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Smoke Management-
A Workbook For Balancing
Air Quality And Land
Management Goals

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ABSTRACT: A process is given for balancing air quality and land management goals through smoke management. The process has application wherever land management open burning has the potential to affect air quality, or wherever air quality restrictions may affect the use of fire as a land management practice. Primary focus of the process is upon confirmation of related public and technical issues, then upon developing issue-resolving criteria. This leads to development and evaluation of alternatives. Two are emphasized. One is increased utilization of residues in place of burning. The other emphasized alternative is scheduling of open burning to meet conditions specified for maintaining downwind concentrations of emissions to acceptable levels. Scheduling may also be employed to favor visibility protection and enhancement. Process supporting technical appendices cover development and evaluation of a smoke management program, predicting downwind concentrations, and determining visibility protection needs. Selected references and a glossary are provided.

KEY WORDS: AGRICULTURAL RESIDUES ● AIR QUALITY PROTECTION ● ALTERNATIVES EVALUATION ● ATMOSPHERIC DISPERSION ● ATMOSPHERIC EMISSIONS ● FOREST RESIDUES ● GOALS-BALANCING ● IMPACT ANALYSIS ● LAND MANAGEMENT OPEN BURNING ● OPEN BURNING ● PRESCRIBED FIRE ● SMOKE MANAGEMENT ● VISIBILITY PROTECTION.

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ADMINISTRATIVE SUMMARY

This Workbook has been prepared for use wherever land management open burning has the potential to affect air quality goals, or wherever air quality goals may affect the use of fire in meeting land management goals.

The objective of this Workbook is to provide information and procedures for: 1) evaluating the relationships between air quality and land management open burning; 2) developing, where necessary, appropriate programs for balancing clean air and land management goals.

Public and technical issues may arise from differing perceptions of these goals. Confirming such issues, then establishing criteria for resolving them, is a focal point of the goals-balancing process recommended in this Workbook. When no issues are confirmed, the process is to be quickly terminated. Criteria established for resolving any confirmed issues lead to development and evaluation of alternatives.

Smoke management may be applied at varying levels of sophistication, as appropriate to varied local situations. In these situations, fire is employed to different degrees to meet objectives falling within the national goals for agricultural lands and for forest, range, and wetlands. To meet required attainment and maintenance of the National Ambient Air Quality Standards (NAAQS), each State must determine the effect of various sources of emissions upon air quality. Emissions produced may make land management open burning a potentially significant source in this respect.

Congress made visibility protection and enhancement a national goal when amending the Clean Air Act in 1977. With this amendment, responsibilities relating to designated Class I Federal Areas were mandated for both air quality managers and land managers. Routes of travel and airport approaches calling for safe visual distances have been incorporated in smoke management programs already in operation. In certain areas of heavy visitation, smoke management has also included timing of burning operations to afford visitors views of scenic attractions. Visibility protection and enhancement for Congressionally mandated areas is then logically one of several key objectives of smoke management.

The recommended process calls for participation by decision-maker representatives from organizations that may be affected, and that will have capabilities for carrying out the process. Technical specialists from both land managing and air quality managing organizations may be needed, depending upon the issues and the issue-resolving criteria determined by the decision-makers. Technical participation may initially include determining the existence or extent of a smoke problem. Subsequent work by technical specialists may be needed for developing and evaluating alternatives to meet established issue-resolving criteria.

A Lead Agency is to be selected in each area where the process is employed. The Lead Agency is responsible for initial identification of issues and potential issues, and for invitation of participating organizations. Final Lead Agency responsibilities are to assure implementation followthrough for chosen actions, and to maintain documentation of the process.

A generalized summary is given for alternatives to open burning, and for carrying out the practice when open burning is selected as the best alternative. Two alternatives are emphasized due to their potentials to benefit air quality. One is increased residues utilization. Despite notable progress already, further implementation may be made possible through the broadened area of concern opened by discussions under the process.

Scheduling is the other emphasized alternative. It can be applied as a tool of smoke management to match burning operations with conditions specified to result in acceptable downwind concentrations of emissions. Where the total burning job is heavy, and days for carrying it out are limited, budgeting of a burn schedule may be necessary. On a day-by-day basis, the schedule may then be rebudgeted to accommodate more or less of the burning job, depending upon conditions. Where this aspect of scheduling is necessary, smoke management entails prior agreement upon priorities, and should provide for negotiations between burners and a coordinator. A further application of scheduling is timing of burning operations so as to provide for visibility protection and enhancement where appropriate.

Three technical appendices support the process. These cover development and evaluation of a smoke management program, predicting downwind concentrations of particulate matter emitted from burning operations, and determining visibility protection needs.

Selected references are suggested for supplemental reading, and a glossary is provided. These anticipate diversity of disciplines among personnel who may be called upon to participate in a joint effort.

