FIRE PROTECTION SERVICES FEASIBILITY GUIDE FOR LOCAL DECISIONMAKERS IN THE RURAL OZARKS

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Contents

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Preface

Local decisionmakers can use this handbook to initially plan new or additional fire protection services. Important budgetary decisions are facilitated by methods outlined herein.

Forms for estimating expected annual number and types of fires; annual capital costs; annual operating and maintenance costs; and total annual costs are presented. An example for a hypothetical community in the study area is shown utilizing these forms as an aid to the decision process. Blank forms are presented in Appendix E for local use.

Information on new fire pumpers and tankers as well as renovated surplus apparatus is presented. Local decisionmakers should also investigate the availability of used apparatus from dealers and nearby communities who may be ready to trade an older model pumper or tanker. Other capital items necessary for fire departments are also discussed. The advice of knowledgeable individuals should be obtained before any purchases are made.

Existing Federal, State, and local laws should be investigated before a new fire department is organized. Inquiries into Federal, State and local sources of funding should be made.

Abstract

Local decisionmakers will find this budget analysis useful in evaluating the need for and estimated annual expenses of a fire protection service in their community. Fire apparatus and other equipment that might be best suited for small, rural communities are discussed. Capital and operating expenses are projected for a hypothetical community and its proposed fire service area of about 13,440 acres. Blank forms to help estimate number and types of fires expected, annual capital costs, annual operating costs and annual revenue are presented. Federal and State funding and regulations are discussed.

Fire Protection Services Feasibility Guide for Local Decisionmakers in the Rural Ozarks

Marlys Knutson Nelson and Gerald A. Doeksen*

Introduction

Fire remains one of the major problems of this country. Although the fire death rate has declined slightly over the last 20 years, it is still among the highest in the world. After adjusting for inflation, direct dollar loss from fires has almost doubled and per capita dollar loss increased by about 40 percent in that same time period. Fire causes more loss of life and property than all natural disasters combined (22).[1]

In 1979, 2.8 million fires caused over $5.0 billion in property loss (Table 1). Fires in structures made up 36 percent of the fires and accounted for 86 percent of the total property loss. Within the structural class of fires, residential fires accounted for 70 percent of the number of fires and 51 percent of the property loss.

The urban fire problem has been highly publicized while the rural problem has not received as much attention (22). Deaths, fires, and dollar loss per capita were high in small communities in both 1978 and 1979 (9). Death rates in areas of less than 2,500 population are about three times as high as for towns of 50,000 to 100,000 population. The number of reported fires per 1,000 population is much higher for towns under 2,500 population than for any other size category. Dollar losses are relatively low in communities with more than 10,000 population but rise dramatically in smaller communities (Figure 1).

In recent years as more people have moved from metropolitan areas to suburban and rural communities, provision of services such as fire protection in these smaller communities may have become more essential (1). Yet people in these areas may be uninformed about the necessary equipment, staffing, and operating expenses to provide the level of service desired. To protect these people, their possessions, and the land on which they locate, information on fire protection services should be available to allow local decisionmakers to plan new or additional services as communities grow.

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[1]Numbers in parentheses refer to items in the References Section.

Table 1. Estimated United States Fires and Property Loss by Type of Fire, 1979

Type of fire	Number	Property loss[1]
		1,000,000 dollars
Structural (total)	1,036,500	4,964
Public Assembly	30,500	284
Educational	22,500	79
Institutional	29,500	34
Residential (total)	721,500	2,529
1- and 2-family dwellings[2]	550,500	2,034
Apartments	146,000	343
Hotels and motels	11,500	100
Other	13,500	52
Stores and offices	64,000	457
Industry, utility, defense	58,000	966
Storage in structure[3]	64,500	507
Special structure	46,000	108
Outside of structures (with value involved but no vehicle)	80,500	38
Vehicular[4]	495,500	682
Brush, grass, wildland (with no value or loss involved)	614,500	—
Rubbish (with no value or loss involved)	342,000	—
All other fires	276,500	66
Total	2,845,500	5,750

[1] Direct property loss only. No adjustments were made for unreported fires and losses.
[2] Includes mobile homes.
[3] These figures are only a portion of U.S. fire experience since some fires in this class are handled privately.
[4] Includes highway vehicles, trains, boats, ships, aircraft, farm vehicles, and construction vehicles.

Source: (9)

Objectives

The major goal of this study is to help local decisionmakers understand the issues involved in setting up a rural fire protection service. Specific objectives include:

1. estimating the need for rural fire protection;
2. presenting pertinent design considerations for fire trucks, fire stations, and communication systems that may be used;
3. estimating capital and operating costs for alternative systems;

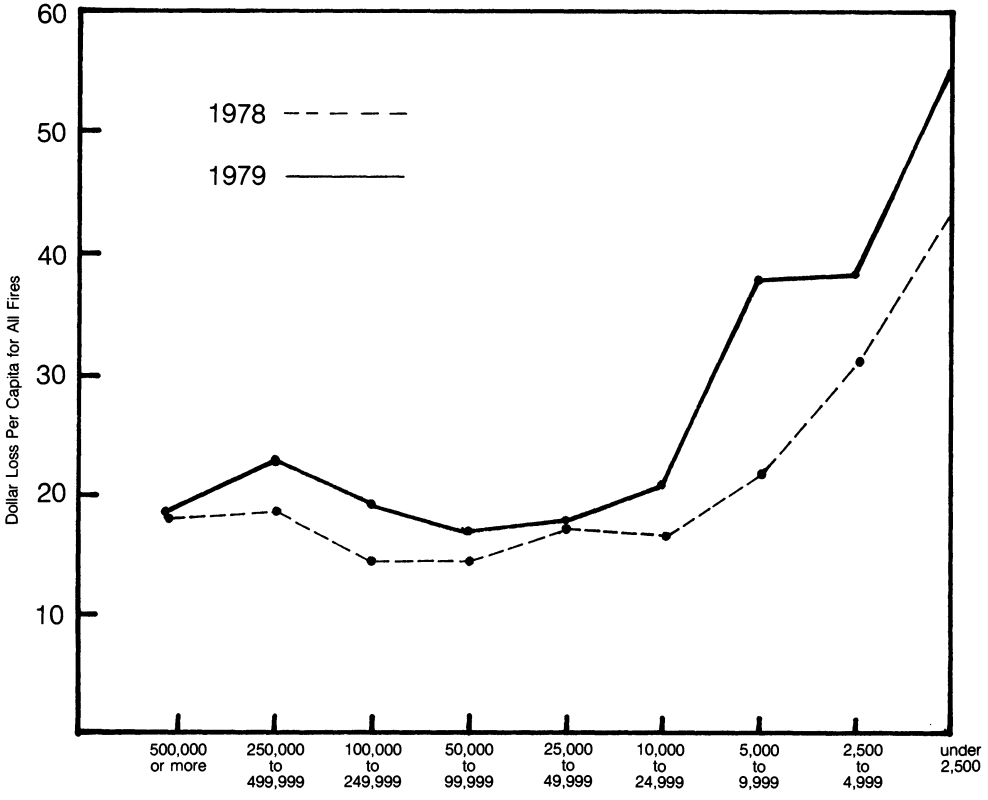

Figure 1. Dollar loss per capita for all fires by population protected and year.

Source: (9)

4. estimating total annual costs;
5. identifying alternative financial arrangements available;
6. listing training programs available through fire schools in the states; and
7. summarizing State and Federal regulations pertinent to fire services.

Following a brief discussion of the study area and data utilized, sections focusing on the estimation of needs and design considerations for fire service equipment are presented. Capital expenses are then summarized, followed by a section on annual operating costs.

To aid decisionmakers further, a fire protection service is developed for a hypothetical community in the study area based on the information provided. Forms for determining fire service needs, capital and operating costs, and revenues for this community are presented. (Blank forms are included in Appendix E for use by community leaders facing such decisions.)

Study Area and Data

The Ozarks area of Missouri and Oklahoma is one of the areas of the country experiencing a rapid influx of people (Figure 2). Between 1970 and 1980,

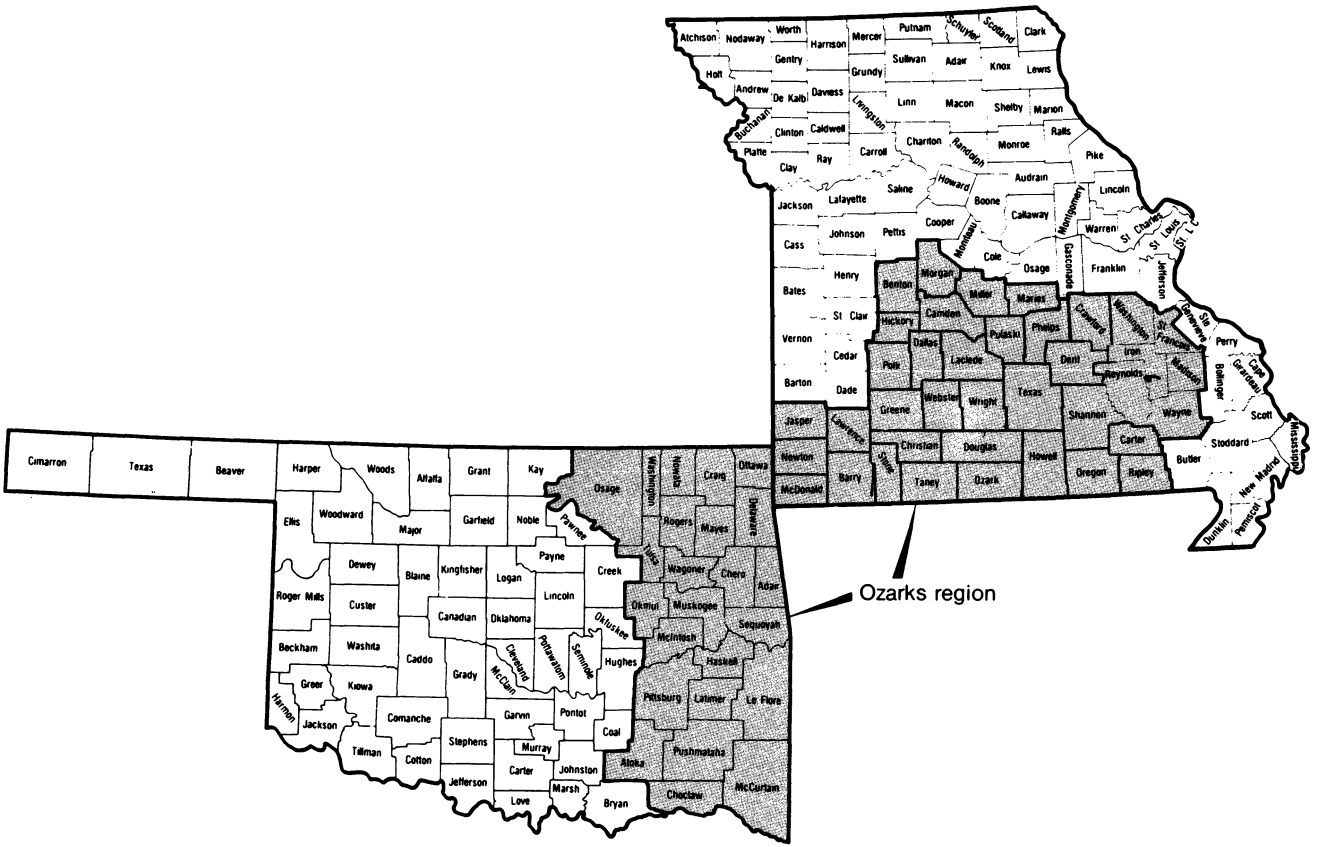

Figure 2. The Ozarks Region of Oklahoma and Missouri.

Oklahoma's population increased 17 percent while the population of its Ozarks region—minus Tulsa County—increased 24 percent. In Missouri the comparison is even more dramatic. The State population increased by 5 percent while its Ozarks region—minus Greene County—increased in population by 18 percent.[2] Tulsa County, Oklahoma, and Greene County, Missouri, are large metropolitan counties and have been omitted from this analysis.

Fire data used in this study came from the State Fire Marshal offices in Oklahoma and Missouri. Fire departments in each State may voluntarily report fire incidents to these offices. The reporting systems used in the two states differ. Missouri uses the reporting form of the National Fire Incident Reporting System (NFIRS) sponsored by the National Fire Data Center of the U.S. Fire Administration. Oklahoma has devised its own reporting system, although it is based on the NFIRS. Only information common to both systems was used in this analysis.

In the 59-county area of study, there are known to be 319 fire departments. Not all departments submitted reports in 1979, however. Reports from 88 departments are used in this analysis (Table 2). Among these, 15 percent were located in communities of under 500 population while 9 percent protected communities of over 10,000 people. Sixty-five percent of the reporting departments fought fewer than 50 fires in 1979, while 4 percent fought more than 200 fires (Table 3).

The 88 departments recorded 5,607 fires in 1979 (Table 4). In the Oklahoma Ozarks, average reported fire loss per fire was $3,357; in the Missouri Ozarks, $1,611. Average loss in the 59-county study area was $2,602 per fire.

The Ozarks region of Missouri and Oklahoma, excluding Tulsa County, Oklahoma, and Greene County, Missouri, is an area of over 28 million acres or 44,260 square miles (Table 5). Average population density was 31 people per square mile in 1979. On the average, there are 2.4 persons per household.

Information on equipment for fire service use and prices of such equipment came from various manufacturers and distributors. Only average list prices are reported here. Operating cost data came from 15 Missouri fire departments that reported this information to the Missouri State Auditor's office.

