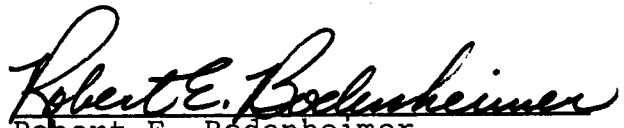
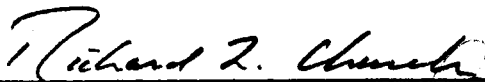


To the Graduate Council:

I am submitting herewith a dissertation written by David J. Icove entitled "Principles of Incendiary Crime Analysis." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Engineering Science.


Robert E. Bodenheimer
Major Professor

We have read this dissertation
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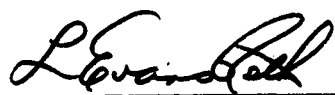








Accepted for the Council:



Vice Chancellor
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PRINCIPLES OF INCENDIARY
CRIME ANALYSIS

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

David J. Icové

June 1979

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ABSTRACT

Arson is the malicious and willful burning of property, sometimes for fraudulent purposes. On a per offense basis, it is the costliest and fastest rising crime in the United States with yearly property losses exceeding \$2.5 billion and deaths amounting to 1000. Reasons given for the nationally accelerating rate of arson include a present lack of uniform law enforcement strategies, low criminal prosecution success rates, and the general multifaceted nature of the offense.

Strategies for incendiary crime abatement programs are explored including a comprehensive analysis of the offense. This analysis forms a model for arson-fraud crimes which can be delineated into detection, prediction, and prevention phases. Computer-assisted techniques aid in this analysis and are documented using actual case data with the Arson Pattern Recognition System (APRS).

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CHAPTER 1

INTRODUCTION

A recent full page advertisement circulated nationally by an insurance company remarked

I burned my business to the ground . . .
Thanks, America, for helping pay for it.

In July 1975, the first National Research Council meeting on the crime of arson was held at the National Academy of Sciences in Washington, D.C. A summary report reflecting the majority opinion of the participants exclaimed

Nobody is really concerned about arson—they all agree that it is a problem that needs work. They just believe that somebody else is working on it. (1)

The public is just recognizing that arson is a crime needing attention; however, as with the weather, they still mostly talk about it.

This text performs a systematic appraisal of the overall arson problem. Principles of the systematic procedures for evaluating the problem are presented with regards to sources of data, investigative techniques, and proposed solutions.

1.1 AN APPRAISAL OF THE ARSON PROBLEM

Background

Arson has been loosely defined as the willful and malicious burning of property, sometimes for fraudulent

intentions. *Also, due to the probable use of flammable accelerants or explosive materials in arson fires, it is also referred to as an incendiary crime.*

Accurate data sources are not always available for appraising the arson problem on the national, state, and local levels. The actual motives for arson fires are also not always known, which complicates the overall situation.

Furthermore, prior to the development and examination of models or strategies to prevent incendiarism, accurate data describing the nature and extent of the problem should be established. These sources of information should also share common terminology and definitions describing and statistically classifying the arson problem.

National Statistics

Statistical data is collected on the national level by the criminal justice and fire protection communities. Efforts are underway to streamline these data collection programs to form a more accurate appraisal of the national arson problem (2).

Uniform crime reporting. The Federal Bureau of Investigation (FBI) has served since 1930 as the national clearinghouse for the collection and compilation of crime data (3). State and local law enforcement agencies forward data monthly to the FBI through the Uniform Crime Reporting (UCR) Program.

Criminal offense data collected through the UCR program are divided into Part I and Part II categories. Recent legislation by Senator John Glenn (D-Ohio) has placed the crime of arson into the Part I Index Crime category (4). The entire text of the legislation, which amended the Omnibus Crime Control and Safe Streets act of 1968 is reproduced in Figure 1.1.

To illustrate the magnitude of the national incendiary crime problem, arson is compared using the 1974 UCR data to other Part I offenses in Table 1.1. Notice that building fires alone outrank all other crimes in both cost per offense and relative percentage increase over the previous decade (5).

Private statistics. Compiled between 1956-75 were a series of statistical studies by the National Fire Protection Association (NFPA), a privately funded organization concerned with fire protection in the United States (6-14). Shown in Figure 1.2 are the reported arson fire losses by year, according to NFPA statistics.

For comparison purposes with the UCR statistics shown previously in Table 1.1, data for building fires during 1974 are listed in Table 1.2 in accordance to NFPA published data. Notice that school buildings are the most frequent victims to intentionally set fires (15).

S. 1882

IN THE SENATE OF THE UNITED STATES

JULY 19 (legislative day, May 18), 1977
Mr. GRASS introduced the following bill; which was read twice and referred
to the Committee on the Judiciary

A BILL

To amend the Omnibus Crime Control and Safe Streets Act of 1968 to authorize the Law Enforcement Assistance Administration to make grants to States for the prevention and detection of certain crimes involving the torching of buildings, and for other purposes.

1 *Be it enacted by the Senate and House of Representatives*
2 *of the United States of America in Congress assembled,*
3 That (a) this Act may be cited as the "Arson Control
4 Assistance Act of 1977".
5 (b) Amend section 301 (b) of the Omnibus Crime
6 Control and Safe Streets Act of 1968 by adding at the end
7 thereof the following:
8 " (15) The development and operation of programs

II

2

1 designed to prevent and to detect crimes involving the inten-
2 tional setting fire to, or burning of, buildings or structures
3 in urban areas by, or under the direction of, the owners of
4 such buildings or structures."

5 SEC. 2. Part I of title I of the Omnibus Crime Con-
6 trol and Safe Streets Act of 1968 is amended by adding at
7 the end thereof the following:

8 "Sec. 671. The Federal Bureau of Investigation is
9 authorized and directed to classify arson as a major crime
10 for its Uniform Crime Reports System."

FIGURE 1.1 The Arson Control Assistance Act (S. 1882).

TABLE 1.1
CRIME IN THE UNITED STATES—1974

Offense	FBI Class	1,000's Cases	% Incr. '64-'74	Average \$ Loss
Murder	I	21	121	--
Rape	I	55	159	--
Robbery	I	441	239	\$321
Aggravated Assault	I	453	125	--
Burglary	I	3,021	150	\$391
Larceny	I	5,228	109	\$156
Motor Vehicle Theft	I	974	107	\$1,246
Arson	II	187	127	\$3,294
Buildings		114	269	\$4,930
Motor Vehicles		42	62	\$214
Wildfires		31	22	\$1,419

Source: FBI Uniform Crime Reports, U.S. Department of Justice, Washington, D.C.

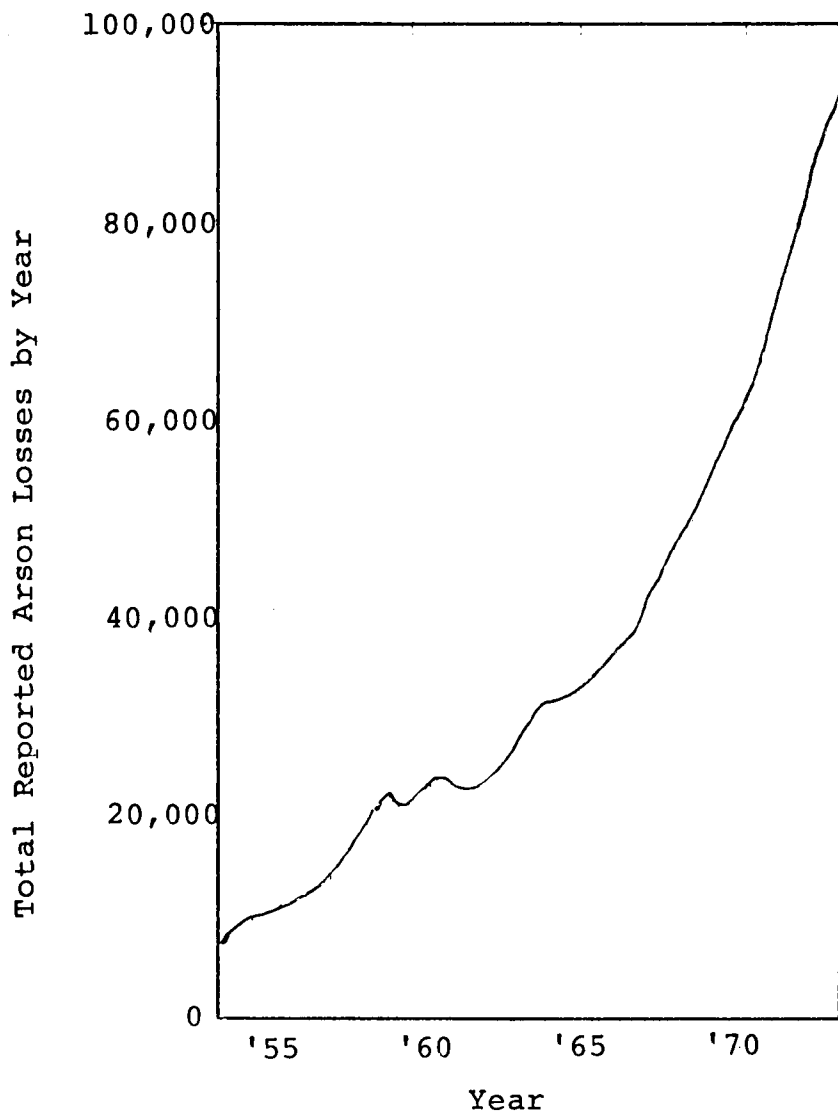


FIGURE 1.2 The Total Reported Arson Losses by Year.

Source: National Fire Protection Association.

TABLE 1.2
BUILDING FIRES IN THE UNITED STATES—1974

Occupancy	Total Fires	Percent Arson	Average \$ Loss
Schools	35,500	75	\$3,500
Churches	5,400	51	\$6,300
Storage	68,500	35	\$6,300
Offices	8,100	34	\$6,900
Restaurants	26,800	31	\$2,400
Hotels	30,200	25	\$2,300
Retail Stores	78,700	25	\$4,800
Apartments	151,500	20	\$2,000
Hospitals	15,600	13	\$1,300
Nursing Homes	9,300	13	\$600
Industrial	60,200	9	\$11,200
Mobile Homes	29,700	7	\$2,600
Dwellings	661,400	7	\$1,200

Source: National Fire Protection Association, Boston, Mass.

Statewide Statistics

In order to further obtain a realistic view of the arson problem on a statewide level in comparison to national statistics, the Tennessee State Fire Marshal's Office in November 1977 attempted to conduct a 100% survey of the total fire incidents during that month (16). A summary of the statewide survey is shown in Table 1.3.

In comparison to nationwide statistics, several of the building categories, such as schools and outside storage, tracked in accordance with percentage arson losses. An analysis of average arson and nonarson losses indicate that intentionally set fires are approximately five times as destructive.

Another comparison between statewide and national statistics demonstrated similar results. The Aerospace Corporation survey (15) of the NFPA 1974 statistical reports projected the national arson profile to be the sum of the total incendiary, suspicious, and one-half of the unknown fires. This analysis showed that 31% of the total fires reported were intentionally set fires. The projected statewide arson profile based upon the November 1977 survey resulted in 33% of the fires in Tennessee being set by arsonists. Table 1.4 summarizes the calculation method.

TABLE 1.3

REPORTED FIRE LOSSES IN TENNESSEE—NOVEMBER 1977

Occupancy	Total Fires	Percent Arson	—Avg. \$ Non-Arson	Loss— Arson
Schools	15	46.7	—	\$9,010
Outside Bldg.	81	37.0	\$4,950	\$141,000
Grasslands	744	27.4	\$1,300	\$5,200
Mobile Homes	107	15.9	\$7,040	\$5,750
Buildings	337	9.5	\$10,100	\$15,900
Dwellings	974	9.0	\$7,190	\$19,600
Other Misc.	887	8.5	\$3,150	\$1,420
Apartments	109	8.2	\$3,400	\$1,260
Vehicles	684	4.7	\$1,440	\$3,870
Total Avg. Loss:			\$5,340	\$24,170

Source: Tenn. State Fire Marshal's Office, Nashville, Tennessee, January 1978.

TABLE 1.4
PROJECTED ARSON PROBLEM IN
TENNESSEE—NOVEMBER 1977

Basis	Total Fires	Percent Arson	Avg. Loss
Incendiary + Suspicious	495	12.6	\$24,170
Incendiary + Suspicious + 1/2 Unknown	1307	33.2	\$17,230

Source: Tenn. State Fire Marshal's Office,
Nashville, Tennessee, January 1978.

Arson Priority Needs

The Aerospace Corporation survey sampled a consensus of opinions from leading experts on the needs in the arson investigation field. A priority matrix, summarized in Table 1.5, lists these needs according to the reported relative rank.

Many of the priority needs mentioned in this survey are obvious responses to any criminal investigation field. Uniform training of investigators would allow for the adoption of standardized definitions, techniques, and data collection efforts. A shortage of trained investigators presently exist nationwide, with the estimated number totaling 6000 (5). Other reported needs including research, cooperation with the insurance industry, jurisdictional clarifications, and the availability of crime laboratories are also obvious responses.

The development of a computerized arson investigation data system is listed as the third priority. Privately, the American Insurance Association (AIA) is developing an insurance claims computer reporting system called the Property Insurance Loss Register (PILR) (17). The PILR lacks full nationwide implementation by several years, with questions as to the availability of information contained within the system to arson investigators with fire and law enforcement agencies.

TABLE 1.5
PRIORITY MATRIX OF NEEDS IN
ARSON INVESTIGATION

Rank	Reported Need
1	Increased Training
2	More Arson Investigators
3	Computerized Arson Investigation Data System
4	Scientific Research
5	Cooperation from Insurance Companies
6	Technological Developments
7	Clarified Jurisdiction over Arson Cases
8	Increased Availability of Crime Laboratories

Source: Aerospace Corporation Survey, Report No. ATR-76(7918-05)-02, U.S. Department of Justice—LEAA, Washington, D.C., October 1976.

The Arson Pattern Recognition System (APRS) described later in this text is also a computerized arson investigation system which meets the requirements and priorities of the Aerospace Corporation survey. Furthermore, the APRS programs perform statistical analyses designed specifically for use in arson investigation problems.

1.2 MODELING THE ARSON PROBLEM

Modeling has often been described as a process in which a real world problem is viewed as an abstraction for the purposes of further study. These modeling abstractions can be described using mathematical, graphical, verbal, or symbolic techniques.

Reasons for modeling the arson problem are varied. One goal of modeling arson is to establish an accurate format for defining and appraising the problem (18). Through this approach, a systematic representation of the concepts and phenomena surrounding incendiary crime can be described and analyzed. Hopefully from this systematic structuring of the problem, abatement and control procedures will be developed which will reduce the magnitude of arson related fire losses.

As previously mentioned in the statewide survey of arson and nonarson losses, intentionally set fires are on the average more destructive than nonarson fires. Motives for setting incendiary fires are varied; however, insurance fraud

is frequently a companion crime. With this fact in mind, it is anticipated that formally modeling the arson-fraud offense can provide a greater understanding of the planning, commission, investigation, prosecution, and insurance related phases of development.

The Arson-Fraud Systems Analysis Model

One conceptual model describing the relevant phases of the insurance related arson fire is shown in Figure 1.3. This conceptionalization is called the Arson-Fraud Systems Analysis Model. Included within the scope of this model are elements describing the investigation and prosecution of criminals who defraud insurance companies through arson fires.

Insurance applications are made by a person who desires coverage on property through an agency representing a licensed company. The insurance agent or broker temporarily binds this requested coverage and forwards the application for further review by an underwriter, who verifies and makes a final decision on coverage. In the event of a fire loss by the insured, claims representatives of the insurance company (adjusters) decide on the amount to be paid based upon their investigation.

The detection on whether the fire loss was caused by an arson fire is usually made by the responding fire department but could also be made by law enforcement agencies of representatives of the insurance company. Should a criminally

set fire be detected, an investigation into the cause and origin of the fire is conducted. Sometimes prosecution of person or persons responsible for the fire is made by the fire or law enforcement agency investigating the crime. During the investigation, information concerning the fire loss is often passed back to the underwriters by the insurance adjuster for future use in evaluating new insurance policy applications.

In the cases of fires cleared by an investigation or fact that a criminal fire did not occur, the prosecution and detailed investigation phases are bypassed to the insurance claim stage. A typical example would be when the insured had no connection with the fire or was cleared by the investigation.

With intentional arson-fraud losses, a criminal who benefits from the insurance claim uses each concept to his or her best advantage. The criminal then becomes, as shown in Figure 1.3, an integral element of the overall system.

Using funds often obtained from previous fire losses, the criminal submits an insurance application to an unsuspecting carrier for a target structure. Next, the insurance underwriters perform a review of the application and make a decision to accept or reject the policy.

The criminal, now having the property insured, sets or has a fire set within the structure. Should arson be

detected as the cause of the fire, an investigation is conducted by a fire or law enforcement agency. Should enough evidence be available, the arsonist and/or owner is criminally prosecuted. Hopefully, the criminal is convicted and the insurance company denies the claim.

If the investigation, however, cannot provide enough information to arrest the criminal or the fire was never detected to be arson, the holder of the insurance policy submits a claim. Payment for the property lost in the fire is made to the criminal, who often reinvests the money in future incendiary crimes.

Future sections will examine the components of the Arson-Fraud Systems Analysis Model with respect to the underlying concepts involved with the decision processes. Emphasis will be placed upon concepts for which viable research has been conducted.

1.3 THE INCENDIARY CRIME ANALYSIS SYSTEM

Described in the previous section is the technique used by professional criminals to defraud the insurance companies through arson related claims. A systematic control of these activities is needed on a national basis.

First, the detection of the incendiary crime must be made before a criminal investigation can proceed. Based upon prior established activity by the criminal, a prediction is

made of when the next fire claim is most likely to occur so that prevention efforts will be in order.

A systematic representation of these three phases mentioned above is schematically shown in Figure 1.4 and is referred to as the Incendiary Crime Analysis System (ICAS). These phases serve also as the basis for the following chapters of this text and formulate a comprehensive framework for future researchers in the field of crime analysis. The following paragraphs highlight these individual phases.

Detection Phase

The detection phase of incendiary crime analysis is a crucial aspect of the problem. Often the crime of arson is not always obvious and usually is only discovered after an investigation has been initiated into the cause and origin of the fire.

Characteristics of the fire, materials, methods, and suspected motive are several concepts studied to determine whether an incendiary crime has taken place. Past historical information on previous fires is often used to determine possible criminal activity in conjunction with the case under investigation.

Prediction Phase

The predictability of incendiary crime is an underlying factor important to this research. The predictions as to the

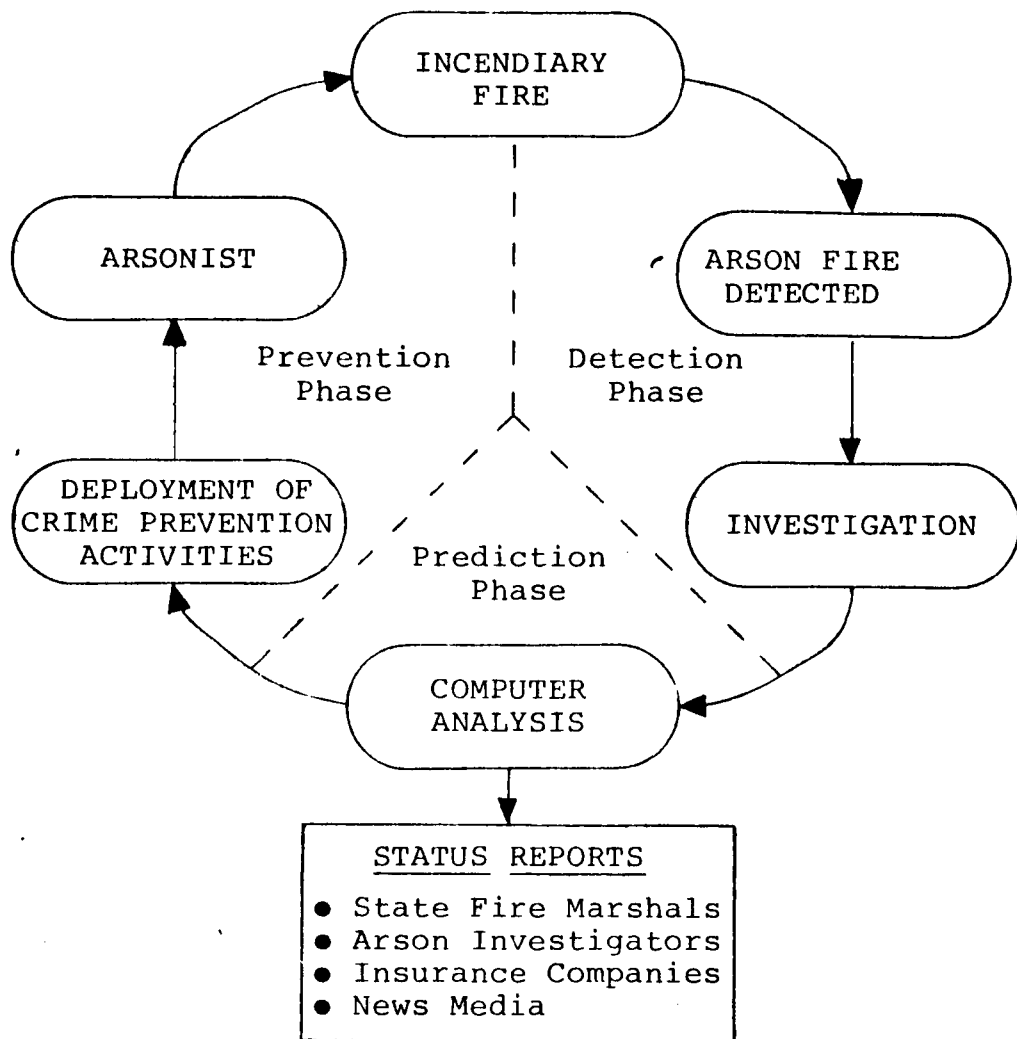


FIGURE 1.4 The Role of the Incendiary Crime Analysis System.

future times, dates, and locations where incendiary crimes are most likely to occur are the basis of this phase of analysis. These predictions are often based upon prior historical patterns established during the detection phase. Also, computer-assisted analysis of these established patterns is an important tool during this phase and provides status reports crucial to the operation of the overall system.

Prevention Phase

Incendiary crime prevention goes beyond the prosecution of the arsonist and concentrates on continuous efforts designed to discourage future activity. Investigative information derived from the previous detection and prediction phases of analysis is used to formulate arson abatement strategies.

Examined during the prevention phase of analysis are several concepts described in Figure 1.3 of this chapter that discourage future incendiary crime activity. Among these concepts are included techniques for insurance underwriting, evaluation of applications, and prosecution programs.

1.4 SUMMARY

This chapter introduces the concepts involving arson as a crime within the United States. Accurate data sources on the incidence of arson are not always available for appraising the problem on the national, state, or local levels. Simple

validity studies, however, can often be conducted on the levels of incendiary activity.

The Arson-Fraud Systems Analysis Model is introduced as a perspective approach to examining the complex arson problem. The criminal is viewed in this model as an integral link of the system. Future chapters will examine specific concepts introduced by this model.

The basis for the remainder of the text is the Incendiary Crime Analysis System (ICAS). This system divides the overall incendiary crime problem into three phases of analysis—detection, prediction, and prevention. These phases are interlinked for a comprehensive analysis of the problem.

CHAPTER 2

DETECTION OF INCENDIARY CRIME

The crime of arson is not always obvious and usually is only detected once an investigation has been initiated into determining the cause and origin of the fire. Therefore, the detection phase of arson investigation becomes the primary step in assessing the problem of incendiarism, as demonstrated in Figure 2.1.

This chapter addresses the techniques necessary for the comprehensive detection of incendiary crime. In utilizing the tools of detection, material is presented that will enable the reader to observe the common characteristics of incendiary fires, the motives displayed by arsonists, and the observed patterns of intentionally set fires. Several examples are given using these facts in the detection phase of incendiary crime analysis.