PART I - BACKGROUND

SMOKE MANAGEMENT

A Workbook for Balancing Air Quality and Land Management Goals

PART I - BACKGROUND

INTRODUCTION

Objective

Fire is used to accomplish specific land management goals. This use of fire produces emissions which can conflict with specific goals for clean air.

The objective of this Workbook is to provide information and procedures for:

1. Evaluating the relationships between air quality and land management open burning, and

2. Developing, where necessary, appropriate programs for balancing clean air and land management goals.

Workbook Application

Where applied. Wherever land management open burning has the potential to affect the air quality goal, or wherever the air quality goal may affect the use of fire in meeting the land management goal, this Workbook will have application.

Congress made visibility protection and enhancement a national goal when amending the Clean Air Act in 1977. With this amendment, responsibilities relating to designated Class I Federal Areas were mandated for both air quality managers and land managers. Routes of travel and airport approaches calling for safe visual distances have been incorporated in smoke management programs already in operation. In areas of scenic attractions, some smoke management programs already provide for timing of burning operations for periods when visitation is low. Visibility protection and enhancement for Congressionally mandated areas is then logically one of several key objectives of smoke management.

Types of burning to which applied. This Workbook applies to open burning conducted by agriculturists and managers of forest, range, and wetlands. Among the included types of open burning are disposal of debris from land clearing for food or fibre production (e.g., using fire in making type conversions), as well as disposal of debris from rights-of-way cleared for land management purposes. Open burning of fuels used in orchard heating, or of backyard and urban land clearing debris, is excluded from the land management practices recognized by this text.

Application to issues resolution. Air quality and land management goals established through legislation are often closely related to private goals. A public-at-large, however, will often place different weights of importance upon them and will have widely different individual expectations of such goals. When there are differences like these, public issues can result. Proposed new actions to meet objectives drawn from these goals may surface both as public issues and as technical issues. For these reasons, issues and potential issues resulting from different perceptions of goals and related objectives are focal points in the recommended goals-balancing process. Establishment of issue resolving criteria as a part of the process leads to development and evaluation of alternative courses of action. On the other hand, if no issues are confirmed, the process ends with documentation of that finding.

An example of the kinds of issues that can be involved is afforded in the hypothetical case of a Federal land manager whose responsibilities include those for visibility protection mandated by Congress in the 1977 Clean Air Act Revision. This manager may have determined that in nature, the Wilderness involved was often frequented by dense smoke from uncontrolled fires. An objective of affording visitors a spectacular view is to be met. At the same time, other objectives call for preserving the wild, natural ecosystem. Nearby, objectives on other land classes call for assuring land productivity. Potential issues in this example are readily identified with priority setting. Criteria for issues resolution may involve compromises technically related to the law, to histories, to public use, to biological requirements, and so forth.

Interdisciplinary application. Individuals from a wide range of disciplines may be needed when issues to be resolved are complex. To aid communication between these individuals, and to define terms as used in this text, a Glossary of terms has been placed at the end of the Workbook. Selected references are suggested for supplemental reading. These selected examples may suggest sources of information that will augment the background summaries in the rest of this part of the text, intended to provide a common starting place.

AIR QUALITY PROTECTION

The Clean Air Act in section 109 directs the U.S. Environmental Protection Agency (U.S. EPA) to develop National Ambient Air Quality Standards (NAAQS). These standards establish acceptable levels of the following pollutants: carbon monoxide, hydrocarbons (nonmethane), lead, nitrogen dioxide, ozone, particulate matter, and sulfur oxide. Two standards are set for certain pollutants. Those identified as Primary Standards protect public health, and those as Secondary Standards protect public welfare.

Attainment or nonattainment of the NAAQS is determined by air quality monitoring and/or modeling on a pollutant-by-pollutant basis. Determinations are based on actual monitoring data, if available. If not, models are used to predict the potential for violation of a standard. Most models used for this purpose are dispersion models. The models are used to evaluate the way pollutants move through the atmosphere, in order to predict impacts on health and welfare (usually measured by the NAAQS). Usually, emissions are treated as produced from single stacks, or from area sources. Transport and dispersion models may use both meteorological inputs and chemical conversion factors to predict downwind impacts. Although some problems remain with this type of modeling (usually in the atmospheric components), effective use in air quality management has been demonstrated.

A major program pertaining to attainment areas is that of Prevention of Significant Deterioration (PSD). Congress established PSD to: 1) protect the air quality in areas cleaner than that required by the NAAQS; 2) protect air quality-related values in National Parks and Wilderness Areas, and 3) insure that economic growth in attainment areas will be consistent with the preservation of existing air resources. PSD established an "increment" system which allows only a specified increase of sulfur dioxide and particulate matter over an established baseline. Baseline is a legal term characterizing the ambient air quality existing at the time of the receipt of the first permit application. It is determined by either monitoring or modeling, or both. Major sources wanting to locate in attainment areas must obtain a permit verifying they will not increase ambient concentrations above the established level before they can begin construction.

