems.

The American National Standards for room heaters have been developed as a result of years of experience, by numerous organizations and individuals engaged in the manufacture, testing, installation, maintenance, inspection, and research of such heaters.

Heaters that have been tested and approved by nationally recognized testing agencies, and which comply with the American National Standards bear the insignia of A.G.A. or American Gas Association. In California the use of heaters non-approved by a nationally recognized testing agency is legally prohibited.

LOCAL PUBLIC AGENCIES

BUILDING DEPARTMENT

The California Health and Safety Code charges the local building department with the authority for enforcement of architectural standards and requirements for construction of structures for human habitation.

The local building codes regulate the manner of installation and location site of gas heaters. Those heating units installed as central heating systems,
wall, floor, or vented room heaters require the issuance of building permits. The installation of illegal, unvented gas heaters in new housing construction is no longer permitted.

In the city of Los Angeles, the use of existing A.G.A. approved, unvented gas heaters is permitted based on a decision rendered years ago by the City Board of Building and Safety Commissioners. This decision stipulated that unvented heaters need not be replaced by vented types as such replacement would require a structural change in the building or residence and thus impose a financial hardship upon the property owner.

The city building code also allows the installation of A.G.A. approved, unvented heaters as replacements for existing unvented heaters in dwelling units established prior to September 20, 1951, if the installation of a vent would require a structural change.

A section of the Los Angeles Municipal Code in effect since August 7, 1958 requires that heaters installed subsequent to that date must be vented to the outer air.

The local building departments of Los Angeles City and County do not have on-going programs for the investigation of CO incidents. Monoxide incidents are not routinely reported to the building departments since
their sphere of enforcement is concerned not with appliance maintenance but the proper installation of the gas appliance.

Building department officials do provide consultation, and on request make joint investigations of CO incidents with investigators from the Health Department. Any on-site inspection by these officials is primarily concerned with heater repair and size, and method of installation to determine if there has been violation of the building code. The gas heater is not normally tested in the field for CO emission by building department officials.

Field consultation with building department representatives can be very helpful in ascertaining causes for the malfunctioning of gas appliances.

FIRE DEPARTMENT

The fire departments of Los Angeles City and County do not routinely investigate CO incidents. Fire department investigators are concerned with incidents of fire caused by a malfunctioning appliance or unvented gas heater rather than with CO emission from such a hazardous heater.

However, annually, prior to and during the heating seasons some local fire departments alert the general public through the news media to be aware of good fire
safety and heater maintenance practices, and discourage the use of the unvented gas heaters because of the potential fire and CO hazards associated with them.
Chapter V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY AND CONCLUSIONS

Each year in the United States approximately 10,000 persons require medical attention as a result of exposure to carbon monoxide. Each year about 1,400 deaths occur due to exposure to carbon monoxide in the residential environment.

In addition to the lethal characteristics of carbon monoxide, physical health may be subject to impairment by chronic exposure to low concentrations of the toxic gas in the home and work environment.

Truly, the incidence and disabling effect of CO on the individual in an industrial environment has long been recognized and investigated as an occupational health problem. However, it has been relatively recent that public health agencies have expressed interest in carbon monoxide as a domestic health problem. As a result, investigative methods of CO incidents vary.

It was the purpose of this study to determine if there was uniformity in the methods of investigation of domestic CO incidents conducted by local public health agencies.

Contact by questionnaire method, was made with
local public health agencies to ascertain if these agencies investigated reported CO incidents occurring within their jurisdiction. In conjunction with this survey of local public health agencies, the records of investigations of domestic CO incidents conducted by the Los Angeles County Health Department were reviewed and analyzed.

An assessment was made of the responsibilities of the local gas utility, and building and fire departments in the investigation of domestic CO incidents.

Twenty-five (25) local health departments to whom questionnaires were mailed were asked if they investigated domestic CO incidents, if an investigative form was used to record pertinent investigative data, and if the implicated gas appliance was tested by instruments to confirm the emission of carbon monoxide.

This study revealed that most local public health agencies do investigate incidents of CO exposure in the residential environment. Fourteen (14) of twenty-one (21) agencies responding to a questionnaire survey reported that domestic CO incidents occurring within their jurisdiction were investigated.

The investigative personnel of eleven (11) agencies prepared a narrative report of the findings of their investigation. The method used in the preparation of the narrative reports by ten (10) agencies was
complete as it related to the identity of the victim, characteristics of the dwelling unit, maintenance condition of the gas appliance, and concentration of carbon monoxide generated. The narrative report of one (1) agency was not as complete and detailed in information as those of the other ten (10) agencies.

One (1) agency recorded the findings of its investigations on its Housing Inspection Form, a document whose design is incomplete for the recording of all pertinent investigative data.

The Los Angeles County Health Department in its investigations uses a form designed specifically for the investigations of CO incidents and the recording of all pertinent data.

Eight (8) public health agencies that investigated CO incidents tested the suspected gas appliances with direct-reading instruments that measure the concentration of CO by a colorimetric method. The types of direct-reading instruments used include the Mine Safety Appliance, the Drager, and the Kita Gawa.

One (1) agency reported that the personnel of its Occupational Health Division conducted the field tests with a direct-reading instrument.

One (1) agency used a "grab" disc to measure the concentration of carbon monoxide. The disc undergoes a color change upon exposure to the gas, and is re-
turned to the laboratory for analysis.

Two (2) agencies reported that the appliance testing was referred to the local gas company. One (1) agency referred the testing of the appliance to the local Bureau of Public Works.