2.1 CHARACTERISTICS OF INCENDIARY FIRES

In examining the problems of arson investigation, the emphasis first lies with the scene of the crime—the physical fire scene. Due to recent U.S. Supreme Court rulings, the arson investigator must visit the crime scene immediately after the fire has been extinguished (25). The investigator is usually summoned to the fire scene by fire or law

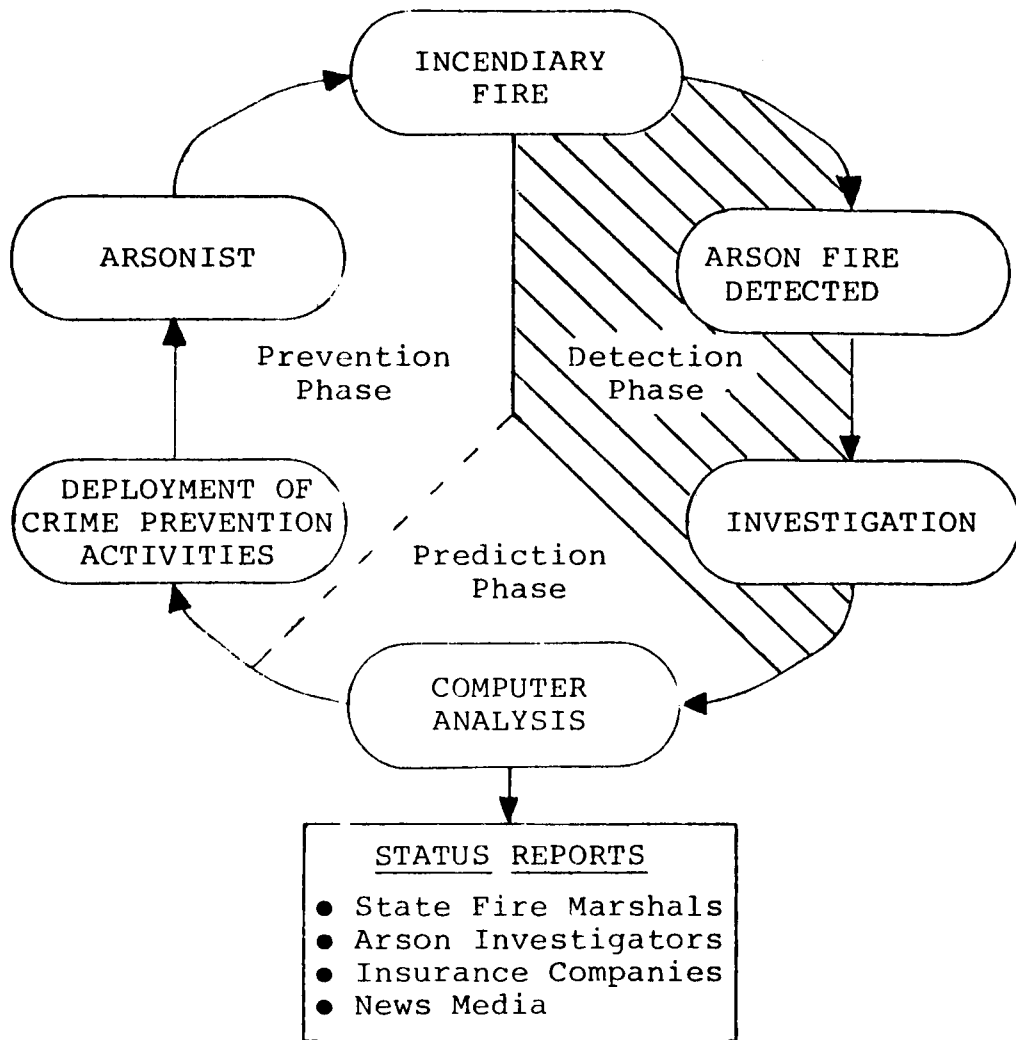


FIGURE 2.1 The Detection Phase of Incendiary Crime Analysis.

enforcement officials who have observed or suspect that an incendiary crime has been committed. According to the Supreme Court's decision, investigators who do not respond to the crime scene immediately after extinguishment of the fire must obtain either consent from the occupant of the structure or a search warrant to enter the fire scene.

From the facts, circumstances, and physical evidence obtained from the fire scene, the investigator can classify the fire into one of the three major categories.

1. Innocent Fires—Accidental or natural causes of ignition.
2. Unknown Fires—Undetermined causes of ignition.
3. Arson Fires—Intentionally set fires.

An arson fire can be further classified into either an incendiary or suspicious fire. A suspicious fire contains all the criminal elements characteristic of an incendiary fire without the rigorous establishment of the proof of arson. Some suspicious fires are often associated with total loss fires where little evidence remains, but extenuating circumstances suggest an incendiary fire.

In the 1950's Detective Lieutenant Urlick M. Burke of the Massachusetts State Police developed a milestone training tool for the detection and classification of arson fires under investigation. Now published by the National Fire Protection Association, the "Burke Procedural and Classification Chart for Arson Investigators" is still a major training

aid to the systematic detection and investigation of incendiary crime (26). A reduced copy of the Burke Chart is shown in Figure 2.2.

Materials and Methods

" Another characteristic to be examined is the technique used by arsonists to set incendiary fires. Materials and methods used to set fires usually differ according to the arsonist."

" The primary goal of an incendiary fire is the rapid destruction of a building, vehicle, human body, business records, or other property without detection that a crime has taken place." Since the development of the Burke Chart, technology has kept in pace to provide better laboratory tools to establish incendiarism through detecting the methods and materials used by the arsonist.

Arson investigators attack the examination of the fire scene by first eliminating any accidental or natural causes of ignition that could have started the fire. Visual examination of the burn patterns left in wooden and other combustible materials can reveal the source and movement of the fire. Physical evidence consisting of debris taken from the area of fire origin is usually submitted to a crime laboratory having the capability of testing for the presence of flammable accelerants.

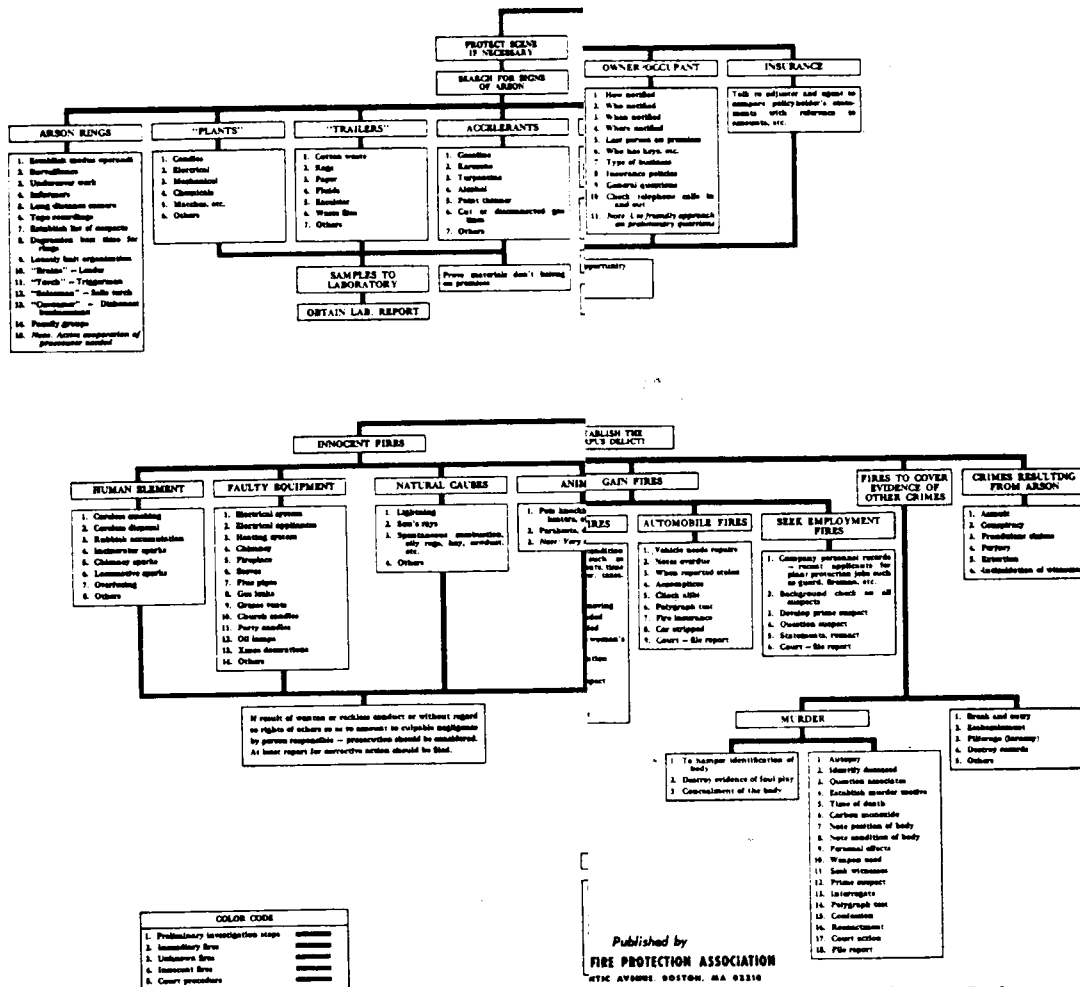


FIGURE :

\ Since rapid destruction of the property is the goal of the arsonist, multiple fires are often set at various locations in the structure to accelerate fire development. Flammable liquids are often used in conjunction with a time delay device, sometimes called an incendiary device, to allow the safe escape of the arsonist who will seek an alibi at the time of ignition of the fire."

Studies done by the Arson Bureau of the Ohio State Fire Marshal's Office show that gasoline is the most frequently used flammable liquid in incendiary fires (27). Table 2.1 summarizes the relative frequencies of fire accelerants by their type, as found in fire debris samples submitted to Ohio's State Arson Bureau Crime Laboratory. Also, due to the frequent use of flammable liquids in arson fires, their presence is often a deciding factor in the classification and detection of incendiary fires.

Multiple and Repetitive Fires

A study conducted in 1974 by the Industrial Risk Insurers (IRI), formerly known as the Factory Insurance Association (FIA), of 637 incendiary losses from 1968 to 1974 addressed the phenomenon of simultaneously set fires during each loss (28). Up to 16 individual fires were detected at losses in industrial occupancies. As previously stated, multiple fires are set during an arson fire to accelerate the destruction of the property being burned.

TABLE 2.1

TEST RESULTS OF ACCELERANTS DETECTED
AT THE STATE ARSON BUREAU OF OHIO
CRIME LABORATORY—1977

Accelerant	Total Cases	Pct. of Cases
Charcoal Lighter	14	2
Cigarette Lighter	15	2
Diesel Fuel	19	2
Gasoline	573	64
Kerosene	61	7
Lantern Fuel	13	1
Paint Thinner	16	2
Turpentine	11	1
Mixtures	18	2
Unidentified Hydrocarbons	23	3
Others	<u>130</u>	<u>15</u>
Totals:	893	100%

Source: Ohio State Fire Marshal's Office, Reynoldsburg,
Ohio, 1977.

With the design and use of active fire extinguishing systems such as automatic water sprinklers, the concept of only one incipient fire becomes an integral part of the engineering calculations for the overall system. Multiple fires often overtax the extinguishing capabilities of the sprinkler system resulting in serious impairment and increased destruction by the fires. New engineering design of these systems now take into consideration the possibilities of multiple incendiary fires.

The IRI study also recognized the problem of repetitious fires over a period of time. In 116 of the 637 industrial fires analyzed, a second fire occurred later at the same location. Table 2.2 summarizes the results obtained by the IRI study into repetitive incidents. The principle thrust of these results indicate that when incendiary losses occur at the same industrial location, there is a 50% chance that a second fire will follow within 3 months of the first.

Removal of Property

Another characteristic of an incendiary loss is the absence of property from the structure. Property removed prior to the fire might include items that are valuable, that have a sentimental meaning to the owner, or that are of an incriminating nature. Sometimes valuable items that are removed will be replaced before the fire with less expensive

TABLE 2.2
RESULTS OF THE IRI STUDY ON THE REPETITION OF
INCENDIARY FIRES FOLLOWING THE FIRST FIRE

Time Interval	Pct. of Total Incidents
1 Day	9
2 Days	15
7 Days	23
2 Weeks	32
4 Weeks	35
3 Months	55
6 Months	59

Source: Industrial Risk Insurers.

items of similar construction, such as furniture or clothing, for example.

Summary

This section concerned the characteristics of suspicious and incendiary fires. These characteristics centered on the physical evidence found at the scene of the fire, the types of fires that are set, and the frequency of these fires. The next sections will concentrate on the profiles of behavior of the arsonist and the patterns exhibited by fire setters.

2.2 PROFILES OF BEHAVIORAL PATTERNS

In the previous section, the arson investigator was presented with the physical aspects of the fire scene in order to detect whether an incendiary fire had been set by an arsonist. With the detection of incendiarism, the patterns of human behavior emerge as a detectable factor.

^ Few other crimes share such obtuse motives, behavioral patterns, and methods of operation as those in the commission of incendiary crimes!! Often investigators are required, out of necessity, to make subjective evaluations of the possible motives of the suspected arsonists whose fires collectively bear their signatures. In many cases, the assumed motives are never verified or substantiated by legal evidence.

This section provides the reader with a survey of the present knowledge of behavioral patterns common with arsonists.

An investigator, cognizant of these profiles, might make a subjective evaluation of the fire scene based upon the suspected motive of the arsonist.

Motives of Arsonists

Many studies have been conducted over the last two decades describing the motives for committing arson. The studies are usually conducted using incarcerated arsonists with the following categories selected for classifying the motives.

① 1. Revenge. This motive involves the return of hostility against another person or group of persons by using fire as a destructive tool. Associated in this category are the concepts of spite, jealousy, feuds, and racial or religious hostilities.

② 2. Pyromania. Associated with arson, pyromania is the best recognized motive for the setting of fires. Sexual gratification, divine guidance, and alcoholism are often linked with this motive. The news media often grasps upon fires where pyromania is suggested due to the human interest view of the story.

③ 3. Malicious mischief. The needless destruction of property by juveniles and young adults using fire is often referred to as malicious mischief or more commonly, vandalism. In the United States during 1974, approximately 75% of fires occurring in schools were the direct result of arson. As

previously shown in Chapter 1, arson in schools was the highest percentage occupancy affected, primarily due to the motive of malicious mischief.

④ 4. Concealment of crime. The use of fire to conceal the commission of crimes such as burglaries, homicides, auto theft, or fraud is a common motive of the professional arsonist. In the case of murder, for example, fire often deteriorates the body beyond recognition. During a fire, the commission of other crimes can take place while attention has been directed towards the suppression of the fire. Burglaries, robberies, and attempted prison escapes often occur during an intentionally set incendiary fire.

④ 5. Insurance fraud. As previously demonstrated in Chapter 1, the successful arson fire associated with a fraudulent insurance claim is relatively a safe endeavor for a criminal. Organized crime thrives on insurance fraud schemes to steal millions of dollars from insurance companies yearly just within the United States (32).

Shown in Table 2.3 is a compilation of several motive studies made between 1964 and 1970 that are cited in the literature. Notice the similarity in the reported percentages for each respective category. The Robbins study provides some additional insight into the problem of juvenile arsonists.

However, researchers must be reminded that the true motive of an arson fire may never be known or otherwise

TABLE 2.3
COMPILATION OF MOTIVE STUDIES

Motive	Robbins 1964-(29) n=136,103*	Steinmetz 1965-(30) n=304	Inciardi 1970-(31) n=138
Revenge	47% / 5%	41%	58%
Pyromania	30% / 14%	49%	18%
Malicious mischieif	10% / 80%	0%	10%
Concealment of crime	9% / 2%	7%	7%
Insurance fraud	4% / 0%	3%	7%

*n=adults/juveniles.

misclassified. Most insurance companies and arson investigators now recognize that the immense financial losses due to arson fires are also linked to insurance fraud. Often an accidental fire will result in a fraudulent insurance claim due to purposely overestimated losses by the insured.

Further study by Inciardi showed that arsonists who commit crimes associated with concealment and fraud motives had significantly higher intelligence quotients and less problems with alcohol consumption than other arsonists. Remember that motive studies are often based upon data obtained from interviews with apprehended or incarcerated arsonists and do not reflect those who have escaped prosecution (33).

In review, the arsonist's motive may be repeatedly reflected in several cases. In these situations, additional factors are introduced into the case of which the investigator should be cognizant of in detecting patterns of behavior. This phenomenon of human behavior in repetitive fires is often classified under "biological rhythms" due primarily to their periodicity of occurrence.

Human Biological Rhythms

With no attempt to solve or explain scientifically observed biological rhythms of human behavior, a simple knowledge of their existence is helpful in detecting patterns of arsonists. Just as with other criminal acts, arsonists

have their favorite times, dates, places, and methods of setting incendiary fires.

Many studies have appeared in the literature describing biological rhythms exhibited by animals, plant life, and man (34). Summarized in Table 2.4 are selected biological rhythms cited in the literature, arranged by their respective time periods. The rhythms are are simple cyclic responses, with maximums indicated with the literature reference.

Daily rhythms of 24 hours in length are often referred to as "circadian" rhythms (35). The lunar phases of the moon form approximately 14 day time periods, while 28 day monthly and 365 day yearly rhythms periods exist.

In the detection of patterns in incendiary crime data, the investigator can utilize the knowledge of these biological rhythms without a rigorous proof to their existence. Just as the casual fisherman is aware of the tidal activity of the oceans, he need not be cognizant of the laws of physics governing their activity.

The Heineke Arson Model

A sophisticated model used to describe the economic representation of human behavior associated with incendiary crime is known as the Heineke Arson Model (18). Using standard modeling principles, this approach to incendiary crime analysis is explored.

TABLE 2.4
 COMPILATION OF HUMAN BIOLOGICAL RHYTHMS

Rhythm	Time Period	Maximum	Ref.
Oral Temperature	24 Hours	9:00 PM	36,37
Mental Efficiency	24 Hours	11:00 AM	36
Alcohol Metabolism	24 Hours	8:00 AM	36
Pain Sensitivity	24 Hours	6:00 PM	36
Psychomotor Performance	24 Hours	11:00 AM	36
Human Mortality	24 Hours	9:00 AM	36
Onset of Labor/Birth	24 Hours	1:00 AM	36
Crime Activity	14 Days	New Moon Full Moon	38,39
Color Perception (Red)	28 Days 365 Days	Full Moon December	36
Menstrual Cycles	28 Days	Varies	36,37

1. Observation. The following variables were chosen by Heineke to describe the model:

- D(L) Damage caused by the fire.
- L Time allocated by the arsonist to plan incendiary crime activities.
- p The probability of prosecution of the arsonist resulting in a prison sentence.
- W^0 The initial wealth of the arsonist.
- F Fines as a result of multiple fire damages.
- W $(W^0 - FD(L))$ = The wealth of the arsonist if prosecuted after starting a fire and causing damage D(L).

These terms represent variables associated with the behavior of an arsonist in terms of his decision making process. The arsonist takes into account his chances of being apprehended versus the economic gains to be made with the criminal activity.

2. Construct hypothesis. Based upon the problem observations, the Heineke Model assumes that the arsonist will follow the decision making process of the von Neumann and Morgenstern expected utility theorem (19). Under this theorem, the arsonist is represented as a function $U(W, L)$, where W is the individual's wealth and L is the time used to plan incendiary crime activity.

3. Develop model. The von Neumann Morganstern utility function is composed of a framework of theorems that attempt to describe the decision behavior of individuals. These theorems state that the decisions made by individuals will always be chosen to optimize the conditions of their

environment. Increased monetary wealth is the goal to be optimized for the professional arsonist.

The solution to the amount of time an arsonist allocates in planning and executing an incendiary fire, denoted by the term L^* , is determined by maximizing the relation

$$\max_L \{ (1 - p) U(W^0, L) + p U(W^0 - FD(L), L) \}$$

When Heineke described the above model, an assumption was made that the value for L^* could only be obtained from a continuously differentiable function, such that

$$L^* = \phi (p, F, W^0)$$

Based upon an analysis of the above function for L^* further examination of the model can be made with regards to changes in the problem parameters.

4. Measurement testing. Having explored the basic model, interest is directed towards the responsiveness of incendiary crime activity to changes of the problem parameters. In exploring these parameters, the mathematical analysis can be obtained with the partial differentiation of L^* by the respective parameter.

Four statements on incendiary crime activity have been derived by the Heineke Arson Model with regards to changes in wealth, severity of punishment, and level of enforcement.

$$\frac{\partial L^*}{\partial W^0} > 0$$

If the punishment is by fines, increasing the level of wealth of the arsonist leads to increased incendiary activity.

$$\frac{\partial L^*}{\partial F} < 0$$

Increasing severity of monetary punishment lowers incendiary activity.

$$\frac{\partial L^*}{\partial p} < 0$$

Increasing the probability of prosecution lowers incendiary activity.

$$\left. \frac{\partial L^*}{\partial p} \right|_{d(pFD)=0} > 0$$

Percentage increases in the probability of prosecution lowers incendiary activity less than equal percentage increases in monetary fines.

The results of the Heineke Arson Model analysis support the research summarized by the Aerospace Corporation study on the level of incendiary crime activity (15). The consistent observation reported was that increased arrest rates produced lower incendiary activity. Also implied by the study was that additional fines and/or prison sentences also acted as a deterrent to arsonists.

5. Conclusions. Based upon the results obtained from these prior steps, the Heineke Arson Model can be considered a valid representation of the human decision making process associated with incendiary crime activity. Examined and validated by supporting research is the concept of the maximum time allocated by the arsonist with regards to varying forms of punishment and/or prosecution. Future users of this

model should review the initial theorems of the von Neumann Morganstern utility function before modifying problem parameters.

2.3 INCENDIARY CRIME DETECTION TECHNIQUES

The prior sections of this chapter have covered the characteristics of how, why, and when arsonists are most likely to set fires. Equipped with this background information, analytical detection techniques are presented for application by arson investigators in their work, remembering that detection is the primary phase of incendiary crime analysis.

Patterns of Incendiary Fires

In the commission of incendiary crimes, arsonists may or may not be aware of their individual behavioral patterns with relation to the times, dates, or geographic locations of the incidents. Continuous studies and observations by this writer over a five year period have noted several distinctive patterns of incendiary fires set by arsonists. The following generalizations have been documented and found to be common to the United States without regard to geographic region.

Geographic clustering. Repetitive incidents, as shown previously in Section 2.1, tend to group within the same

geographical location. These groupings of incendiary fires form high concentrations of incidents within the same locale and are often referred to as "clusters" (38,40).

Lunar frequency. Incendiary fires have a higher probability of being set by arsonists during the four day period of the new and full phases of the moon's lunar cycles. Replication of this study using nonarson crimes support this observation for other criminal acts (38).

Temporal frequency. Arson fires are often set during certain periods of the day or week. Mechanisms governing this behavior might include availability, level of darkness in the evening hours, or probability of success to strike the target chosen by the arsonist (38,40).

Incendiary Crime Detection Example

A unique example was found by this writer that demonstrates the previously mentioned general patterns of incendiary fires. In Hyattsville, Maryland from February through September of 1974, a gang of juvenile boys was engaged in starting incendiary fires within a section of the city. Items set on fire by these youths included garages and wooded areas within Hyattsville.

Data from these fires were collected and analyzed to provide a surveillance schedule to local law enforcement

agencies concerned with the apprehension of these boys. The juveniles were eventually caught, and the fires ceased.

Summarized in Table 2.5 is the recommended procedure for detection patterns of incendiary crime. Included in the table are references to this example problem on the Hyattsville, Maryland fires.

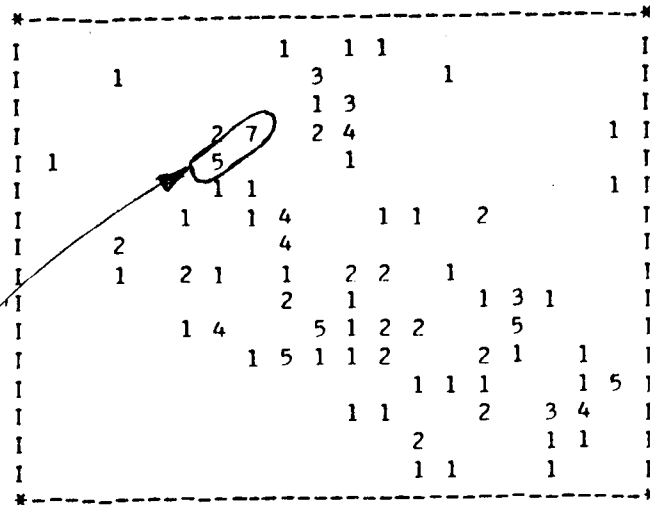
The first step in detecting incendiary crime patterns is to define the area of study and construct a gridded lattice over the area. Within each grid of the lattice, the number of total incendiary and suspicious fires is represented by an integer value. Shown in Figure 2.3a is a map of the Hyattsville area on which a gridded lattice has been placed and the arson fires totaled.

The second step consists of the detection of geographic clusters among the gridded incident map. Several analytical methods exist for performing cluster analysis. One method is to computer contour the gridded incident map, with typical results resembling Figure 2.3b. Another method is to project a three-dimensional image of the gridded incident map, and rotate the image for the best perspective view such as shown in Figure 2.4.

After geographic cluster analysis has been performed, major clusters are selected for detailed numerical analysis. Step three for this example selected the major cluster indicated in Figure 2.3 for analysis.