The Clean Air Act, Amended 1977, designates certain National Parks and Wildernesses as mandatory "Class I Federal Areas." PSD provisions assign the Federal land manager an affirmative responsibility to protect the air quality-related values (including visibility) of these Class I Federal Areas.

The Clean Air Act gives the individual States primary responsibility for implementing the various air programs. Federal regulations act as minimum requirements and guidelines - States are free to develop more stringent programs. Each State must bring Nonattainment Areas into compliance with the NAAQS and insure the Standards are maintained in Attainment Areas. States with approved programs have final authority for permitting sources under the PSD program. U.S. EPA issues permits in other areas. Strategies the State will pursue to meet Federal requirements are outlined in a State implementation plan ("SIP"). When approved by U.S. EPA, these SIPs become Federally enforceable.

LAND MANAGEMENT OPEN BURNING

Fire employed in the management of agricultural lands is usually called, "controlled burning," and in the management of forest, range, and wetlands is called, "prescribed burning,"1/ a name derived from the prescriptions written for this type of burning. Objectives for this use of fire will generally fall within the following list, traceable to the broader national goals established for these lands.

1. Through reduction of fire hazard, to reduce costs and losses from otherwise inevitable and destructive wildfires.2/

2. Prevent naturally the infestations of diseases and insects which would otherwise develop in the absence of fire.

1/ The term "prescribed burning" is used somewhat differently in different areas of the United States. See the Glossary for the definition followed in this text.

2/ Due to histories of disastrous wildfires originating in fuels which had been allowed to accumulate without treatment, fire hazard reduction has long been a forestry practice required by law in many States. While these histories are readily associated with huge monetary costs and losses, other costs and losses also underlie the need for continuing this practice. These include potentially severe environmental impacts like: production of massive amounts of emissions to the atmosphere, removal of protective vegetative mantles from watersheds with consequent increases in stream and lake turbidity, unwanted changes in chemical balances, marring of a desired esthetic quality of the landscape.

3. Preparation of farmland for cultivation, (i.e., that which has lain fallow, or which is covered by residues from harvesting).

4. Preparation for reforestation.

5. Reintroduce fire as a natural element in the ecosystems of certain Wildernesses and Parks. (In some organizations, called "Natural Prescribed Fire.")

6. Renew and improve range forage and wildlife habitat.

7. Seed stimulation by "thermal shock" (e.g., to increase the yield of perennial grass crops).

8. Disease control by burning of infected plants or plant parts.

9. Enhancement of chemical application (e.g.: indirect control of weeds when used as a pre- or post-treatment for areas treated with herbicides.)

10. Reduction of nitrogen fertilizer requirements.

11. Destruction of pests such as mites, insects, and rodents.

12. Direct control of weeds by destruction of weed seeds and plants.

Open burning employed as a recognized agricultural practice is temporary and is usually seasonal. The burning takes place annually, in most cases on a schedule determined by harvesting and other practices, such as pruning in orchards and vineyards. Prescribed fires are temporary, are usually seasonal, and are periodic. Many burn for only a few hours. (A sometimes notable exception is the "Natural Prescribed Fire" which may burn for days or weeks.) Seasons of prescription burning are delimited by climatologies in which the probabilities of favorable weather parameters coincide with those of desired fuel conditions.

Periods between burning may be as short as 1 year where agricultural crops are mostly the same, year-in, year-out. In prescription burning, there are special cases for annual burning, such as when an objective calls for maintaining certain herbaceous species in dominance (notably, in understory burning in a few quail habitat management areas in the Southeastern States). More commonly, the interval between prescription burns is several years. For all areas, this is determined by land management objectives. Fire history and fuels accumulations are the determinants where fire is being returned to its natural role, as may be appropriate to Park and Wilderness objectives.

Prescribed fire intervals in southern coastal plain areas may be as short as 2 or 3 years where management objectives call for reducing rapid regrowth of competing flammable vegetation. On the other hand, in some timber production areas of the West, the interval may be determined only by the scheduling of a harvest cutting (which is then followed by use of prescribed fire to reduce the fuel hazard and to remove residues in preparation for reforestation). In the brushfields of Arizona and California, chaparral matures to an extremely hazardous fuel. There, the interval is based on species composition, age, amounts of living and dead vegetation, and the moisture of the living and dead fuel. Chaparral older than 7 years is regarded as very hazardous to safe burning in many southern California management situations.

SMOKE AND AIR QUALITY

The smoke from wildfires and from land management open burning is usually highly visible during initial phases when well defined plumes are rising to the atmosphere above burn areas. Even small fires are characterized by such plumes during the time when there is sufficient convective heat from the fire to loft the smoke. In later phases, remaining fuels will continue to burn, producing smoke, but not enough heat to bring about plume rise. Where there are light fuels, or fuels which have been burned with a type of fire that results in almost complete fuel consumption as the fire advances (e.g., a backing fire), the period of no plume rise is often so short that it can be regarded of negligible importance. In fuels which burn with relatively low intensity for several hours (as with large logs, damp or soil-laden piles and windrows, deep organic soils), or in a type of fire which does not consume most of the fuel during its initial advance (e.g., a heading fire), smoldering combustion may produce high concentrations of smoke that remain close to the earth's surface.

