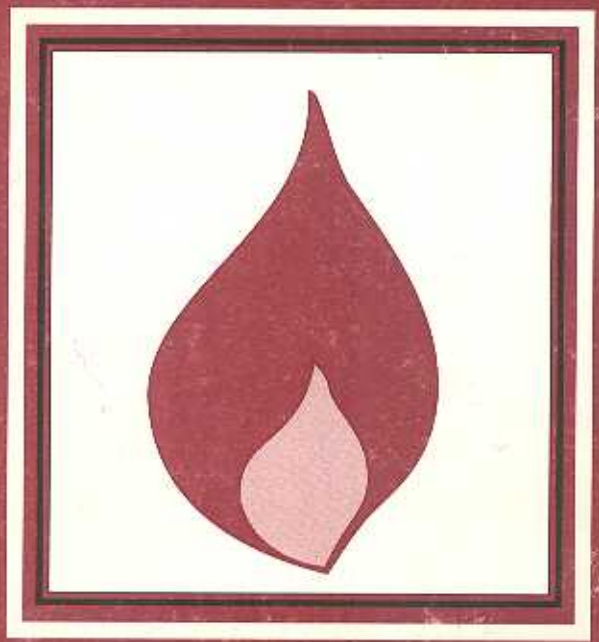
ARISTOTLE UNIVERSITY - THESSALONIKI
MINISTRY OF THE ENVIROMENT - GREECE



# 1996 INTERNATIONAL FIRE SAFETY CONFERENCE

24 - 25 May 1996 - Santorini - GREECE

## PROCEEDINGS

Organized by
Department of Civil Engineering
ARISTOTLE UNIVERSITY
Thessaloniki - GREECE

# WILDLAND FIRE SAFETY IN RESIDENTIAL AREAS

**Dr. Kostas D. Kalabokidis**

*Forest Fire Laboratory, Forest Research Institute, 57006 Vasilika-Thessaloniki, Greece*

*Tel. (3 031) 461-173; Fax (3 031) 461-341; E-mail kalabokidis@olymp.ccf.auth.gr*

**ABSTRACT.** Homes and other buildings in wildland settings (the so-called urban/wildland interface) are susceptible to increased fire hazards. Catastrophic wildfires in Australia, southern Europe, and western United States of America have illustrated forces of tremendous severity and complexity in the wildland-urban interface due to ecological and societal reasons. Urban spread into traditional wildland areas complicates fire safety problems but does not negate effective solutions. Proper infra-structural design, construction, and landscaping hold the most promise for controlling wildfire activity and damage yet maintain natural appearances. Vegetation management (e.g., thinnings or clearings for adequate defensible space around and within structures) based on potential fire behavior criteria, firesafe building construction features, adequate water and road systems for fire protection, and technocratic land-use planning and zoning are the key measures that need to be implemented. Homeowners should become aware that complete fire-proofing is not possible and residential developments are built at owners' risk in wildland surroundings; nevertheless, the above fire safety measures provide possibilities for proactively reducing fire hazards and protecting life and property. Procedures discussed aid in development of presuppression planning that will ensure public safety, maintain natural resources physically and aesthetically intact, and yet allow people to live in natural environments.

## INTRODUCTION

Fire safety and protection have nowadays become essential with adverse physical phenomena, increased fire risks, and unique resource values in wildland

ecosystems located adjacent to residential areas (the so-called wildland-urban interface). Fire managers often seek alternatives for reducing wildfire hazards within the urban interface, but there seems to be a lack of knowledge and certain amount of improvisation when it comes to application of actual safety measures.

Every year, forest and rangeland fires threaten hundreds of homes and other structures worldwide and some of these wildfires are responsible for the loss of invaluable human life and property. The problem is epitomized in certain parts of the world with ecological and societal conditions prone to catastrophic fire outbreaks (e.g., Australia, southern Europe, and western United States). Conditions favorably contributing to increased fire hazards are:

- the urban spread into traditional wildland areas of highly flammable vegetation and/or mountainous topography
- large population density and high land demand/pressure that unwittingly (either accidentally or criminally) may cause ignitions, and
- certain fire-prone climatic regimes and/or anomalies (e.g., Mediterranean-type of climate).