Estimate of Needs

Knowledge of the number and types of fires to be expected in a year is essential for planning purposes. For example, if a large number of acreage fires is expected, consideration should be given to obtaining a truck equipped for fighting such fires. Two methods are presented below for estimating the number and types of fires in a community in the Ozarks regions of Missouri and Oklahoma.

The methodology used for developing "fire frequency coefficients" (FFCs) uses sample data to estimate the characteristics of a population.[3] Statistics were computed separately for sub-groups of the sample and then combined to provide an overall estimate for the area. The FFCs for the Ozarks study area are reported in Table 6.

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[2]Calculated from preliminary 1980 Census data.

[3]This technique is known as "ratio estimation with stratification of population" (3). This technique is also employed by the National Fire Protection Association's Fire Analysis Department (9). Reliability of these estimates may be measured, also. (See Appendix B.)

Table 2. Number of Fire Departments in Selected Counties of the Missouri and Oklahoma Ozarks, by 1977 Community Population[1]

Population category[2]	Number of known departments	Number of reporting departments[3]	Percent reporting
			Percent
0-250	25	5	20
251-500	46	8	17
501-1,000	56	16	28
1,001-2,000	56	17	30
2,001-3,000	33	13	39
3,001-4,000	16	9	56
4,001-5,000	1	0	0
5,001-6,000	4	3	75
6,001-7,000	5	4	80
7,001-8,000	4	3	75
8,001-9,000	3	2	67
9,001-10,000	0	0	0
over 10,000	8	8	100
unknown population	62	0	0
TOTAL	319	88	28

[1] Tulsa County, Oklahoma, and Greene County, Missouri, have been omitted from this analysis.
[2] Population taken from: Department of the Treasury, Office of Revenue Sharing. *Final State and Local Data Elements, Entitlement Period II.* Washington, D.C.: U.S.G.P.O., May 1980.
[3] Reporting to the Missouri or Oklahoma State Fire Marshal's Offices.

Table 3. Number of Reported Fire Calls by Reporting Fire Departments for Selected Counties, Oklahoma and Missouri Ozarks, 1979[1]

Number of fire calls	Number of reporting departments[2]	Percent of total
		Percent
0-25	36	41
26-50	21	24
51-100	11	12
101-150	13	15
151-200	3	3
over 200	4	4
TOTAL	88	100

[1] Tulsa County, Oklahoma, and Greene County, Missouri, have been omitted from this analysis.
[2] Reporting to the Missouri or Oklahoma State Fire Marshal's Office.

Table 4. Number of Reported Fires, Oklahoma and Missouri Ozarks Selected Counties, by Category of Fire, 1979[1]

Category of fire	Oklahoma Ozarks	Missouri Ozarks	Total area
Acreage[2]	780	747	1,527
Registered vehicles[3]	652	497	1,149
Residential units[4]	1,047	580	1,627
Businesses[5]	215	124	339
Other[6]	489	476	965
TOTAL	3,183	2,424	5,607

[1] Tulsa County, Oklahoma, and Greene County, Missouri, have been omitted from the analysis.
[2] Includes field, park, public land, dump, road property, railroad right-of-way, bridges, trestles, and lawns.
[3] Includes automobiles, motor homes, travel trailers, road transport vehicles, trucks, pickups, motorcycles, vans, trailers, and others.
[4] Includes houses, apartments, hotels, motels, dormitories, mobile homes, and other residential units.
[5] Includes industrial or manufacturing establishments, mercantile establishments, and offices.
[6] Includes institutions, places of public assembly, educational facilities, storage facilities, other special property, railroad cars, aircraft, heavy equipment, agricultural equipment, and watercraft.

Source: Oklahoma's and Missouri's State Fire Marshal's Offices.

Table 5. Demographic Characteristics for Selected Counties of the Oklahoma and Missouri Ozarks Regions[1]

Demographic characteristic	Oklahoma Ozarks	Missouri Ozarks	Total Area
Population, 1979[2]	638,134	727,385	1,365,519
Land area (acres)[3]	12,520,320	15,806,080	28,326,400
Registered vehicles, 1979[4]	594,480	744,871	1,339,351
Business establishments, 1979[5]	9,756	13,521	23,277
Residential units, 1979[6]	259,218	312,931	572,149

[1] Tulsa County, Oklahoma, and Greene County, Missouri, as major metropolitan counties, have been omitted from the analysis.
[2] Estimated.
[3] U.S. Bureau of the Census. *County and City Data Book, 1977.* Washington, D.C.: U.S. Goverment Printing Office, 1978.
[4] For Oklahoma: Oklahoma Tax Commission. *Annual Vehicle Registration Report.* Oklahoma City, 1979. For Missouri: Missouri Department of Revenue, unpublished data, 1979.
[5] U.S. Bureau of the Census. *County Business Patterns, 1979.* Washington, D.C.: U.S. Government Printing Office, 1981.
[6] Estimated.

Table 6. Annual Fire Frequency Coefficients by Demographic Characteristic Selected Oklahoma and Missouri Ozarks Counties, 1979[1]

Demographic characteristic	Number in area	Estimated total number of fires[2]	Fire frequency coefficient[3]
Method One:[4]			
Population	1,365,519	25,191	54
Method Two:[4]			
Acres	28,326,400	5,527	5,125
Registered vehicles	1,339,351	5,055	265
Business establishments	23,277	1,882	12
Residential units	572,149	9,191	62
"Other"[5]	1,365,519	3,534	386

[1] Tulsa County, Oklahoma, and Greene County, Missouri, have been omitted from this analysis.
[2] Estimated from sample data (3, 25).
[3] To be interpreted as one fire occurring per 54 people in the study area, for example.
[4] See Form 1.
[5] This fire frequency coefficient for "other" fires (see Table 4) is estimated based on the population of the area.

The FFC for population is estimated to be 54. This may be interpreted as predicting one fire annually for every 54 people in the area. To estimate the total number of fires in any defined service area of the Ozarks, the population FFC may be used alone as follows:

$$\frac{\text{Area Population}}{54} = \text{Estimated annual fires in the defined area}$$

FFCs were developed for other demographic characteristics of the area, also: one fire for every 12 businesses, 62 residential units, 265 vehicles, and 5,125 acres of land area. An FFC for other types of fires was also developed based on the population of the area. Its value is 386, implying one "other" fire for every 386 people. These FFCs may also be used to estimate the number and types of fires in a specified portion of the study area if local decisionmakers have the needed information. Application of these methods is discussed later.

Capital Items

Fire apparatus and equipment must be designed to meet an area's specific needs. Information on several new and renovated surplus apparatus that may be suitable for small, rural fire departments is provided below. Availability of used fire trucks should also be investigated. Communication systems, the fire station, and protective gear are also discussed.

New Fire Apparatus and Equipment

The United States Fire Administration and the National Fire Protection Association (NFPA) have both published manuals to aid a community in determining the detailed specifications of a new fire apparatus designed to meet that community's needs (11, 24). These guides, plus the advice of knowledgeable people—neighboring fire chiefs, engineers, State Fire Marshals, Fire Training Service Staff—may help a community avoid the problem of ordering fire apparatus that may be underpowered, overloaded, too high, too wide, or too heavy for local conditions. If apparatus performance is inadequate, the lives of firefighters and the lives and property of local residents may be greatly endangered. Factors to be considered in determining the type of apparatus best suited to protect rural areas include topography, roads, traffic, distance of response, types of buildings, availability of water, and the financial status of the fire department.

Specifying fire apparatus performance levels that are properly matched to the fire hazards and road conditions in a given community is a key element in evaluating cost-effectiveness. Most manufacturers are aware of compulsory Federal Motor Vehicle Safety, Environmental Protection Agency (EPA), and Occupational Safety and Health Administration (OSHA) regulations as well as NFPA-1901 voluntary standards (11). Society of Automotive Engineers (SAE) standards are often recommended for inclusion in apparatus specifications (24). Suggested specifications for the apparatus are summarized in Appendix D.

Large Pumper. The modern fire engine is designed to go to the fire scene with everything needed to start fighting the fire immediately. Three or four people arriving on a large pumper may accomplish more in a short period of time than two or three fire companies with standard pumpers not comparably equipped.

The large pumper will usually have a 500-gallon water tank. This is ample to provide supply for initial streams until water is obtained from other sources. The apparatus carries at least three lines of preconnected hose of various lengths and sizes: 1½-inch (at least 400 feet); 2½-inch (800 to 1,000 feet); and 3-inch or larger. Fog nozzles are usually recommended. The three preconnected lines will discharge approximately 400 gallons of water per minute. Some large pumpers also carry a large preconnected line which permits the hosemen to put a 500 gallon per minute (gpm) fog nozzle in service.

NFPA has recommended that the pump for this pumper have a rated capacity of 1,000 gpm so that it can easily handle all of the water that may be applied from its operating position. In fact, pumps with 1,250 gpm ratings are in common use.

The large pumper should carry a selection of aluminum ladders to be used for rescue or access. These ladders may include a 35-foot extension which is adequate for three-story buildings; a 24-foot extension; a straight ladder with folding roof hooks; and a folding ladder for use inside buildings. Such a pumper had an average price of $56,900 in May 1981 (Table 7).

Additional equipment may include an electric generator and floodlights for use by the driver in lighting the fireground or scene of an emergency. A smoke ejector and other electrically powered equipment may also be carried. Equipment compartments may contain rescue equipment (resuscitator and first-aid kit), salvage equipment, additional tools for truck work, and various hose fittings and appliances.

Table 7. Capital Cost of Fire Apparatus, May 1981

Apparatus[1]	Average list price
	Dollars
Large pumper	56,900
Standard pumper	52,900
Grass and brush pumper, complete	27,700
1-ton pickup equipped with slip-in unit (300-gallon capacity)	18,900
Tanker[2] (1,250-gallon capacity)	55,100

[1]Detailed descriptions of the apparatus are listed in Appendix D.
[2]Tankers may also carry portable folding tanks. (See text, page12) A 1,000 gallon portable tank costs about $950.

Standard Pumper. The standard pumper has a smaller capacity pump (often 500 gpm or less) and a smaller water tank than the large pumper described above. This type of pumper may be valuable as a second unit for small community fire departments. This pumper would typically respond to alarms for fires in major buildings along with the large pumper, making it possible to get water quickly from two hydrants, if available, or other water souce. It costs about $52,900.

Grass and Brush Pumper. A popular type of apparatus in small fire departments is a small pumper used for initial response to automobile, rubbish, grass, brush, and woods fires. Although not appropriate for initial response to structural fires, it may then be useful as an auxiliary piece of equipment (11). Such apparatus is often equipped with 4-wheel drive so that it can operate on rough terrain. It may be equipped to provide small streams of water when the vehicle is used along a fire line.

For fire department service the brush pumper may have a 500-gallon water tank and a 500 gpm pump. The pump may be front-mounted on the truck. Normally, one or two reels of booster hose are provided or it may carry 1,000 feet of 1-inch lined forestry hose. It should have at least one line of preconnected 1½-inch hose which can be used both for protecting structures from brush fires and for fighting fires in buildings. A desirable provision is a 50-foot line of small hose which the operator can use to protect the apparatus when the longer lines have been run out at a field or woods fire. The short line can also be used on vehicle and small rubbish fires. The apparatus should also carry at least 500 feet of large hose which can be used to lay a supply line from a hydrant, another pumper, or from a portable pump. List price for this pumper averages $27,700.

A pickup truck may be equipped with a slip-in unit, a small tank with a capacity usually ranging from 100 to 300 gallons of water,[4] booster line hose reel with 1-inch booster line hose (perhaps 150 feet), and an independently powered pump

[4]The 100-gallon tank would be best suited for use on a mini-pickup chassis; the 200-gallon tank on a ¾-ton pickup; and the 300-gallon tank on a 1-ton pickup.

usually driven by a small, 4-cycle gasoline engine, mounted on a skid (Figure 3). An advantage of this unit is that the tank, pump, and hose reel may be easily removed or placed on another pickup chassis when the original chassis is worn out. A 300-gallon unit costs about $5,800; complete with pickup chassis, the price would average $18,900. This unit is also available mounted on a trailer.

Water Tankers. The primary purpose of mobile water supply apparatus is to transport additional water to fires in areas not adequately served by fire hydrants. Normally, this apparatus is supplemental to a fire department pumper. A tanker's efficiency depends on over-the-road mobility, the ability to quickly unload water at a fire, and the ability to quickly refill the tank to transport additional water.

Tank capacity is a major determinant of a tanker's mobility. Larger tanks require heavier vehicles and may seriously limit the mobility of the apparatus on rural roads. A truck chassis with tandem rear axles is suggested for a tanker carrying between 1,500 and 2,000 U.S. gallons. For water tanks up to 2,500-gallon capacity, a semi-trailer chassis with tandem trailer axles is recommended (11). Maximum capacity should not exceed 4,800 gallons—almost 20 tons of water. In any case, where more than 1,500 gallons of water are to be transported to fires, serious consideration must be given to load-bearing capacity of roads, bridges, and the effect of slopes in the area served.

The ability to quickly refill the tank to transport additional water is important in a rural tanker. To permit the rapid filling of a tank, a 2½-inch gated connection is required (11). Tanks may be emptied at a fire by a standard pump or a booster

Figure 3. A pickup and slip-in unit ready for fire service use.

pump on the tanker, by another pumper drawing from the tank connection, or by gravity into a portable reservoir. Some fire departments specify a larger auxiliary dump valve to speed gravity flow.