If low level temperature inversions interfere with dispersion of this smoke, safe visibility can be impaired along routes of travel in low lying areas. Surface winds moving downslope and downcanyon from smoldering fires can carry smoke into "smoke sensitive areas." Haze resulting from dispersed smoke can also interfere with visibility.

Knowledge of these effects, and of how to avoid or mitigate them, makes smoke management possible. In its simplest forms, the doing job of smoke management may mean little more than selecting the right wind direction and some very broad dispersion conditions under which established levels of pollutant concentrations will not be exceeded in locations where these are of importance. Even at this simple level, alternatives to burning are considered.

With increased knowledge, a new smoke management technology is emerging. It is suggested that under this new technology, smoke management consists of 3 major functions: APPRAISAL (of alternatives — this will include that of existing air quality, and of predicted smoke effects downwind from burn areas); SPECIFICATIONS (conditions under which smoke will disperse to acceptable locations and concentrations) & SCHEDULING (to meet these specifications); EXECUTION (of an Operating Plan based upon the first 2 functions).

Several States have enacted rules bearing directly on land management open burning. Actions taken in response to these rules, and taken voluntarily elsewhere in the absence of rules, have resulted in smoke management programs. Formally recognized cooperative smoke management operating plans, in particular those between prescribed burners, and between prescribed burners and State or local authorities responsible for air quality management, are being successfully followed in several States. These operating plans have been effective in minimizing transport of smoke to populated areas, and in reducing concentrations of emissions in designated Nonattainment Areas as well as in "smoke sensitive areas" (such as highways, airfields, and hospitals).

Contributing to this emerging technology, fire scientists have studied the characteristics of smoke from different kinds of fires and from fires in different fuels. With research oriented to finding new ways to avoid violations of the (NAAQS), particulate matter production, transport, and dispersion have become key elements in the management of smoke from land management open burning.

Results from empirical studies have yielded usable emission factors for total suspended particulate matter (TSP) production from fires burning in certain fuel types. These studies have also shown some important differences between emissions from heading fires and backing fires. The high cost of such studies has led scientists to seek an alternate research approach related to the carbon-balance equation. To date, however, available emission factors are limited.

A high proportion of particulate matter in smoke from land management open burning is in the fine fraction. This is illustrated by the particle size relationship shown in figure 1, found to hold generally true for related studies by others. The light scattering property of fine particulate matter has led to suggesting a method (in appendix C to this Workbook) by which the haze resulting from dispersing smoke may be included in input evaluations to be made by Federal land managers responsible for visibility protection in designated Class I Federal Areas.

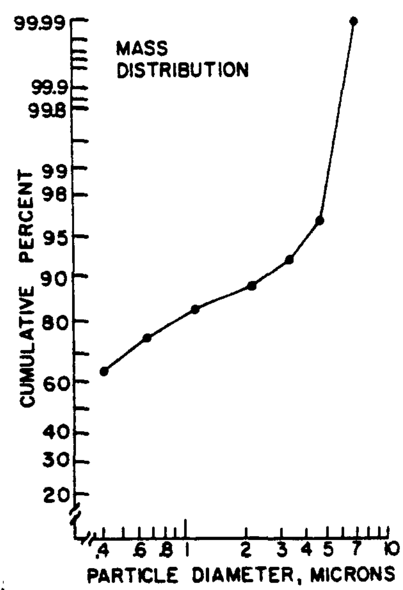


Figure 1. Distribution of smoke particles larger than 0.4 micron. Distribution is based on particle mass.3/

3/ From: Tangren, Charles D., Charles W. McMahon, & Paul W. Ryan, 1976. Ch. II. Contents and effects of forest fire smoke. In: Southern Forest Fire Laboratory Personnel. Southern forestry smoke management guidebook. USDA For. Serv., Southeastern For. & Range Exp. Sta., Asheville, N.C. (p. 9-22). NOTE: citations are omitted from Workbook text for reader convenience except where direct credit or recommended reference is appropriate. For references related to subject fields, see the section giving Selected References.

At present, most predictive models adapted to management of smoke from land management open burning deal with total suspended particulate matter (TSP). Predictive models are employed in evaluations of alternatives to land management open burning, and of alternative approaches to operational smoke management when burning is the selected alternative. Development and evaluation of alternatives is a key element of the process recommended in Parts II and III of this Workbook. (See discussions starting on pages 13 and 24.) Model adaptations now available are used both indirectly and directly in operational smoke management. Indirect applications are found in the use of model-derived case examples, screening methods, and check lists. Direct applications are found in use of models programmed for interactive electronic data processing. With these adaptations, it is possible to pretest trial specifications being set forth in smoke management operating plans, as well as those being considered in "real-time" for individual burning operations. For planning tests, climatologically derived weather variables are used. For "real-time" tests, current weather observations and forecasts are used.