The purpose of this paper is to summarize state-of-the-art on safety measures for protecting people and homes from wildland fires, and to provide standards to meet that responsibility in a technocratic manner. The report consists of 4 parts that synthesize the fire safety problem and its effective solutions (vegetation management, infra-structural design, water and road systems, planning and zoning) and provides recommendations to assist all parties involved in wildland-urban interface fire protection.

## VEGETATION MANAGEMENT

Inasmuch as wildland fire potential is a product of weather, topography, and vegetation, there is little that can be done to preempt wildfire activity by modifying either weather or topography. However, potential exists to modify the vegetation in such a way as to eliminate or reduce fire outbreaks and impacts. Vegetation management is applied around and within residential areas to create fire safe zones,

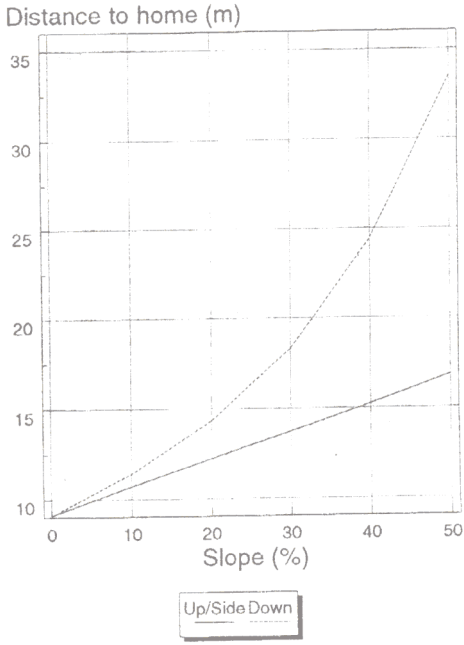



**Figure 1.** Fire-defensible space dimensions on the downhill side (Down), uphill (Up) and to the sides (Side) of homes for specific topographic slopes.

where homes can be defended from wildfires. The size of this defensible space for suppression efforts is dependent upon the structure position on the ground (Fig. 1).

Alternative vegetation management practices within the defensible-space areas change the kind, amount, and arrangement of wildland fire fuels by (Fig. 2):

- clearing flammable vegetation (e.g., grassy fuels, shrubs, small conifer trees, and eucalyptus trees) for some distance in all directions from the structure;
- thinning larger trees to prevent crowns from spreading the fire laterally from one crown to the other;
- pruning tree branches far enough from the ground to reduce the probability of surface fires spreading into the crowns;
- removing dead woody debris from standing or downed trees (including firewood) to a location safely away from the house;
- maintaining a green belt (e.g., watered lawns) and/or rock gardens for a space around the house.

- Thin & prune trees
- Mow grass & remove brush
- Plant & maintain a green belt or lawn around the house

BEFORE

- Move firewood from house
- Clean leaves from roof & rain gutter
- Screen chimneys & incinerators

AFTER

**Figure 2.** Vegetation hazard reduction around the structure.

The above safety measures should be based on fire behavior criteria that ensure reduction of fire incidence (ignition), fire intensity (resource and property damage), and fire spread (resistance-to-control). Figure 3 models fire behavior potential of experimental thinning/slash fuel treatments along the wildland-urban interface. Under simulated severe fuel moisture and weather conditions, treatments reduced spread rates by more than half and brought flame lengths closer to limits of direct suppression methods from levels of serious control problems--thus, mitigating fire losses and resistance-to-control (Kalabokidis and Omi 1994).