TABLE 2.5
PROCEDURES FOR INCENDIARY CRIME DETECTION

Step	Procedure	Display	Example
1	Select Gridded Area	Gridded Incident Map	Figure 2.3 (a)
2	Check for Clusters	Contour Incident Map 3-Dimensional Display	Figure 2.3(b) Figure 2.4
3	Select Major Clusters	_____	_____
4	Perform Temporal Analysis on Major Cluster	Histogram—Time of Day Histogram—Day of Week Scatterplot—Time vs Wk. Scatterplot—Time vs Day	Figure 2.5(a) Figure 2.5(b) Figure 2.6(a) Figure 2.6(b)
5	Multivariate Analysis	_____	_____



(a) Gridded Incident Map

Major Cluster



(b) Contour Map of Incidents

FIGURE 2.3 Gridded Incident and Contour Maps with Major Clusters of Arson Fires.

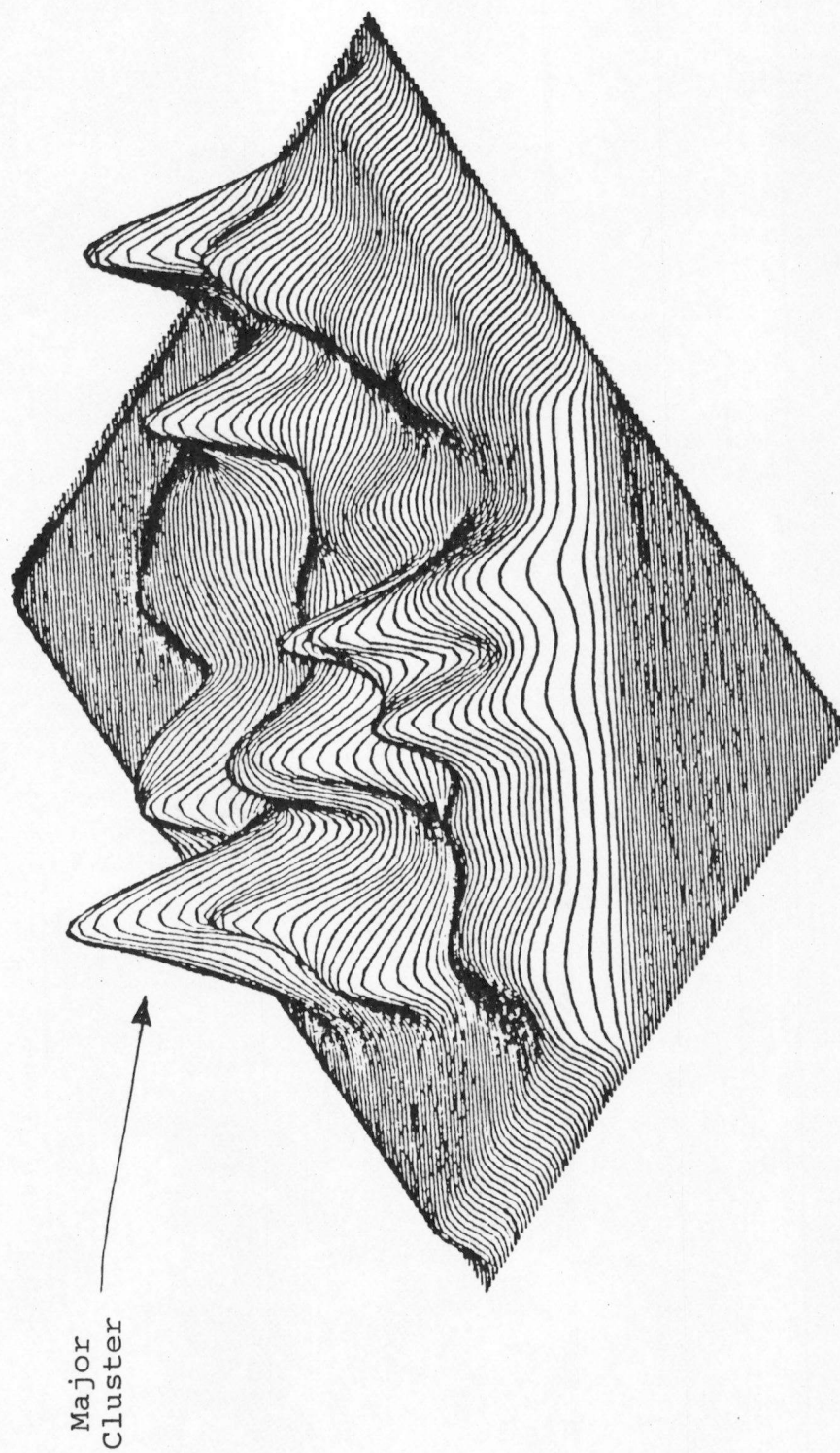


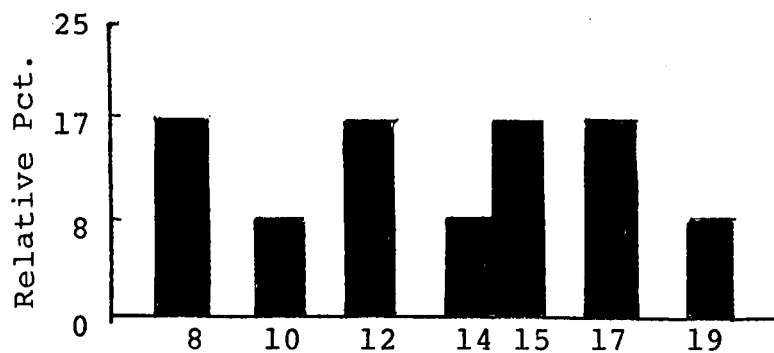
FIGURE 2.4 The Detection of Geographic Clusters of Arson Fires in Three Dimensions (350 CCW Rotation).

The major cluster of arson fires selected from the map of incidents were twelve of the fires set by the group of juveniles in Hyattsville. Temporal analysis of the time of day and day of the week for the incidents contained in this major cluster was performed. Histograms for the time and day of week are displayed in Figures 2.5a and b.

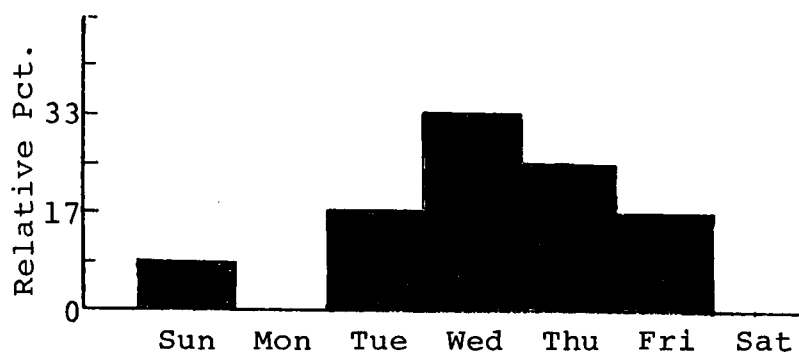
Scattergrams displaying the time of day versus the day of the week and week of the year are shown in Figures 2.6a and b. Indicated on these figures are the general patterns formed by linking the incidents by line segments.

The fifth step in detecting incendiary crime trends is to perform additional multivariate analyses on other data variables. During this step, lunar patterns are often detected. For this example, 75% of the fires occurred within four days of either the new or full moon phases.

In the final analysis of this example, it was observed that the juveniles set these incendiary fires during breaks in the school day. In the summer months, fires occurred in the evening hours; but the trend resorted back to the original pattern at the start of school in the fall. With few exceptions, the fires were on weekdays. Analysis of the incidents ceases when the investigator believes that no other patterns can be obtained from the data provided.

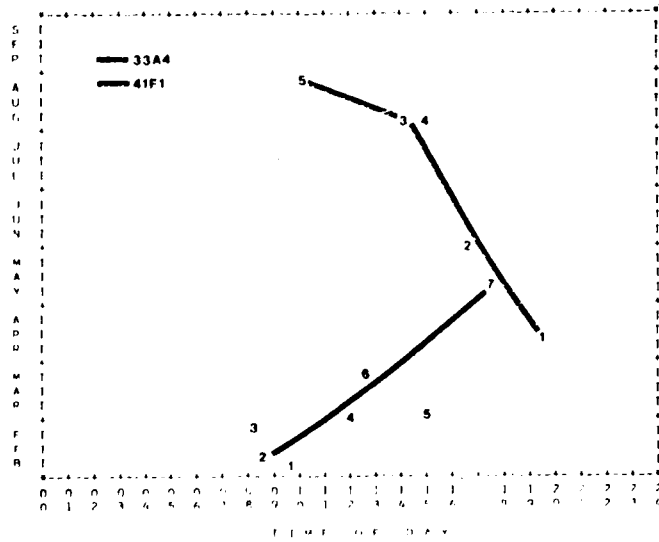


(a) Histogram by Time of Day

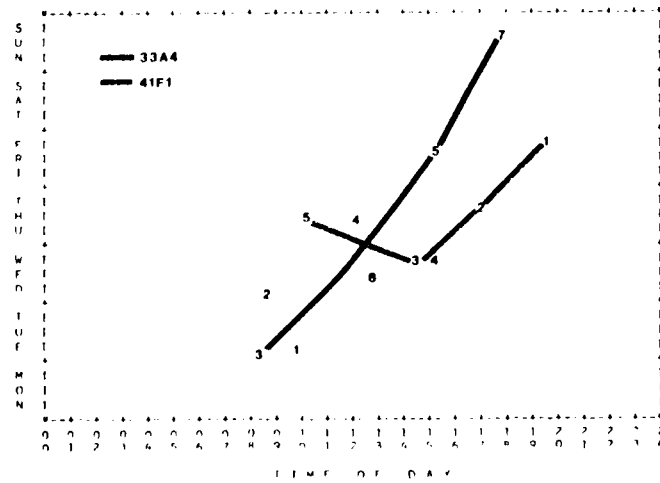


(b) Histogram by Day of Week

FIGURE 2.5 The Detection of Temporal Trends by Histograms.



(a) Time of Day vs. Week of Year



(b) Time of Day vs. Day of Week

FIGURE 2.6 The Detection of Temporal Trends.

2.4 SUMMARY

Shown by this chapter has been how the detection phase of arson investigation is the primary step in assessing the problem of incendiarism. Not often obvious, arson is a crime that is only detected after a comprehensive investigation has taken place.

In order for the arson investigator to be able to detect incendiarism, the characteristics of the crime must be known. Classification of the fire, materials and methods used, and behavioral patterns displayed by the arsonist are several characteristics of an incendiary fire.

As in other professional fields, an investigator often relies on intuitive knowledge of past criminal fires with regards to interpretation of present and future cases. Likewise, incendiary crime detection techniques include, but are not limited to, known historical patterns of intentionally set fires. Patterns found to be significant with no regard to geographical region include clusters of time dependent incidents.

The analysis of incendiary crime does not cease with the detection phase. The following chapters will cover the prediction and prevention phases with computer assisted analysis techniques being emphasized.

CHAPTER 3

PREDICTION OF INCENDIARY CRIME

This chapter is concerned with the prediction phase of incendiary crime analysis. As indicated in Figure 3.1, this phase of analysis relies mainly upon the computer-assisted processing of historical trends revealed during the previous detection phase. Results of these predictive analyses are used to study incendiary crime phenomena as well as to formulate arson prevention programs during later phases of study.

3.1 INCENDIARY CRIME ACTIVITY

Predictability

The predictability of incendiary crime is an underlying factor important to this research. The predictions as to the future times, dates, and locations where incendiary crimes are most likely to occur are based upon prior historical patterns established during the detection phase. Computer-assisted analysis of these established patterns is an important crime prediction tool for the investigator and is illustrated in later examples.

Three categories of predictable incendiary crime activity have been observed to dominate this area of research (38,39). The first category contains the one-time arsonist,

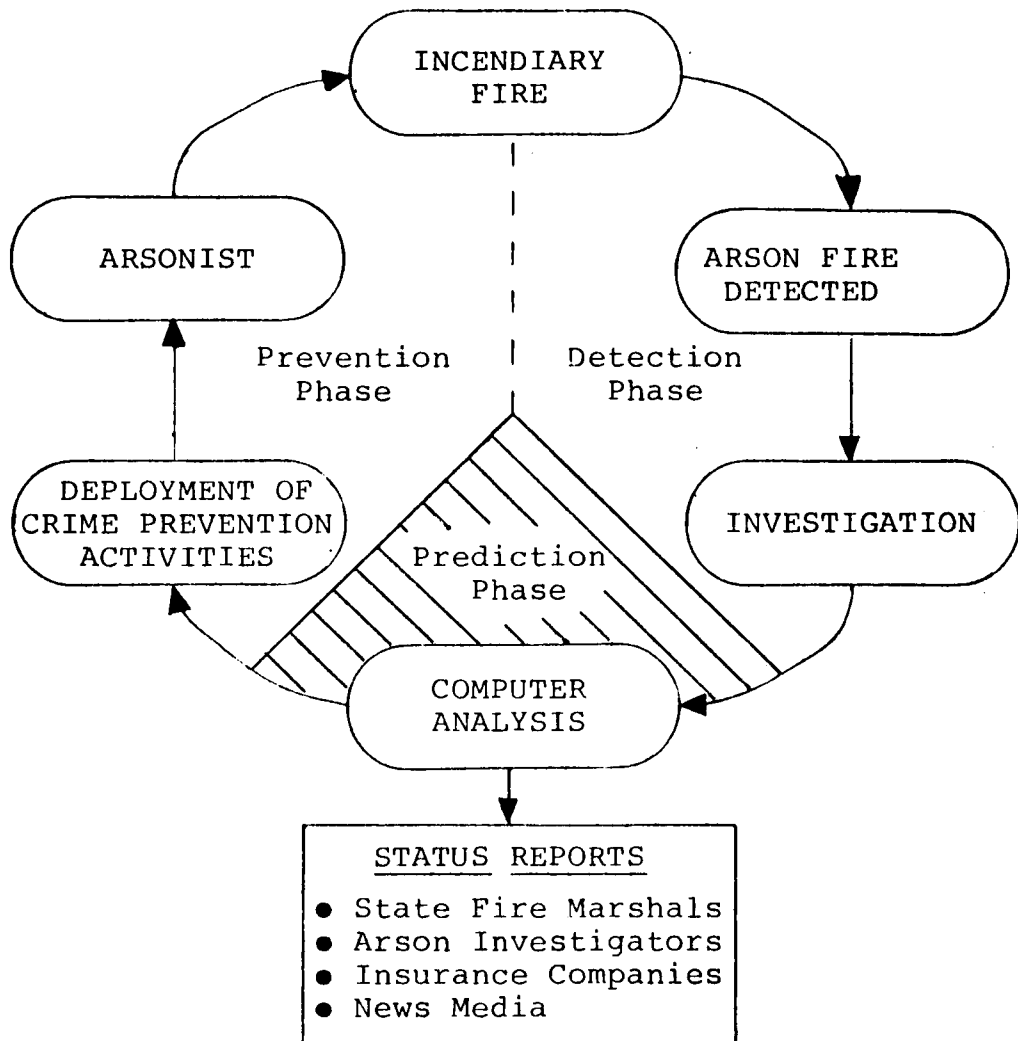


FIGURE 3.1 The Prediction Phase of Incendiary Crime Analysis.

who has had no prior experiences with fire setting. A second category of activity is dominated by the individual arsonist who has committed prior incendiary crimes. Group participation of arsonists encompasses the third category of predictable incendiary crime activity. Further discussion below documents these concepts involved with the predictability of incendiary crimes.

One-Time Incendiary Activity

Previous studies into the motives of arsonists (29,30,31) have shown that one-time incendiary firesetting behavior is not dominated by any one category. For example, an estranged lover may resort to setting fire to his or her mate's personal affects during a single fit of rage, with no past experience with incendiarism. Also, a small businessman may resort to recovering from an unwise investment by personally setting fire to his store and having no prior experience with fire.

Nevertheless, the one-time arsonist has been found to follow the profiles detected in previous fire-setting behavior of fellow arsonists (39). This profile matches that established earlier in Section 2.2 as well as profiles to be discussed in later sections. In continuing with the examples mentioned above, the estranged lover would most likely use a readily available flammable liquid to set a fire. Also, the businessman would most probably use an available flammable

liquid. Past profiles show that both arsonists would be most likely to set their fires according to the lunar phase of the moon (38,39).

In summary, the one-time arsonist is the hardest behavior to predict based upon the limited data available. However, prior studies have shown that one-time arson fires do conform to a profile that is detectable without regards to motive of the individual committing the crime.

Individual Incendiary Activity

Observations by this researcher, supported by other previous studies (38,39), demonstrate that individual arsonists are predictably consistent as to the times, materials, methods, and geographic locations at which they set fires. Once an arsonist establishes a pattern of fire setting behavior, he or she is not likely to deviate from that pattern.

An example of the pattern behavior established by an arsonist was documented by the U.S. Department of Agriculture's Forest Service in 1963 (40). A five year investigation of a forest arsonist who placed incendiary devices along foottrails revealed a characteristic pattern of activity in which the methods, materials, geographic sites, and times of the year were rarely deviated. Investigators, armed with this knowledge, were eventually able to predict and apprehend the arsonist.

Group Incendiary Activity

The group efforts of arsonists reveal patterns similar to that of the individual arsonist, with a minor exception. When several arsonists have been found to engage in group incendiary activities, their pattern of behavior often predictably shift with respect to the characteristics of the fires.

An example of group incendiary activity was documented in Chapter 2 involving juvenile arsonists. Examined in this study were the predictable shifts in geographic distribution, time of day, day of the week, and lunar trends of twelve fires. Figure 2.6, page 49, illustrated the predictable shifts in temporal data.

An explanation for the predictable shifts observed with group incendiary activity could be accounted for by the blending of each arsonist's methodology unto a unified effort. Changes as to the methods of operation by the group participants would be reflected in minor shifts of activity.

Summary

Incendiary crime activity, whether the results of one-time, individual, or group participation of arsonists, is a predictable factor as documented by research. The one-time arsonist shares a profile similar to the behavior of the individual arsonist. Group incendiary activities often deviate with predictability from the established pattern or profile.

The next section examines more closely the prediction of group incendiary activity involving organized crime. This example illustrates the use of detected incendiary crime patterns in the formulation of a model to predict future occurrences of fires within the problem area.

3.2 PREDICTION OF GROUP INCENDIARY ACTIVITY

Introduction

This section examines more closely the predictability of group incendiary crime activity by arsonists. Studied are the characteristics which provide the arson investigator with the most appropriate information on crime patterns for surveillance scheduling purposes. These crime patterns also include investigative data linking and predicting of future incendiary activity regions.

Organized incendiary crime is a subset of group incendiary crime activity where arson fires are often planned according to prearranged times, dates, locations, and types of property to be burned. With economic gain being the primary goal of organized incendiary crime activity, the insurance companies and their premium paying customers often underwrite major arson losses of group incendiary activities (40).

The following example illustrates group organized incendiary crime activity operating in a major eastern

metropolitan area of the United States. This activity consisted of the systematic theft and burning of vehicles. The concept of prediction of incendiary crime activity is developed along with surveillance scheduling, using computer-assisted algorithms.

Vehicular Incendiary Crime: A Case Study

The large production of automobiles and trucks within the last decade compounded with the mandatory insurance on financed property has encouraged the operation of organized automobile theft rings (42). A stolen vehicle, stripped of its valuable parts and burned to dispose of incriminating evidence of the theft, is easily replaced as a total fire loss under the policy of any insurance contract.

Within the Washington, D.C., Maryland, and Virginia areas, the operation of an organized interjurisdictional vehicle theft ring is common knowledge among fire and law enforcement agencies. Hindered by the jurisdictional boundaries, the lack of a global strategy for multigovernmental law enforcement efforts is evident (41,42).

During the year of 1972 in Alexandria, Virginia, there were 333 incendiary and suspicious vehicle fires. An analysis of these fires detected time dependent geographic clusters (42). Predictions based upon these detected trends were later verified by Alexandria Fire Department officials

who had been concerned with the incendiary crime problems in their city.

Following the procedures outlined in the previous chapter for incendiary crime detection, an appropriate gridded map was selected for the area of study. The gridded coordinate map used to display the fire incidents was developed by Dr. Harry E. Hickey of the University of Maryland for use in fire research studies (43,44), shown in Figure 3.2.

The second step of cluster analysis was compiled using a nonhierarchial clustering strategy called K-Means, which is summarized in Table 3.1 (45). This clustering strategy was chosen due to its ability to partition the clusters on a nonhierarchial basis and to provide statistical data needed for the prediction phase of the problem.

The solution to the problem using the geographic row, column, and time of day converged with nine clusters. Results for this analysis are listed in Table 3.2. The convergence was based upon the program's analysis of variance that was conducted after each clustering step. Cluster #4 was selected for further study due to a low standard deviation for the three variables.

Temporal and multivariate analyses were performed on Cluster #4 in accordance with the prescribed detection procedures. The following results were based upon these analyses.

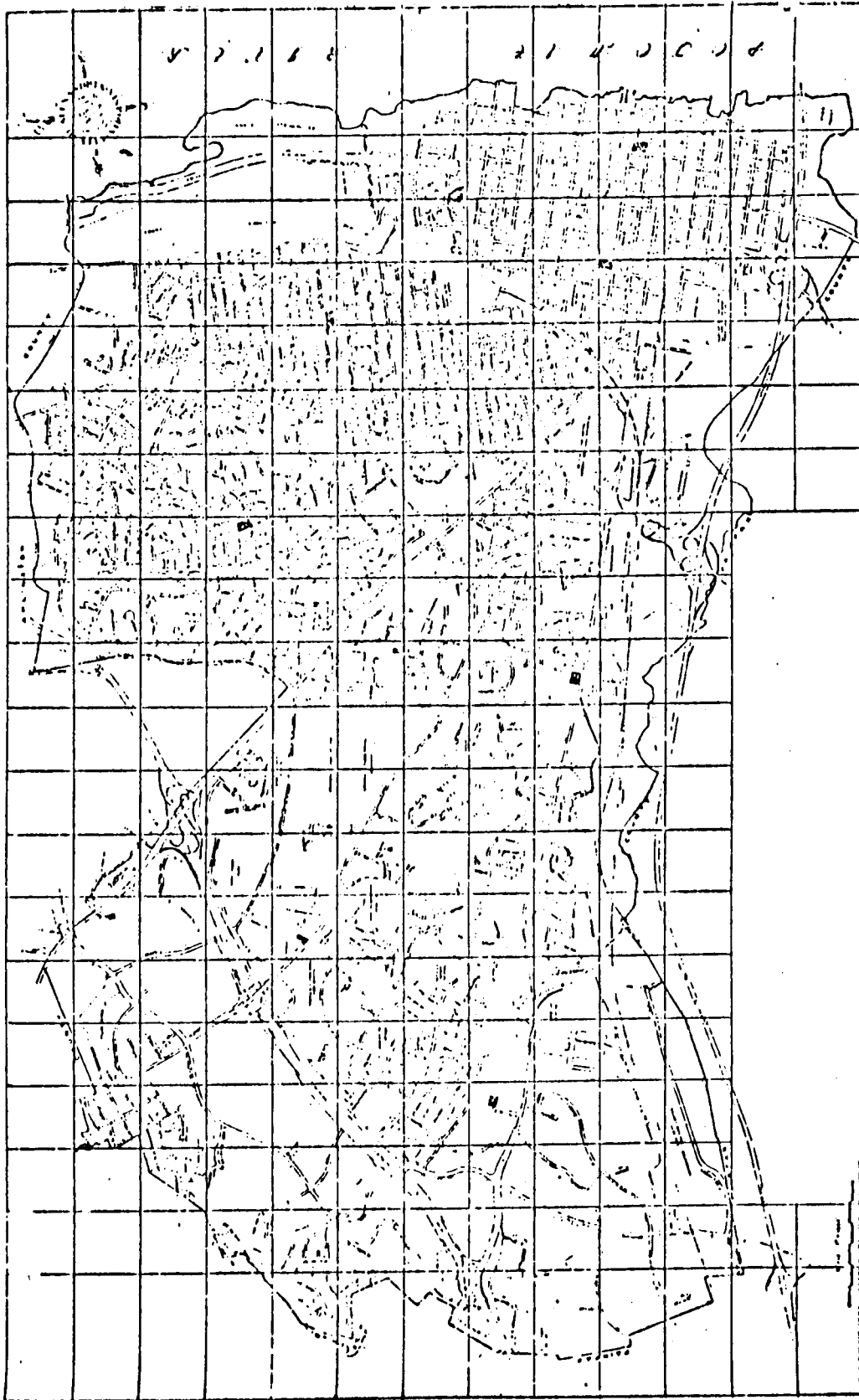


FIGURE 3.2 The Row-Column Coordinate Map for Alexandria
Virginia Fire Incident Data.