Two (2) agencies that investigated CO incidents did not use a direct-reading instrument to test the suspected gas appliance.

The investigators of the Los Angeles County Health Department tested the suspected gas appliances with the Mine Safety Appliance or Drager direct-reading instruments.

The data gleaned from this study revealed that although the majority of local health departments (67%) surveyed did investigate domestic carbon monoxide incidents, there appears to be some degree of lack of uniformity in their methods of investigation.

One (1) agency among the seven (7) agencies that did not investigate CO incidents referred all reported incidents to the local gas company for investigation. Although not reported by them, it appears that the other six (6) agencies followed the same referral procedure.

A written report of the observations and findings of the investigation is prepared by the vast majority (87%) of public health agencies conducting CO investi-
gations. The report method of choice of eleven (11) of twelve (12) agencies is the narrative report. Ten (10) agencies prepared a detailed narrative report, as required by departmental guidelines, relating to specific information about the victim, dwelling unit, gas appliance, and the concentration of carbon monoxide emitted.

One (1) agency prepared a more incomplete and less detailed narrative report. One (1) agency recorded some but not all investigative data on its Housing Inspection Form, a form inadequate in content for this purpose.

One (1) local health department designed and utilizes in its investigation, a form specific for the recording of all pertinent data.

Field tests of the suspected gas appliances were conducted by most of the public health agencies. Such tests were conducted by the Environmental Health personnel of eight (8) agencies. One (1) agency reported that the appliance testing was conducted by personnel of its Occupational Health Division.

Two (2) local health departments referred the testing procedure to the local gas company. One (1) agency referred this procedure to the local Bureau of Public Works.

Direct-reading instruments which provide a reading of the CO concentration by colorimetric method were used
for appliance testing by eight (8) agencies.

A "grab" disc which undergoes a color change on exposure to carbon monoxide is the testing method employed by one (1) agency.

In conclusion, it appears to be evident that there was a lack of uniformity in the investigation of domestic carbon monoxide incidents as different agencies were conducting investigations differently.

RECOMMENDATIONS

As a result of this study the following recommendations are made:

1. Local health departments should investigate domestic carbon monoxide incidents. This environmental service should be structured so that it comprises an element of a Housing Conservation Program within the Division of Environmental Management.

2. If the local health department is without a Housing Conservation Program, an Environmental Sanitarian should be given proper on-the-job training and the testing equipment necessary to respond to complaints or requests for investigation of domestic CO exposures.

3. Since the domestic CO incidents occur in a residential environment, it is more appropriate that these poisoning episodes be investigated by personnel
of the Environmental Management Division.

4. If this kind of environmental service cannot be provided by the Environmental Management Division, then the assignment for this responsibility should be given to that department's Occupational Health personnel.

5. A written report of the CO incident definitely must be a component of any investigative method. More important than the kind of report that should be completed, whether it be narrative, inspection-type form, or checklist, is the necessity to record all relevant data pertaining to the victim, dwelling unit, appliance condition, and concentration level of CO as assessed by testing instruments.

6. In the course of the investigation, the gas appliance suspected of emitting carbon monoxide should be tested to confirm this suspicion. Any kind of direct-reading instrument would be satisfactory for a "one-shot" assessment of the quantitative level of carbon monoxide. The use of a testing instrument would probably prove to be more reliable than the use of a "grab" disc.

7. If the local health department is unable to investigate CO poisonings, then preferably, reported CO cases should be referred to the local gas utility rather than any other public agency. The gas utility has trained personnel, testing equipment, and is imbued
with a deep commitment to supply the general public with a safe heating and cooking fuel. As the gas utility does not have law enforcement powers referrals for consultation and enforcement of legal standards would have to be made to the local health and building departments.

8. If more than one agency, private or public, investigates domestic carbon monoxide incidents, there should be involved a central reporting agency, to which all CO cases would be reported, and which would coordinate the investigative procedures of those participating agencies.

9. Guidelines should be established by the California State Department of Public Health to insure that there is a uniform method of investigation of domestic CO incidents in all public health jurisdictions.
BIBLIOGRAPHY
BIBLIOGRAPHY


APPENDIX
APPENDIX I

2611 Maple Avenue
Manhattan Beach, California 90266
April 20, 1972

Mr. William B. Walshe, Director of Sanitation
San Diego County Health Department
1600 Pacific Highway
San Diego, California 92101

Dear Mr. Walshe:

I am a Chief Sanitarian with the Los Angeles County Health Department, and a candidate for the Master's Degree in Health Science at San Fernando Valley State College, Los Angeles.

Presently, I am researching the need for development of a uniform method for investigation of carbon monoxide incidents involving domestic gas appliances. I am seeking information as to whether local health departments in California have an ongoing program for the investigation of carbon monoxide incidents in residential units.

Your cooperation in completing the brief attached form and returning it to me in the enclosed self-addressed envelope is greatly appreciated.

Very truly yours,

Daniel R. Esposito
APPENDIX II

San Fernando Valley State College
Department of Health Science
Daniel R. Esposito

Title: Carbon Monoxide Incidents and Domestic Gas Appliances; The Need For A Uniform Method of Investigation

Does the local Health Department investigate carbon monoxide incidents involving gas appliances in residential units?

Yes_________ No_________

In the course of such an investigation, is an investigative form completed by the investigator?

Yes_________ No_________

(Please remit sample copy of investigative form.)

In the course of such an investigation, is the gas appliance checked with a testing apparatus for emission of carbon monoxide?

Yes_________ No_________
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- San Bernardino County
- San Luis Obispo County

* Not included in questionnaire survey.