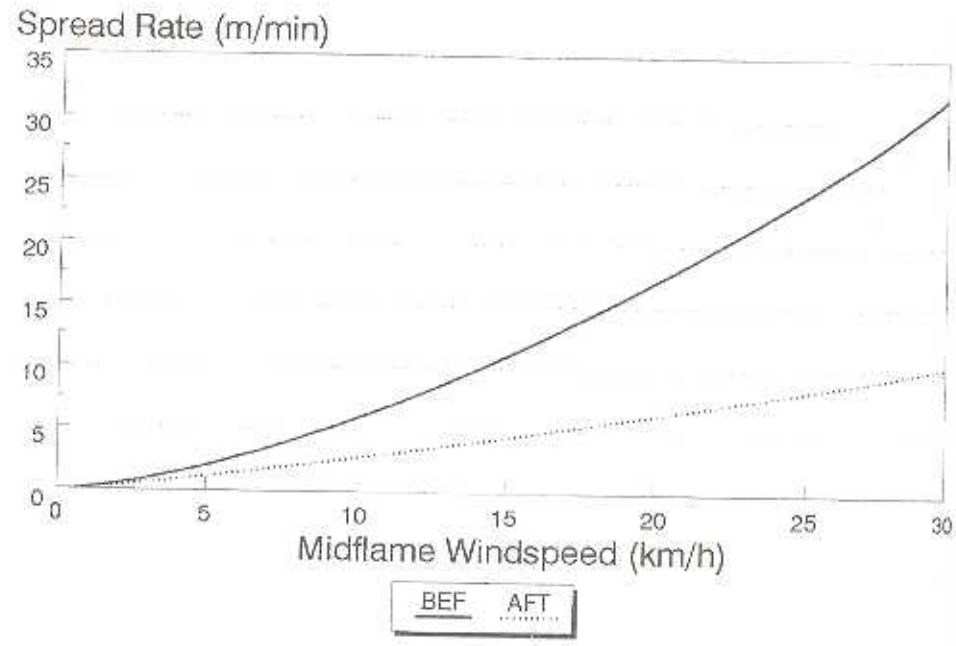
## INFRA-STRUCTURAL DESIGN

Managing vegetation around the house according to proposed standards will not in itself guarantee protection against fire, if not constructing the structure for fire safety. Buildings in hazardous wildland areas should be designed with safety in mind by using non-combustible materials and by preventing the fire from taking hold.

Concrete or brick structures are usually safer than those made entirely of wood. A wood building poses a great problem since it will start to burn in an intense fire; it is also more likely to collapse than a brick building. A building should be designed in a manner that as little as possible air flow gets to the fire; this is accomplished by using compartments (i.e., spaces with walls) with its own doors that, during a fire, should remain closed to prevent large supplies of oxygen kindle the flames. This would give time for the firefighters to arrive.

Other fire safety practices are graphically illustrated in Figure 4 and call for extreme care to check and correct every hazard in residences surrounded by wildland vegetation. Some of the measures that are deemed essential in providing wildfire safety include:

- firesafe roofing materials (e.g., nonflammable, fire-retardant treated) that inhibit flying firebrands to inflame the roof--the most vulnerable part of a building;
- external sprinklers permanently mounted on the roof, with dependable water flow;
- rain gutters and other areas of the roof free of leaves and debris;



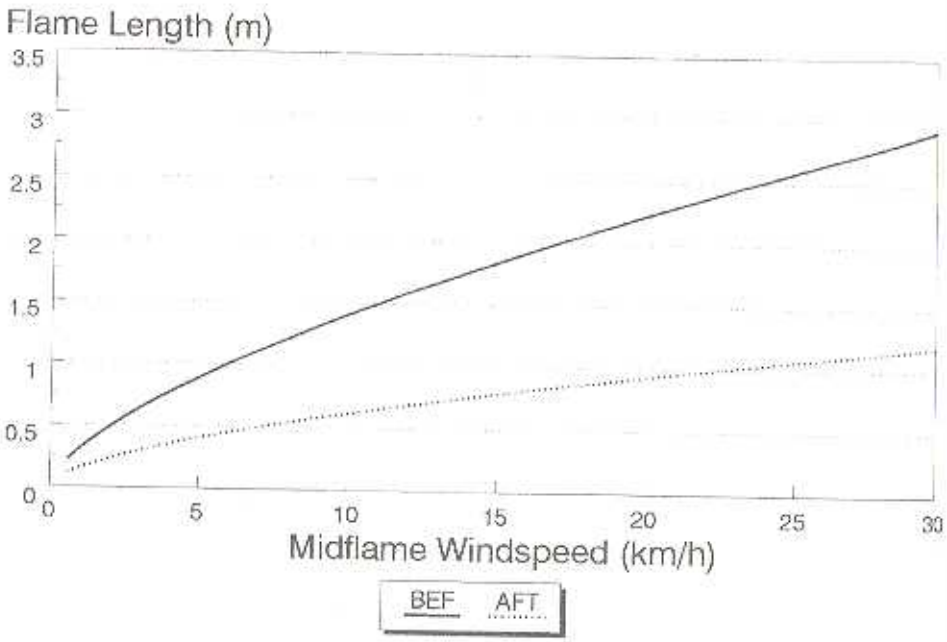




**Figure 3.** Fire hazard reduction (BEFore treatment versus AFTer treatment fire behavior) through vegetation management (i.e., tree thinning with slash fuel disposal) in the wildland-urban interface.