It is recommended that the tanker carry a folding water tank of at least 1,000-gallon capacity (larger for larger tankers). On arrival at a fire it would discharge its load into the unfolded tank, providing the pumper with enough water to discharge at an average rate of 100 gpm while the tanker goes to refill from a nearby water source. Tankers should have a 500 gpm pump, at the minimum. A front-mounted pump saves space on the apparatus, and increases the tanker's traction since the tanker can head toward a water source (pond, river) while its back wheels are on firm ground.

While the tanker's main job is to carry water, it may also be used for other purposes. Some fire departments equip their tankers to make that possible. Two preconnected lines of 1½-inch hose with fog nozzles can supply two streams on a fire where desired. Some tankers also have turret nozzles; the size varies, but 500 gpm fog nozzles are very effective. They permit a fast knockdown of a blaze which can then be handled by smaller streams. Without such an effective initial attack the fire is often beyond control with 1½-inch hose or it at least takes much longer and much more water to control it.

Tankers may also carry a few basic firefighting tools such as short ladders, axes, and a plaster hook. It is appropriate in some areas for the tanker to carry 1,000 feet or more of 1-inch or 1½-inch forestry hose and other forest fire equipment. A commonly available commercial tanker with 1,250-gallon capacity has an average retail price of $55,100.

Where large capacity water carriers are involved, serious consideration should be given to the need for power brakes and power steering. Specially trained and experienced drivers are necessary for the safe operation of large capacity tank vehicles.

Assembling Fire Apparatus from Surplus Equipment

Obtaining a truck commercially may be quite expensive. With a moderate amount of ingenuity, hard work, and a minimal financial contribution, however, a community can obtain a basic level of fire protection using government surplus equipment. Serious mistakes may be made, however, in modifying surplus equipment for fire service use if guidelines provided by sources such as the NFPA, State Fire Marshal's Office, or the State Fire Service Training School are not followed. Seek advice from qualified individuals (11, 14).

A fire truck is assembled from four basic components: chassis, water tank, pump, and other equipment. Each component is briefly discussed below.

The Chassis. A Federal "excess properties" program allows for public use of military vehicles. State Forestry Departments screen these vehicles before they are leased to any community. They are for fire service use only. When a community signs the cooperative lease agreement to obtain the use of the vehicle for an indefinite period, it agrees to maintain the vehicle and provide liability insurance for it. Inquiries should be made to the State Forestry Department as to the availability of these vehicles. A "surplus property" program also exists under which military vehicles may be purchased for a reasonable price (Figure 4).

Figure 4. A military surplus vehicle converted for fire service use.

Most military vehicles are not designed for fire service use. Care must be taken in the conversion to insure that the cost of converting and maintaining the older equipment does not exceed that of newer commercially available equipment.

The gross vehicle weight (GVW) of a truck must not be exceeded. This means that the weight of the chassis plus the weight of everything put on the chassis — including personnel — must be less than the GVW. Location of the weight placed on the vehicle is also very critical since this affects both the overall stability and stopping distance.[5] A gallon of water weighs approximately 8.33 pounds. Consider using a weight factor of 10 pounds per gallon of water, allowing for the weight of the tank.

Before making a final decision on a truck chassis, consider these issues:

1. the maximum weight safely supported by bridges and roads in the proposed service area;
2. the maximum turning radius of the truck being considered (Will this truck be able to travel and maneuver on the narrow country roads of the area?); and
3. the punishment of rural roads and the off-road terrain travel the truck will typically experience in most rural fighting operations.

[5]As a general guideline, for horizontal center of gravity, place one-third (1/3) of the total GVW on the front axle and two-thirds (2/3) on the rear axle. Key the vertical center of gravity less than three-fourths (3/4) of the rear axle width (14).

Water Tank. A converted chassis should carry a water tank of 1,000-gallon capacity or less (14). The recommended maximum tank size for commonly used military vehicles is: (a) standard 6 x 6 - 1,000 gallons; (b) standard 4 x 4 (¾- or 1½-ton) - 150 to 200 gallons; and (c) standard jeep - 60 gallons. Although 4 x 4s and jeeps cannot carry as much water (or equipment), they are generally less expensive than larger trucks and are more maneuverable in rugged terrain. A 1,000-gallon tank will weigh at least 5 tons when loaded (without the truck chassis) and may exceed the capacity of many county bridges.

A rectangular tank allows optimum distribution of weight both from side to side and front to back. It also reduces the hazards of shifting liquids because the vertical center of gravity can be kept low (14). Elliptical or cylindrical tanks may also be used for fire trucks.[6]

Tanks should be constructed from lightweight materials that will hold the liquid load, resist corrosion, and stand up under rough treatment. Conserving weight in construction allows more water to be carried. Fiberglass, aluminum, and mild steel are the materials most commonly used.

All water tanks must have baffles (swash partitions) to help prevent water from moving inside the tank. If a tank is not properly baffled, the large force from shifting water can cause a truck to overturn or greatly reduce its ability to stop quickly. Baffles should be constructed so that no individual area of the tank contains more than approximately 75 gallons of water. Holes must be cut in the tops and bottoms of the baffles to allow air to escape from the tank as it is filled and water to circulate as it is pumped (Figure 5).

Adequate tank venting is needed to allow free movement of air and to handle any water overflow. A fill opening of 5-inch diameter or larger should be safely and easily accessible and have a removable, readily-cleaned screen. A sump at the bottom of the tank should be provided to allow drainage of corrosion residue from the lowest point of the tank.

The tank should have flanges attached to the side to permit securing it to the truck bed or frame. All plumbing equipment should be easily accessible for purposes of modification and repair. The pump intake should be at least 2½ inches in diameter. Considerable flexibility may be built into a truck by running at least one 1-inch line to the front of the truck for use in fighting brush and grass fires on the run.

The Pump. Many different types of pumps are available for fire service use. They may be divided into two broad classifications: 1) power take-off (PTO) and 2) independently powered. A PTO pump is powered by the truck engine. This type is most commonly used by commercial fire apparatus manufacturers. Independently powered pumps are powered by gasoline engines or electric motors which are independent of the truck engine. Since PTO pumps are expensive, will not work if the truck engine fails, and their pump speed depends on engine speed, independently gasoline-powered pumps may be most suitable for rural use (14).

[6]These are often encountered when converting tanks formerly used for crude oil, milk, or fuel transport. It should be noted that different liquids have different specific gravities; a truck designed to haul 1,000 gallons of gasoline can safely transport only 800 gallons of water. In order to overcome the problem of overloading the chassis, the tank will need to be reduced.

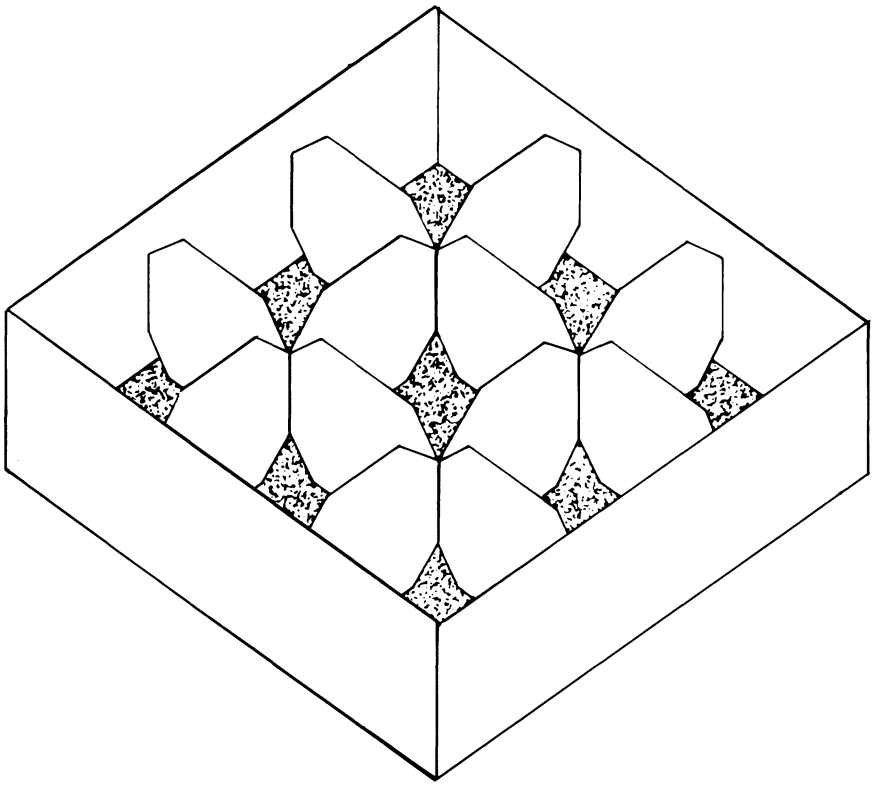


Figure 5. An inside view showing baffles within the tank.

Fire pumps may be centrifugal, piston, or rotary type. With few exceptions, the centrifugal pump is preferred for fire service use. A centrifugal pump can pump water contaminated with dirt and abrasives with less damage than a rotary or piston pump.

Other Equipment. Once a surplus vehicle has been renovated for fire service use, a community may wish to equip it to better handle emergency situations. Equipment of most importance might include: self-contained breathing apparatus for the truck crew; first aid kit; battery operated handlights; an axe — flat or pick head; wrenches — one hydrant, two spanner, and one crescent; a 36-inch crowbar; a 36-inch claw tool; wire cutters — high voltage and fence; bolt cutters; screwdrivers — regular and Phillips; a long chain; and a ladder — 14 to 24 feet long. Other suggested equipment is outlined in (14).

A surplus vehicle equipped as a pumper will cost about $7,580, assuming the chassis and tank are obtained through the excess properties program (Table 8). Converting a surplus vehicle to a tanker will cost about $4,000 when it is equipped with a folding tank in addition to a solid tank.

Communication System

The efficiency of a rural fire department may be greatly improved by a dependable communication system. The basic element of the system is a public

Table 8. Estimated Costs of Capital Equipment Items for Conversion of Surplus Vehicles to Fire Service Use, May 1981

Capital equipment item	Cost
	Dollars
Fire pumper:	
Chassis[1]	—
Pump	600
Hose reel	460
Hose: 1-inch booster (150 feet)	415
1½-inch 2-ply (200 feet)	290
Nozzles: 1-inch (4)	1,095
1½-inch (3)	1,350
Tank (1,000 gallon)[2]	1,500
Miscellaneous equipment[3]	1,870
Total capital costs	7,580
Tanker:	
Chassis[1]	—
Pump	600
Tank (1,000 gallon)[2]	1,500
Folding tank (1,000 gallon)	950
Suction hose, 2½-inch (30 feet)	650
Strainer for suction hose	65
Miscellaneous equipment	250
Total capital cost	4,015

[1]Government surplus equipment may be available free from the State forestry department.
[2]The cost listed here is for renovating a surplus tank for fire department use. The tank itself is free through the excess properties program. The 1,000-gallon capacity is a maximum size. A smaller tank may be better suited to your community's needs.
[3]Miscellaneous equipment includes: 2 breathing apparatus, 2 electric handlights, 1 axe, 1 36-inch crowbar, and a 14-foot ladder.

telephone. Base station radio equipment is also essential for it is capable of sending and receiving messages between the headquarters and fire apparatus. Antennas are necessary for the base station segment of the system. Mobile units for each vehicle complete the system (13).

Telephone Communication. Telephone service depends upon the size of the fire department and its workload. There may be single or multiple lines for emergency calls only, or several trunk lines may be divided between the emergency and administrative needs of the department.

Fire departments with volunteers must summon them at any hour. This can be handled by telephone. Fire calls may be telephoned to a central telephone office where an operator may start a siren or operate an air horn, indicating that there is a fire. In rural areas where operators are not on duty 24 hours a day, telephone companies may provide a special telephone line which connects to special telephones located in places of business or residences selected by the town. A town with this special reporting system would have prearranged plans of action when a

fire call is received. Information about special lines and services is available from local telephone companies.

Radio Communication. Radio communication in most fire control agencies is handled through two-way equipment. Such equipment is uniquely suited to the needs of mobility required for rural and forestry fire sevices. Radio keeps firefighting units in touch with headquarters and facilitates requests for additional assistance in emergencies.

Groups of frequencies on the radio spectrum have been assigned for land mobile service: low band; very high frequency (VHF), high band; and ultra high frequency (UHF). The low band gives the longest signal range among the three and is ideal for open country operation except where affected by long range interference. VHF gives a stronger signal with shorter range than low band and is less subject to radio interference, making it desirable for combination city-country coverage. UHF has a very strong signal, but shorter range than either of the other two. It is the least affected by interference. (13).

Channels on the VHF and UHF bands have desirable characteristics. If used properly, they provide the most efficient coverage of an area, reaching into all locations. They do not travel over long distances (or "skip") to cause interference in distant places. Because of their desirability and the relatively small area of spectrum available in each, both bands have become crowded causing interference in some areas. Frequencies are regulated in the United States by the Federal Communications Commission (FCC). Allocation, licensing, and rule making for all except Federal government allocations are made by the FCC.

If a sophisticated system of communication is economically beyond the reach of a new fire protection service, the use of a citizen band (CB) system may be a temporary answer. VHF, UHF, and citizen band (CB) systems are briefly described below. Professional advice should be obtained before purchasing any communication equipment.

VHF System. General specifications for a new VHF communication system might include a 100-watt base station with a 2-frequency capability. One frequency would be available at all times for paging personnel within a 10-mile radius. A base station costs about $4,100 (Table 9). If a remote console is used in another station, it would add $710 to the system cost. Installation costs for the two units are about $150. A mobile radio, installed in a fire apparatus, would cost $2,060. Expected life of the system is 10 years.