Models thus applied can be valuable aids to decision makers. They are not, however, suited to independently determining when to burn. This is a consequence both of limitations of the models and of the need to exercise judgement regarding situations not represented by available models. (Examples of model limitations are: the statistical bases for many of those commonly applied; adequately representing the flow of winds in complex terrain. Examples of situations not represented are: a locally urgent need; a priority that must be met, as when an opportunity to burn a difficult location might otherwise be lost.)

ONGOING RESEARCH & DEVELOPMENT

Research and development expected to yield results bearing upon resolution of issues related to land management open burning is most likely to be from among 3 sponsor categories. Two are the U.S. EPA and the USDA, Forest Service. The third category is the States, through State universities or agricultural experiment stations.

Related U.S. EPA research and development will generally fall under the headings of atmospheric modeling, source assessments, state of art reviews. For a guide to the U.S. EPA research and development program, see the "ORD Publications Announcement," as well as others, listed under Air Quality Protection, Abstracting Services & Related, in the Selected References Section of this Workbook, page 89.

USDA, Forest Service research and development may fall either in the general resource fields (e.g., timber, range, recreation, etc.), as these may yield results useful to alternatives evaluation, or in specialized fields. These latter include forest fire, smoke management, energy & forest residues, forest meteorology, forest economics (all within the Forest Service Research Arm), and Equipment Development and Testing. Local USDA, Forest Service Experiment Station personnel and Regional staff group specialists are the best sources of information on relevancy of ongoing work.

State universities and agricultural experiment stations may deal with locally important matters in crop management alternatives and equipment development options where alternatives are being sought. They may also be directly involved in smoke management. State agricultural extension agents and State Forestry staff specialists are the best sources of information on relevancy in this category.

PART II - A RECOMMENDED GOALS-BALANCING PROCESS, IN BRIEF

PART II - A RECOMMENDED GOALS-BALANCING PROCESS, IN BRIEF

It is the intent of this Part to capsule the process to be presented in detail later.

LEADERSHIP & APPROPRIATE PARTICIPATION

A Lead Agency should be designated for the process. Functions of the Lead Agency are those of:

Tentatively identifying any smoke problems. It is suggested that the Lead Agency start the process by including a list of tentatively identified issues with the letter of invitation to organizations. Participating organizations can be invited to submit additional, tentative identifications. All issues should be identified with locales (i.e., whether state-wide or confined to a named local area); this will help to obtain the best matches of issue-resolving actions to issues.

Examples of issues which might be identified are: when smoke from open burning is believed to be a cause for violations of NAAQS; when it is suggested existing air quality regulations are resulting in unmet land management objectives; where visibility protection and enhancement are mandated and a conflict has been perceived between visitor enjoyment and open burning during the same season.

Inviting representatives from affected organizations. Invited participation should be from organizations with capabilities for solving problems. This will include both organizations with interests in meeting air quality objectives and organizations with direct and indirect interests in meeting land managememt objectives. (Examples are: recognized air pollution control districts where land management open burning is believed to have an important effect upon air quality; associations advocating clean air and improved visibility; land managing agencies and private owners; associations advocating specialized resources like improved wildlife habitat or wilderness experiences.)

Representatives should be decision-makers. Each affected organization can be expected to have 2 major concerns in addition to meeting the overall objective of balanced air quality and land management goals. A first concern will be that any problems are properly identified; organizations will also be concerned that any process-supporting work will be commensurate with problems being addressed. These policy-level concerns are intended to be addressed by the decision-makers in subsequent process segments.

Technical specialist participation will depend upon the nature of issues confirmed, issue-resolving criteria established, and commitments to be made by decision-makers in subsequent process segments.

Maintaining documentation, and assuring that any followthrough actions decided upon by participants are taken. By maintaining a record of key decisions as the process moves forward, the Lead Agency can assure that actions which may have to be taken over a fairly long time period are not lost with the passage of time.

Table 1 is provided for use as a documentation checklist. It may also be of help for tracking the sequence of work to be done while following the goals-balancing process.

Table 1. Suggested documentation checklist

☐	Designated Lead Agency
☐	Organizations invited and participating
☐	Decision-maker organizational representatives
☐	Any Technical Assessments performed as needed to reach decisions on issues to be confirmed
☐	Confirmed issues and potential issues, by locales (if none, this should be documented)
☐	Issue-resolving criteria, suggestions, special instructions
☐	Technical specialists and resources committed to supporting work
☐	Any technical reports covering developed and evaluated alternatives
☐	Record of action decisions, including implementation follow-through, and by whom. (Should also include any record of public information and involvement in reaching final decisions.)

SMOKE PROBLEM DETERMINATION

With public and technical issues as focal points for this goals-balancing process, their confirmation by the participating decision-makers will determine the existence and extent of any smoke problems. Obviously, if no issues or potential issues are confirmed, this can be documented and the process quickly closed out. When issues or potential issues are confirmed, the work to be done in the remaining process segments becomes a logical result.