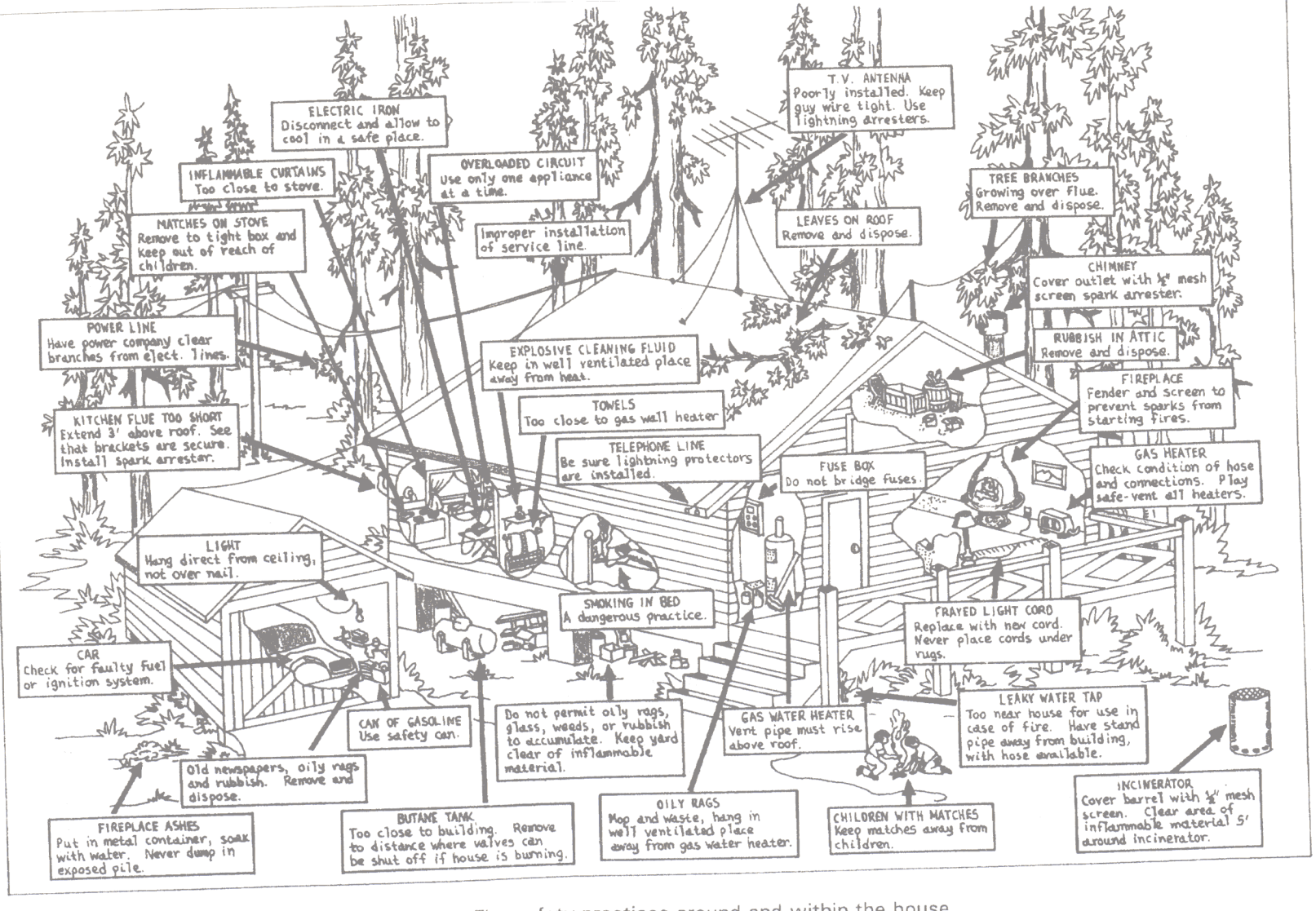



**Figure 4.** Fire safety practices around and within the house.

- window and vent screens, extra-strength glass, nonflammable shutters and balconies (or decks), and fire-resistant drapes that do not allow entrance of radiated or convective heat, firebrands, and flames;
- enclosed overhanging balconies and underflooring, made of nonflammable elements or kept free of all inflammable material;
- fire extinguishers, equipment (e.g., shovels, rakes, axes, hoses), smoke detectors, fire doors, and escape routes to prevent the loss of human life.