The installed height of the system's antenna will depend on the area to be served, but 100 to 150 feet is often adequate. The cost of a 100-foot tower and antenna is about $1,795, including installation of the tower. Life expectancy of the tower is 20 years. Transmission line costs of $2.84 per foot are also part of the total VHF system cost.

If a community has an existing VHF system for its police department, it may be used for a fire service communication system at a lower cost than a totally new system. Addition of a 2-way radio in each fire apparatus would be required.

UHF System. A UHF system may accommodate up to ten channels. A 100-watt base station with three frequencies may be adequate for rural areas. This unit costs approximately $5,700. More frequencies may be added at additional cost. A mobile radio for each fire apparatus will cost about $2,980; a remote console

Table 9. Capital Cost of Communication Equipment by Type of System, May 1981

Equipment	Type of system		
	VHF[1]	UHF[1]	CB[1]
	Dollars		
Base station, installed	4,200	5,700	120
Remote console, installed	760	760	n.a.[2]
Mobile radio, installed	2,060	3,040	100[3]
Tower, installed	1,525	1,525	n.a.
Antenna	270	270	50[4]
Transmission line, per foot	2.84	2.84	1.50

[1]VHF = very high frequency; UHF = ultra high frequency; CB = citizen band. See text for explanation.
[2]n.a. = not applicable.
[3]Includes antenna for mobile unit.
[4]Price for an 18-foot antenna, allowing a range of 10-14 miles.

about $710. Installation charges average $60 for a mobile unit and $150 for the base station and console (Table 9). Life expectancy for this system is ten years.

A 100-foot tower might also be used with a UHF system. Adding in its cost, a UHF system with one mobile radio would cost slightly more than $11,000. Transmission line expense should be added to this amount.

Citizen Band System. The CB radio most commonly available is a class D station operating between the frequencies of 26.96 and 27.23 megahertz (MHz) with an input power of 5 watts or less. With an 18-foot antenna, the range of this station would be 10 to 14 miles. The base station would average $95; the antenna price is about $50. Coaxial cable for transmission line from the base station to its antenna costs about $1.50 per foot.

A mobile unit should be installed in each fire apparatus. Per unit, including the required antenna, this would average $100.

Fire Station

A fire staion is necessary as a communications headquarters, a storage area for apparatus (to prevent water from freezing in their tanks) and auxiliary equipment, and as a meeting place for firefighters and other groups. A new station may be constructed under contract or by local citizens. An existing structure may be remodeled for fire service use.

The station depicted in Figure 6 would be best suited for a volunteer department. Part-paid, full-time, and some volunteer departments would need extra room for sleeping quarters and shower facilities. This station would house two fire trucks. A small storage area, meeting room, and lavatory facilities are also provided.

If a new station were an all-metal structure with concrete floors (linoleum in the bathrooms) and heating and air conditioning for the meeting room and bathroom, construction costs would be about $27 per square foot for complete contracting. The building shown in Figure 6 would cost about $48,600 and have an expected life of 40 years. These costs could be greatly reduced by the use of local volunteer labor.

Protective Gear

A wide variety of types of protective gear are available for fire service use. The quality and reliability of the gear must be considered before any selections are made.

Firefighters should be fully informed about protective gear available for their use. They should understand the reasons for using each item and its inherent limitations. Training in the use of some items may be beneficial.

Protective clothing for fighting structural fires normally consists of turnout coats, boots, helmets, gloves, and pants. Suits are available for other types of firefighting. Average cost of a basic suit for structural fires was $210 in May 1981.

Statistics on firefighters injured each year due to inhalation of toxic gases clearly indicate that protective breathing apparatus should receive a high priority (8). It is extremely important to select the proper type of breathing apparatus and to train firefighters in its use and maintenance. NFPA standards state that all firefighters should be provided with self-contained breathing apparatus approved by the United States Bureau of Mines. A 30-minute self-contained unit costs about $800.[7]

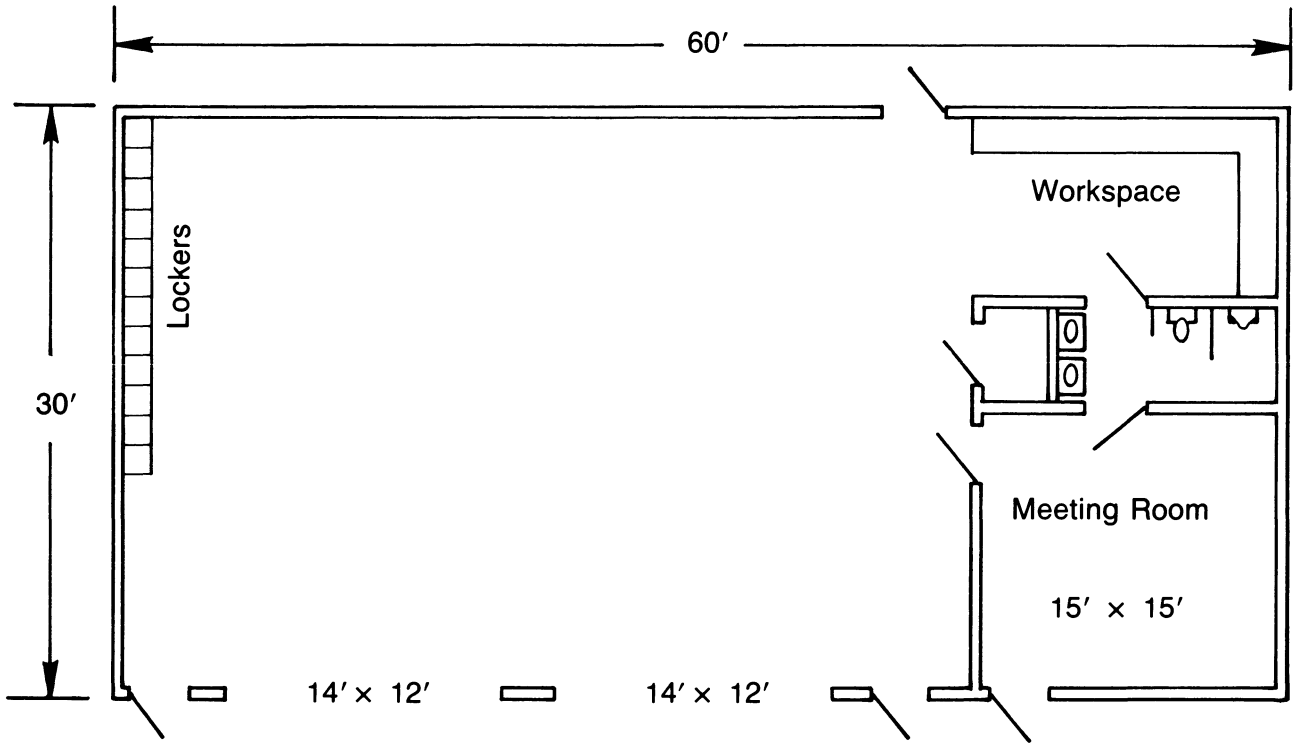
Operating and Maintenance Costs

Local decisionmakers should have information on operating and maintenance costs for all aspects of a fire service before the most cost-effective, long-term solution to their local fire problem is found. These costs include: 1) fire station operation and maintenance; 2) vehicle expenses; and 3) labor cost. Each is discussed below.

Fire Station

Operating a fire station over the course of a year involves several expenses (Table 10). The building itself must be insured, heated, and, perhaps, air conditioned in the meeting room and bathroom. For the station shown in Figure 6, insurance would cost about $120 per year and electricity would be slightly more than $1,000 per year, based on 1980 prices. Water, sewer, trash pickup, and general maintenance would cost about $360 per year. Total annual station costs would average about $1,500.

[7]The rating of 30 minutes is not absolute. The actual time rate is dependent on both the physical and psychological conditioning of the firefighter using the apparatus. The average retail price listed is for May 1981.



Source: (2).

Figure 6. Two-bay Fire Station

Table 10. Annual Fire Department Operating and Maintenance Costs, 1980[1]

Cost category	Annual expense
	Dollars per unit
Fire Station[2]	
Insurance	2.40 per $1,000 value
Water, sewer, trash	156
Electricity[3]: meeting room and bathroom	1.28 per square foot
vehicle storage area	0.42 per square foot
Maintenance	200
Vehicle(s)	
Insurance[4]	40 per $1,000 value
Repairs[5]	535 per truck
Gas, oil, tires[6]: large vehicles	0.39 per mile
grass and brush rig	0.22 per mile
Miscellaneous, including small equipment[5]	1,131 per truck
Communication system	
VHF or UHF: base unit[7]	450 per unit
mobile unit[7]	120 per unit
CB: base and mobile unit	35 per unit
Labor, part-paid systems[8]	
Chief	11,784
Assistant chief	10,560
Firefighter: beginning	9,072
after probation	9,444

[1]If local costs are available, they should be used in estimating operating costs replacing data in this table.
[2]From (4).
[3]Electricity is used for heating and air conditioning in this study.
[4]Includes collision ($500 deductible) and physical damage ($250 deductible).
[5]Based on records of 15 volunteer and part-paid systems as submitted to the Missouri State Auditor's Office.
[6]Time frequency may be more important than road miles. Change oil twice a year or every 500 miles. Tire life averages 10,000 miles or 5 years.
[7]Service contracts for VHF and UHF systems.
[8]Based on information used with permission and compiled by the Oklahoma State Firefighters Association.

Vehicle Expenses

Keeping apparatus operational for every fire call involves both preventive maintenance and repair work.[8] Expenses for such work in several Missouri departments averaged $535 per fire truck (Table 10).

Insurance coverage for collision ($500 deductible) and physical damage ($250 deductible) averages $40 per $1,000 truck value. Other expenses depend on mileage driven annually or time frequency.[9] For larger apparatus (all except the grass and brush rig), gasoline, tires, and oil changes cost $0.39 per mile. For a grass and brush rig, these expenses are $0.22 per mile. Miscellaneous expenses, including small equipment repair and replacement, averaged around $1,100 per truck.

Communication System

Servicing the communication system is also an operating expense. An annual service contract may be available for the UHF or VHF equipment. This would cost about $450 for a base station and $120 for each mobile unit (Table 10).

If a CB unit (base or mobile) is properly set up when first installed and its users are properly handling it, it might require virtually no service over its lifetime. If problems occur, maintenance costs might be about $35 per year per unit.

Labor

Three types of labor arrangements are used in fire-service departments: volunteer; part-paid; and full-paid. Volunteer systems are common in small, rural communities in the Ozarks. Some communities of less than 10,000 population in the study area have part-paid departments, however. Full-paid systems are most common in larger communities. Each is briefly described below.

Volunteer System. Volunteers often receive some compensation for their services. In many small Oklahoma towns, contributions to a pension fund (described in a later section) are made for each firefighter. Many communities also pay volunteers for each fire call attended, plus each meeting attended. A common figure is $5 per fire and $6 per meeting. Since a firefighter's costs are usually not covered by these means of compensation, the term "volunteer" is appropriate.

State Statutes in Oklahoma restrict the number of volunteers on a fire department's rolls to 20. If a department relies strictly on volunteers, a number between 12 and 20 might be required to adequately handle the department's fire calls.

If a department has 12 volunteers, about 4 of them should respond to each fire call. At $5 per firefighter, the total labor charge per fire call will be $20. If the department has 20 volunteers, with 7 reporting to each fire, the labor charge would increase to $35.

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[8]This may be especially true in small fire departments where reserve equipment is not readily available. Departments may find the NFPA's *Fire Apparatus Maintenance* helpful in setting up a program for planned preventive maintenance. (See 12.)

[9]With fire apparatus, time frequency may be more important than road miles as a basis for lubricating and other servicing (12). These costs assume gasoline at $1.30 per gallon, oil changes twice a year or every 500 miles, and tire life average of 10,000 miles or 5 years.

Even an "all-volunteer" system likely will find it necessary to have a chief to handle scheduling of monthly meetings and/or training sessions. This individual might also be responsible for supervising equipment and apparatus maintenance and service work. The chief's duties may be full-time responsibilities. Compensation for these duties might be $11,784 per year (Table 10).

Annual labor charges for a 12-volunteer system are $12,648, assuming $11,784 for the chief and $864 for 12 monthly meetings of 12 volunteers at $6 per meeting. Estimates of the costs for fire runs depend upon the number of runs made during the year. The average number of runs in the study area was 64. Therefore, if 4 volunteers attend each fire, an annual cost of $1,280 should be added to this amount. The labor charge for a 20-volunteer system would be $13,224, plus $2,240 for 7 volunteers attending 64 fires annually.

Part-paid System. In a part-paid system, some of the people on the rolls are full-time and some are volunteers. This system is widely seen in the Ozarks region of Oklahoma for communities under 10,000 population. Among these communities, departments had as few as 3 paid personnel and as many as 18 volunteers. The average size of the department in 1980 was 18 members with 8 paid and 10 volunteers.

Average monthly salaries for these systems are reported in Table 10. Volunteers are typically compensated in the manner of an all-volunteer system.

Full-paid System. All members of the fire department are full-time firefighters under this system. It is typical of communities over 10,000 population. Since this study is geared to smaller communities, costs for this system will not be discussed.