Issue confirmation, including determining that locales are correctly described, is a key role for the decision-makers. When issues are not clear cut, the decison-makers may also find it necessary to provide for specialists to make further technical assessments of the situations which led to tentative identification.

Common sense may also anticipate potential future problems that could become issues. These are to be handled as "supplemental criteria" in the next section.

DEVELOPING ISSUE-RESOLVING CRITERIA

With development of criteria for resolving issues, the participating decision-makers can function both as a team solving a problem and as representatives assuring that organizational concerns are given voice. For example, if the issue is related to violations of the NAAQS, criteria could be established specifying both: "There will be no future violations; land management open burning will be assured a proportionate share of the atmosphere's capacity for dispersal of pollutants."

The example immediately above illustrates that the job of developing and evaluating alternatives can be technically demanding. For specialists who may be called upon to do this work, the decision-makers may find that they have insights to problems which can be passed on as special instructions, along with the documented criteria. As part of these special instructions, supplemental criteria may be suggested, or the technical specialists should be given the understood freedom to add these for common-sense avoidance of problems which are not currently issues.

COMMITMENTS OF TECHNICAL SPECIALISTS AND RESOURCES

Some criteria will clearly indicate an action calling for little or no technical development and evaluation outside the decision-maker group. Other issues and their criteria may call for supporting work by technical specialists who will subsequently recommend actions to be taken.

Specialists and resources needed for developing and evaluating alternatives will come from the participating organizations. This calls for commitments to be made by the decision-makers who represent affected organizations with capabilities for solving the problems to be addressed. In some cases it may be necessary to fund outside technical help.

Examples of the kinds of specialists that might be needed include: residues harvesting and utilization technologists, silviculturists, agriculturists, agronomists, smoke management and air quality technologists, economists, meteorologists, statisticians, modelers, equipment develpment and test engineers.

Examples of resources include: funds for travel, for contracted specialists and equipment, for data processing; office space and equipment; secretarial support; special services such as cartographic, report duplication.

A special case of commitments of technical specialists and resources would be when it appears to participating decision-makers that criteria for an issue to be resolved can be met by an action taken internal to one organization. In this case, the commitment would be to complete an internal evaluation of this action and to implement same, if feasible.

ALTERNATIVES DEVELOPMENT & EVALUATION

For issues and criteria that were determined to require supporting work by technical specialists, this segment of the process is devoted to development of candidate alternatives, and to alternatives evaluation. Technical specialists performing this work include in their evaluations the issue-resolving criteria, and any supplemental criteria, established by the decision-makers. Suggestions and special instructions passed on with these criteria are also taken into account. Technical specialists should also consider any supplemental criteria of their own, seen as needed to avoid potential future problems.

Of several alternatives evaluated, the specialists may recommend only the top few to the decision-makers for action decisions. With these, their evaluation reports should summarize the deciding factors to be considered. Specialists should also append supporting materials (e.g., draft or skeleton proposals) related to recommendations implementation.

DOCUMENTATION, IMPLEMENTATION

Implementation is a result of action decisions. Those issues and criteria calling for supporting technical work in development and evaluation of alternatives are, by this point, covered by recommendations from the technical specialists.

The variety of possibilities for action decisions, and the possibility that implementation of these decisions may require a long time period, indicate a need for documentation and responsible followthrough.

The Lead Agency fills a necessary role by maintaining documentation for the process. Followthrough by participating organizations will complete the process.

PART III - A RECOMMENDED GOALS-BALANCING PROCESS, IN DETAIL

PART III - A RECOMMENDED GOALS-BALANCING PROCESS, IN DETAIL

It is the intent of this Part to parallel the process capsule from Part II with amplifying discussions under the same headings. Subheadings are added to provide separations for the expanded discussions. While Part II could be used alone, this Part is somewhat dependent upon information previously supplied, and here repeated only as necessary for maintaining continuity.

DETAILS: LEADERSHIP & APPROPRIATE PARTICIPATION

Lead Agency Designation

At the State level, the State Forester and the State Air Quality Protection Chief are most likely to have knowledge of issues and potential issues where land management open burning may be related to air quality. In some States, the counterpart for Agriculture may have similar knowledge. A working relationship between these state-level policy makers is seen as essential to operation of the process.

At this and other levels where the process may be applied among several agencies, any one of those represented in the paragraph above is a likely candidate for designation as Lead Agency.

The role of the Lead Agency includes tasks covered by the following subheadings.

Tentatively identifying any smoke problems

Personnel of the Lead Agency, working with those of its air quality or land management counterparts (see immediately above), should develop a LIST OF TENTATIVE ISSUES. Issues should be identified with locales as appropriate.

CATEGORIES OF ISSUES, here supplied along with some "prompters" of possibly conflicting goals or objectives, include the following:

National Ambient Air Quality Standards (NAAQS) attainment & maintenance. Are open burning sources known, or believed, to be responsible for NAAQS violations?