## WATER AND ROAD SYSTEMS

Despite the fact that the most important factors in wildfire safety of a structure are its construction materials and its location with respect to vegetative fuels, water supply and road access must also be considered for hazard reduction.

Water is still the most effective firefighting tool, if it can be supplied in sufficient quantities. The amount of water stored and the type of delivery system for firefighting needs will depend on the degree of hazard and the nature of the structure involved. In many cases, adequate water flow is not available for fire-fighting purposes which require high volume for a relatively short duration. These water requirements involve large storage facilities, high-volume mains and dependable delivery systems (either gravity or pumps with alternate standby power source).

A minimum storage capacity of 2500 gallons, supply mains of at least 1.5-inch diameter, one 1.5-inch standpipe for fire engine filling, and at least two outlets 15 or more meters from the building, in addition to outlets on the exterior of the building, are usually considered adequate for protecting the building from an encroaching wildland fire (Moore 1981). Swimming pools can also be important for structural fire protection, provided there is unobstructed direct access to the water by fire engines or people and a pumping/suction system for residents to draft water from the pool (water pumps should be capable of delivering an average of 250 gal/min at 100 $lb/in^2$). Installment of a garden irrigation and sprinkling system and strategic placement of fire hydrants at 100-200 m intervals also safeguard residential areas against wildland fires.

A street and road network engineered with fire safety standards becomes critical during a conflagration for safe and rapid passage of fire equipment and private vehicles. These safety standards provide for proper ingress and egress (two or more routes of access, right-of-way zoning, no dead-end streets), wide enough lanes and turn-around areas (at least 3.5-m wide at intervals not to exceed 400 m), low road grades (8-12%), and maintenance that not only allow easy access by the firefighting forces to the treated area but sometimes also create crucial firebreaks.

## PLANNING AND ZONING

General planning and zoning require political actions that when enforced manage to achieve significant levels of wildfire safety (Rice and Davis 1991). This planning for fire protection should proactively establish land-use priorities (e.g., residential, commercial, manufacturing, agricultural, open space) and development codes on a basis of environmental and socio-economic factors; after public hearings, the above procedures need to be enacted into regulations and zones with appropriate mechanisms of enforcement by state authorities.

Technically correct and practically applicable plans establish local fire hazard severity zones, based on fire potential factors (Ryan 1984), that translate into minimum spacing and building standards in wooded urban areas. Provided that the proposed landscaping and construction standards are followed, the risk of a structure to be ignited can be expressed as a probability that is dependant on air temperature and relative humidity both in areas shaded by trees (Table 1) and in open sunny locations (Table 2). Thus, homeowners could have an early warning of the potential for ignition by listening to weather reports and, if needed, take extra precautionary measures to protect their property; the critical time of the year is when the ignition probability exceeds 50 percent (Tables 1 and 2).

## RECOMMENDATIONS

Safety measures discussed provide possibilities for proactively reducing wildfire hazards and protecting life and property in the urban-wildland intermix. Even if all

Table 1. Estimates of ignition probability (%) based on air temperature and relative humidity of areas shaded by trees.

| Air Temp. | Relative Humidity (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| (°C) | 5 | 15 | 25 | 35 | 45 | 55 | 65 |
| 15 | 80 | 50 | 30 | 20 | 10 | 10 | 10 |
| 20 | 80 | 50 | 30 | 20 | 20 | 10 | 10 |
| 25 | 80 | 60 | 50 | 40 | 30 | 20 | 20 |
| 30 | 80 | 70 | 50 | 40 | 30 | 30 | 20 |
| 35 | 80 | 70 | 50 | 40 | 40 | 30 | 20 |
| 40 | 90 | 70 | 60 | 50 | 40 | 30 | 30 |
| 45 | 90 | 70 | 60 | 50 | 40 | 40 | 30 |