Alternative Financial Arrangements

To meet the financial obligations of any fire protection service — financing capital investments and operating expenses for the service — the source of funds must be dependable. Services in rural areas may be more vulnerable to an undependable source of funds than services in other settings. Some arrangements that are currently used with varying degrees of success include: volunteer services, donations, and benefits; fees; local governments; fire districts; and Federal funding. Of course, combinations of several of these arrangements may be appropriate.

Volunteer Services, Donations, and Benefits

Volunteer labor has long played an important role in the provision of fire protection services across America. By one estimate, on the basis of the cost of replacing volunteers with paid firefighters, the Nation's volunteers render a service worth at least $4.5 billion annually (10).

Citizens may donate other things, besides their labor, to the successful operation of their community's fire service. Small equipment and consumable supplies are always needed and may be furnished by local citizens.

Benefits may be held to raise money for a capital purchase for the local fire service or for operating expenses. Such activities might include picnics, dances, pie suppers, and so forth. For example, the unincorporated community of Moyers, Oklahoma, is raising money to purchase a fire truck through a pie

supper, a bean supper, a games night, a community fish fry, and a dance, among other things. The success of such events depends on the enthusiastic support of the community.

Fees

The costs of fire protection services may be covered by charging fees for services rendered. These may be made on a per-run basis, by subscription (or membership), or by some combination of the two.

When charging by the run, the total annual cost of the service (from last year's records or a projected figure for this year's total amount) is divided by the number of runs made (the average number of runs in recent years) to arrive at the per-run fee. An insurance rider may be available to cover this charge.

If each potential user of the fire service is charged an annual subscription or membership fee, the cost to each would be significantly lower than a fee per call charge. Again, past records of annual total costs are used to determine the necessary fee to each subscriber (member). If subscriptions (memberships) are faithfully paid, this financial arrangement can be quite dependable.

Subscription and fee per call methods of charging for fire service may be combined. A one-time membership fee may be collected from residents new to an area. These members will then receive reduced fees per run for any fires occurring on their property, while non-members pay a higher fee per run.

Local Governments

Local governments may provide financial assistance for fire protection services to rural residents. This assistance may vary greatly, depending on State law. Check with local authorities.

County commissioners in Oklahoma have two options for providing local fire protection (17). The first option permits the use of county funds to rent, lease, or purchase firefighting equipment; to rent or construct fire stations and equip and operate them; and to employ fire personnel. One or all of these things may be done using money from the regularly appropriated funds for all county operations. As a second option, fire protection may be provided through an agreement with any city, town, or municipality within the county to any portion of that county outside its corporate limits.

Some city fire departments respond to calls in nearby unincorporated areas on a fee or contract basis, provided sufficient personnel and apparatus remain to protect the city. Cities and/or fire protection districts can sign inter-local cooperation agreements and mutual aid agreements. Cities may purchase equipment for use by volunteer fire protection associations and contract with such associations for fire protection.

Fire Protection Districts

Both Missouri and Oklahoma have statutory provisions for the establishment of fire protection districts. In each case a petition must be circulated and signed

(by 100 voters in Missouri; by 25 percent of the land holders in Oklahoma). An election is ultimately required to establish the district. A board of directors is elected in Missouri. In Oklahoma the board is initially appointed by the county commissioners (5, 18).

To raise money, fire protection districts in Missouri are allowed to levy, with voter approval, up to $.90 per one hundred dollars of assessed value of the property in the district (5). This is to be allocated as follows: up to $.15 for emergency ambulance service; up to $.65 for operation of the district; and up to $.10 for a firefighters' pension fund. Voters may also authorize issuance of general obligation bonds and a tax to pay for them. This tax is in addition to those authorized by other provisions with no limit on the amount for this purpose.

In Oklahoma, voters may approve bonds to finance capital items. A tax of up to seven mills may be collected to support yearly expenses. Pension funds are handled independently from the protection districts in Oklahoma. (See section on State and Federal Regulations.)

Federal Funding

Several Federal agencies can provide assistance to rural communities interested in providing fire protection services to their citizens and to residents of the surrounding countryside (6, 23). These agencies are the Farmers Home Administration (FmHA), the United States Department of Agriculture (USDA); Community Planning and Development, the Department of Housing and Urban Development (HUD); Office of Revenue Sharing, the Department of the Treasury; and the Forest Service, USDA.

Community facilities loans are available through FmHA (Catalog No. 10.423)[10]. Communities not exceeding 10,000 population are eligible for funds "to construct, enlarge, extend, or otherwise improve facilities providing or supporting overall community development including fire and rescue services" (23). The funds may also cover such costs as purchases of equipment (fire truck, for example) and initial operating expenses. Interest rates for these loans are typically below the prevailing market interest rate.

Community Planning and Development of HUD conducts a program—Community Development Block Grants/Small Cities Program (Catalog No. 14.219) — for which all states, counties, and units of general local government except metropolitan cities and urban counties are eligible. This program provides grant funds to pay for "certain public services not otherwise available but which are necessary or appropriate to support other block grant activities" (23). This program can cover funding for construction or improvement of fire protection services and facilities.

The Office of Revenue Sharing of the Department of the Treasury makes funds available to State and local governments. Revenue sharing (Catalog No. 21.300) provides formula entitlement payments to be used at the discretion of the

[10] These numbers refer to listings in (6).

local governments. Expenditures for a local fire service may receive some of the government's total revenue sharing funds.

Grants for fire protection of non-federal lands are available through the Forest Service of USDA (Catalog No. 10.664). These funds may cover such costs as equipment purchasing, training and education, developing detection systems, and fire look-outs. Acquisitions and use of Federal excess property by State foresters for fire control use is also authorized under this program. "A state should receive not more than 50 percent of its current estimated cost of adequate fire protection" (23). Many small communities in the Ozarks area of Oklahoma and Missouri have received these grants and use the funds plus matching funds from their own residents to set up volunteer fire departments where no fire protection service previously existed.

For specific information on these sources of funding, Federal, State or regional offices should be consulted. Information on funds available, specific criteria concerning a community's eligibility, and procedures for applying for loans or grants are available through these offices.

Planning a Rural Fire Protection Service

Information presented in previous sections may be used to design a fire protection service. Methods for estimating the expected number and types of fires and annual capital and operating costs for alternative fire department systems are presented below. Combining these methods with local information allows decisionmakers to estimate costs and evaluate the feasibility of alternative fire protection services.

To illustrate these methods, a fire protection service for a small, rural town of 145 people in the Oklahoma Ozarks is developed. The proposed service area, based on natural boundaries (rivers, roads, bridges, neighboring communities' fire services), covers the town and the surrounding rural area, a total of 13,440 acres. Total population of the proposed service area is 607. This area contains 233 residences, 12 businesses, and 595 registered vehicles.

Budgets for two fire service alternatives are illustrated. The first includes a large pumper, VHF communication system, 12 fire suits, and 2 breathing apparatus. The second incorporates a renovated surplus pumper, 1-ton pickup and slip-in unit, CB system, and 12 fire suits. Each alternative includes a fire station (Figure 6) and the use of volunteers. Forms for estimating number and types of annual fires, annual capital and operating costs, and costs per fire are presented. Appendix E contains blank copies of the forms for use by local decisionmakers.

Cost Adjustments

Community decisionmakers should use local, current costs in the methodology presented below. When not available, costs reported in earlier sections of this study may be used. These costs are regional averages and may not be accurate for individual communities in the Ozarks or elsewhere.

Costs for fire apparatus and equipment are reported for May 1981. Operating and maintenance expenses are for 1980. Decisionmakers need to adjust reported costs to reflect current price trends. Methods presented in the forms include an adjustment for this purpose involving the use of indices reported monthly in the U.S. Department of Commerce's *Survey of Current Business*. Multiplying a price shown in this study by the ratio of the current index value to the base period index value will result in an "inflated price" that reflects current price trends. For example, the capital cost for a pumper can be adjusted as follows:

$$\text{reported pumper price (May 1981)} \times \frac{\text{current consumer price index-urban consumers}}{\text{May 1981 consumer price index-urban consumers}} = \text{adjusted pumper price}$$

Operating and maintenance expenses require a similar adjustment.

Amortization

Capital costs for buildings and equipment are often financed by loans and repaid over a period of years. This process is called amortization. Two or more separate loans at different rates of interest and for different lengths of time may be required. If so, different amortization factors should be used to determine annual capital costs for each loan. Amortization factors are shown in Appendix A for selected interest rates and repayment periods.

If capital costs are paid immediately with cash on hand, they should also be amortized at an interest rate that reflects the community's opportunity cost of money. Cash on hand could be invested in interest-bearing deposits. Methods presented in the forms provide for amortization.

Estimating Annual Fires

Using the fire frequency coefficients (FFCs) developed earlier (Table 6) and information on the proposed fire service area for the hypothetical community's fire service, it is possible to estimate the number and types of fires the area might expect to occur within a year. Form 1 has been developed to help local leaders complete this first step in planning.

Two methods of estimation are presented in Form 1. The first uses information on current population of the service area only. The hypothetical community may expect 11 fires based on this method. The second method uses information on acreage of the service area, registered vehicles, businesses, and residences, as well as population data, to estimate the total number and types of fires that might be expected in a year. For the hypothetical community, this method predicts 12 fires: 3 acreage, 2 registered vehicles, 1 business, 4 residences, and 2 other fires.

Form 1. Procedure to Estimate Number of Fires in a Given Service Area in Ozarks Study Region

Method One
Estimate based on population only

Population (607) ÷ FFC[1] for population (54) = Number: 11

Method Two
Estimate based on demographic characteristics — Number

1. Number of acres (1340) ÷ land area FFC (5,125) = 3
2. Number of registered vehicles (595) ÷ vehicle FFC (265) = 2
3. Number of businesses (12) ÷ businesses FFC (12) = 1
4. Number of residences (233) ÷ residence FFC (62) = 4
5. Population (607) ÷ other fires FFC (386) = 2
6. Estimated total number of fires (add 1 through 5) 12

[1]See explanation of fire frequency coefficients (FFC) on p. 8 Derivation of FFCs is in Table 6.

Cost Analysis

Once the service area is defined and the expected number and types of annual fires are determined, an examination of the costs of a fire protection system should be made by local decisionmakers. A capital costs form and an operating costs form have been developed for this purpose. Revenues to cover the costs of the system are also estimated.

Capital Costs. Capital costs are estimated through the use of Form 2. Two of these forms have been filled out for the hypothetical community, one for each of the two alternatives described above. In each case it is assumed that loans are obtained at 5 percent interest for both the vehicle and fire station. The communication system and protective gear are assumed to be financed by loans at 15 percent interest.

Using Form 2, annual capital costs of $10,914.12 are estimated for the first alternative which included a large pumper. When the second alternative was analyzed, including the renovated surplus pumper and a pickup with slip-in unit, annual capital costs are about $6,033.45. Since this alternative is the less costly, it will be used later in calculations of total annual costs.

Operating and Maintenance Costs. Annual operating costs must also be examined in the budgeting process. Form 3 has been developed to help in this step. For the system involving a renovated surplus truck, pickup with slip-in unit, CB communication system, one fire station, and a chief with 12 volunteer firefighters, annual operating costs, adjusted for inflation, are $21,045.52.

Total Annual Costs and Potential Revenues. Total annual costs, the sum of annual capital and operating expenses, for the hypothetical community are $27,078.97 (Form 4). If a charge is made per expected fire, cost per fire is estimated to be $2,256.58. If annual memberships are sold to at least 200 of the 245 residences and businesses, an annual membership fee of $135.39 would cover annual expenses. Other financing schemes in addition to these should be investigated by the community's leaders.

Training

Members of small town fire departments should receive high quality training in firefighting just as their counterparts in large, urban departments. Different agencies in almost all of the United States sponsor fire training programs: State fire marshal's offices, State firefighting associations, and so forth. In both Oklahoma and Missouri the State-level training is handled by separate departments at their respective State universities.

In Oklahoma, the Fire Service Training Department (FSTD) is a university extension service of the Division of Engineering, Technology, and Architecture at Oklahoma State University in Stillwater. The purpose of the program is to provide training and training programs for all firefighters in the State of Oklahoma. Assistance is also provided in the form of water supply surveys and fire station location analysis. Fire service training is available to assist the municipal and industrial departments of Oklahoma with any fire-related problems. Besides the basic training courses outlined in Table 11, classes at more advanced levels are available as well as classes to certify fire department instructors and to provide training in public fire education.

All volunteer and part-paid fire departments in Oklahoma without training officers are eligible for free training from FSTD. The staff are qualified to administer training programs in the field. Certified training officers from nearby communities may also be used.