Protection & enhancement of visibility in Class I Federal Areas. Does smoke from land management open burning pose definition problems (e.g., what is acceptable visibility)?

Smoke Sensitive Areas. Are there incidents of highway accidents or airfield closures due to the smoke from open burning operations? While this issue category is not part of the objectives usually stated in gauging the air quality goal, it is usually an objective of smoke management.

Continuation PART III, DETAILS: LEADERSHIP & APPROPRIATE PARTICIPATION

It is believed excessive smoke results from alternatives not being properly evaluated. Are there unexplored opportunities, or barriers which might be overcome if the alternatives to open burning are examined on the broader basis afforded by this process? Is there public pressure to employ alternatives?

Constraints in the absence of viable alternatives to open burning. Can fuels, fire, and weather parameters be specified for improved smoke dispersal? Can amounts of burning be coordinated between burners? Do land managers report unmet land management objectives or excessive costs as a consequence of existing constraints?

LOCALES identified with each issue will help to pinpoint those underlying causes which are definitely area specific. While some issues may be statewide, others may be confined to a very small area. For such issues, the more narrowly the locale is defined, the more precise can be its treatment under subsequent issue-resolving statements.

Suggested levels of locale include the following:

Designated Class I Federal Area
Designated Nonattainment Area
Airshed
Air Quality Control Region
Statewide, county-wide, or other recognized politically bounded area.

Inviting representatives from affected organizations to participate.

A LETTER TRANSMITTING the tentative issues list should also enclose a copy of this Workbook, and should invite replies to include:

Suggested modifications of issues statements.

Suggested additions of other issues identified with locales.

An expression of interest in possible further participation through designation of a policy-level individual to function as a decision-maker.

ORGANIZATIONS to which invitations are sent may include the following:

Air quality related
- Air quality associations
- Air quality advisory boards & commissions
- State air quality agency
- State-authorized air pollution control districts, or similar entities

Continuation PART III, DETAILS: LEADERSHIP & APPROPRIATE PARTICIPATION

Land management related

- Conservation associations
- Farm Bureaus
- Granges
- Forest owner associations
- Agriculture industry associations
- Wildlife organizations
- Livestock associations
- Small woodlands owners associations
- State Forestry agency
- State Game agency
- State Parks System agency
- USDA, Forest Service
- USDI, Bureau of Indian Affairs
- USDI, Bureau of Land Management
- USDI, Fish & Wildlife Service
- USDI, National Park Service

Other organizations that might be affected
(Example: State Department of Transportation)

Counterpart organizations where long range transport of smoke from open burning is of concern. Smoke from land management open burning may originate and/or impact in other States and countries. Where long range transport of smoke from open burning is of possible consequence to counterpart organizations, it may be advisable to defer their participation. Deferment will make possible more clear statements of resolving criteria for any intrastate issues. The possible modeling and broad scale coordination difficulties will then be better understood for the long range transport problem as well. If achievement of balanced goals remains contingent upon the added participation of out-of-state counterparts, issues related to long range transport can then be treated as an expansion of this same process.

Maintaining documentation, and assuring that any followthrough actions decided upon by participants are taken. As an addition to the documentation table suggested in Part II, a second checklist to be used by all participants will be covered in the final process segment on page 34.

Participation Governed by Issues

If no tentative issues are identified by the Lead Agency, and none is proposed by affected organizations, the recommended process will logically terminate with a letter to each organization so stating. Where the issues are few and simple, the participation may logically be handled by correspondence or telephone conferences. Meeting participation may be the most efficient approach where the issues are complex or there are several.

DETAILS: SMOKE PROBLEM DETERMINATION

Confirmation of Issues

A major concern of participating organizations, to be addressed by participants, will be the existence and/or extent of smoke problems.

An issue may arise from lack of data, lack of quantitative examinations of available data, public misunderstanding as a consequence of combinations of these, or merely from inadequate communication. Situations like these call for more than redefining issues and locales. Some such issues may call for technical assessment before they can be confirmed or denied.

Commitments to Technical Assessments for Issues Confirmation

Participating organizations are the source of technical specialists and resources necessary to completing any needed technical assessments.

"Technical Assessments" should not be confused with the formal "Impact Analyses," even though they may be similar in many cases. For example, one technical assessment may deal only with determining if available monitoring data show land management open burning to be an important contributor to an air quality problem area. Another, however, may be concerned with the level of smoke management sophistication now being applied.

Documentation for Smoke Problem Determination

Documentation for this process segment should include:

A list of participants;

A list of issues examined, showing decisions reached, on: (1) confirmation, (2) deferment for technical assessment, with target date for completion of decision, (3) nonconfirmed, or rejected, issues;

Commitments to technical assessment, and instructions prepared for specialists being assigned (including target dates for completion).