TABLE 3.1

THE K-MEANS CLUSTERING ALGORITHM

Step	Procedure	Analysis Technique
1	Compute Number of Cluster Centers, K	Calculate the average RMS distance of all patterns from the overall mean. The total number of cluster centers desired is equal to the number of patterns outside of the region formed by a sphere of radius of the RMS distance from the mean center.
2	Distribute the Patterns	Distribute the pattern samples $\underline{x}$ among the K cluster domains, such that $\underline{x} \in S_j(k) \text{ if } \underline{x} - \underline{z}_j(k) < \underline{x} - \underline{z}_i(k) $ for all $i = 1, 2, \dots, K, i \neq j$, where $S_j(k)$ is the set of all pattern samples whose cluster center is $\underline{z}_j(k)$.
3	Compute other Cluster Centers	Compute new cluster centers $\underline{z}_j(k+1), j=1, 2, \dots, K$, such that the performance index J_j is minimized. $J_j = \underline{x} - \underline{z}_j(k+1) ^2 \quad j = 1, 2, \dots, K$ $\underline{z}_j(k+1) = \frac{1}{N} \sum \underline{x} \quad j = 1, 2, \dots, K$ $\underline{x} \in S_j(k)$
4	Check Convergence	Check if $\underline{z}_j(k+1) = \underline{z}_j(k)$ for $j = 1, 2, \dots, K$. If this is not the case, go to Step 2.

TABLE 3.2
RESULTS OF THE K-MEANS CLUSTERING

Cluster No.	Variables			Time		Total Incidents
	Row	Col	Hour	Range	S.D.	
1	10.0	13.6	8.6	19.0	5.7	10
2	9.8	45.5	14.5	23.0	5.7	71
3	28.2	56.3	16.4	15.0	3.5	95
4	28.2	53.0	3.8	10.0	3.8	29
5	23.8	9.6	16.5	17.0	4.0	36
6	24.8	22.6	14.1	21.0	5.6	26
7	10.3	23.2	18.6	10.0	2.5	25
8	13.6	25.5	7.5	14.0	3.4	12
9	28.3	38.7	15.4	9.0	4.9	29

Geographic bounding. The geographic distribution of vehicle fires contained in Cluster #4 were within a bounded area of the city. This bounded area forms a wedge shaped polygon within the southeastern corner of Alexandria whose sides consist of the Potomic River, a railroad yard, and an interstate highway, illustrated in Figure 3.3.

Temporal trends. The computer analysis for temporal trends displayed by Cluster #4 showed that the hours of 1:00 and 7:00 a.m. had been peaks of activity for vehicle fires. Over 30% of the fires were on Fridays, with fires occurring later in the mornings as the year progressed.

Lunar trends. As previously noted, peaks of incendiary fire activity often occur during the new and full moon phases. Of the 29 incidents in Cluster #4, 20 fires (69%) fell within a ± 4 day period surrounding the new and full moons. Also, 16 of the fires (55%) were during the full moon phase. These percentages reflect similar results obtained in both arson and other criminal studies (38,39).

The next step in the prediction of incendiary crime activities is to construct a model based upon a multivariate analysis of the detection phase. This model would be used for predicting future fires based upon historical knowledge of prior incendiary fires. This model is the sixth step in the procedural summary shown in Table 3.3.

ARSON PATTERN RECOGNITION SYSTEM

INCIDENT MAP

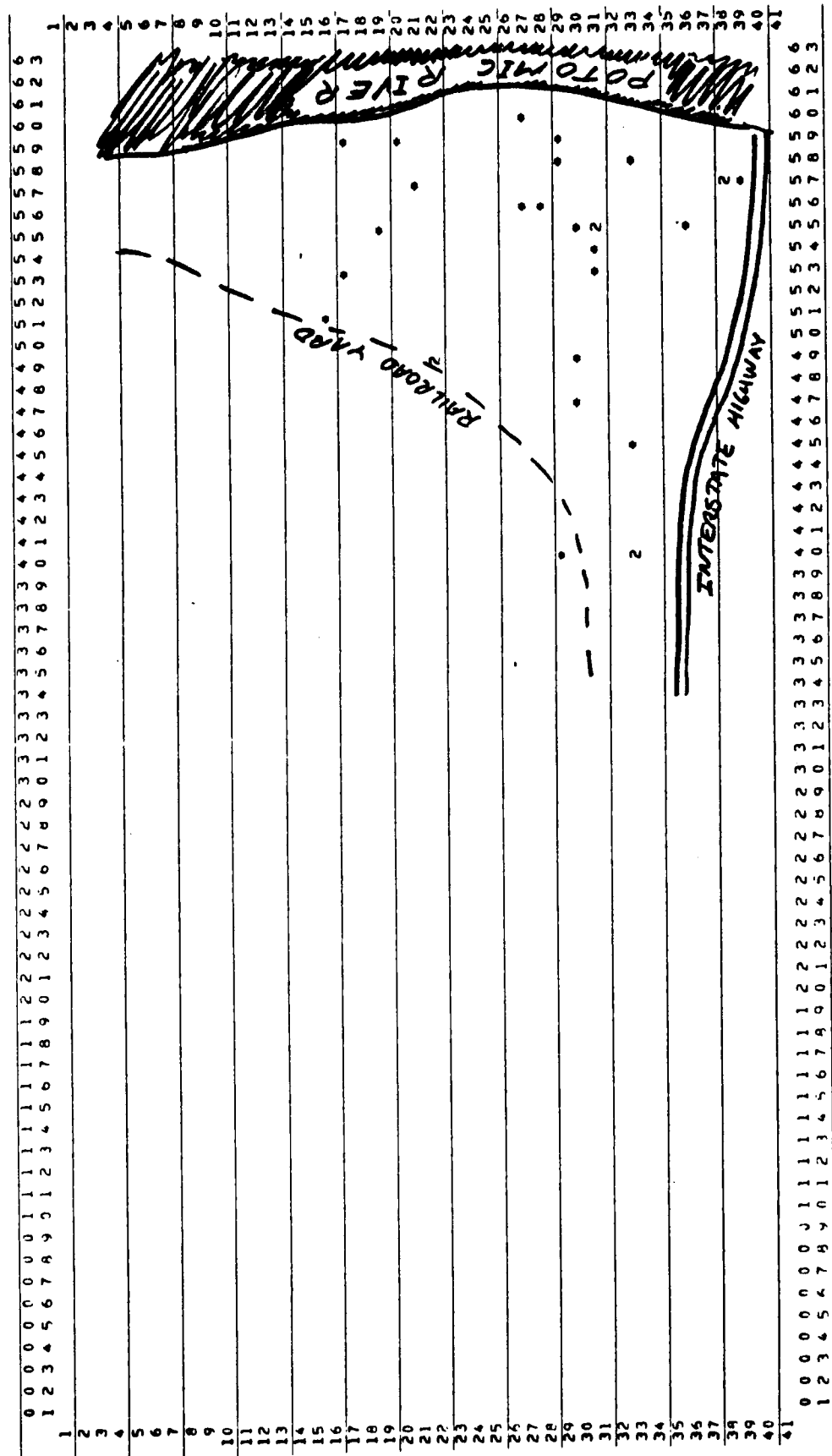


FIGURE 3.3 Geographic Bounding of Cluster #4.

TABLE 3.3
COMPUTER RESULTS FOR CLUSTER #4 ANALYSIS

CLUSTER	4	CF	9	CLUSTER MEMBERS WITH THEIR DISTANCES TO CLUSTER CENTER							
	1	2	3	4	5	6	7	8	9	10	
	0144	0198	0277	0420	0613	0644	0793	0863	1096	1128	
	5.590	8.304	8.169	4.883	7.544	3.362	6.961	4.785	1.801	2.668	
	1135	1330	1386	1407	1594	1633	1741	1821	1974	2032	
	2.223	4.435	3.157	2.800	3.923	3.561	5.516	1.894	3.834	6.545	
	2054	2090	2109	2323	2341	2440	2652	2709	2717		
	7.367	6.334	6.453	4.633	5.684	3.520	6.112	4.144	7.712		
SUMMARY STATISTICS FOR THE CLUSTER											
LABEL	CENTER	COUNT	AVE	SD	KMIN	KMAX	SSQ				
MCUR	3.828	29.	3.828	3.217	0.0	10.000	300.137				
RCW	28.276	29.	28.276	6.400	16.000	39.000	1187.789				
CDL	53.034	29.	53.034	5.780	40.000	60.000	968.966				

Results of the multivariate analysis for Cluster #4 showed that the center had the coordinates of Row = 28.2, Column = 53.0, and Hour = 3.8 a.m. A simple interpretation of this solution is that the "typical" fire within Cluster #4 was detected at approximately 3:45 a.m. close to the gridded coordinates Row = 28 and Column = 53 on the Alexandria map on Figure 3.4.

The prediction model used in this example consists of a simple patrol of the area surrounding the cluster center at the specified times of the day or night. Making the assumptions that the standard deviations of the row and column variables are approximately equal, as seen in Table 3.4, a circular patrol model whose radius emerges from the cluster center can be developed. Another assumption is that the fire incidents form a normal distribution throughout the cluster.

Confidence intervals for normal distributions state that 68% of the incendiary fires contained within Cluster #4 should fall within a radius of one standard deviation of the gridded coordinates. This assumption can be supported by the data obtained from Table 3.4 on the distances from each fire to the cluster center as well as by Figure 3.4 which shows the circular area bounded by a radius of one standard deviation. This radius is the mean value of the row and column standard deviations, which encompasses 19 fire incidents or 66% of the total when $r = 6$ units.

ARSUN PATTERN RECOGNITION SYSTEM

INCIDENT MAP

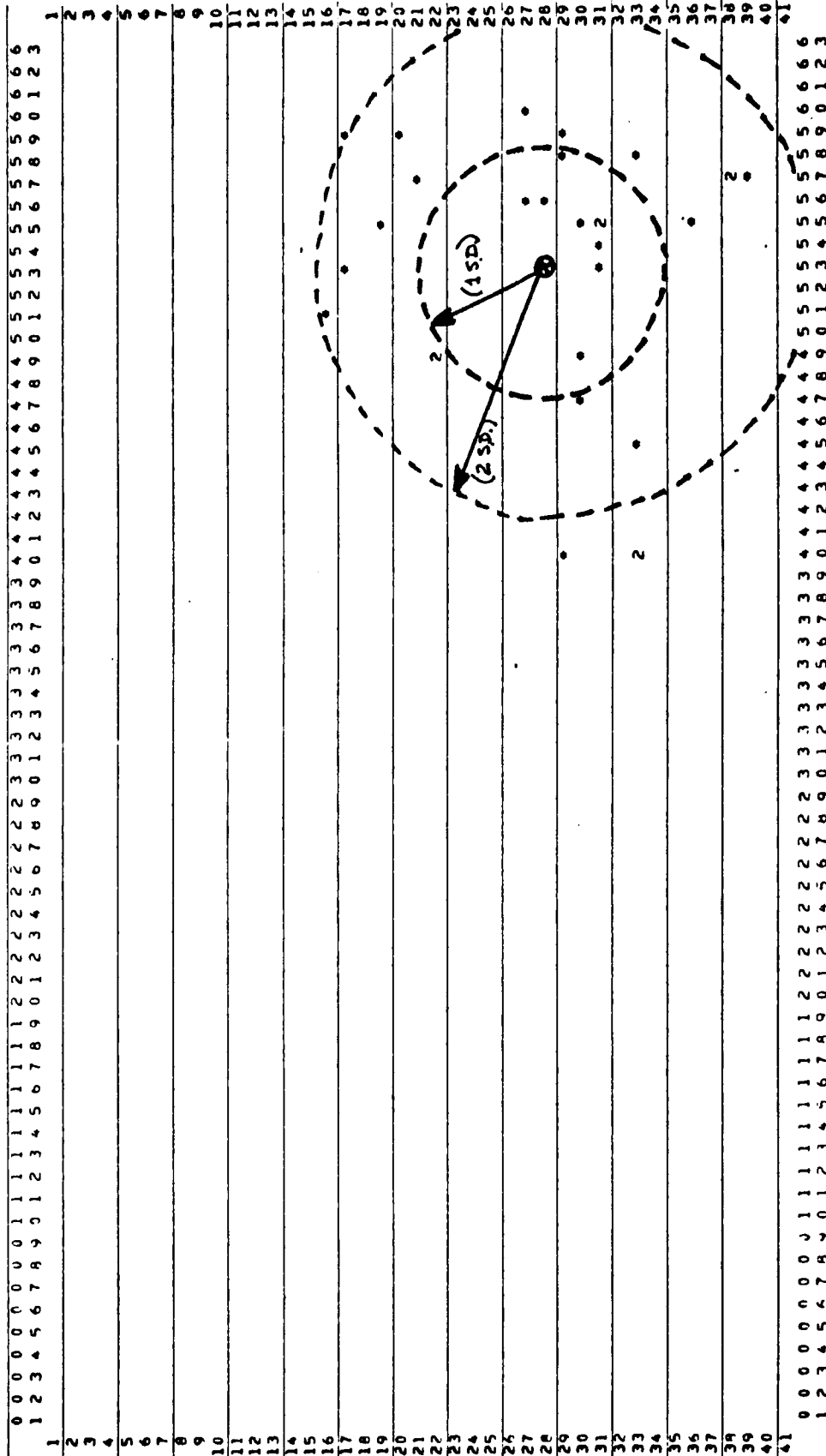


FIGURE 3.4 The Estimation of a Surveillance Area within One and Two Standard Deviations from the Cluster Center (28,53).

TABLE 3.4

PROCEDURES FOR INCENDIARY CRIME PREDICTION

Step	Procedure	Display or Analysis	Example
1	Select Gridded Area	Gridded Incident Map	Figure 3.2
2	Check for Clusters	K-Means Clustering	Table 3.2
3	Select Major Cluster	Analysis of Variance	Table 3.3
4	Perform Temporal Analysis on Major Cluster	Geographic Bounding	Figure 3.3
5	Multivariate Analysis	Cluster Radius	Figure 3.4
6	Construct Model	Confidence Intervals	Figure 3.4
7	Test Model	—	Figure 3.4

This prediction model assumes that future incendiary fires will follow past historical patterns. Patrol and surveillance activities within the circular region for this problem should take place between the hours of 12:00 midnight and 7:00 a.m. Expanding the patrol radius past two standard deviations of $r = 12$ could account for 95.5% of the total fires.

Summary

Shown in this section is the application of both the detection and prediction phases of incendiary crime analysis to a problem involving organized crime. Data from vehicles burned in 1972 within Alexandria, Virginia were used to construct a mathematical patrol and surveillance model. This model was tested for validity and fell within acceptable statistical limits of confidence of a normally distributed function.

A procedural summary for constructing a general prediction model for incendiary analysis is given in Table 3.4, with reference to the previous example. Advanced models for use in the prediction phase of analysis are covered in the following section.

3.3 ADDITIONAL PREDICTION TECHNIQUES

As previously stated in this chapter, the multivariate environment of factors involving incendiary crime activity

must often be decomposed and reduced to fewer variables to allow for precise predictions. This section presents several applications of additional prediction concepts which have been successfully implemented in other research fields. These applications warrant future development.

Fourier Analysis

Often, a periodic trend appears within crime data; for example, the rise and fall of the number of incidents during designated time periods. A researcher observes this trend and seeks an equation describing this phenomenon as well as a decomposition of the pattern into the simplest terms.

A mathematical tool called Fourier analysis (47) is a valid technique for decomposing a time varying trend into a simple sum of sinusoidal functions. A typical application of Fourier theory is the digital processing of image pictures sent back from space by weather satellites (48).

Using the monthly arrest data for a hypothetical city, a simple example of the Fourier analysis technique is demonstrated. Shown in Figure 3.5 is a periodic plot of the number of arrests between the months of September and December. The following three months are expected to complete the cycle as indicated. A formula $f(t)$ is needed by the city to predict this expected trend, which has an even periodicity (49).

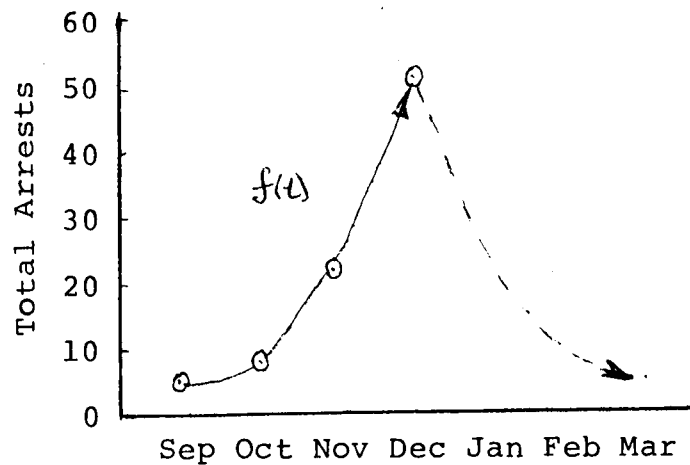


FIGURE 3.5 Total Arrests by Month.

The solution to this and similar problems is based upon the discrete form of the Fourier equation expressed as a series and commonly written

$$f(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty} \left[a_n \cos\left(\frac{n\pi t}{T/2}\right) + b_n \sin\left(\frac{n\pi t}{T/2}\right) \right]$$

where a_0 , a_n , b_n , and c_n are often called the Fourier coefficients and calculated using the integral formulas

$$a_n = \frac{2}{T} \int_{-T/2}^{T/2} f(t) \cos\left(\frac{n\pi t}{T/2}\right) dt \quad (n = 0, 1, 2, \dots)$$

$$b_n = \frac{2}{T} \int_{-T/2}^{T/2} f(t) \sin\left(\frac{n\pi t}{T/2}\right) dt \quad (n = 1, 2, 3, \dots)$$

$$c_n = (a_n^2 + b_n^2)^{1/2}$$

The time interval or period for the trend is six months for this example problem, with the sampling frequency being once a month. Users of the discrete Fourier analysis method must be cautious of the limitations during calculations. The highest frequency that the Fourier analysis is mathematically valid is called the folding or Nyquist (50,51) frequency, which is equal to one-half of the sampling frequency.

Results for a computer analysis of the time varying arrest data is shown in Table 3.5. Even periodic trends are characteristic of numerically small b_n terms, which is demonstrated in the analysis. The resulting formula representing the time varying function $f(t)$ contained only cosine terms, such that

$$f(t) = 9.6 + 8.99 \cos(\pi t/3) + 0.88 \cos(2\pi t/3)$$

for the first two terms of the series expansion.

If the magnitude of the c_n term is plotted versus the frequency $n\omega$ as shown in Figure 3.6, the graph is called the discrete frequency spectrum of the time varying function $f(t)$. The term at zero frequency is $a_0/2$, which represents the average value of the function $f(t)$. The researcher therefore sees the usefulness of Fourier analysis in the ability to display both the time varying and frequency domains of the problem.

TABLE 3.5
COMPUTER ANALYSIS OF THE FOURIER COEFFICIENTS FOR
THE FIRST TEN TERMS OF THE SERIES

A(0) = 0.192F 02					
A(1) = 0.889F 01	B(1) = 0.878E-05	C(1) = 0.889E 01	THETA(1) =	0.00	
A(2) = 0.889F 00	B(2) = 0.231E-05	C(2) = 0.889E 00	THETA(2) =	0.00	
A(3) = -0.344F 01	B(3) = 0.474E-05	C(3) = 0.344E 01	THETA(3) =	180.00	
A(4) = 0.889F 00	B(4) = -0.183E-04	C(4) = 0.889E 00	THETA(4) =	-0.00	
A(5) = 0.889F 01	B(5) = 0.607E-04	C(5) = 0.889E 01	THETA(5) =	0.00	
A(6) = 0.192F 02	B(6) = 0.158E-03	C(6) = 0.192E 02	THETA(6) =	0.00	
A(7) = 0.889F 01	B(7) = 0.524E-04	C(7) = 0.889E 01	THETA(7) =	0.00	
A(8) = 0.889F 00	B(8) = 0.669E-05	C(8) = 0.889E 00	THETA(8) =	0.00	
A(9) = -0.344F 01	B(9) = -0.294E-04	C(9) = 0.344E 01	THETA(9) =	-180.00	
A(10) = 0.889F 00	B(10) = 0.264E-04	C(10) = 0.889E 00	THETA(10) =	0.00	

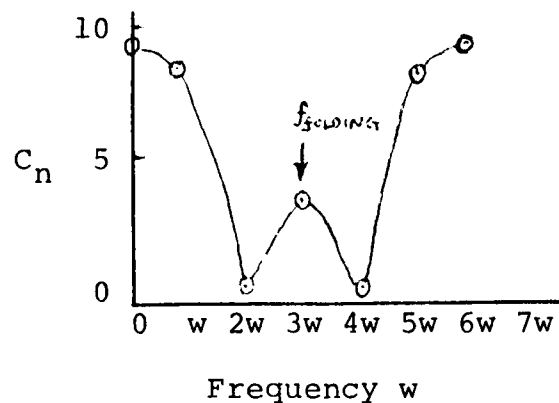


FIGURE 3.6 The Discrete Frequency Spectrum of $f(t)$.

Indicated on Figure 3.6 is the folding frequency for which the initial spectrum can be reflected along the plot past the third Fourier coefficient. In brief, the time varying function for $f(t)$ of the Fourier series will correctly represent the original function as long as the highest term of the series is less than the folding frequency, in this example c_3 .

Intuitively, the more data sample points taken during a given time period results in a longer time series expansion and better approximation of the original function under study. Also, in the frequency domain, peaks in the discrete spectrum are easier to detect. Therefore, the Fourier time series equation becomes an appropriate prediction equation when based upon prior historical data trends. Frequency updates based upon new incendiary crime activity is recommended for a viable and accurate prediction model.

Summarized in Table 3.6 are the procedures for the Fourier analysis of time varying periodic incendiary crime activity data. As with previous prediction techniques and models, future incendiary activity is projected based upon prior historical trends.

Geographic Distribution Patterns

An important concept in the prediction phase of incendiary crime analysis is the geographic distribution of incidents. As previously documented in Section 2.3, an emphasis is placed on the selection of major clusters of incidents when displayed as a gridded geographic distribution. Examples based upon the gridded map from Figure 2.3, page 45, were studied in Section 2.3.

The prediction phase of analysis often requires a model to represent the expected number of incidents per grid. This sample grid is also referred to as a quadrat in ecological studies (52,53). Previous observations by this writer on the geographic distributions of incendiary fires have determined them to fit a truncated Poisson formula (39, 42).

The truncated Poisson process model considers only the total number of incidents observed within each quadrat. Quadrats with no fires are ignored by this model. The equation for this model is expressed

TABLE 3.6
PROCEDURES FOR FOURIER ANALYSIS OF
PERIODIC INCENDIARY CRIME DATA

Step	Procedure	Display or Analysis	Example
1	Select Sampling Period	$f_s = 1/T$	Figure 3.5
2	Calculate Folding Freq.	$f_f = 0.5f_s$	Figure 3.6
3	Display Freq. Spectrum	$c_n = (a_n^2 + b_n^2)^{1/2}$	Figure 3.6
4	Expand Fourier Series		
5	Test and Apply Model		Figure 3.5
6	Update Model Equation (Go to Step 1)		Figure 3.5

$$P(x; \phi) = \frac{\phi^x}{(e^\phi - 1) x!} \quad (x = 1, 2, 3, \dots)$$

where the parameter ϕ is calculated from the observed mean value of the number of fires per quadrat

$$\phi = m - \sum_{j=1}^{\infty} \frac{j^{j-1}}{j!} (m e^{-m})^j \quad (j = 1, 2, 3, \dots)$$

and the theoretical mean

$$u = \frac{\phi}{(1 - e^{-\phi})}$$

Using the gridded incident map from Section 2.3, the truncated Poisson process model was constructed. The resulting equation for $P(x; \phi)$, which represents the expected proportion of the number of quadrats having x fires and an observed mean m , is expressed

$$P(x; 1.52) = \frac{1.52^x}{3.75 x!}$$

and having a theoretical mean of $u = 1.95$.

Table 3.7 summarizes the chi-square goodness of fit test which is used to validate this model. The chi-square test is often used to obtain confidence limits based upon numerical models (52,53). Shown in Table 3.8 is a step by step procedure for evaluating and constructing a Poisson model of a geographic distribution of incendiary incidents.

TABLE 3.7

A TRUNCATED POISSON PROCESS MODEL FOR THE
GRIDDED INCIDENT MAP PROBLEM

Fires per Quadrat	Observed Freq.	Expected Freq.	Expected Prop.	Term for Chi-square
1	41	29.7	.425	5.30
2	14	22.7	.325	3.33
3	4	11.4	.164	4.80
4	5	4.5	.064	3.78
5	5	1.3	.019	
6	0	.3	.005	
7	1	.1	.001	
(N)	70	70.0	1.000	16.21
df = 2		$\chi^2_{.005} = 10.60$		$\chi^2 = 16.21$

TABLE 3.8
PROCEDURES FOR PREDICTING GEOGRAPHIC POISSON
DISTRIBUTIONS OF INCENDIARY CRIMES

Step	Procedure	Display or Analysis	Example
1	Select Gridded Area	Gridded Incident Map	Figure 3.2
2	Calculate Poisson Model Parameters	$P(x, \phi), \phi, m, u$	—
3	Construct and Test Model	Chi-square	Table 3.7
4	Examine Large Quadrats	Multivariate	—
5	Evaluate Confidence Interval for Problem	Chi-square Statistics	Table 3.7

The significance of this example is that given the mean number of incendiary fires within a geographic area, a prediction model can be developed for the expected number of fires per quadrat. Should the number of incidents observed in a specific quadrat exceed an expected frequency, a detailed study of these incidents is recommended. Also note that in the example of Section 2.3, the quadrats containing the highest number of incidents were selected for multivariate analysis due to clustering.