In Missouri, the Fire Training Division, a part of the Institute of Public Safety, College of Public and Community Services, has functioned as an integral part of the University of Missouri's training and education program since 1947. The Division's responsibilities are diversified, encompassing every aspect of training fire department personnel and related emergency service individuals. The instruction takes place both on campus and in the field and deals with skills-

Form 2. Procedure to Estimate Annual Capital Costs

A. System description

1. Pumpers (number):
   - a. Large (1)
   - b. Standard (_____)
   - c. Grass and brush (_____)
   - d. Renovated surplus (_____)
   - e. Pickup and slip-in unit (_____)
2. Tankers (number):
   - a. 1,250-gallon (_____)
   - b. Renovated surplus (_____)
3. VHF Communication system (number):
   - a. Base unit(s) (1)
   - b. Remote console(s) (_____)
   - c. Mobile unit(s) (1)
   - d. Tower (1)
   - e. Antenna (1)
   - f. Transmission line, feet (25)
4. Protective gear (number):
   - a. Fire suits (12)
   - b. Breathing apparatus (2)
5. Fire station (square feet): (1800)

B. Depreciation and interest

	Cost[1]	Inflation factor[2]	Total capital cost	Amortization factor[3]	Annual cost
1. Vehicle(s)					
Large pumper	$ 56,900 ×	274.4 / 269.0	= $ 58,042.23 ×	0.0963 (15 years, 5 % interest)	= $ 5,589.47
_____	$ _____ ×	_____ / 269.0	= $ _____ ×	_____ (__ years, __% interest)	= $ _____
_____	$ _____ ×	_____ / 269.0	= $ _____ ×	_____ (__ years, __% interest)	= $ _____
Vehicle subtotal					$ 5,589.47
2. Communication system					
Base unit(s)	$ 4,200 ×	274.4 / 269.0	= $ 4,284.31 ×	0.1993 (10 years, 15 % interest)	= $ 853.86
Remote console(s)	$ _____ ×	_____ / 269.0	= $ _____ ×	_____ (__ years, __ % interest)	= $ _____
Mobile unit(s)	$ 2,060 ×	274.4 / 269.0	= $ 2,101.35 ×	0.1993 (10 years, 15 % interest)	= $ 418.80
Tower	$ 1,525 ×	274.4 / 269.0	= $ 1,555.61 ×	0.1993 (10 years, 15 % interest)	= $ 310.03
Antenna	$ 270 ×	274.4 / 269.0	= $ 275.42 ×	0.1993 (10 years, 15 % interest)	= $ 54.89
Transmission line	$ 71 ×	274.4 / 269.0	= $ 72.42 ×	0.1993 (10 years, 15 % interest)	= $ 14.43
Communication system subtotal					$ 1,652.01

Form 2. Procedure to Estimate Annual Capital Costs (Continued)

	Cost[1]	Inflation factor[2]	Total capital cost	Amortization factor[3]	Annual cost
3. Protective gear					
Fire suits	$ 2,520 ×	274.4 / 269.0 =	$ 2,570.59 ×	0.1993 (10 years, 5% interest) =	$ 512.32
Breathing apparatus	$ 1,590 ×	274.4 / 269.0 =	$ 1,621.92 ×	0.1993 (10 years, 5% interest) =	$ 323.25
Protective gear subtotal					$ 835.57
4. Fire stations					
Station One	$ 48,600 ×	153.7 / 153.5 =	$ 48,663.32 ×	0.0583 (10 years, 5% interest) =	$ 2,837.07
Station Two	$ ____ ×	____ / 153.5 =	$ ____ ×	____ (__ years, __% interest) =	$ ____
Fire station subtotal					$ 2,837.07
Total annual capital costs (add B-1, B-2, B-3 and B-4 subtotals)					$ 10,914.12

[1] For vehicle costs, see Tables 7 and 8. For communication system costs, see Table 9. For fire station costs, see page 18. Protective gear expenses are found on page 19

[2] To correct for changes in the price level, an "inflation factor" is used: for the fire station, the U.S. Department of Commerce's Composite Construction Cost Index; for other items, the Consumer Price Index-Urban Consumers. Values of these indices are available in the U.S. Department of Commerce's *Survey of Current Business*. (Construction Cost Index: 1977 = 100; CPI-U 1967 = 100)

[3] See Appendix A for these factors.

Form 2. Procedure to Estimate Annual Capital Costs

A. System description

1. Pumpers (number):
   - a. Large (_____)
   - b. Standard (_____)
   - c. Grass and brush (_____)
   - d. Renovated surplus (1)
   - e. Pickup and slip-in unit (1)
2. Tankers (number):
   - a. 1,250-gallon (_____)
   - b. Renovated surplus (_____)
3. CB Communication system (number):
   - a. Base unit(s) (1)
   - b. Remote console(s) (_____)
   - c. Mobile unit(s) (2)
   - d. Tower (_____)
   - e. Antenna (1)
   - f. Transmission line, feet (25)
4. Protective gear (number):
   - a. Fire suits (12)
   - b. Breathing apparatus (_____)
5. Fire station (square feet): (1800)

B. Depreciation and interest

	Cost[1]	Inflation factor[2]	Total capital cost	Amortization factor[3]	Annual cost
1. Vehicle(s)					
Renovated surplus pumper	$ 7,580	× 274.4 / 269.0 =	$ 7,732.16	× 0.09163 (15 years, 5 % interest) =	$ 744.61
Pickup & slip-in unit	$ 18,900	× 274.4 / 269.0 =	$ 19,279.40	× 0.09163 (15 years, 5 % interest) =	$ 1,856.61
_____	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __% interest) =	$ _____
Vehicle subtotal					$ 2,601.22
2. Communication system					
Base unit(s)	$ 120	× 274.4 / 269.0 =	$ 122.41	× 0.1993 (10 years, 15 % interest) =	$ 24.40
Remote console(s)	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __ % interest) =	$ _____
Mobile unit(s)	$ 200	× 274.4 / 269.0 =	$ 204.01	× 0.1993 (10 years, 15 % interest) =	$ 40.66
Tower	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __ % interest) =	$ _____
Antenna	$ 50	× 274.4 / 269.0 =	$ 51.00	× 0.1993 (10 years, 15 % interest) =	$ 10.16
Transmission line	$ 37.50	× 274.4 / 269.0 =	$ 38.25	× 0.1993 (10 years, 15 % interest) =	$ 7.62
Communication system subtotal					$ 82.84

Form 2. Procedure to Estimate Annual Capital Costs (Continued)

	Cost[1]	Inflation factor[2]	Total capital cost	Amortization factor[3]	Annual cost
3. Protective gear					
Fire suits	$ 2,520	× 274.4 / 269.0	= $ 2,570.59	× 0.1993 (10 years, 15% interest)	= $ 512.32
Breathing apparatus	$ _____	× _____ / 269.0	= $ _____	× _____ (__ years, __ % interest)	= $ _____
Protective gear subtotal					$ 512.32
4. Fire stations					
Station One	$ 48,600	× 153.7 / 153.5	= $ 48,663.32	× 0.0583 (40 years, 5% interest)	= $ 2,837.07
Station Two	$ _____	× _____ / 153.5	= $ _____	× _____ (__ years, __ % interest)	= $ _____
Fire station subtotal					$ 2837.07
Total annual capital costs (add B-1, B-2, B-3 and B-4 subtotals)					$ 6,033.45

[1] For vehicle costs, see Tables 7 and 8. For communication system costs, see Table 9. For fire station costs, see page **18**. Protective gear expenses are found on page **19**

[2] To correct for changes in the price level, an "inflation factor" is used: for the fire station, the U.S. Department of Commerce's Composite Construction Cost Index; for other items, the Consumer Price Index-Urban Consumers. Values of these indices are available in the U.S. Department of Commerce's *Survey of Current Business*. (Construction Cost Index: 1977 = 100; CPI-U 1967 = 100)

[3] See Appendix A for these factors.

Form 3. Procedure to Estimate Annual Operating and Maintenance Costs[1]

A. Fire station

Item			Annual cost
1. insurance	$2.40 $1,000 value × $ 48,600 value of building		= $ 116.64
2. water, sewer, trash			= $ 156.00
3. electricity: office area	$1.28 sq. ft. × 300 sq. ft.		= $ 384.00
vehicle storage area	$0.42 sq. ft. × 1,500 sq. ft.		= $ 630.00
4. maintenance			= $ 200.00
Fire station subtotal			$ 1,486.64

B. Vehicle(s)

Item			Annual cost
1. insurance	$ 40 $1.000 × $ 27,012 value		= $ 1,080.48
2. repairs	$ 535 vehicle × 2 vehicles		= $ 1,070.00
3. gasoline, oil, and tires			
a. vehicle 1	$0.39 mile × 60 miles[2]		= $ 23.40
b. vehicle 2	$0.22 mile × 60 miles[2]		= $ 13.20
c. vehicle 3	$ ___ mile × ___ miles[2]		= $ ___
d. vehicle 4	$ ___ mile × ___ miles[2]		= $ ___
4. miscellaneous	$ 1131 vehicle × 2 vehicles		= $ 2,262.00
Vehicle(s) subtotal			$ 4,449.08

C. Communication system

Item		Annual cost
1. Base unit(s)	$ 35 unit × 1 units	= $ 35.00
2. Mobile unit(s)	$ 35 unit × 2 units	= $ 70.00
Communication system subtotal		$ 105.00

Form 3. Procedure to Estimate Annual Operating and Maintenance Costs[1] (Continued)

D. Labor

Item		Annual cost
1. Paid personnel		
a. chief	=	$ 11,784.00
b. assistant chief	=	$
c. firefighter: beginning	=	$
after probation	=	$
2. Volunteers		
a. meetings $ 6 person × 12 persons × 12 months	=	$ 864.00
b. fire calls $ 5 fire × 12 fires × 4 persons	=	$ 240.00
Labor subtotal		$ 12,888.00

E. Unadjusted total annual operating expenses

(Add subtotals for A, B, C, and D) $ 18,928.72

F. Cost adjustment factor if current costs are not available[3]

$$\frac{\text{Current consumer price index}}{\text{1980 consumer price index}} = \frac{274.4}{246.8} = 1.11183$$

G. Adjusted total annual operating expenses

(E times F) $ 21,045.52

[1]Use local cost information or costs shown in Table 10 when local data are not available.

[2]Mileage is based on average distance traveled per fire call for the given service area. This distance will change as the fire service area changes.

[3]Current values of the Consumer Price Index—All Urban Consumers (CPI-U) are reported monthly in the U.S. Department of Labor's *Monthly Labor Review* and the U.S. Department of Commerce's *Survey of Current Business*. (For CPI-U: 1967 = 100)

Form 4.: Procedure to Estimate Total Annual Costs, Costs Per Fire, and Costs Per Membership[1]

A. Total annual cost estimation

1. Total annual capital costs (Form 2) $ 6,033.45
2. Total annual operating expenses (Form 3) $ 21,045.52
3. Total annual costs (add A.1 and A.2) $ 27,078.97

B. Estimated cost per fire

1. Total annual costs (A.3 above) $ 27,078.97
2. Expected annual fires (Form 1) 12
3. Cost per fire (B.1 ÷ B.2) $ 2,256.58 /fire

C. Estimated cost per membership

1. Total annual costs (A.3 above) $ 27,078.97
2. Total memberships sold 200
3. Cost per membership (C.1 ÷ C.2) $ 135.39 /membership

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[1]Other methods of financing should be investigated by local decisionmakers before the plans for a fire protection service are finalized.

oriented activities such as pump operations, ladder procedures, hose practices, fire streams, hydraulics, and other fire service activities as well as management skills such as instructor development and fire service management. A list of courses of this Division is presented in Table 12.

It should be realized that a State program may not provide all the training that a local department might need. Individual department training activities should be planned to augment any training received from a State program.

State and Federal Regulations

There are few enforceable rules and regulations applying to fire protection services. Some states have established guidelines for the management and organization of fire departments. Others may have laws regarding the establishment of pension funds for State firefighters. State laws and guidelines should be investigated by communities seeking to establish fire departments.

In Oklahoma, minimum rules and regulations for volunteer fire departments are outlined in the State Statutes (15). The duties of the chief, assistant chief, and other members are presented as well as some bylaws that should be included in a new department's rules.

Table 11. Fire Service Training Courses Available in Oklahoma[1]

Course	Time	Description
	Hours	
Forcible entry	3.5	Demonstrates the use of forcible entry tools.
Protective breathing apparatus	3.5	Demonstrates the use of protective breathing apparatus.
First aid	3.5	Identifies life-threatening injuries and demonstrates appropriate procedures for each situation.
Ropes	3.5	Demonstrates use, inspection, and maintenance of ropes.
Salvage	3.5	Describes salvage operations.
Fire hose, nozzles, appliances and fire streams	7.0	Demonstrates equipment.
Ladders	3.5	Demonstrates ladder use including methods of working with tools and appliances from ladders.
Ventilation	1.5	Identifies the advantages and effects of ventilation and demonstrates its use in firefighting.
Inspection	unsp.[2]	Demonstrates fire inspection procedures.
Rescue	unsp.	Demonstrates removal of injured persons, search for victims.
Sprinklers	unsp.	Demonstrates sprinkler systems.
Fire alarm and communication	unsp.	Explains fire alarm signals governing the movements of fire apparatus.
Safety	2	Demonstrates the use of safety equipment in various emergency situations.
Fire behavior	1.5	Describes fire behavior.

[1]This training is provided through the Fire Service Training Department of the Division of Engineering, Technology, and Architecture at Oklahoma State University. It is in compliance with NFPA Standard 1001, Firefighter Level I.
[2]Unsp. = unspecified.

The Oklahoma Firemen's Relief and Pension Fund (FRPF) was established in 1909. Under State law, there is appropriated for the use of the FRPF a percentage of all premiums collected by all fire insurance companies in the State, after all cancellations and dividends to policyholders and other credits are deducted (16). The Insurance Commissioner then certifies the exact amount each qualified municipality shall be entitled to receive on the basis of need.[11] Portions of paid

[11]Even municipalities of less than 1,000 population may qualify and receive funds if the town has a fire apparatus of value not less than $1,000.