Table 2. Estimates of ignition probability (%) based on air temperature and relative humidity of open sunny locations.

| Air Temp. | Relative Humidity (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| (°C) | 5 | 15 | 25 | 35 | 45 | 55 | 65 |
| 15 | 100 | 90 | 80 | 80 | 70 | 70 | 70 |
| 20 | 100 | 90 | 80 | 80 | 80 | 80 | 70 |
| 25 | 100 | 100 | 90 | 80 | 80 | 80 | 70 |
| 30 | 100 | 100 | 90 | 80 | 80 | 80 | 80 |
| 35 | 100 | 100 | 90 | 90 | 90 | 80 | 80 |
| 40 | 100 | 100 | 100 | 90 | 90 | 90 | 80 |
| 45 | 100 | 100 | 100 | 90 | 90 | 90 | 90 |

standards proposed are adhered to, vegetation fires are probable ecological events destined to happen in certain wildland ecosystems (e.g., Mediterranean-type of ecosystems). Once homeowners accept the fact that fire risks are substantial when they built in wildland situations, it is prudent for the homeowners to take all necessary steps to reduce the potential impact from wildfires to their lives and homesites. Keeping in mind that fire protection cannot be 100 percent foolproof, the following advises are considered critical to eliminate residential wildfire damage:

- Thin the trees to 35 percent crown cover or to a minimum of 3 m of spacing between tree crowns.
- Prune the trees up to 3 m above the ground.
- Remove all dead stems from trees and shrubs annually.
- Leave no dead trees except one or two widely-spaced trees at the outer edge of the property.
- Remove all ladder fuels (i.e., small trees, shrubs, and limbs) beneath the trees.
- Clean up downed dead woody material.
- Remove or thin shrubs so that the in between space is at least 5 times the height of the plants.
- Prune isolated shrubs periodically to maintain vigorous growth and low form.
- Do not plant shrubs directly under windows or next to foundation vents.
- Mow and/or cut as needed to keep grass height at a maximum of 2 cm throughout the growing season.
- Do not store firewood or other combustible material underneath decks or immediately adjacent to the structure.
- Have an adequate spark arrestor on the fireplace chimney.
- Locate the barbecue grill and incinerators away from trees and the house.
- Clear a 2 m wide trail around the boundaries of the structure to firebreak standards.
- Construct fuelbreaks on key ridges or greenbelts around the perimeter of wildland communities up to 100 m wide.

- Provide for fuelbreak maintenance in perpetuity.
- Pay attention to the choice of site and location of the house considering the slope of the ground and the direction of prevailing winds.
- Adhere to development and building regulations for fire safety purposes.
- Try to convince local authorities to accept and consider fire protection criteria in planning.
- Educate and change attitudes of people and authorities regarding the role of fire protection.
- Learn and understand potential fire behavior and the importance of fire management to prevent the loss of life and property.
- Protect aesthetical and ecological values when landscaping and constructing for fire safety.
- Give priority to life safety rather than property safety.

Procedures discussed in this paper should aid in the development of pre-suppression planning that will ensure public safety, maintain natural resources both physically and aesthetically intact, and yet allow people to live in the natural environment.

## LITERATURE CITED

Kalabokidis, K.D., and P.N. Omi. 1994. Managing forest fire fuels in the urban interface. In Proceedings 2nd International Conference on Forest Fire Research, 21-24 November 1994, Coimbra, Portugal. Published by D.X. Viegas, University of Coimbra, Portugal. Pp. 723-731.

Moore, H.E. 1981. Protecting residences from wildfires: a guide for homeowners, lawmakers, and planners. United States Department of Agriculture, Forest Service, General Technical Report PSW-50.

Rice, C.L., and J.B. Davis. 1991. Land-use planning may reduce fire damage in the urban-wildland intermix. United States Department of Agriculture, Forest Service, General Technical Report PSW-127.

Ryan, B.C. 1984. Potential fire behavior in California: an atlas and guide for forest and brushland managers. United States Department of Agriculture, Forest Service, General Technical Report PSW-77.