Additional Clustering Techniques

As previously described, the technique of cluster analysis often plays a useful role on both the detection and prediction phases of incendiary crime analysis. Often a researcher is not aware of the numerous clustering strategies that exist.

There are two general approaches in the clustering field, hierarchial and nonhierarchial. Basically the non-hierarchial clustering methods partition patterns of cases into domains that are represented by individual cluster centers.

Hierarchial clustering initially assumes the number of cases to also be the number of clusters. During each clustering cycle, one case is absorbed by another cluster until the entire set of cases represent one major cluster. Interpretation of the number of total clusters is left to

the researcher, who views the analysis in the form of a hierarchial tree.

An example clustering problem is shown to demonstrate the difference between hierarchial and nonhierarchial concepts along with a literature review citing applications. Figure 3.7 is a hypothetical city in which eight incendiary fires have been set, forming two major clusters.

Table 3.8 cites several representative clustering techniques, classified under the categories of hierarchial and nonhierarchial analyses. Due to parallel research in several fields of study, similar techniques exist under other names.

A nonhierarchial analysis using the K-Means clustering techniques was run using the data in Figure 3.7. As with the detection and prediction phases of incendiary crime analysis, the geographic distributions of incidents were placed on a gridded map prior to analysis. Figure 3.8 lists the results for the K-Means computer analysis, solving for two major clusters.

The nearest neighbor algorithm cited in Table 3.9 was used to perform a computer assisted hierarchial analysis of the same problem. Visual inspection of the hierarchial tree produced by the analysis clearly verified that two major clusters exist within the gridded incident map.

Thus, the two opposite approaches produced similar results. The researcher is cautioned, however, not to rely

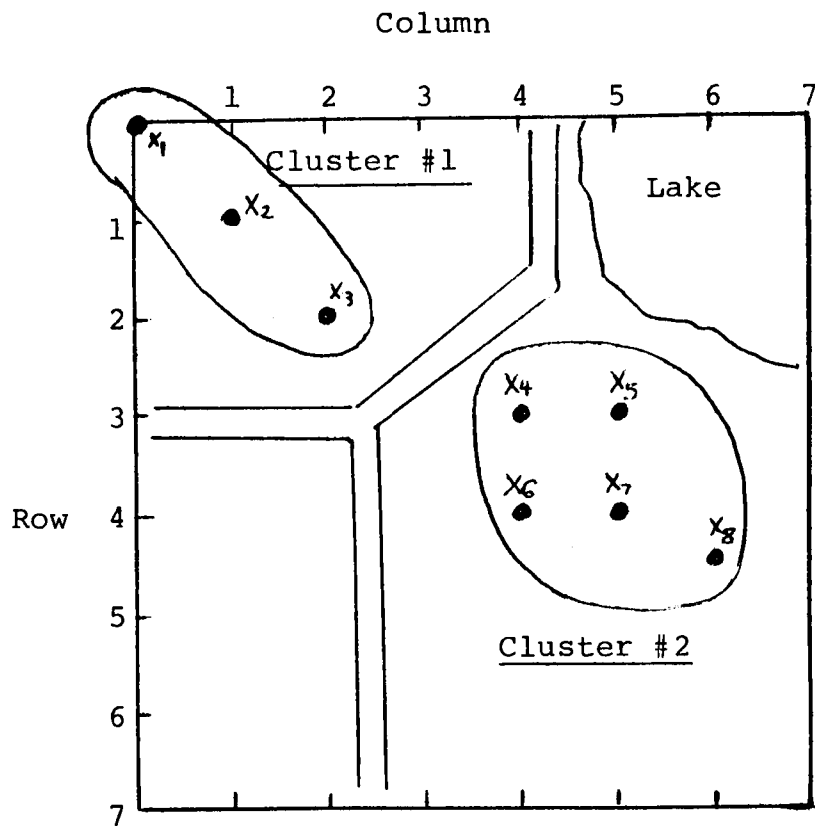


FIGURE 3.7 A Hypothetical City in which Eight Incendiary Fires Form Two Clusters.

K - M E A N S C L U S T E R I N G P R O G R A M

OVERALL MEAN SQUARE CALCULATIONS FOR EACH VARIABLE WITH 2 CLUSTERS

VARIABLE	WITHIN MEAN SQ.	WITHIN DF	BETWEEN MSQ	BETWEEN DF	FRATIO
ROW	1.333	6.000	16.875	1.000	12.656
COL	0.533	6.000	24.300	1.000	45.563

OVERALL WITHIN SUM OF SQUARES = 11.200

CLUSTER 1 OF 2

CLUSTER MEMBERS WITH THEIR DISTANCES TO CLUSTER CENTER

	1	2	3	4	5	6	7	8	9	10
--	---	---	---	---	---	---	---	---	---	----

X1	1.000	X2	0.000	X3	1.000
----	-------	----	-------	----	-------

SUMMARY STATISTICS FOR THE CLUSTER

LABEL	CENTER	COUNT	AVE	SD	XMIN	XMAX	SSQ
ROW	1.000	3.	1.000	0.816	0.000	2.000	2.000
COL	1.000	3.	1.000	0.816	0.000	2.000	2.000

CLUSTER 2 OF 2

CLUSTER MEMBERS WITH THEIR DISTANCES TO CLUSTER CENTER

	1	2	3	4	5	6	7	8	9	10
--	---	---	---	---	---	---	---	---	---	----

X4	0.825	X5	0.762	X6	0.424	X7	0.283	X8	1.442
----	-------	----	-------	----	-------	----	-------	----	-------

SUMMARY STATISTICS FOR THE CLUSTER

LABEL	CENTER	COUNT	AVE	SD	XMIN	XMAX	SSQ
ROW	4.000	5.	4.000	1.095	3.000	6.000	6.000
COL	4.600	5.	4.600	0.490	4.000	5.000	1.200

DISTANCE BETWEEN CLUSTER CENTERS

1	0.000E+00	0.300E+01
2	0.300E+01	0.000E+00

FIGURE 3.8 K-Means Analysis of the Two Cluster Nonhierarchical Problem.

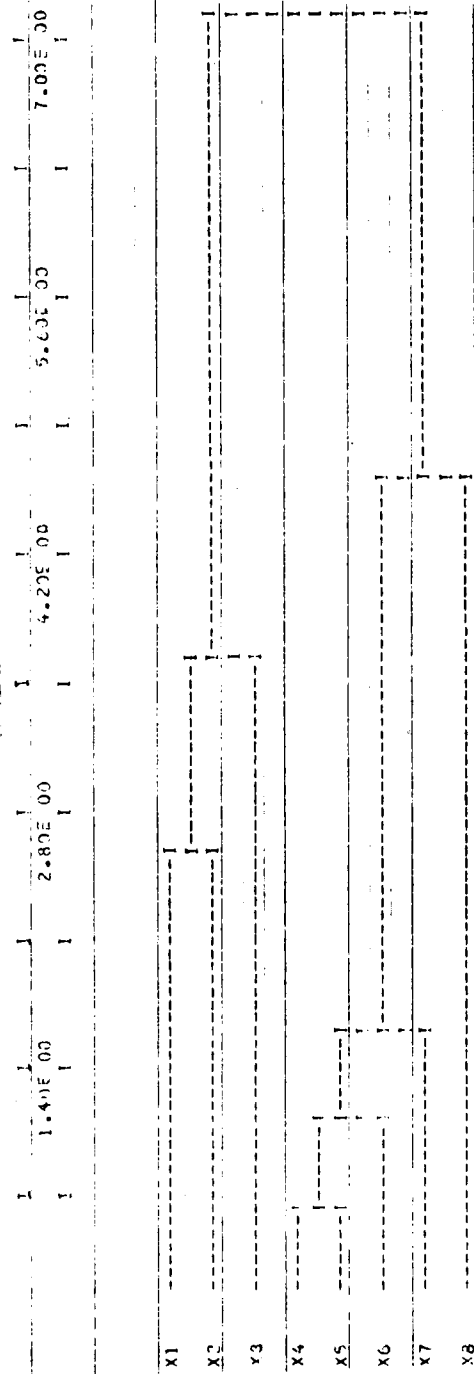


FIGURE 3.9 Nearest Neighbor Analysis of the Two Cluster Hierarchical Problem.

TABLE 3.9
HIERARCHIAL AND NONHIERARCHIAL
TECHNIQUES FOR CLUSTERING

Classification	Technique	Ref.
Nonhierarchial	K-Means Analysis	54
	ISODATA Analysis	55
	Linear Discr. Analysis	56
	Forgy's Method	57
	Jancy's Method	58
Hierarchial	Nearest Neighbor	59
	Farthest Neighbor	60
	Median	60
	Group Average	60
	Centroid	60
	Ward's Method	60,61
	Flexible Beta	62
	McQuitty's Method	60

upon one clustering strategy due to the vast variations in their convergence properties as well as interpretations by the individual user.

Other Research Activity

At this time there appears that two other research programs may contribute data to the subject of arson prediction. As previously referenced in Chapter 1, the Property Insurance Loss Register (PILR) could provide meaningful data into the prediction of incendiary crime activity on a nationwide basis, but this is not a major focus of the project.

Work by the Urban Educational Systems located in Boston, Massachusetts (63,65) observed that once a multifamily residence has acquired several lienholders and refrains from mortgage and tax payments, an incendiary fire is likely to occur. These generalizations contribute to the research activities but have not been tested on a large scale basis.

3.4 SUMMARY

This chapter describes the techniques which have proved successful in the prediction of incendiary crime. A major example involving organized incendiary crime activities within an East coast city illustrated the construction and testing of prediction models. Step by step analysis techniques were documented for future researchers.

Advanced prediction techniques including Fourier analysis, spatial distribution patterns, and various clustering approaches were presented, each having future applications. Again, numerous examples were used to illustrate key points of each analysis.

The prediction phase of incendiary crime analysis is not the final setp. Information derived from the previous detection phase is combined to be applied during the final prevention phase of analysis.

The next chapter will make use of the prior tools to deal with the prevention of incendiary crime activities. Prior historical trends will be blended with efficient allocation of investigative manpower to maximize the deterrent concepts presented.

CHAPTER 4

PREVENTION OF INCENDIARY CRIME

Incendiary crime prevention was a concept unknown to fire investigators who retired more than a decade ago. To them the incarceration of an arsonist was the only definite solution to incendiary crime activity.

This chapter presents concepts for incendiary crime prevention—the third and final phase of analysis as shown in Figure 4.1. Investigative information derived from the detection and prevention phases of analysis is used to formulate and deploy incendiary crime prevention efforts. Alternatives and strategies are presented for incendiary crime prevention programs.

4.1 PRESENT ARSON PREVENTION PROGRAMS

When the subject of fire prevention is raised, most individuals remember the typical activities carried out by their fire departments in the area of building inspections and the education of elementary school children.¹¹ Arson prevention is a multifaceted task that cannot be readily grasped by all fire departments or law enforcement agencies.¹² However, several successful arson prevention programs have been initiated across the United States which deserve mentioning.

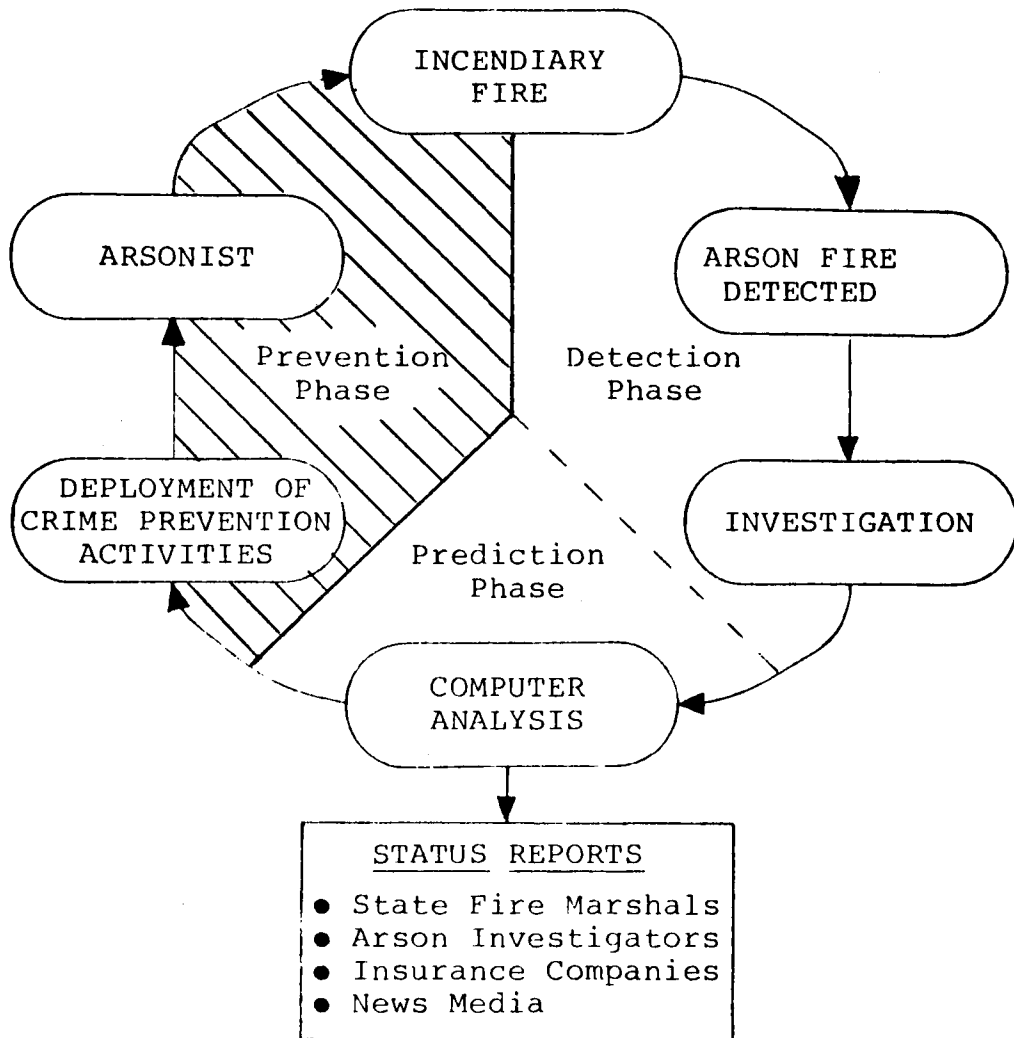


FIGURE 4.1 The Prevention Phase of Incendiary Crime Analysis.

① Public Awareness Programs

Educational programs directed towards the public have been reported successful in reducing the incidence of arson in Seattle, Chicago, and the state of Ohio. These public awareness programs were often funded by private insurance groups, who defrayed the publication costs for the printing of pamphlets, award signs, etc. Shown in Figure 4.2 is a typical public awareness pamphlet distributed by the Ohio Insurance Institute (65).

① Arson Award Programs

Many jurisdictions have established arson award programs which provide money to individuals who volunteer information leading to the arrest and conviction of an arsonist. Depending upon the level of assistance provided by the informant, the award can total several thousand dollars. Financing of the award funds, which amount to as high as \$10,000, is most often handled by an association representing the insurance industry within that jurisdiction. Shown in Figure 4.3 is a typical arson award sign which is placed at the scene of arson fires within Ohio and is sponsored by the "Blue Ribbon Arson Committee" (65).

Advanced Prevention Efforts

The following sections of this chapter will present ongoing incendiary crime prevention efforts, which are not

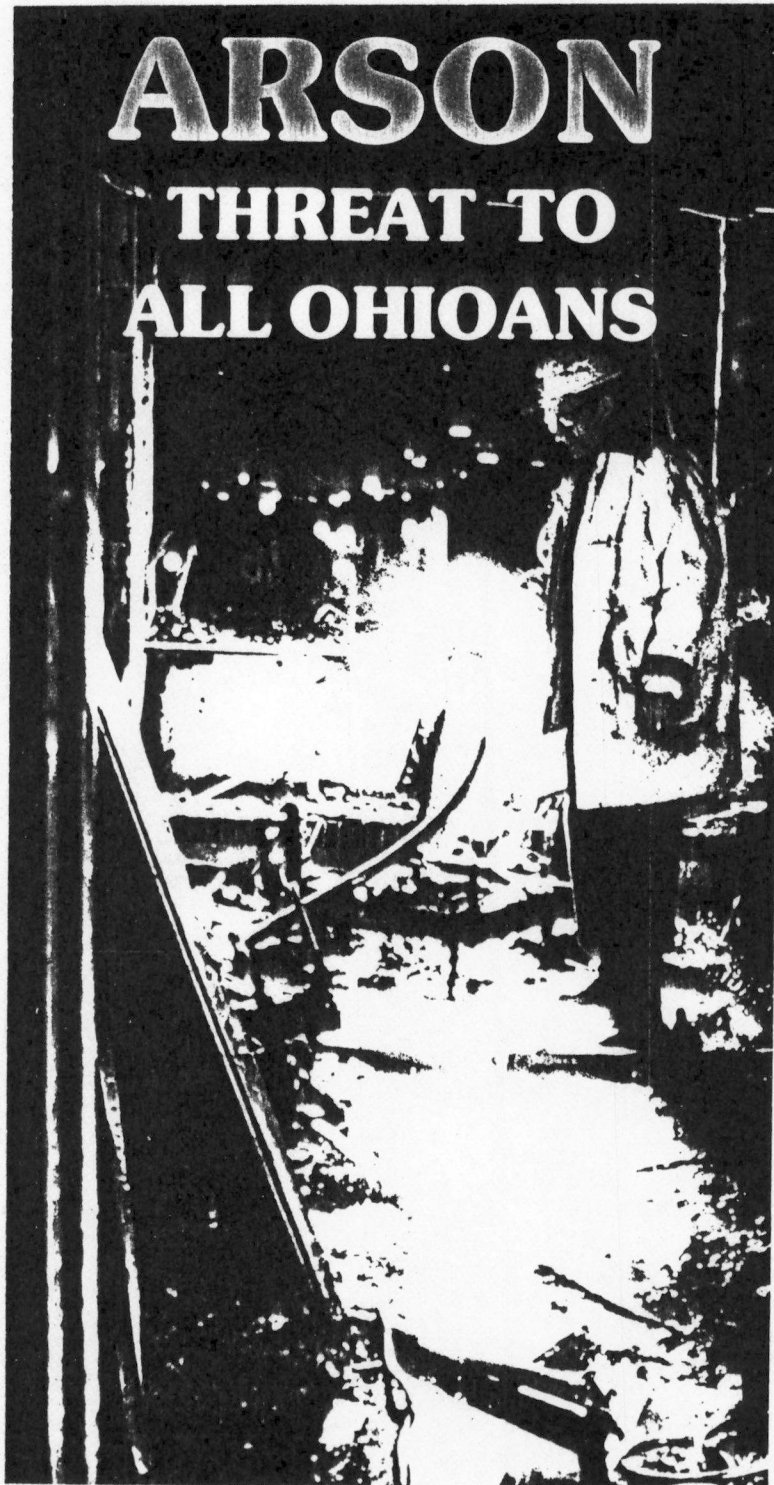


FIGURE 4.2 A Typical Public Awareness Pamphlet
by the Ohio Insurance Institute.

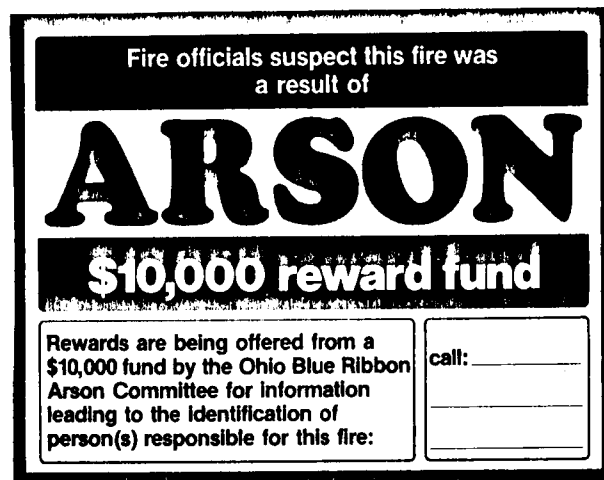


FIGURE 4.3 A \$10,000 Reward Fund Sign That Is
Placed at Arson Fires within Ohio.

always covered in public awareness programs. An overall view of the Arson-Fraud Analysis Model presented in Chapter 1 provides the basis for these advanced incendiary crime prevention efforts.

The following programs summarized below are considered by this writer to have direct bearing upon the Arson-Fraud Analysis Model concept. Examples of these program applications are covered later in this chapter.

6 1. Insurance Underwriting. The first and most logical step in preventing fraudulent insurance claims is to lessen the chances of arsonists over or incorrectly insuring property. Careful and uniform underwriting practices by the insurance industry could be a reasonable deterrent to these claims resulting from incendiary activity.

6 2. Arson Task Forces. Aggressive and coordinated prosecution of arsonists is the major goal of Arson Task Forces, who form investigative coalitions of local, state, and federal agencies charged with arson investigative responsibilities. Prior efforts have proven effective against incendiary crime (66,67,68).

6 3. Arson Control Acts. The reporting of incendiary or suspicious fires to the State Fire Marshal's Office is a responsibility of the insurance industry under Ohio's Arson Control Act of 1976. In return for reporting of arson claims, the insurance company is granted immunity from

civil retaliation from the insured for information revealed to fire and law enforcement agencies during their investigations. In the past subpoenas or court orders were required to obtain this information.

Summary

The prevention of incendiary crime can be accomplished through a combination of public awareness programs and aggressive prosecution efforts. The next sections deal with the three underlying incendiary crime prevention efforts that are briefly summarized above.

4.2 DECISION RULES FOR INSURANCE UNDERWRITING

As demonstrated in the previous section's analysis of the Arson-Fraud Analysis Model, the first and most logical step in preventing the success of arsonists lies with the blocking of their ability to obtain insurance. The more careless an insurance company is in underwriting a poor property risk, the better the success an arsonist has with overinsuring the structure. Obviously, careful underwriting practices could be a deterrent to incendiary crime activities (69).

FAIR Plan Underwriting

In 28 of the United States, there are insurance industry managed organizations called FAIR Plans (Fair

Access to Insurance Requirements) which provide insurance underwriting in high risk areas. The FAIR Plan property insurance coverage was traditionally extended to riot-prone areas of the inner cities, but the coverage has recently been passed onto questionable businesses and applicants who have had prior insurance losses and problems (69). Often, known arsonists who have been denied coverage by other insurance companies use the FAIR Plan underwriting programs.

An investigation by the U.S. General Accounting Office (GAO), requested by Senator Charles H. Percy (R-Ill.), recently reported that the state operated FAIR Plans often encouraged incendiary crime activity (70). Cited in their report were these primary reasons for this phenomenon:

- (1) Insuring inner-city properties at replacement value rather than true market value, thus providing a financial incentive to burn dilapidated buildings;
- (2) Insuring policies without sufficient scrutiny of the physical condition of the properties or the record and character of applicants;
- (3) Requiring 30-day notice prior to policy cancellation even for deteriorating and abandoned properties likely to be torched at any time.

Several alternatives have been adopted by FAIR Plans which include more careful underwriting procedures. These procedures include evaluation of the insured value of the risk, including the ability to deny coverage in certain cases.

Discriminant Analysis of Insurance Applications

The major stumbling block in the insurance underwriting process appears to be the screening of policy applications. This screening process becomes a two-class problem involving a simple decision—to accept or deny the policy application for insurance. The use of discriminant analysis is one approach to the statistical solution to this problem.

Shown in Table 4.1 are several variables selected from the Ohio FAIR Plan Underwriting Association application for property insurance. Indicated beside each variable are the possible numerical responses, which will later serve as the input to a problem model.

The discriminant analysis technique weights and linearly combines the data from the variables in Table 4.2 to produce decision functions. These decision function formulas are later used to "discriminate" future insurance applications as to their class membership.

To illustrate the application of discriminant analysis for generating decision rules for insurance underwriting, twenty recent Nationwide Insurance Company applications were obtained. These applications were also screened by Nationwide's underwriting staff to compile ten policy acceptances and ten denials.

These twenty applications were coded based upon the guidelines provided in Table 4.1 for use as the input to a

TABLE 4.1
SELECTED FAIR PLAN UNDERWRITING VARIABLES

Variable	Description
1. State of Building	0 = Unoccupied 1 = Occupied
2. Applicant	0 = Other 3 = Tenant 1 = Owner/Occ. 4 = Mortgagee 2 = Owner 5 = Land Contract
3. Fire Prot. Class	1 - 10 ISO Grade
4. Occupancy	1 - 99 No. of families or businesses
5. Actual Cash Value	Thousands of Dollars
6. Total Mortgages	0 - 99 Mortgages
7. Total Prior Losses	0 - 99 Prior losses

Source: Ohio FAIR Plan Underwriting Association
Application for Property Insurance.