Table 12. Primary Fire Protection Courses Available in Missouri[1]

Course title[2]	Hours of study
Principles of firefighting I	12
Principles of firefighting II	12
Rope/rescue	12
Inspection practices	12
Sprinklers	12
Salvage/overhaul	12
Hose practices	12
Fire streams	12
Extinguishers	12
Fire prevention and public fire education	12
Indoctrination/fire behavior/communication	12
Natural cover firefighting	12
Forcible entry/ventilation	12
Ground ladder practices	12
Aerial apparatus practices	12
Fire ground tactics and strategy	12
Protective breathing apparatus	12
Vehicle extrication	12
Pesticide fire safety	12
Essentials of firefighting	12
Fire service first aid	12
Fire department management	12
Arson investigation	12
Liquified petroleum gas firefighting	12
Portable fire extinguishers	12
Certified firefighter I	132
Certified fire department instructor I	45

[1]This training is provided through the Fire Training Division of the Institute of Public Safety, College of Public and Community Services, University of Missouri. These courses are taught in volunteer as well as paid departments.

[2]Complete course descriptions and a list of audiovisual materials are available in the catalog: "Missouri State Fire Prevention, Public Education, and Training Resource Catalog and Fire Training Classes."

firefighters' salaries and funds from the municipality are also set aside for FRPF use. A copy of Oklahoma's laws pertaining to its pension fund is available from the Oklahoma State Firefighters Association. These should be reviewed carefully by concerned communities.

Each State has an insurance service office which establishes the fire insurance classifications for all municipalities and fire protection districts in that State. These classifications are assigned based on a community's fire defenses and local conditions. (See Appendix C for a description of the most recent guidelines.) A low rating implies lower fire insurance premiums. Therefore, knowledge of the rating system may prove valuable in establishing a new fire department. Contact the State insurance service office before planning is very advanced.

A Federal regulation that pertains to public agencies employing 5 or more persons in fire protection activities dictates the maximum number of hours an employee may work consecutively before receiving overtime pay. This is part of the Fair Labor Standards Act. As most recently amended, it states that employees must receive overtime pay for tours of duty in excess of 216 hours[12] in a work period of 28 consecutive days. In the case of an employee for whom a work period of at least 7 but less than 28 days applies, overtime pay is received for tours of duty in the same ratio as 216 hours to 28 days (19). More details of the law may be obtained from a district attorney.

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(6) Executive Office of the President, Office of Management and Budget. *Catalog of Federal Domestic Assistance*. Washington, D.C.: U.S. Government Printing Office, September 1980.

(7) Insurance Services Office. *Fire Suppression Rating Schedule*. New York: Insurance Services Office, June 1980.

(8) International Fire Service Training Association, *Firefighter Safety*. IFSTA 209, 1979.

(9) Karter, Michael J., Jr. "Fire Loss in the United States During 1979," *Fire Journal*, Vol. 74, No. 5 (September 1980), 52-65.

(10) National Commission on Fire Prevention and Control. *America Burning*. Washington, D.C.: U.S. Government Printing Office, May 1973.

(11) National Fire Protection Association. *Automotive Fire Apparatus, 1979*. NFPA No. 1901, 1979.

(12) _____. *Fire Apparatus Maintenance*. NFPA, 1966.

(13) _____. *Telecommunication Systems: Principles and Practices for Rural and Forestry Fire Services*. NFPA No. NSP-41, 1975.

(14) Penland, Douglas, and others. "Planning a Rural Fire Truck." OSU Extension Facts No. 841, Cooperative Extension Service, Division of Agriculture, Oklahoma State University.

[12] . . . "or an average number of hours determined by the Secretary pursuant to section 6(c)(3) of the Fair Labor Standards Amendments of 1974" (19).

(15) State of Oklahoma. *Oklahoma State Statutes.* Title 11, Section 29: "Fire Departments." 1971.

(16) _____. *Oklahoma State Statutes.* Title 11, Section 49: "Firemen's Relief and Pension Fund." 1971.

(17) _____. *Oklahoma State Statutes.* Title 19, Section 301: "Authority to Provide Fire-fighting Service in County—Equipment—Fire Stations and Personnel." 1971.

(18) _____. *Oklahoma State Statues.* Title 19, Section 901: "Steps in the Formation of a Fire Protection District." 1971.

(19) 29 USC 207(k) (1978 suppl).

(20) U.S. Department of Agriculture, Forest Service, Forest Fire Management. *Guide for Design of a Ground Tanker for Rural Fire Protection.* Atlanta, Georgia: Southeastern Area State and Private Forestry, 1975.

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Appendix A

Amortization factors

Interest rate	Years for repayment						
	10	15	20	25	30	35	40
Percent	Factor						
5	0.1295	0.0963	0.0802	0.0710	0.0651	0.0611	0.0583
6	.1359	.1030	.0872	.0782	.0726	.0690	.0665
7	.1424	.1098	.0944	.0858	.0806	.0772	.0750
8	.1490	.1168	.1019	.0937	.0888	.0858	.0839
9	.1558	.1241	.1095	.1018	.0973	.0946	.0930
10	.1628	.1315	.1175	.1102	.1061	.1037	.1023
11	.1698	.1391	.1256	.1187	.1150	.1129	.1117
12	.1770	.1468	.1339	.1275	.1241	.1223	.1213
13	.1843	.1547	.1424	.1364	.1334	.1318	.1310
14	.1917	.1628	.1510	.1455	.1428	.1414	.1407
15	.1993	.1710	.1598	.1547	.1523	.1511	.1506

Appendix B

Range of Estimated Fire Frequency Coefficients Estimated for Selected Oklahoma and Missouri Ozarks Counties, 1979[1]

Fire frequency coefficient	Range of estimate[2]		
	Low	Middle	High
Population	49	54	59
Acres	4,471	5,125	6,002
Registered vehicles	236	265	301
Business establishments	11	12	14
Residential units	56	62	69
"Other"[3]	337	386	452

[1]Tulsa County, Oklahoma, and Greene County, Missouri, have been omitted from this analysis.
[2]Based on 95-percent confidence intervals (3, 25).
[3]See Table 4 for definition of "other" fires.

Appendix C: ISO Grading

The Fire Suppression Rating Schedule of the Insurance Services Office (ISO) reviews for fire insurance rating purposes the major elements of a city's fire suppression system — the fire department, water supply, and telephone facilities for handling fire alarms. From this review, a "public protection classification number" on a relative schedule from one to ten, with ten representing less than the minimum recognized protection, is developed for the city, town, village, district, county, or other civil jurisdiction.

The public protection classifications developed by this schedule are only one of several elements used to develop fire insurance rates for individual properties. Other features specifically relating to individual properties such as construction, occupancy, processing hazards, exposures, and private fire protection have similar importance in the development of fire insurance rates. As stated in the Schedule (7, p. 1):

> This is a fire insurance rating tool, and is not intended to analyze all aspects of a comprehensive public fire protection program. It should not be used for purposes other than insurance rating.

To obtain a rating other than a ten, ISO has specified minimum standards in the areas of fire department organization, membership and training, alarm notification, and apparatus and its housing. Each is described briefly below:

(1) organization — on a permanent basis under applicable State or local laws with one person responsible for operation of the department (usually called the chief); the department must serve an area with definite boundaries;

(2) membership — sufficient to assure the response of at least four members to fires in structures (one may be the chief);

(3) training — conducted at least 2 hours every 2 months;

(4) alarm notification — alarm facilities and arrangement shall be such that there is no delay in the receipt of alarms and the dispatch of fire fighters and apparatus;
(5) apparatus — there shall be at least one piece of apparatus meeting the general criteria of National Fire Protection Association (NFPA) Standard 1901, "Automotive Fire Apparatus;" and
(6) housing — apparatus shall be housed to provide protection from the weather.

Even when these standards are met, a rating above a ten is not automatic.

For a Class 9 rating, in addition to the minimum standards listed above, the Schedule specifically states that the fire department shall have at least one piece of apparatus with a permanently-mounted pump capable of delivering 50 gallons per minute or more at 150 pounds per square inch, and a water tank with at least a 300-gallon capacity. Items necessary for this rating are summarized in Table 13.

Table 13. Criteria, Specifications, and Tools for Establishing Class 9 Protection

Item	Description
Apparatus	At least one piece of apparatus meeting the general criteria of NFPA 1901 (11)[1]
Records	Indicate date, time and location of fires, the number of responding members, meetings, training sessions, and maintenance of apparatus and equipment.[2]
Equipment	2 150-foot lengths of ¾- or 1-inch booster hose, 1½-inch preconnected hose, or the equivalent, each length with a nozzle
	2 portable fire extinguishers suitable for use on Class A, B, and C fires
	1 12-foot ladder with folding hooks
	1 24-foot extension ladder
	1 pick-head axe
	2 electric hand lights
	1 pike pole
	1 bolt cutter
	1 claw tool
	1 crowbar

[1]The apparatus should have a permanently-mounted pump capable of delivering 50 gallons of water per minute or more at 150 pounds per square inch pressure, and a water tank with at least 300-gallon capacity.
[2]An up-to-date roster of fire department members should be kept.

Source: (7)

Table 14. Items Reviewed for Development of Public Protection Classifications,[1] by Feature

Feature	Items
Receiving and handling fire alarms	Telephone lines Telephone directory Recording device Operators Dispatch circuits
Fire department	Needed and existing engine companies Equipment on existing engine companies Needed and existing reserve pumpers Pump capacity Needed and existing ladder companies Ladder company equipment Service company equipment Automatic—aid Existing company personnel Training
Water supply	Supplies works: minimum storage, pumps, filters, emergency supply, suction supply, fire department supply Supply works capacity Main capacity Hydrant distribution, size, type, installation Inspection and condition of hydrants

[1]The public protection classification number summarizes the credits given for each of the three features reviewed. Contact your State Insurance Services Office to schedule a review to determine the number appropriate for your community.

Source: (7)

Each item listed is important. The specific size and nomenclature of each individual subitem, however, may be subject to local conditions in the city graded. Equipment having other names, or different dimensions, than indicated in the apparatus specifications shall be credited as a proportional equivalent to the required equipment according to its ability to perform similar fire ground jobs.

For communities wishing to receive a rating above 9, many additional items are reviewed. Besides developing a "needed fire flow" for selected locations in a community, the community's communication system, fire department, and water supply are inspected. Particular aspects of each of these items to be reviewed are summarized in Table 14.

Appendix D

Suggested Specifications for Fire Apparatus

The National Fire Protection Association (NFPA) provides basic technical descriptions of fire apparatus (11). These may be used as guidelines for the purchase of new equipment by a fire department. Competent advice should also be obtained from knowledgeable and informed sources. The fire insurance rating authority in the State should be consulted before a purchase is made.

Specifications listed here are brief and may not be completely applicable to a specific community's needs. Consult the NFPA standards for more details (11).

Large Pumpers

1. pump:
   a. capacity greater than 500 gpm, specified by purchaser (from draft through 20 feet of suction hose with strainer attached shall have a pumping capacity of 150 psi net pump pressure)
   b. centrifugal type constructed of cast iron with stainless steel shaft and bronze impellers and other trim
   c. single-stage; multi-stage, series only; or multi-stage, series/parallel
   d. power to drive the pump shall be provided by the same engine that propels the apparatus
   e. located near the middle of the chassis ("mid-ship mounted") — purchaser may specify a different location (e.g., front-mounted)
2. pump connections:
   a. one outlet provided for each 250 gpm of rated capacity equipped with 2½-inch male National Standard threads
   b. two suction inlets of the same size as the suction hose
   c. where a water tank is installed, it shall be connected to the suction side of the pump with a valve controllable at the pump operator's position
3. hose:
   a. hard suction, 20 feet minimum
   b. 1½-inch, 400 feet
   c. 2½-inch, 1,500 feet
   d. booster hose reel for 200 feet of 1-inch booster hose
4. tank:
   a. constructed of noncorrosive material or steel suitably protected against corrosion and deterioration; readily accessible cleanout holes or other means to permit complete cleaning
   b. constructed to be independent of the body and equipped with suitable method for removal from body (for tanks less than 1,500-gallon capacity)
   c. sufficient swash partitions shall be built in so that the maximum dimension of any spaces in the tank shall be greater than 23 inches but less than 46 inches

d. a capped fill opening of 5-inch diameter with screen shall be provided; an overflow outlet is necessary
e. minimum capacity is 300 gallon

5. basic equipment[1]:
   a. ladders — 14-foot metal with folding hooks; 24-foot extension
   b. 2 axes, 1 pick-head and 1 flat-head type
   c. 2 electric handlights
   d. 2 approved portable fire extinguishers (20 BC rating in dry chemicals, 10 BC rating in CO_2, or 2 A rating in water-type)
   e. 1 pike pole or plaster hook (6-foot minimum)
   f. suction hose
   g. swivel connections
   h. 200 feet of 1-inch booster hose
   i. 1 1-inch booster hose shutoff nozzle

Standard Pumpers

1. pump:
   a. permanently mounted "booster pump" (rated capacity less than 500 gpm) capable of delivering rated capacity when taking suction from the water tank
   b. under special provisions this pump may be required to deliver rated capacity from draft (stipulate maximum lift, suction hose size, and maximum altitude of use)
   c. centrifugal type, constructed of cast iron with stainless steel shaft and bronze impeller(s) and other trim
   d. under special provisions the pump may be capable of being operated while the vehicle is moving under power
2. pump connections:
   a. suction inlets commensurate with the specified pump capacity
   b. discharge outlets shall have National Standard fire hose coupling threads and be equipped with a valve which can be operated smoothly and readily under all rated pressures
3. hose:
   a. suction hose as specified under special provisions
   b. booster hose
4. tank (see section under larger capacity pumpers)
5. basic equipment:
   a. 1 pick-head axe
   b. 1 electric handlight
   c. 1 approved portable fire extinguisher, Class ABC, 10 pound or equal rating
   d. 1 pike pole or plaster hook (6-foot minimum)
   e. 2 self-contained breathing apparatus, 30-minute rated

[1]"It is not the intent ... to dictate mandatory equipment as to absolute types, numbers ... It is expected that the requirements of service in different communities will necessitate variations from the equipment listed." (11, p.85). Other equipment is listed as "recommended." Please consult the NFPA standards (11).

Grass and Brush Pumper

1. pump:
   a. capacity of 225 gpm at 50 psi; 100 gpm at 150 psi
   b. centrifugal type constructed of cast iron with hard bronze parts
   c. power to drive the pump shall be provided by the same engine that propels the apparatus
2. pump connections:
   a. two 2½-inch suction line from tank to pump
   b. one 1½-inch discharge line with ball valve
   c. one 1-inch discharge line from pump to tank for recirculating
3. hose:
   a. two lengths of 1-inch booster, 150 feet and 15 feet
   b. booster hose reel for 200 feet of 1-inch booster hose
4. tank:
   a. constructed of noncorrosive material with dimensions allowing it to fit into truck bed
   b. capacity will vary with GVW of vehicle used
5. basic equipment:
   a. two 1-inch nozzles
   b. one 10-pound ABC fire extinguisher, CO_2 operated
   c. one pickup nozzle and tube for foam
   d. one 36-inch crowbar
   e. one shovel
   f. two self-contained breathing apparatus, 30-minute rated

Tankers

1. pump:
   a. may be larger than 500 gpm capacity (see appropriate section above)
   b. may be a "booster pump" (see appropriate section above)
   c. may be a portable pump (installed with flexible, semi-permanent connections properly valved so they may be quickly disconnected to permit easy removal of the portable pump)
2. hose:
   a. 2½-inch double jacket, rubber lined, 400 feet
   b. 1½-inch double jacket, rubber lined, 400 feet (or 1-inch booster hose, 400 feet)
3. tank:
   a. less than 4,800-gallon capacity with 2½-inch or larger gated connection for filling and emptying the tank in addition to a 5-inch or larger diameter capped fill opening
   b. if pump capacity is less than 500 gpm, a 4-inch or larger dump valve connection shall be installed in a convenient location (if tank capacity is 2,000 gallons or larger, two dump valve connections are required, one at each end of the tank)
   c. a water level gauge shall be provided

4. basic equipment:
   a. ladder, 16-foot extension
   b. 2 axes, 1 pick-head and 1 flat-head
   c. 2 electric handlights
   d. 2 approved portable fire extinguishers
   e. 1 pike pole (6-foot minimum)
   f. 30 feet of smooth-bore suction hose
   g. strainer for suction hose
   h. 2½-inch double-jacket, rubber lined hose, 400 feet
   i. 1½-inch double-jacket, rubber lined hose, 400 feet
   j. 2 1½-inch shutoff nozzles, spray or straight stream

Renovated Surplus Pumper

1. pump:
   a. independently-powered, four-cycle, gasoline fueled
   b. centrifugal type with exhaust/electric primer
   c. capacity 100 gpm at 250 psi or 250 gpm at 150 psi
2. chassis — 6x6 military vehicle
3. tank:
   a. 1,000-gallon capacity (maximum)
   b. rectangular shape of fiberglass, aluminum, or mild steel, properly baffled
   c. 2½-inch pump intake with adapter to 1- or 1½-inch
4. hose:
   a. 1-inch booster, 150 feet
   b. 1½-inch, 200 feet
5. basic equipment:
   a. 2 electric handlights
   b. 1 axe
   c. 1 36-inch crowbar
   d. ladder, 14-foot or 24-foot extension
   e. 2 self-contained breathing apparatus, 30-minute

Renovated Tanker

1. pump (see section under renovated surplus pumper)
2. chassis — 6x6 military vehicle
3. tank (see section under renovated surplus pumper)
4. hose — 2½-inch suction hose, 30 feet, and strainer
5. basic equipment:
   a. folding tank, 1,000 gallon capacity
   b. 2 electric handlights
   c. 2 axes, 1 pick-head and 1 flat-head
   d. 1 36-inch crowbar
   e. 1 pike pole

Appendix E: Blank Forms

Form 1. Procedure to Estimate Number of Fires in a Given Service Area in Ozarks Study Region

Method One
Estimate based on population only

Number

Population (_____) ÷ FFC[1] for population (_____) = _____

Method Two
Estimate based on demographic characteristics Number

1. Number of acres (_____) ÷ land area FFC (_____) = _____
2. Number of registered vehicles (_____) ÷ vehicle FFC (_____) = _____
3. Number of businesses (_____) ÷ businesses FFC (_____) = _____
4. Number of residences (_____)÷ residence FFC (_____) = _____
5. Population (_____) ÷ other fires FFC (_____) = _____
6. Estimated total number of fires (add 1 through 5) _____

[1]See explanation of fire frequency coefficients (FFC) on p. **8** Derivation of FFCs is in Table 6.

Form 2. Procedure to Estimate Annual Capital Costs

A. System description

1. Pumpers (number):
   - a. Large (_____)
   - b. Standard (_____)
   - c. Grass and brush (_____)
   - d. Renovated surplus (_____)
   - e. Pickup and slip-in unit (_____)
2. Tankers (number):
   - a. 1,250-gallon (_____)
   - b. Renovated surplus (_____)
3. _____ Communication system (number):
   - a. Base unit(s) (_____)
   - b. Remote console(s) (_____)
   - c. Mobile unit(s) (_____)
   - d. Tower (_____)
   - e. Antenna (_____)
   - f. Transmission line, feet (_____)
4. Protective gear (number):
   - a. Fire suits (_____)
   - b. Breathing apparatus (_____)
5. Fire station (square feet): (_____)

B. Depreciation and interest

	Cost[1]	Inflation factor[2]	Total capital cost	Amortization factor[3]	Annual cost
1. Vehicle(s)					
_____	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __% interest) =	$ _____
_____	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __% interest) =	$ _____
_____	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __% interest) =	$ _____
Vehicle subtotal					$ _____
2. Communication system					
Base unit(s)	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __ % interest) =	$ _____
Remote console(s)	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __ % interest) =	$ _____
Mobile unit(s)	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __ % interest) =	$ _____
Tower	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __ % interest) =	$ _____
Antenna	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __ % interest) =	$ _____
Transmission line	$ _____	× _____ / 269.0 =	$ _____	× _____ (__ years, __ % interest) =	$ _____
Communication system subtotal					$ _____

Form 2. Procedure to Estimate Annual Capital Costs (Continued)

	Cost[1]	Inflation factor[2]	Total capital cost	Amortization factor[3]	Annual cost
3. Protective gear					
Fire suits	$ _____	× _____ / 269.0	= $ _____	× _____ (__ years, __ % interest)	= $ _____
Breathing apparatus	$ _____	× _____ / 269.0	= $ _____	× _____ (__ years, __ % interest)	= $ _____
Protective gear subtotal					$ _____
4. Fire stations					
Station One	$ _____	× _____ / 153.5	= $ _____	× _____ (__ years, __ % interest)	= $ _____
Station Two	$ _____	× _____ / 153.5	= $ _____	× _____ (__ years, __ % interest)	= $ _____
Fire station subtotal					$ _____
Total annual capital costs (add B-1, B-2, B-3 and B-4 subtotals)					$ _____

[1] For vehicle costs, see Tables 7 and 8. For communication system costs, see Table 9. For fire station costs, see page 18. Protective gear expenses are found on page 19

[2] To correct for changes in the price level, an "inflation factor" is used: for the fire station, the U.S. Department of Commerce's Composite Construction Cost Index; for other items, the Consumer Price Index-Urban Consumers. Values of these indices are available in the U.S. Department of Commerce's *Survey of Current Business*. (Construction Cost Index: 1977 = 100; CPI-U 1967 = 100)

[3] See Appendix A for these factors.

Form 3. Procedure to Estimate Annual Operating and Maintenance Costs[1]

A. Fire station

Item		Annual cost
1. insurance	$___/$1,000 value × $ ___ value of building	= $ _____
2. water, sewer, trash		= $ _____
3. electricity: office area	$ ___/sq. ft. × ___ sq. ft.	= $ _____
vehicle storage area	$ ___/sq. ft. × ___ sq. ft.	= $ _____
4. maintenance		= $ _____
Fire station subtotal		$ _____

B. Vehicle(s)

Item		Annual cost
1. insurance	$ ___/$1,000 × $ ___ value	= $ _____
2. repairs	$ ___/vehicle × ___ vehicles	= $ _____
3. gasoline, oil, and tires		
a. vehicle 1	$ ___/mile × ___ miles[2]	= $ _____
b. vehicle 2	$ ___/mile × ___ miles[2]	= $ _____
c. vehicle 3	$ ___/mile × ___ miles[2]	= $ _____
d. vehicle 4	$ ___/mile × ___ miles[2]	= $ _____
4. miscellaneous	$ ___/vehicle × ___ vehicles	= $ _____
Vehicle(s) subtotal		$ _____

C. Communication system

Item		Annual cost
1. Base unit(s)	$ ___/unit × ___ units	= $ _____
2. Mobile unit(s)	$ ___/unit × ___ units	= $ _____
Communication system subtotal		$ _____

Form 3. Procedure to Estimate Annual Operating and Maintenance Costs[1] (Continued)

D. Labor

Item	Annual cost
1. Paid personnel	
a. chief	= $ _____
b. assistant chief	= $ _____
c. firefighter: beginning	= $ _____
after probation	= $ _____
2. Volunteers	
a. meetings $___/person × ___ persons × 12 months	= $ _____
b. fire calls $___/fire × ___ fires × ___ persons	= $ _____
Labor subtotal	$ _____

E. Unadjusted total annual operating expenses

(Add subtotals for A, B, C, and D) $ _____

F. Cost adjustment factor if current costs are not available[3]

$$\frac{\text{Current consumer price index}}{\text{1980 consumer price index}} = \frac{\qquad}{246.8} = \_\_\_\_\_$$

G. Adjusted total annual operating expenses

(E times F) $ _____

[1]Use local cost information or costs shown in Table 10 when local data are not available.
[2]Mileage is based on average distance traveled per fire call for the given service area. This distance will change as the fire service area changes.
[3]Current values of the Consumer Price Index—All Urban Consumers (CPI-U) are reported monthly in the U.S. Department of Labor's *Monthly Labor Review* and the U.S. Department of Commerce's *Survey of Current Business.* (For CPI-U; 1967 = 100)

Form 4.: Procedure to Estimate Total Annual Costs, Costs Per Fire, and Costs Per Membership[1]

A. Total annual cost estimation

1. Total annual capital costs (Form 2) $ _____
2. Total annual operating expenses (Form 3) $ _____
3. Total annual costs (add A.1 and A.2) $ _____

B. Estimated cost per fire

1. Total annual costs (A.3 above) $ _____
2. Expected annual fires (Form 1) _____
3. Cost per fire (B.1 ÷ B.2) $ _____/fire

C. Estimated cost per membership

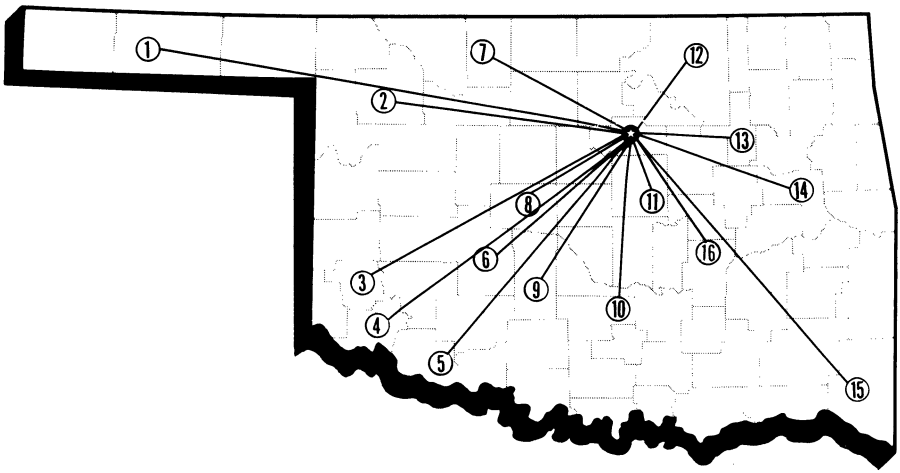
1. Total annual costs (A.3 above) $ _____
2. Total memberships sold _____
3. Cost per membership (C.1 ÷ C.2) $ _____/membership

[1]Other methods of financing should be investigated by local decisionmakers before the plans for a fire protection service are finalized.

OKLAHOMA

Agricultural Experiment Station

System Covers the State



Main Station — *Stillwater, Perkins and Lake Carl Blackwell*

1. **Panhandle Research Station — *Goodwell***
2. **Southern Great Plains Field Station — *Woodward***
3. **Sandyland Research Station — *Mangum***
4. **Irrigation Research Station — *Altus***
5. **Southwest Agronomy Research Station — *Tipton***
6. **Caddo Research Station — *Ft. Cobb***
7. **North Central Research Station — *Lahoma***
8. **Southwestern Livestock and Forage Research Station — *El Reno***
9. **South Central Research Station — *Chickasha***
10. **Agronomy Research Station — *Stratford***
11. **Pecan Research Station — *Sparks***
12. **Veterinary Research Station — *Pawhuska***
13. **Vegetable Research Station — *Bixby***
14. **Eastern Research Station — *Haskell***
15. **Kiamichi Field Station — *Idabel***
16. **Sarkeys Research and Demonstration Project — *Lamar***