TABLE 4.2
DISCRIMINANT ANALYSIS COMPUTER PROGRAMS

Statistical Package	Program	Ref.
SPSS	DISCRIMINANT	71
BMD	BMD07M	72
SAS	DISCRIM	73

discriminant analysis. Listed in Table 4.2 are several acceptable computer programs for discriminant analysis, including references to their sources.

The general objective of this problem of finding a decision function for the insurance application problem is diagrammed in Figure 4.4. New and labeled pattern samples, which are the policy application data, are represented by pattern vectors, such that

$$\underline{X} = \begin{bmatrix} x_1 & x_2 & x_3 & x_4 & x_5 & x_6 & x_7 & 1 \end{bmatrix}^T$$

where the features of the vector are the variables of Table 4.2 and a constant.

The discriminant analysis of the labeled pattern policies, that is the twenty original applications, form a two-class linear decision function

$$d_i(\underline{X}) = \underline{W}_i^T \cdot \underline{X} \quad (i = 1, 2)$$

where $\underline{W}_i$ is a vector of the classification weight coefficients

$$\underline{W}_i = \begin{bmatrix} w_1 & w_2 & w_3 & w_4 & w_5 & w_6 & w_7 & w_8 \end{bmatrix}^T .$$

New pattern samples of insurance policy applications can be tested using the decision functions to quickly screen the policy for further study. This decision model can be updated by performing additional discriminant analyses on new pattern samples and changing the decision functions to reflect this

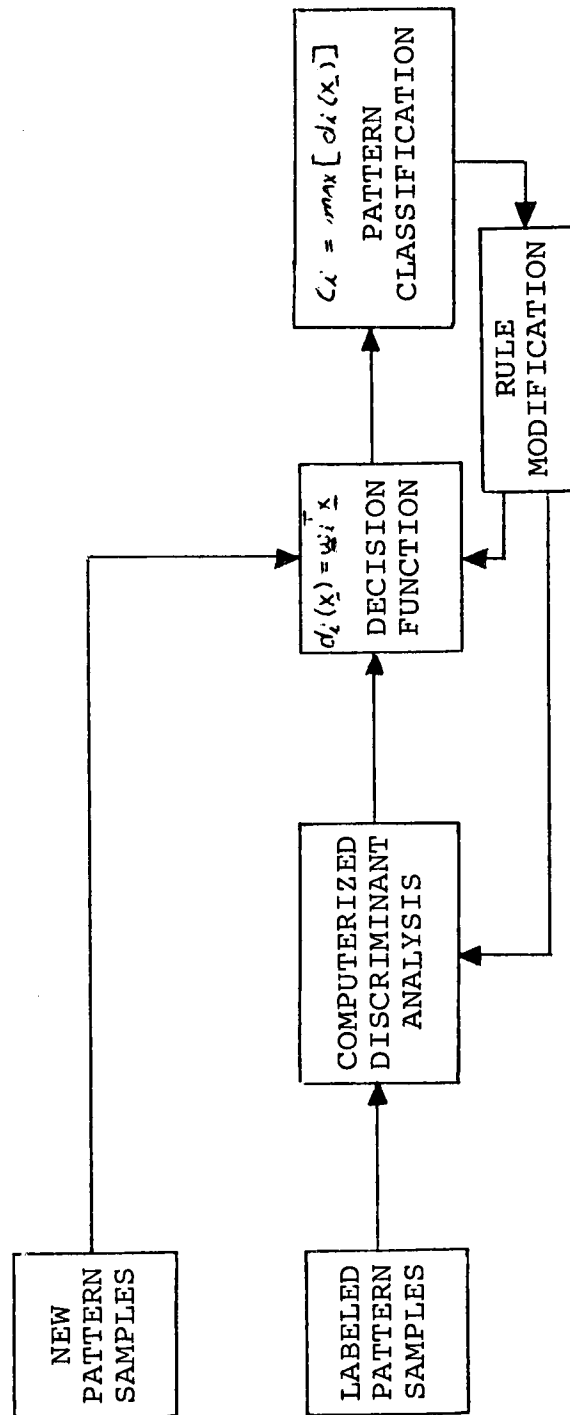


FIGURE 4.4 Discriminant Analysis of Insurance Underwriting.

new data. Updating of the decision function is called rule modification, as indicated in Figure 4.4.

The solution to the problem of which class C_i to place a new pattern sample $\underline{x}$ is found by the equation

$$C_i = \max [d_i(\underline{x})] \quad (i = 1, 2)$$

where C_1 and C_2 are the classes 1 and 2, respectively. This equation can be easily extended into higher class dimensions.

Results for the discriminant analysis of the twenty Nationwide policy applications are shown in Tables 4.3 and 4.4. The classification weight coefficients are listed by their classes in Table 4.3 along with the problem variables. Table 4.4 is an analysis of the results for the classification of the twenty applications and their respective relative classification errors (74).

A summary of the procedures for determining decision rules for insurance underwriting is listed in Table 4.5. Included in this summary is the option for evaluating new policy applications as well as updating the present decision function through rule modifications.

Summary

As demonstrated in the discriminant analysis example, routine screening of insurance policy applications can be quickly and accurately accomplished using a linear decision

TABLE 4.3

DISCRIMINANT FUNCTION COEFFICIENTS FOR THE
INSURANCE UNDERWRITING PROBLEM

Variable	—Coefficients—	
	Class 1 "Accept"	Class 2 "Deny"
1. State of Building	5.90	3.77
2. Applicant	5.04	5.46
3. Fire Prot. Class	0.71	1.36
4. Occupancy	0.18	0.49
5. Actual Cash Value	9.97×10^{-6}	1.25×10^{-6}
6. Total Mortgages	2.39	3.64
7. Total Prior Losses	-0.80	-1.45
8. Constant	-9.58	-13.26

TABLE 4.4

CLASSIFICATION RESULTS FOR LABELED PATTERN SAMPLES

Insurance Policy Pattern Classification	—Classification Results—		
	Class 1 "Accept"	Class 2 "Deny"	R.C.E.*
"Accept" Policy - Class 1	8	2	0.20
"Deny" Policy - Class 2	2	8	0.20

*R.C.E. = Relative classification error =

$$\left(\frac{\text{Incorrect classif.}}{\text{Total classif.}} \right)$$

TABLE 4.5
PROCEDURES FOR INCENDIARY CRIME PREVENTION THROUGH INSURANCE
UNDERWRITING DECISION RULES

Step	Procedure	Display or Analysis	Example
1	Select Labeled Pattern Sample Features	$\underline{X}$	Table 4.2
2	Determine Policy Class	Underwriting Step	—
3	Perform Computer-Aided Discriminant Analysis	$\underline{W}_i$	Figure 4.3 Table 4.4
4	Construct Decision Function Model Equation	$d_i(\underline{X}) = \underline{W}_i^T \underline{X}$	Figure 4.3 Table 4.5
5	Test Classifications of New Policies on Model	$C_i = \max [d_i(\underline{X})]$	Figure 4.3
6	Modify Decision Functions by Rule Modification if Necessary on New Policies	Go to Step 3	—

equation. This equation can even be used with a calculator by the insurance agent or underwriter.

Historical information based upon prior fire losses is the basis for risk underwriting. Discriminant analysis can be routinely used to update the decision function equation to reflect current loss history experience. This simple task is an important resource feature of the model.

Future research should be conducted into the selection of key underwriting variables. The number of these variables should be minimized, while still retaining a high statistical confidence interval during decision function analysis.

Clearly, the first and most logical step in preventing the success of arsonists lies within the blocking of their ability to obtain insurance. If coverage of a property risk is underwritten, this policy could still be flagged for surveillance by insurance risk managers as to compliance with policy regulations.

4.3 ADVANCED PREVENTION TECHNIQUES

Several advanced incendiary crime prevention programs have been discussed but none surpass the coordinated techniques set forth by individual leaders in the arson field. Discussed in this section are the progressive arson task force concepts of enforcement and the arson control laws governing the immunity reporting of arson by the insurance industry to the state arson bureaus.

Arson Task Forces

The use of coordinated Arson Task Forces have proven effective in controlling incendiary crime activities within jurisdictions where other singular efforts have failed (66). These investigative coalitions involve a cross section of local, state, and federal agencies as well as interfaces with the prosecutors and the insurance industry. Results and reactions to these programs have been favorable, and guidelines for establishing similar task forces have been made available (67,75).

An analysis of the existing Arson Task Force programs by this author have produced a recommended one-year implementation program for any local, state, or federal agency. Due to various law enforcement goals, coordination is needed during implementation of such a program.

1. Study of Problem Area. Identification of data sources, prior historical trends, and enforcement statistics of the jurisdictional area. Task: 3 months.
2. Enact Arson Reporting System. Initiate a program to uniformly report every instance of arson within the area of study by both law enforcement and insurance representatives having the responsibility and jurisdiction. The data should be systematically filed and/or computer encoded for future retrieval and analysis. Task: 3 months.
3. Apply Arson-Fraud Analysis Model. With the data collected from Steps #1 and #2, apply the information to the

Arson-Fraud Analysis Model. This model will be the basis for later evaluation of the efforts of the Arson Task Force.

Task: 1 month.

4. Form Arson Investigation Unit. Assimilate an investigative unit of hand-picked men and women based upon their skills for benefit of the agency. Maintain a police-fire interface whenever possible, and have the unit's leader reporting directly to the chief officer of the agency.

Task: 2 months.

5. Initiate Uniform Investigative Training. A two month on-the-job probationary period should be followed by routine intensive training courses. Training should be in all phases of investigation, with rotation of responsibilities within the unit to acquaint the officers with various aspects of arson. Task: 2 months.

6. Extended Task Force Interfaces. Develop contacts within other local, state, and federal agencies sharing similar interests within the arson enforcement field. Plan monthly intelligence meetings to keep abreast of developments. Task: 1 month.

7. Perform Quarterly Evaluations. Supply superior officers and public information agencies with performance indicators of the unit. These indicators include the application of the Arson-Fraud Analysis Model as well as the rates of arrests, convictions, and case closures. Also

include the solution of cases using the funds from arson reward programs. Task: every 3 months.

Not included in this summary analysis of Arson Task Force programs is a national strategy for implementation. Once a viable plan is available with proven horizontal transferability, a federal seeded funding program is needed to promulgate the concept. National coordination is urgently needed without, however, local intervention.

Ohio's Arson Control Act of 1976

The Ohio Senate Bill No. 462, sponsored by Senator Charles E. Butts (D-Cleveland), became effective on August 20, 1976 as one of the nation's first model insurance immunity reporting laws. This act was also the first to provide the insurance industry with a system of legally providing information to state authorities as well as establishing evidentiary rules relating to the use of insurance data.

Shown in Figure 4.5, is a schematic representation of the entire reporting system required under the Arson Control Act. The law requires an immediate notification to the Chief of the State Arson Bureau (Division of State Fire Marshal) of insurance claims which are the result of suspicious or incendiary losses. The initial and further communications are protected by immunity from civil retaliation from the insured as long as they are done in good faith.

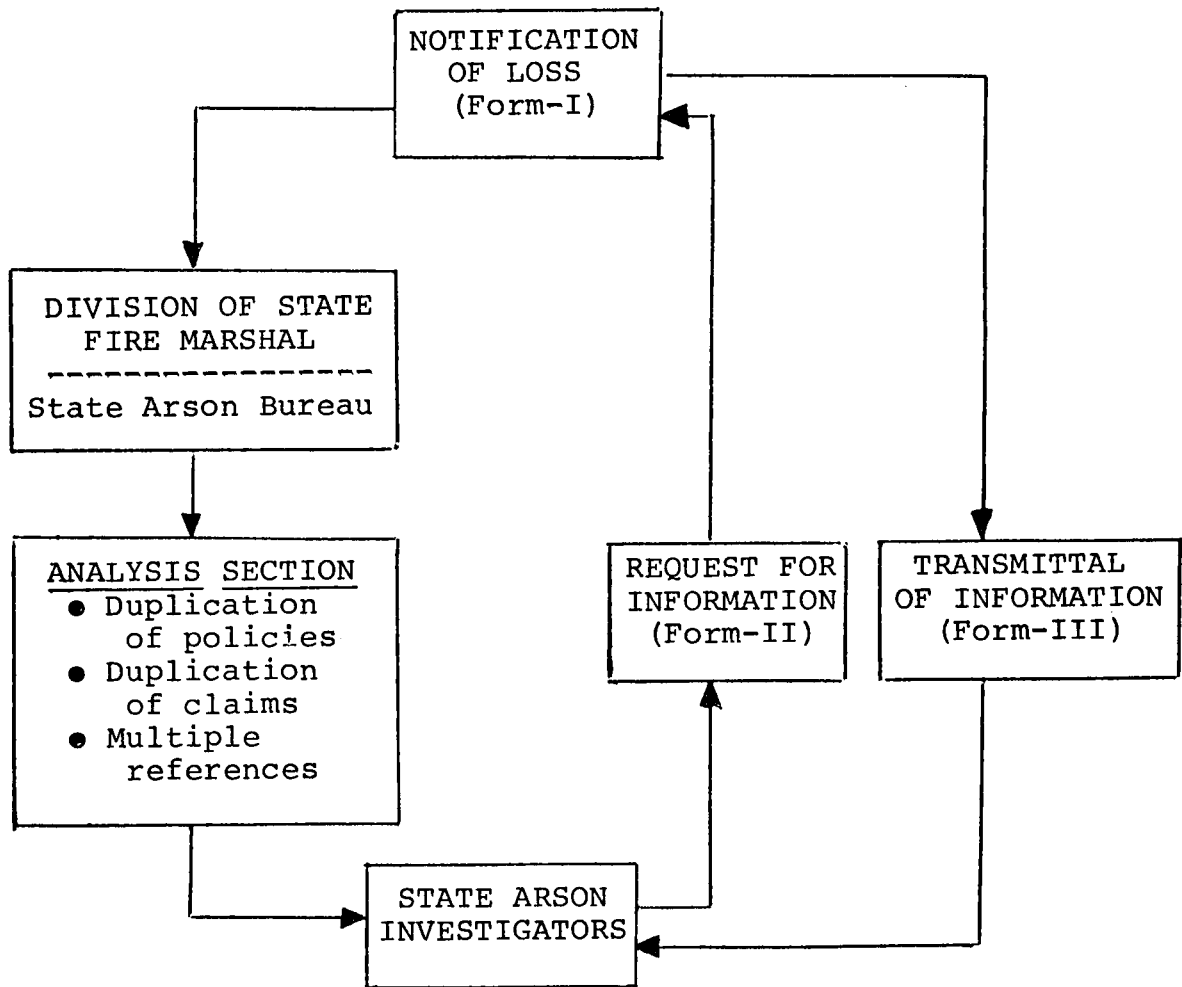


FIGURE 4.5 The Insurance Loss Reporting System Under Ohio's Arson Control Act of 1976.

As soon as the Notification of Loss is received by the State Arson Bureau, the information relating to the owner, occupants, and lienholders of the property are cross-referenced and checked for duplicate claims or policies. Repeating names are retained for further investigation. State Arson Investigators receive copies of these notifications for use in their cases.

Requests for additional information on individual losses can be made by any fire or law enforcement agency, using the forms provided (Form-II). Prior to the Arson Control Act of 1976, subpoenas were often required by the insurance company to obtain the desired information.

Replies by the insurance company are made using Form-III, the Transmittal of Information Form. The original copies of the material are retained by the insurance company until they are needed in court for civil or criminal cases. Information typically requested by an investigator might include the insurance application, premium payment records of the insured, history of prior losses, and other material relating to the investigation such as a proof of loss and statements to the company's adjusters.

Based upon the favorable publicity since the passage of the Arson Control Act in Ohio, several other states have adopted similar legislation. To date, Maryland, Michigan, Illinois, and West Virginia have reported to enacted state

laws for immunity reporting of arson losses by insurance companies. Copies of the forms and the model legislation are included in the appendix of this text.

4.4 SUMMARY

The third and final phase of incendiary crime analysis is the prevention phase. Investigative information that was obtained from the prior detection and prevention phases of analysis is used to formulate and deploy incendiary crime prevention efforts.

This chapter presented ongoing arson prevention programs from the public awareness sector as well as advanced efforts within the insurance and law enforcement agencies. Insurance underwriting and arson task forces are discussed from the standpoint of maximizing and coordinating effective incendiary crime prevention efforts.

CHAPTER 5

COMPUTER-ASSISTED ARSON INVESTIGATION

Incendiary crime analysis programs require the continuous monitoring and evaluation of arson information and case data. Raw verbal and numerical data are of little use to field investigators, whose heavy caseloads do not allow them to subjectively evaluate the global aspects of the incendiary crime problem. Inferences and investigative goals are often based upon the historical limitations of the arson investigator's personal case experiences.

The introduction of digital computers to nearly every aspect of business and education has had a pronounced effect on information processing. The arson investigation process is in need of significant computer applications that will assist in the intelligence analysis phases of criminal investigation. Goals of this process should include increased investigative success in the form of total arrests and convictions for incendiary crimes and uniform enforcement policies.

Computer-assisted arson investigation is already a reality for the fire investigator who has observed the act of arson emerge as the fastest rising crime in the United States and Canada (1). Since 1972, a computer-assisted arson technique has been continuously developed and refined

by this writer at the University of Tennessee and the University of Maryland (39,76). During the initial testing period, the Arson Pattern Recognition System (APRS) has proven to be an effective incendiary crime deterrent and indicator on a city, county, and state level (39,76).

The Arson Pattern Recognition System

The APR System is designed to be a systematic data analysis tool for the detection, prediction, and prevention phases of arson investigation. Using APRS predictions of where, when, and how incendiary crimes will be most likely to occur, arson investigators can concentrate on regions needing patrol and surveillance activities.

In brief, "pattern recognition" is a newly formed field in computer engineering noted as a state-of-the-art tool for identifying and classifying data trends (45). Arson fire incident data, which by its nature contains numerous trends, constitutes a valid application of pattern recognition techniques.

Shown in Figure 5.1 is a general flowchart of the APR System. Note that the arson investigator serves as an integral element of the overall system.

The APR System has the ability to evaluate, link, and classify multidimensional factors shared by similar arson cases. Seasoned investigators often acquire over their career information on the names, locations, and methods used

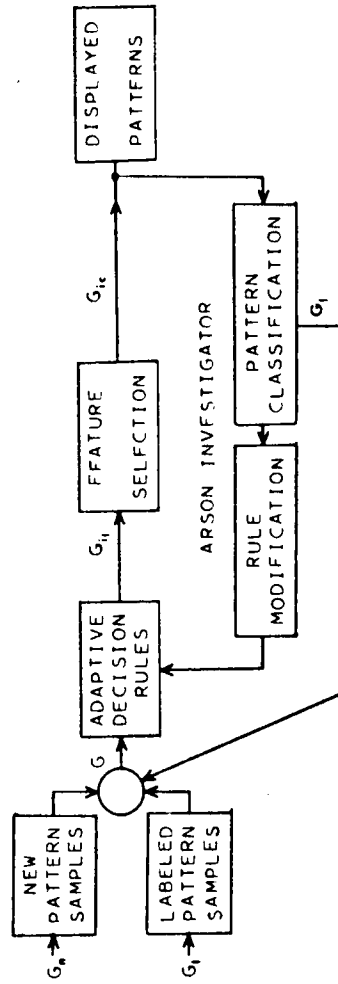


FIGURE 5.1 The ARS System Flowchart showing the Arson Investigator as an Integral Element in the System.

by arsonists during fires. Upon retirement or death, this investigative information is not passed onto younger arson investigators for their future use.

The APRS Data Base

A major goal of the APR System is to provide the medium for a comprehensive and complete criminal records system. The basic fire incident data is recorded and coded using the nationally accepted NFPA No. 901 standard for reporting (77). Complementing this standard, the APR System provides for the coding of names, insurance data, and case closure information. Since almost every data element is considered public information, confidentiality is not a major concern. Included in the appendix are the federal guidelines for computerized criminal history systems with which any user of the APR System should be familiar.

Shown in Figures 5.2, 5.3, and 5.4 are the APRS data coding forms for the fire incident, casualty, and investigation reports, respectively. Notice that the fire incident and casualty reports are in accordance with the suggested NFPCA reporting guidelines. Furthermore, the APRS Investigation Report has been recommended as a standard for incendiary crime reporting, with minor modifications being expected in the near future.

BASIC INCIDENT REPORT												
1	FD ID	County of Incident				Fire Department				FOR SFM OFFICE Use Only ☐ Revised Report		
A	Incident No.	Exp. No.	Month	Day	Year	Day of the Week	Alarm Time	Time—"In Service"				
B	CORRECT ADDRESS		Street	Post Office			Zip Code	Census Tract				
C	Occupant Name						Telephone	Room or Apt.				
D	Owner Name			Address				Telephone				
E	Method of Alarm from Public						Type of Situation Found					
F	Type of Action Taken					Co. Insp. District	Shift	No. Alarms	Mutual Aid ☐ Rec'd ☐ Given			
G	No. Fire Service Personnel Used at Scene			No. Engines Used at Scene		No. Trucks Used at Scene		No. Other Vehicles Used at Scene				
H	2		No. Incident-related Injuries*		No. Incident-related Fatalities*		Property Type					
I	Fire Service		Others		Fire Service		Others		Mobile Property Type (Complete Line S)			
J	Fixed Property Use Classification		Complex		Mobile Property Type (Complete Line S)							
K	Area of Origin		Level of Origin		Construction Type		Construction Method					
L	*List name, age, sex, and description of injury for each casualty on form 902G											
M	Equipment Involved in Ignition (if any) (Complete Line T)						Form of Heat of Ignition					
N	Type of Material Ignited		Form of Material Ignited		Ignition Factor							
O	Extent of Flame Travel		If Flame Spread Beyond Space of Origin		Type of Material Generating Most Flame		Avenue of Flame Travel					
P	Extent of Smoke Travel		If Smoke Spread Beyond Space of Origin		Type of Material Generating Most Smoke		Avenue of Smoke Travel					
Q	Extent of Water Damage		Extent of Fire Control Damage		Termination Stage							
R	Time from Alarm to Agent Application				Method of Extinguishment				Detector Performance			
S	Estimated Total Dollar Loss				Class				Sprinkler Performance			
T	3		If Mobile Property		Year	Make	Model	Serial No.	License No.			
U	4		If Equipment Involved in Ignition		Year	Make	Model	Serial No.	Voltage (if any)			

☒ This element is requested by the National Fire Data System ☐ Check box if remarks are made on reverse side.

FIGURE 5.2 The APRS Fire Incident Reporting Form.

BASIC CASUALTY REPORT												
5		FD ID		County of Incident				Page _____ of _____				
Incident No.		Map No.		Month		Day		Year		Day of Week		
										Alarm Time		
CASUALTY 1												
Casualty No.		FOR SFM OFFICE Use Only ☐ Revised Report										
Casualty Last Name		First Name			MI		D.O.B.		Age		Time of Injury	
Home Address										Telephone		
SEX 1 ☐ Male 2 ☐ Female		CASUALTY TYPE 1 ☐ Fire Casualty 2 ☐ Action Casualty 3 ☐ EMS Casualty		SEVERITY 1 ☐ Injury 2 ☐ Death		AFFILIATION 1 ☐ Fire Service 2 ☐ Other Emergency Personnel 3 ☐ Civilian						
Familiarity With Structure		Location at Ignition				Condition Before Injury						
Conditions Preventing Escape		Activity at Time of Injury				Cause of Injury						
Nature of Injury		Part of Body Injured				Disposition						
See Remarks on Back ☐ See Additional Report												
CASUALTY 2												
Casualty No.		FOR SFM OFFICE Use Only ☐ Revised Report										
Casualty Last Name		First Name			MI		D.O.B.		Age		Time of Injury	
Home Address										Telephone		
SEX 1 ☐ Male 2 ☐ Female		CASUALTY TYPE 1 ☐ Fire Casualty 2 ☐ Action Casualty 3 ☐ EMS Casualty		SEVERITY 1 ☐ Injury 2 ☐ Death		AFFILIATION 1 ☐ Fire Service 2 ☐ Other Emergency Personnel 3 ☐ Civilian						
Familiarity With Structure		Location at Ignition				Condition Before Injury						
Conditions Preventing Escape		Activity at Time of Injury				Cause of Injury						
Nature of Injury		Part of Body Injured				Disposition						
See Remarks on Back ☐ See Additional Report												
CASUALTY 3												
Casualty No.		FOR SFM OFFICE Use Only ☐ Revised Report										
Casualty Last Name		First Name			MI		D.O.B.		Age		Time of Injury	
Home Address										Telephone		
SEX 1 ☐ Male 2 ☐ Female		CASUALTY TYPE 1 ☐ Fire Casualty 2 ☐ Action Casualty 3 ☐ EMS Casualty		SEVERITY 1 ☐ Injury 2 ☐ Death		AFFILIATION 1 ☐ Fire Service 2 ☐ Other Emergency Personnel 3 ☐ Civilian						
Familiarity With Structure		Location at Ignition				Condition Before Injury						
Conditions Preventing Escape		Activity at Time of Injury				Cause of Injury						
Nature of Injury		Part of Body Injured				Disposition						
See Remarks on Back ☐ See Additional Report												

FIGURE 5.3 The APRS Fire Casualty Reporting Form.

ARSON INVESTIGATION REPORT

FD 113		County of Incident		Page _____ of _____									
Incident No.		Hap. No.		Month		Day		Year		Day of Week		Alarm Time	

Names	IL	(Last, First MI)	ADDRESS	ZIP	S	R	DOB

A
↓
 ↓
 A

1=Inv. Requested by	2=Occupant	3=Owner
4=Arrested	5=Fire Death	6=Mortgagee
7=Insurance Agent	8=Insurance Adjuster	9=Public Adjuster
0=Other (witness, etc.)		

Insurance	ID	Policy Number	Company	Dates	Bldg	Cont	other

Laboratory	AB Case Number	Item	Test	Description of Item

Closing Reports	Closing	Arrests	Convict.	Motive	\$Loss	\$Liens	\$Savings	\$Rewards

FIGURE 5.4 The APRS Investigation Reporting Form.

The APRS Computer Programs

The APR System consists of a set of computer programs written in ANSI FORTRAN IV and used exclusively for the analysis of incendiary crime. Developed from the Fire Engineering Data Analysis Program (FEDAP), the APR System program consists of approximately 6000 source card images and resides in 128K of core storage (78). Designed in a flexible modular format, the subprograms have been overlaid to minimize core storage requirements.

Subprograms provided under the APR System fall under four general categories—data input/output, display, analysis, and experimental analysis. Table 5.1 lists the APRS subprograms written to date.

Input/output. The subprogram FEATRS interfaces the APRS Data Base with the analytical portions of the program. Subprogram INSUM provides a summary of incidents compiled in the data base. These subprograms can be used at anytime during execution of the APR System.

Display. Uni- and bivariate displays are made by the subprograms in this data category of analysis. The subprograms HISTO, HTIME, and HDAY perform univariate histograms of a selected feature, time of day, or day of the week, respectively. The histogram percentiles are autoranging to produce maximum deflection of the maximum values.

TABLE 5.1
THE APR SYSTEM COMPUTER PROGRAM SUMMARY

Data Category	Subprogram	Description	Example
Input/output	FEATRS INSUM	Inputs APRS Data into File Prints APRS Data Summary	_____
Display	HISTO HTIME HDAY PSGEN PSDXT PSWXT INMAP DENMAP	Histogram of Selected Variable Histogram by Time of Day Histogram by Day of Week Scatterplot of Two Variables Scatterplot of Day by Time Scatterplot of Week by Time Geographic Incident Map Geographic Incident Density Map	Figure 2.5(a) Figure 2.5(b) _____ Figure 2.6(a) Figure 2.6(b) Figure 2.3(a) Figure 2.3(b)
Analysis	KMEANS ISODTA TREES IMAGE* DISCR* SPECTM NLINK*	Nonhierarchical Clustering Nonhierarchical Clustering Hierarchical Clustering Fourier Map Processing Discriminant Analysis Interface Fourier Periodic Trend Analysis Alphanumeric Data Linkage	Table 3.3 _____ Figure 3.9 _____ _____ Table 3.5 _____

*Experimental subprograms being tested.

The remaining subprograms produce two-dimensional displays of selected or specific variables. Scatterplots of two selected features, day of the week by time of day, and week of the year by time of day are available using subprograms PSGEN, PSDXT, and PSWXT, respectively.

Geographic displays of the location of incidents according to a specific location grid system are accomplished through subprogram INMAP. Converting an incident map to a grey scaled density map of the same dimensions can be done with subprogram DENMAP.

Analysis. Computer analysis using pattern recognition techniques is the purpose of this group of subprograms. Nonhierarchial clustering techniques are accomplished using either subprogram KMEANS or ISODTA. Hierarchial analysis of clusters as well as a tree showing their relationships can be drawn with subprogram TREES.

Fourier filtering of geographic incident using high and low pass techniques are done using subprogram IMAGE. Subprogram NLINK provides the facility for alphanumeric linking of investigative case data elements, such as names, addresses, or fire trends. Subprogram SPECTM solves for periodic trends in univariate data by applying Fourier transform techniques. DISCR is an interface to standard statistical analysis programs involving discriminant analysis routines.

Listed in Table 5.1 are the present APR System Computer Subprograms. Experimental programs are indicated with a star and are in their final testing stages. Subprograms whose outputs are used as examples within this text are also indicated.

Recent APRS Advances

The APR System represents over five years of research and analysis of fire incidents and incendiary crime activities. Within the last three years, numerous developments within the pattern recognition and computer engineering fields have been added to the APR System to update and streamline its operation. The following items represent several of the newest additions.

Minicomputers. The APRS computer program has been modified to operate on any computer system supporting ANSI FORTRAN IV, including minicomputers. Minicomputers are low-cost digital computers that can be purchased for less than the cost of a fire engine. The current advantages of an arson investigation or fire prevention bureau owning a minicomputer include:

1. No computer running costs other than periodic maintenance, electricity, paper supplies, etc.
2. Security of the data in accordance with the guidelines specified for criminal records
(Appendix B).

3. Reliable 24-hour availability.

4. Size: approximately one filing cabinet.

Additional advantages include the capability for interactive control of the APR System using a portable teleprinter and modem acoustically coupled to a telephone. This capacity allows an investigator in the field to access the APR System and other pertinent files stored in the file system.

Computer-generated maps. The APR System now has the capability of synagraphically displaying the density of incidents over a given geographic area. Three-dimensional maps can also be generated on a digital plotter, while either integer value or gray-scaled density-coded maps can be printed on either a terminal or lineprinter. These forms of displays give the investigator a visual perception of the levels and centers of incendiary crime activity and aid in the organization of priorities of arson prevention.

Intelligence network capabilities. The APR System is linked by a common program that can enable an investigator to interface with another reporting system, immediately initiate status reports on arson activity, and retrieve active fire incident data on a case-by-case basis. All of these capabilities are the minimum requirements for an interactive intelligence analysis operation for combatting organized incendiary crime activities.

Cluster analysis. A relatively new analytical tool, cluster analysis was developed in the 1960's by researchers seeking efficient techniques for determining measures of similarity in multidimensional data (45).

The APR System includes several efficient clustering routines. A typical analysis reveals groups of similar cases, taking into account up to 300 variables. In conjunction with the APRS mapping programs, these groups of cases can be displayed individually for planning arson prevention and surveillance programs.

Conclusions

Incendiary crime analysis can be most efficiently accomplished using computer-assisted techniques. Future research into the application of computer-assisted arson investigation techniques is needed, with expansion to state-wide and national levels as an underlying theme.

CHAPTER 6

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Incendiary crime has been presented as a growing nationwide problem costing thousands of lives and billions of dollars annually. The problem has been attacked from the perspective of the disciplines of psychology, psychiatry, criminology, and geography fields. This text examines the crime of arson from the field of fire protection engineering.

Summary

From within the field of fire protection engineering, tools for the uniform analysis of the incendiary crime problem were applied. Broken into the steps of detection, prediction, and prevention, a systematic modeling and analysis of the problem was accomplished. Principle achievements of this research have been:

- Development of systematic analysis procedures for the detection, prediction, and prevention of incendiary crimes.
- Development of strategies of enforcement based upon an Arson-Fraud Systems Analysis Model which evaluates the success of an arsonist.
- Isolation of specific patterns of incendiary fires set by arsonists with regard to geographic, temporal, and behavioral characteristics.

- Development of a statistical model for surveillance scheduling of enforcement and prevention activities.
- Application of Fourier and Poisson theories to trends and distribution of incendiary fires.
- Application of hierarchial and nonhierarchial clustering theory to the geographic and temporal distributions of incendiary fire data.
- Introduction of strategies of insurance underwriting practices based upon policy application data.
- Summary of key Arson Task Force goals in the format of a one-year implementation program.
- Development of a systematic representation of Ohio's Arson Control Act of 1976.
- Development of the first successful computer-assisted arson investigation system containing sophisticated analysis routines.

Conclusions

Based upon the research conducted within the scope of this text as well as professional involvement in the arson field, the following conclusions can be drawn:

- The incendiary crime problem can be modeled for analysis using present economic and engineering principles.

- Analysis based upon incendiary crime models can produce viable prevention strategies for combatting incendiary crime activities.

Recommendations

A uniform and coordinated strategy of enforcement activities among fire and criminal investigative agencies will soon remove the stigma of arson being the impossible crime to prove. The following recommendations are suggested for controlling the incendiary crime problem:

- Expand computer-assisted arson investigation systems to statewide and national levels through the adoption of uniform incident reporting.
- Initiate the investigation of correlations of meteorological and astronomical phenomenon to trends in incendiary crime.
- Isolate a valid set of decision rules with horizontal transferability to be placed in a national clearinghouse for computer-assisted arson investigation systems.
- Establish no-cost distribution and training seminars for computer-assisted arson investigation systems under the auspices of the National Fire Academy.
- Encourage the insurance industry to develop and use uniform policy applications as well as sound underwriting practices.

As previously demonstrated, a uniform approach to the incendiary crime problem will someday bring the economic losses and human lives lost under control.

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LIST OF REFERENCES

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APPENDICES

APPENDIX A

OHIO'S ARSON CONTROL ACT OF 1976 (SB 462)

Sec. 3737.16. (A) The fire marshal, any assistant fire marshal, the chief or any deputy of the arson bureau established pursuant to section ~~3737.02~~ 3737.22 of the Revised Code, the chief of a fire department of any municipal corporation or township where a fire department is established, or the fire prevention officer of any municipal corporation or township where no fire department exists may request any insurance company investigating a fire loss of real or personal property to release any information in its possession relative to that loss. The company shall release the information and cooperate with any official authorized to request such information pursuant to this section. The information shall include, but is not limited to:

(1) Any insurance policy relevant to a fire loss under investigation and any application for such a policy;

(2) Policy premium payment records;

(3) History of previous claims made by the insured for fire loss;

(4) Material relating to the investigation of the loss, including statements of any person, proof of loss, and any other relevant evidence.

(B) If an insurance company has reason to suspect that a fire loss to its insured's real or personal property was caused by incendiary means, the company shall notify the fire marshal and furnish him with all relevant material acquired during its investigation of the fire loss, cooperate with and take such action as may be requested of it by any law enforcement agency, and permit any person ordered by a court to inspect any of its records pertaining to the policy and the loss.

(C) In the absence of fraud or malice, no insurance company, or person who furnishes information on its behalf, is liable for damages in a civil action or subject to criminal prosecution for any oral or written statement made or any other action taken that is necessary to supply information required pursuant to this section.

(D) The officials and departmental and agency personnel receiving any information furnished pursuant to this section shall hold the information in confidence until such time as its release is required pursuant to a criminal or civil proceeding.

(E) Any official referred to in division (A) of this section may be required to testify as to any information in his possession regarding the fire loss of real or personal property in any civil action in which any person seeks recovery under a policy against an insurance company for the fire loss.

(F) As used in this section, "insurance company" includes the Ohio fair plan underwriting association as established in section 3929.43 of the Revised Code.

(G) (1) No person shall purposely refuse to release any information requested, pursuant to division (A) of this section, by a fire marshal, an assistant fire marshal, the chief or a deputy of the arson bureau, a chief of a fire department, or a fire prevention officer.

(2) No person shall purposely refuse to notify the fire marshal of a fire loss required to be reported pursuant to division (B) of this section.

(3) No person shall purposely refuse to supply the fire marshal with pertinent information required to be furnished pursuant to division (B) of this section.

(4) No person shall purposely fail to hold in confidence information required to be held in confidence by division (D) of this section.

FORM I

NOTIFICATION OF LOSS

(Section 3737.16-B)

(141)

Confidential

The information submitted herein is confidential. Section 3737.16 of the Revised Code states:

- (D) THE OFFICIALS AND DEPARTMENTAL AND AGENCY PERSONNEL RECEIVING ANY INFORMATION FURNISHED PURSUANT TO THIS SECTION SHALL HOLD THE INFORMATION IN CONFIDENCE UNTIL SUCH TIME AS ITS RELEASE IS REQUIRED PURSUANT TO A CRIMINAL OR CIVIL PROCEEDING. (Subject to Criminal Penalties)

THE ENVELOPE CONTAINING THIS REPORT MUST BE MARKED TYPE A REPORT — CONFIDENTIAL

State Fire Marshal's Division
ATTN: Chief Eugene L. Jewell
31 North Grant Street
Columbus, OH 43215

TO REQUEST ADDITIONAL INFORMATION USE FORM 2. SAMPLE PRINTED ON REVERSE SIDE.

COUNTY OF INCIDENT		FIRE DEPARTMENT	
FIRE DEPT. INCIDENT NO.	EXP. NO.	MONTH	DAY
YEAR	DAY OF THE WEEK	ALARM TIME	
CORRECT ADDRESS	STREET P.D.	POST OFFICE	ZIP CODE
NO.	DIR.	TYPE	C
OCCUPANT NAME	TELEPHONE	ROOM OR APT.	
OWNER NAME	ADDRESS	TELEPHONE	

COMPANY CLAIM NO.	
ASSURED'S	TELEPHONE
MAILING ADDRESS	
OTHER INSURABLE INTEREST (LAND CONTRACT HOLDER, MORTGAGEE, OR OTHER)	ADDRESS
MORTGAGEE	ADDRESS
AGENT(S)	ADDRESS
ORIGIN OR CAUSE OF FIRE	

INSURED ITEM	AMOUNT OF COVERAGE	ESTIMATED DAMAGE	PREVIOUS FIRES	HERE OR ELSEWHERE
BUILDING				☐ ☐
CONTENTS				☐ ☐
OTHER (SPECIFY)				☐ ☐

FROM: (SUBMITTING COMPANY)
NAME & TITLE
COMPANY
ADDRESS

PART I of this form must be mailed to the (Ohio) State Fire Marshal's Division, Attn: Chief Eugene L. Jewell, 31 N. Grant Street, Columbus, Ohio 43215. This form must be mailed in an envelope marked "Type A Report-Confidential."

PART II of this form must be kept in permanent claim file at companies highest supervisory level.

THIS PAGE IS PART II

FORM II

REQUEST FOR INFORMATION

Section 3737.16 (A) Ohio Revised Code

(142)

The Fire Marshal, any Assistant Fire Marshal, the Chief of any Deputy of the Arson Bureau established pursuant to Section 3737.02 of the Revised Code, the Chief of a fire department of any municipal corporation or township where a fire department is established, or the fire prevention officer of any municipal corporation or township where no fire department exists may request any insurance company investigating a fire loss of real or personal property to release any information in its possession relative to that loss.

TO:

PHOTO COPIES OF THIS FORM, IF PROPERLY COMPLETED, WILL BE ACCEPTED

RE:

CLAIM NO.

INSURED

ADDRESS

FIRE DEPT. INCIDENT NO.

DATE OF FIRE

This Department (or agency) is charged with the responsibility to investigate the fire which was reported by your company on the reverse side of this form. Pursuant to Section 3737.16 of the Ohio Revised Code, I/we hereby request the following additional information:

- ☐ (1) Any insurance policy relevant to a fire loss under investigation and any application for such a policy;
- ☐ (2) Policy premium payment records;
- ☐ (3) History of previous claims made by the insured for fire loss;
- ☐ (4) Material relating to the investigation of the loss, including statements of any person, proof of loss, and any other relevant evidence;
- ☐ (5) Other (Please specify type of information desired and preferred method of communication.)

Signature of Requesting Officer & Rank

(Print)

Name of Officer Requesting Information

Department or Agency Requesting Information

Address

DATE

A 14

P 14

FORM III

TRANSMITTAL OF INFORMATION

Confidential
(143)

The information submitted herein is confidential. Section 3737.16 of the Revised Code states:

- (D) THE OFFICIALS AND DEPARTMENTAL AND AGENCY PERSONNEL RECEIVING ANY INFORMATION FURNISHED PURSUANT TO THIS SECTION SHALL HOLD THE INFORMATION IN CONFIDENCE UNTIL SUCH TIME AS ITS RELEASE IS REQUIRED PURSUANT TO A CRIMINAL OR CIVIL PROCEEDING. (Subject to Criminal Penalties)

The information submitted herewith is in accordance with Section 3737.16 (A) (B) of the Ohio Revised Code and pursuant to a request dated _____

TO: _____

NAME OF OFFICER REQUESTING INFORMATION
DEPT. OR AGENCY REQUESTING INFORMATION
STREET ADDRESS
CITY STATE ZIP

TYPE B REPORT — CONFIDENTIAL
THE FOLLOWING INFORMATION OR ENCLOSURES RESPONDS TO YOUR REQUEST

- ☐ (1) Insurance policy _____
Policy No., Date of Issue, Etc.
- ☐ (2) Policy premium records _____
Description
- ☐ (3) Claims history _____
Description
- ☐ (4) Other relevant material or information _____
Description
- ☐ Enclosures

COMPANY CLAIM NO.	DATE OF LOSS	INCIDENT NUMBER
INCLUDED		
ADDRESS		

FROM:
NAME & TITLE
COMPANY
ADDRESS

- This form and information should be sent to the individual and agency requesting it.
- Copies of materials should be sent unless originals are specifically requested. The envelope should contain the notation: "TYPE B REPORT - CONFIDENTIAL".
- A copy of the form should be kept in permanent claim file at the highest level of authority maintaining such file.

APPENDIX B

DEPARTMENT OF JUSTICE—TITLE 28, CH. I, PT. 20

FRIDAY, MARCH 19, 1976



PART III:

DEPARTMENT OF JUSTICE

Law Enforcement Assistance
Administration



CRIMINAL HISTORY RECORDS

Collection, Storage, and Dissemination
of Information

Title 28—Judicial Administration
CHAPTER I—DEPARTMENT OF JUSTICE
PART 20—CRIMINAL JUSTICE
INFORMATION SYSTEMS

On May 20, 1975, regulations were published in the *FEDERAL REGISTER* (40 FR 22114) relating to the collection, storage, and dissemination of criminal history record information. Amendments to these regulations were proposed October 24, 1975 (40 FR 49789) based upon a re-evaluation of the dedication requirement contained in § 20.21(f). Hearings on the proposed changes were held November 17, 18, 21 and December 4, 1975. In addition, hearings were held to consider changes to the dissemination provisions of the regulations (40 FR 52846). These hearings were held December 11, 12 and 15, 1975, to consider comments from interested parties on the limitations placed on dissemination of criminal history record information to non-criminal justice agencies. The purpose of the hearings was to determine whether the regulations, as they were drafted, appropriately made the balance between the public's right to know such information with the individual's right of privacy.

As a result of these hearings modifications to the regulations have now been made to better draw this balance. The regulations are based upon section 524 (b) of the Crime Control Act of 1973 which provides in relevant part:

"All criminal history information collected, stored or disseminated through support under this title shall contain, to the maximum extent feasible, disposition as well as arrest data where arrest data is included therein. The collection, storage, and dissemination of such information shall take place under procedures reasonably designed to insure that all such information is kept current therein; the Administration shall assure that the security and privacy of all information is adequately provided for and that information shall only be used for law enforcement and criminal justice and other lawful purposes. In addition, an individual who believes that criminal history information concerning him contained in an automated system is inaccurate, incomplete, or maintained in violation of this title, shall, upon satisfactory verification of his identity, be entitled to review such information and to obtain a copy of it for the purpose of challenge or correction."

The regulations, as now amended, provide that conviction data may be disseminated without limitation; that criminal history record information relating to the offense for which an individual is currently within the criminal justice system may be disseminated without limitations. Insofar as nonconviction record information is concerned (nonconviction data is defined in § 20.20(k)), the regulations require that after December 31, 1977, most non-criminal justice access would require authorization pursuant to a statute, ordinance, executive order or court rule, decision or order. The regulations no longer require express authority, that is specific language in the authorizing statute or order requiring access to

such information, but only that such dissemination is pursuant to and can be construed from the general requirement in the statute or order. Such statutes include State public record laws which have been interpreted by a State to require that criminal history record information, including nonconviction information, be made available to the public. Determinations as to the purposes for which dissemination of criminal history record information is authorized by State law, executive order, local ordinance, court rule, decision or order will be made by the appropriate State or local officials. The deadline of December 31, 1977, will permit States to obtain the authority, as they believe necessary, to disseminate nonconviction data.

The regulations, as now amended, remove the prohibition that criminal history record information in court records of public judicial proceedings can only be accessed on a chronological basis. § 20.20(b)(3) deletes the words "compiled chronologically". Therefore, court records of public judicial proceedings whether accessed on a chronological basis or on an alphabetical basis are not covered by the regulations.

In addition, the regulations would not prohibit the dissemination of criminal history record information for purposes of international travel (issuance of visas and granting of citizenship). The commentary on selected portions of the regulations have been amended to conform to the changes.

Pursuant to the authority vested in the Law Enforcement Assistance Administration by sections 501 and 524 of the Omnibus Crime Control and Safe Streets Act of 1968, as amended by the Crime Control Act of 1973, Pub. L. 93-83, 87 Stat. 197 (42 USC 3701 *et seq.*) (Aug. 6, 1973), these amendments to Chapter I of Title 28 of the Code of Federal Regulations are hereby adopted to become final on April 19, 1976. These amendments only amend subparts A and B. Subpart C remains the same.

Subpart A—General Provisions

- Sec.
 20.1 Purpose.
 20.2 Authority.
 20.3 Definitions.

Subpart B—State and Local Criminal History Record Information Systems

- 20.20 Applicability.
 20.21 Preparation and submission of a Criminal History Record Information Plan.
 20.22 Certification of Compliance.
 20.23 Documentation: Approval by LEAA.
 20.24 State laws on privacy and security.
 20.25 Penalties.

Subpart C—Federal System and Interstate Exchange of Criminal History Record Information

- 20.30 Applicability.
 20.31 Responsibilities.
 20.32 Includable offenses.
 20.33 Dissemination of criminal history record information.
 20.34 Individual's right to access criminal history record information.
 20.35 National Crime Information Center Advisory Policy Board.
 20.36 Participation in the Computerized Criminal History Program.

- Sec.
 20.37 Responsibility for accuracy; completeness, currency.
 20.38 Sanction for noncompliance.

AUTHORITY: Pub. L. 93-83, 87 Stat. 197 (42 USC 3701, *et seq.*; 28 USC 534), Pub. L. 92-544, 86 Stat. 1115.

Subpart A—General Provisions

§ 20.1 Purpose.

It is the purpose of these regulations to assure that criminal history record information wherever it appears is collected, stored, and disseminated in a manner to insure the completeness, integrity, accuracy and security of such information and to protect individual privacy.

§ 20.2 Authority.

These regulations are issued pursuant to sections 501 and 524(b) of the Omnibus Crime Control and Safe Streets Act of 1968, as amended by the Crime Control Act of 1973, Pub. L. 93-83, 87 Stat. 197, 42 USC 3701, *et seq.* (Act), 28 USC 534, and Pub. L. 92-544, 86 Stat. 1115.

§ 20.3 Definitions.

As used in these regulations:

(a) "Criminal history record information system" means a system including the equipment, facilities, procedures, agreements, and organizations thereof, for the collection, processing, preservation or dissemination of criminal history record information.

(b) "Criminal history record information" means information collected by criminal justice agencies on individuals consisting of identifiable descriptions and notations of arrests, detentions, indictments, informations, or other formal criminal charges, and any disposition arising therefrom, sentencing, correctional supervision, and release. The term does not include identification information such as fingerprint records to the extent that such information does not indicate involvement of the individual in the criminal justice system.

(c) "Criminal justice agency" means: (1) courts; (2) a government agency or any subunit thereof which performs the administration of criminal justice pursuant to a statute or executive order, and which allocates a substantial part of its annual budget to the administration of criminal justice.

(d) The "administration of criminal justice" means performance of any of the following activities: detection, apprehension, detention, pretrial release, post-trial release, prosecution, adjudication, correctional supervision, or rehabilitation of accused persons or criminal offenders. The administration of criminal justice shall include criminal identification activities and the collection, storage, and dissemination of criminal history record information.

(e) "Disposition" means information disclosing that criminal proceedings have been concluded, including information disclosing that the police have elected not to refer a matter to a prosecutor or that a prosecutor has elected not to com-

mence criminal proceedings and also disclosing the nature of the termination in the proceedings; or information disclosing that proceedings have been indefinitely postponed and also disclosing the reason for such postponement. Dispositions shall include, but not be limited to, acquittal, acquittal by reason of insanity, acquittal by reason of mental incompetence, case continued without finding, charge dismissed, charge dismissed due to insanity, charge dismissed due to mental incompetency, charge still pending due to insanity, charge still pending due to mental incompetence, guilty plea, nolle prosequi, no paper, nolo contendere plea, convicted, youthful offender determination, deceased, deferred disposition, dismissed—civil action, found insane, found mentally incompetent, pardoned, probation before conviction, sentence commuted, adjudication withheld, mistrial—defendant discharged, executive clemency, placed on probation, paroled, or released from correctional supervision.

(f) "Statute" means an Act of Congress or State legislature or a provision of the Constitution of the United States or of a State.

(g) "State" means any State of the United States, the District of Columbia, the Commonwealth of Puerto Rico, and any territory or possession of the United States.

(h) An "executive order" means an order of the President of the United States or the Chief Executive of a State which has the force of law and which is published in a manner permitting regular public access thereto.

(i) "Act" means the Omnibus Crime Control and Safe Streets Act, 42 USC 3701, et seq., as amended.

(j) "Department of Justice criminal history record information system" means the Identification Division and the Computerized Criminal History File systems operated by the Federal Bureau of Investigation.

(k) "Nonconviction data" means arrest information without disposition if an interval of one year has elapsed from the date of arrest and no active prosecution of the charge is pending; or information disclosing that the police have elected not to refer a matter to a prosecutor, or that a prosecutor has elected not to commence criminal proceedings, or that proceedings have been indefinitely postponed, as well as all acquittals and all dismissals.

(l) "Direct access" means having the authority to access the criminal history record data base, whether by manual or automated methods.

Subpart B—State and Local Criminal History Record Information Systems

§ 20.20 Applicability.

(a) The regulations in this subpart apply to all State and local agencies and individuals collecting, storing, or disseminating criminal history record information processed by manual or automated operations where such collection, storage, or dissemination has been funded in whole or in part with funds

made available by the Law Enforcement Assistance Administration subsequent to July 1, 1973, pursuant to Title I of the Act. Use of information obtained from the FBI Identification Division or the FBI/NCIC system shall also be subject to limitations contained in Subpart C.

(b) The regulations in this subpart shall not apply to criminal history record information contained in: (1) posters, announcements, or lists for identifying or apprehending fugitives or wanted persons; (2) original records of entry such as police blotters maintained by criminal justice agencies, compiled chronologically and required by law or long standing custom to be made public, if such records are organized on a chronological basis; (3) court records of public judicial proceedings; (4) published court or administrative opinions or public judicial, administrative or legislative proceedings; (5) records of traffic offenses maintained by State departments of transportation, motor vehicles or the equivalent thereof for the purpose of regulating the issuance, suspension, revocation, or renewal of driver's, pilot's or other operators' licenses; (6) announcements of executive clemency.

(c) Nothing in these regulations prevents a criminal justice agency from disclosing to the public criminal history record information related to the offense for which an individual is currently within the criminal justice system. Nor is a criminal justice agency prohibited from confirming prior criminal history record information to members of the news media or any other person, upon specific inquiry as to whether a named individual was arrested, detained, indicted, or whether an information or other formal charge was filed, on a specified date, if the arrest record information or criminal record information disclosed is based on data excluded by paragraph (b) of this section. The regulations do not prohibit the dissemination of criminal history record information for purposes of international travel, such as issuing visas and granting of citizenship.

§ 20.21 Preparation and submission of a Criminal History Record Information Plan.

A plan shall be submitted to LEAA by each State on March 16, 1976, to set forth all operational procedures, except those portions relating to dissemination and security. A supplemental plan covering these portions shall be submitted no later than 90 days after promulgation of these amended regulations. The plan shall set forth operational procedures to—

(a) *Completeness and accuracy.* Insure that criminal history record information is complete and accurate.

(1) Complete records should be maintained at a central State repository. To be complete, a record maintained at a central State repository which contains information that an individual has been arrested, and which is available for dissemination, must contain information of any dispositions occurring within the State within 90 days after the disposi-

tion has occurred. The above shall apply to all arrests occurring subsequent to the effective date of these regulations. Procedures shall be established for criminal justice agencies to query the central repository prior to dissemination of any criminal history record information to assure that the most up-to-date disposition data is being used. Inquiries of a central State repository shall be made prior to any dissemination except in those cases where time is of the essence and the repository is technically incapable of responding within the necessary time period.

(2) To be accurate means that no record containing criminal history record information shall contain erroneous information. To accomplish this end, criminal justice agencies shall institute a process of data collection, entry, storage, and systematic audit that will minimize the possibility of recording and storing inaccurate information and upon finding inaccurate information of a material nature, shall notify all criminal justice agencies known to have received such information.

(b) *Limitations on dissemination.* By December 31, 1977, insure that dissemination of nonconviction data has been limited, whether directly or through any intermediary only to:

(1) Criminal justice agencies, for purposes of the administration of criminal justice and criminal justice agency employment;

(2) Individuals and agencies for any purpose authorized by statute, ordinance, executive order, or court rule, decision, or order, as construed by appropriate State or local officials or agencies;

(3) Individuals and agencies pursuant to a specific agreement with a criminal justice agency to provide services required for the administration of criminal justice pursuant to that agreement. The agreement shall specifically authorize access to data, limit the use of data to purposes for which given, insure the security and confidentiality of the data consistent with these regulations, and provide sanctions for violation thereof;

(4) Individuals and agencies for the express purpose of research, evaluative, or statistical activities pursuant to an agreement with a criminal justice agency. The agreement shall specifically authorize access to data, limit the use of data to research, evaluative, or statistical purposes, insure the confidentiality and security of the data consistent with these regulations and with section 524(a) of the Act and any regulations implementing section 534(a), and provide sanctions for the violation thereof. These dissemination limitations do not apply to conviction data.

(c) *General policies on use and dissemination.* (1) Use of criminal history record information disseminated to non-criminal justice agencies shall be limited to the purpose for which it was given.

(2) No agency or individual shall confirm the existence or nonexistence of criminal history record information to any person or agency that would not be eligible to receive the information itself.

(3) Subsection (b) does not mandate dissemination of criminal history record information to any agency or individual. States and local governments will determine the purposes for which dissemination of criminal history record information is authorized by State law, executive order, local ordinance, court rule, decision or order.

(d) *Juvenile records.* Insure that dissemination of records concerning proceedings relating to the adjudication of a juvenile as delinquent or in need or supervision (or the equivalent) to non-criminal justice agencies is prohibited, unless a statute, court order, rule or court decision specifically authorizes dissemination of juvenile records, except to the same extent as criminal history records may be disseminated as provided in § 20.21(b) (3) and (4).

(e) *Audit.* Insure that annual audits of a representative sample of State and local criminal justice agencies chosen on a random basis shall be conducted by the State to verify adherence to these regulations and that appropriate records shall be retained to facilitate such audits. Such records shall include, but are not limited to, the names of all persons or agencies to whom information is disseminated and the date upon which such information is disseminated. The reporting of a criminal justice transaction to a State, local or Federal repository is not a dissemination of information.

(f) *Security.* Wherever criminal history record information is collected, stored, or disseminated, each State shall insure that the following requirements are satisfied by security standards established by State legislation, or in the absence of such legislation, by regulations approved or issued by the Governor of the State.

(1) Where computerized data processing is employed, effective and technologically advanced software and hardware designs are instituted to prevent unauthorized access to such information.

(2) Access to criminal history record information system facilities, systems operating environments, data file contents whether while in use or when stored in a media library, and system documentation is restricted to authorized organizations and personnel.

(3) (A) Computer operations, whether dedicated or shared, which support criminal justice information systems, operate in accordance with procedures developed or approved by the participating criminal justice agencies that assure that:

(i) Criminal history record information is stored by the computer in such manner that it cannot be modified, destroyed, accessed, changed, purged, or overlaid in any fashion by non-criminal justice terminals.

(ii) Operation programs are used that will prohibit inquiry, record updates, or destruction of records, from any terminal other than criminal justice system terminals which are so designated.

(iii) The destruction of records is limited to designated terminals under the direct control of the criminal justice agency responsible for creating or storing

the criminal history record information.

(iv) Operational programs are used to detect and store for the output of designated criminal justice agency employees all unauthorized attempts to penetrate any criminal history record information system, program or file.

(v) The programs specified in (ii) and (iv) of this subsection are known only to criminal justice agency employees responsible for criminal history record information system control or individuals and agencies pursuant to a specific agreement with the criminal justice agency to provide such programs and the program(s) are kept continuously under maximum security conditions.

(vi) Procedures are instituted to assure that an individual or agency authorized direct access is responsible for A the physical security of criminal history record information under its control or in its custody and B the protection of such information from unauthorized access, disclosure or dissemination.

(vii) Procedures are instituted to protect any central repository of criminal history record information from unauthorized access, theft, sabotage, fire, flood, wind, or other natural or manmade disasters.

(B) A criminal justice agency shall have the right to audit, monitor and inspect procedures established above.

(4) The criminal justice agency will:

(A) Screen and have the right to reject for employment, based on good cause, all personnel to be authorized to have direct access to criminal history record information.

(B) Have the right to initiate or cause to be initiated administrative action leading to the transfer or removal of personnel authorized to have direct access to such information where such personnel violate the provisions of these regulations or other security requirements established for the collection, storage, or dissemination of criminal history record information.

(C) Institute procedures, where computer processing is not utilized, to assure that an individual or agency authorized direct access is responsible for (i) the physical security of criminal history record information under its control or in its custody and (ii) the protection of such information from unauthorized access, disclosure, or dissemination.

(D) Institute procedures, where computer processing is not utilized, to protect any central repository of criminal history record information from unauthorized access, theft, sabotage, fire, flood, wind, or other natural or manmade disasters.

(E) Provide that direct access to criminal history record information shall be available only to authorized officers or employees of a criminal justice agency and, as necessary, other authorized personnel essential to the proper operation of the criminal history record information system.

(5) Each employee working with or having access to criminal history record

information shall be made familiar with the substance and intent of these regulations.

(g) *Access and review.* Insure the individual's right to access and review of criminal history information for purposes of accuracy and completeness by instituting procedures so that—

(1) Any individual shall, upon satisfactory verification of his identity, be entitled to review without undue burden to either the criminal justice agency or the individual, any criminal history record information maintained about the individual and obtain a copy thereof when necessary for the purpose of challenge or correction;

(2) Administrative review and necessary correction of any claim by the individual to whom the information relates that the information is inaccurate or incomplete is provided;

(3) The State shall establish and implement procedures for administrative appeal where a criminal justice agency refuses to correct challenged information to the satisfaction of the individual to whom the information relates;

(4) Upon request, an individual whose record has been corrected shall be given the names of all non-criminal justice agencies to whom the data has been given;

(5) The correcting agency shall notify all criminal justice recipients of corrected information; and

(6) The individual's right to access and review of criminal history record information shall not extend to data contained in intelligence, investigatory, or other related files and shall not be construed to include any other information than that defined by § 20.3(b).

§ 20.22 Certification of Compliance.

(a) Each State to which these regulations are applicable shall with the submission of its plan provide a certification that to the maximum extent feasible action has been taken to comply with the procedures set forth in the plan. Maximum extent feasible, in this subsection, means actions which can be taken to comply with the procedures set forth in the plan that do not require additional legislative authority or involve unreasonable cost or do not exceed existing technical ability.

(b) The certification shall include—

(1) An outline of the action which has been instituted. At a minimum, the requirements of access and review under § 20.21(g) must be completely operational;

(2) A description of any legislation or executive order, or attempts to obtain such authority that has been instituted to comply with these regulations;

(3) A description of the steps taken to overcome any fiscal, technical, and administrative barriers to the development of complete and accurate criminal history record information;

(4) A description of existing system capability and steps being taken to upgrade such capability to meet the requirements of these regulations; and

(5) A listing setting forth categories of non-criminal justice dissemination. See § 20.21(b).

§ 20.23 Documentation: Approval by LEAA.

Within 90 days of the receipt of the plan, LEAA shall approve or disapprove the adequacy of the provisions of the plan and certification. Evaluation of the plan by LEAA will be based upon whether the procedures set forth will accomplish the required objectives. The evaluation of the certification(s) will be based upon whether a good faith effort has been shown to initiate and/or further compliance with the plan and regulations. All procedures in the approved plan must be fully operational and implemented by December 31, 1977. A final certification shall be submitted in December 1977.

§ 20.24 State laws on privacy and security.

Where a State originating criminal history record information provides for sealing or purging thereof, nothing in these regulations shall be construed to prevent any other State receiving such information, upon notification, from complying with the originating State's sealing or purging requirements.

§ 20.25 Penalties.

Any agency or individual violating subpart B of these regulations shall be subject to a fine not to exceed \$10,000. In addition, LEAA may initiate fund cut-off procedures against recipients of LEAA assistance.

RICHARD W. VELDE,
Administrator.

APPENDIX—COMMENTARY ON SELECTED SECTIONS OF THE REGULATIONS ON CRIMINAL HISTORY RECORD INFORMATION SYSTEMS

Subpart A—§ 20.3(b). The definition of criminal history record information is intended to include the basic offender-based transaction statistics/computerized criminal history (OBTSC/CH) data elements. If notations of an arrest, disposition, or other formal criminal justice transactions occur in records other than the traditional "rap sheet" such as arrest reports, any criminal history record information contained in such reports comes under the definition of this subsection.

The definition, however, does not extend to other information contained in criminal justice agency reports. Intelligence or investigative information (e.g., suspected criminal activity, associates, hangouts, financial information, ownership of property and vehicles) is not included in the definition of criminal history information.

§ 20.3(c). The definitions of criminal justice agency and administration of criminal justice of 20.3(c) must be considered together. Included as criminal justice agencies would be traditional police, courts, and corrections agencies as well as subunits of non-criminal justice agencies performing a function of the administration of criminal justice pursuant to Federal or State statute or

executive order. The above subunits of non-criminal justice agencies would include for example, the Office of Investigation of the U.S. Department of Agriculture which has as its principal function the collection of evidence for criminal prosecutions of fraud. Also included under the definition of criminal justice agency are umbrella-type administrative agencies supplying criminal history information services such as New York's Division of Criminal Justice Services.

§ 20.3(e). Disposition is a key concept in section 524(b) of the Act and in 20.21(a)(1) and 20.21(b). It, therefore, is defined in some detail. The specific dispositions listed in this subsection are examples only and are not to be construed as excluding other unspecified transactions concluding criminal proceedings within a particular agency.

§ 20.3(k). The different kinds of acquittals and dismissals as delineated in 20.3(e) are all considered examples of nonconviction data.

Subpart B—§ 20.20(a). These regulations apply to criminal justice agencies receiving funds under the Omnibus Crime Control and Safe Streets Act for manual or automated systems subsequent to July 1, 1973. In the hearings on the regulations, a number of those testifying challenged LEAA's authority to promulgate regulations for manual systems by contending that section 524(b) of the Act governs criminal history information contained in automated systems.

The intent of section 524(b), however, would be subverted by only regulating automated systems. Any agency that wished to circumvent the regulations would be able to create duplicate manual files for purposes contrary to the letter and spirit of the regulations.

Regulation of manual systems, therefore, is authorized by section 524(b) when coupled with section 501 of the Act which authorizes the Administration to establish rules and regulations "necessary to the exercise of its functions . . ."

The Act clearly applies to all criminal history record information collected, stored, or disseminated with LEAA support subsequent to July 1, 1973.

Limitations as contained in Subpart C also apply to information obtained from the FBI Identification Division or the FBI/NCIC System.

§ 20.20 (b) and (c). Section 20.20 (b) and (c) exempts from regulations certain types of records vital to the apprehension of fugitives, freedom of the press, and the public's right to know. Court records of public judicial proceedings are also exempt from the provisions of the regulations.

Section 20.20(b)(2) attempts to deal with the problem of computerized police blotters. In some local jurisdictions, it is apparently possible for private individuals and/or newsmen upon submission of a specific name to obtain through a computer search of the blotter a history of a person's arrests. Such files create a partial criminal history data bank

potentially damaging to individual privacy, especially since they do not contain final dispositions. By requiring that such records be accessed solely on a chronological basis, the regulations limit inquiries to specific time periods and discourage general fishing expeditions into a person's private life.

Subsection 20.20(c) recognizes that announcements of ongoing developments in the criminal justice process should not be precluded from public disclosure. Thus, announcements of arrest, convictions, new developments in the course of an investigation may be made. It is also permissible for a criminal justice agency to confirm certain matters of public record information upon specific inquiry. Thus, if a question is raised: "Was X arrested by your agency on January 3, 1975" and this can be confirmed or denied by looking at one of the records enumerated in subsection (b) above, then the criminal justice agency may respond to the inquiry. Conviction data as stated in 20.21(b) may be disseminated without limitation.

§ 20.21. The regulations deliberately refrain from specifying who within a State should be responsible for preparing the plan. This specific determination should be made by the Governor. The State has 90 days from the publication of these revised regulations to submit the portion of the plan covering 20.21(b) and 20.21(f).

§ 20.21(a)(1). Section 524(b) of the Act requires that LEAA insure criminal history information be current and that, to the maximum extent feasible, it contain disposition as well as current data.

It is, however, economically and administratively impractical to maintain complete criminal histories at the local level. Arrangements for local police departments to keep track of dispositions by agencies outside of the local jurisdictions generally do not exist. It would, moreover, be bad public policy to encourage such arrangements since it would result in an expensive duplication of files.

The alternatives to locally kept criminal histories are records maintained by a central State repository. A central State repository is a State agency having the function pursuant to a statute or executive order of maintaining comprehensive statewide criminal history record information files. Ultimately, through automatic data processing the State level will have the capability to handle all requests for in-State criminal history information.

Section 20.20(a)(1) is written with a centralized State criminal history repository in mind. The first sentence of the subsection states that complete records should be retained at a central State repository. The word "should" is permissive; it suggests but does not mandate a central State repository.

The regulations do require that States establish procedures for State and local criminal justice agencies to query central State repositories wherever they exist. Such procedures are intended to insure that the most current criminal justice information is used.

As a minimum, criminal justice agencies subject to these regulations must make inquiries of central State repositories whenever the repository is capable of meeting the user's request within a reasonable time. Presently, comprehensive records of an individual's transactions within a State are maintained in manual files at the State level, if at all. It is probably unrealistic to expect manual systems to be able immediately to meet many rapid-access needs of police and prosecutors. On the other hand, queries of the State central repository for most non-criminal justice purposes probably can and should be made prior to dissemination of criminal history record information.

§ 20.21(b). The limitations on dissemination in this subsection are essential to fulfill the mandate of section 524(b) of the Act which requires the Administration to assure that the "privacy of all information is adequately provided for and that information shall only be used for law enforcement and criminal justice and other lawful purposes." The categories for dissemination established in this section reflect suggestions by hearing witnesses and respondents submitting written commentary.

The regulations distinguish between conviction and nonconviction information insofar as dissemination is concerned. Conviction information is currently made available without limitation in many jurisdictions. Under these regulations, conviction data and pending charges could continue to be disseminated routinely. No statute, ordinance, executive order, or court rule is necessary in order to authorize dissemination of conviction data. However, nothing in the regulations shall be construed to negate a State law limiting such dissemination.

After December 31, 1977, dissemination of nonconviction data would be allowed, if authorized by a statute, ordinance, executive order, or court rule, decision, or order. The December 31, 1977, deadline allows the States time to review and determine the kinds of dissemination for non-criminal justice purposes to be authorized. When a State enacts comprehensive legislation in this area, such legislation will govern dissemination by local jurisdictions within the State. It is possible for a public record law which has been construed by the State to authorize access to the public of all State records, including criminal history record information, to be considered as statutory authority under this subsection. Federal legislation and executive orders can also authorize dissemination and would be relevant authority.

For example, Civil Service suitability investigations are conducted under Executive Order 10450. This is the authority for most investigations conducted by the Commission. Section 3(a) of 10450 prescribes the minimum scope of investigation and requires a check of FBI fingerprint files and written inquiries to appropriate law enforcement agencies.

§ 20.21(b)(3). This subsection would permit private agencies such as the Vera Institute to receive criminal histories

where they perform a necessary administration of justice function such as pretrial release. Private consulting firms which commonly assist criminal justice agencies in information systems development would also be included here.

§ 20.21(b)(4). Under this subsection, any good faith researchers including private individuals would be permitted to use criminal history record information for research purposes. As with the agencies designated in § 20.21(b)(3), researchers would be bound by an agreement with the disseminating criminal justice agency and would, of course, be subject to the sanctions of the Act.

The drafters of the regulations expressly rejected a suggestion which would have limited access for research purposes to certified research organizations. Specifically "certification" criteria would have been extremely difficult to draft and would have inevitably led to unnecessary restrictions on legitimate research.

Section 524(a) of the Act which forms part of the requirements of this section states:

"Except as provided by Federal law other than this title, no officer or employee of the Federal Government, nor any recipient of assistance under the provisions of this title shall use or reveal any research or statistical information furnished under this title by any person and identifiable to any specific private person for any purpose other than the purpose for which it was obtained in accordance with this title. Copies of such information shall be immune from legal process, and shall not, without the consent of the person furnishing such information, be admitted as evidence or used for any purpose in any action, suit, or other judicial or administrative proceedings."

LEAA anticipates issuing regulations pursuant to Section 524(a) as soon as possible.

§ 20.21(c)(2). Presently some employers are circumventing State and local dissemination restrictions by requesting applicants to obtain an official certification of no criminal record. An employer's request under the above circumstances gives the applicant the unenviable choice of invasion of his privacy or loss of possible job opportunities. Under this subsection routine certifications of no record would no longer be permitted. In extraordinary circumstances, however, an individual could obtain a court order permitting such a certification.

§ 20.21(c)(3). The language of this subsection leaves to the States the question of who among the agencies and individuals listed in § 20.21(b) shall actually receive criminal records. Under these regulations a State could place a total ban on dissemination if it so wished. The State could, on the other hand, enact laws authorizing any member of the private sector to have access to non-conviction data.

§ 20.21(d). Non-criminal justice agencies will not be able to receive records of juveniles unless the language of a statute or court order, rule, or court decision specifies that juvenile records shall be available for dissemination. Perhaps the most controversial part of this subsection is that it denies access to records of

juveniles by Federal agencies conducting background investigations for eligibility to classified information under existing legal authority.

§ 20.21(e). Since it would be too costly to audit each criminal justice agency in most States (Wisconsin, for example, has 1075 criminal justice agencies) random audits of a "representative sample" of agencies are the next best alternative. The term "representative sample" is used to insure that audits do not simply focus on certain types of agencies. Although this subsection requires that there be records kept with the names of all persons or agencies to whom information is disseminated, criminal justice agencies are not required to maintain dissemination logs for "no record" responses.

§ 20.21(f). Requirements are set forth which the States must meet in order to assure that criminal history record information is adequately protected. Automated systems may operate in shared environments and the regulations require certain minimum assurances.

§ 20.21(g)(1). A "challenge" under this section is an oral or written contention by an individual that his record is inaccurate or incomplete; it would require him to give a correct version of his record and explain why he believes his version to be correct. While an individual should have access to his record for review, a copy of the record should ordinarily only be given when it is clearly established that it is necessary for the purpose of challenge.

The drafters of the subsection expressly rejected a suggestion that would have called for a satisfactory verification of identity by fingerprint comparison. It was felt that States ought to be free to determine other means of identity verification.

§ 20.21(g)(5). Not every agency will have done this in the past, but henceforth adequate records including those required under 20.21(e) must be kept so that notification can be made.

§ 20.21(g)(6). This section emphasizes that the right to access and review extends only to criminal history record information and does not include other information such as intelligence or treatment data.

§ 20.22(a). The purpose for the certification requirement is to indicate the extent of compliance with these regulations. The term "maximum extent feasible" acknowledges that there are some areas such as the completeness requirement which create complex legislative and financial problems.

NOTE: In preparing the plans required by these regulations, States should look for guidance to the following documents: National Advisory Commission on Criminal Justice Standards and Goals, Report on the Criminal Justice System; Project SEARCH: Security and Privacy Considerations in Criminal History Information Systems, Technical Reports No. 2 and No. 13; Project SEARCH: A Model State Act for Criminal Offender Record Information, Technical Memorandum No. 3; and Project SEARCH: Model Administrative Regulations for Criminal Offender Record Information, Technical Memorandum No. 4.

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VITA

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In May 1975, Mr. Icové graduated from the University of Maryland with a Bachelor of Science degree in Fire Protection Engineering. During his studies, he served as the Assistant Fire Marshal of the City of Hyattsville, Maryland Fire Department.

Returning to the University of Tennessee to complete a Doctor of Philosophy degree under the Engineering Science and Mechanics Department, Mr. Icové was employed as an Arson Investigator with the Tennessee State Fire Marshal's Office from August 1976 through March 1978. Additional dissertation research was done while he was employed by the Ohio State Fire Marshal's Office as an Arson Investigator from March 1978 to the present date.