DETAILS: DEVELOPING ISSUE-RESOLVING CRITERIA

This is a critical process segment in that criteria developed set the pattern for all subsequent technical work in development and evaluation of alternatives.

Examples of documented issue-resolving criteria, along with other documentation for this process segment, are given in Exhibits 1, 2, 3, and 4, introduced in the next subsection.

Continuation PART III, DETAILS

DETAILS: COMMITMENTS OF TECHNICAL SPECIALISTS AND RESOURCES

The kinds of specializations and resources that may be needed for this process segment are shown under this heading in PART II. Exhibits 1, 2, and 3, on the following pages, illustrate how commitments of personnel and resources may be documented when confirmed issues pertain to more than one organization. Exhibit 4 illustrates how a commitment to an internal effort might be documented when the confirmed issue pertains to only one organization.

(TEXT CONTINUES ON PAGE 24, FOLLOWING EXIBITS.)

Continuation PART III, DETAILS

Exhibit 1. Example 1 (of 3) of documentation for a confirmed issue pertaining to more than one participating organization.

DOCUMENTATION FOR CONFIRMED ISSUE:

Present Nonattainment status & growth projections have brought about the belief that land management open burning should be curtailed to favor further residential and industrial growth.

Locale: *Browntown Air Quality Control Region*

Issue Resolving Criteria: *Land productivity will be maintained either by public acceptance of a smoke management program (i.e., covered by an operating plan with adequate specifications and procedures), or by other cost-effective treatment alternatives.*

If it is found necessary to reduce the amount of land management open burning, a fair share of the atmosphere's capacity to disperse pollutants will be reserved for the use of fire in those areas for which no acceptable alternatives are available.

Commitments of Technical Specialists & Resources:

Fire management specialist from USDA, Forest Service
Forest residues specialist from Straight Grain Lbr. Co.
Smoke management specialist from State Department of Forestry
Silviculturist from Brown Bag Co.
Fire ecologist from State University (funded by USDI, National Park Service)
Dispersion modeler for complex terrain (hired consultant funded by USDI, National Park Service, and Straight Grain Lbr. Co.)
Air quality specialist from State Department of Environment
Air quality specialist from Brown County A.P.C.D.
Economist from State University (funded by State Department of Environment & USDA, Forest Service)

Team Leader - Assistant V.P. for Community Relations, Brown Paper Bag Co.

Office space, computational and report duplication facilities, and secretarial support from Brown Paper Bag Co.

Suggestions & Special Instructions: *Preliminary data collection & impact modeling from issue-confirming technical assessment should be of value ... shows less than full smoke management employed at present.*

Any special public involvement to be employed will be coordinated by the Process Panel. If to be employed, submit proposed informational materials with report of recommendations.

Report due 11/20.

Continuation PART III, DETAILS

Exhibit 2. Example 2 (of 3) of documentation for a confirmed issue pertaining to more than one participating organization.

DOCUMENTATION FOR CONFIRMED ISSUE:

State air quality regulation prohibiting open burning of any piled silvicultural debris is believed to be unduly restrictive.

Locale: *Statewide*

Issue-Resolving Criteria: *Land productivity will not be reduced.*

Land management open burning will not result in violations of NAAQS.

All valid reasons for the prohibition will be satisfied.

Commitments of Technical Specialists & Resources:

Silviculturist from Indus. Forestry Assoc.
Silviculturist from State Department of Forestry
Smoke management specialist from USDI, Bureau of Land Management
Mechanical pretreatments specialist from Long Slat Lbr. Co.
Air quality specialist from Big Catalpa River Air Pollution Control District
Equipment development engineer from USDA, Forest Service
Fire behavior research scientist from USDA, Forest Service
Team Leader - Assoc. Chief for Legis. Matters, State Air Board
Office space, secretarial support, and report duplicating service from State Air Board

Suggestions & Special Instructions: *The air quality and land management effects of present practices will be compared with those of any alternatives considered for proposal.*

If it appears that the prohibition resulted from the past kinds of piles, how they were constructed, dirt content, or how burning was scheduled, the evaluation should include possible new specifications; if feasible, it should recommend a means of placing these into effect.

The report is to be completed by 6/30.

Continuation PART III, DETAILS

Exhibit 3. Example 3 (of 3) of documentation for a confirmed issue pertaining to more than one participating organization.

DOCUMENTATION FOR CONFIRMED ISSUE:
It is believed that excessive smoke results from alternatives not being properly evaluated.

Locale: Western half of State

Issue-Resolving Criteria: NAAQS will not be violated.

Land productivity will be maintained

Commitments of Technical Specialists & Resources:
Timber marketing economist from State Department of Forestry
Timber sales specialist from USDI, Fish & Wildlife Service
Energy specialist from State Dep't of Energy Conservation
Orchardist from State Agricultural Experiment Station
Pulp & paper procurement specialist (part time) from Brown Bag Company
Logging engineer from Clean Fibre Company
County Agent (part time) from U.S. Department of Agriculture
Materials handling engineer, consultant, paid for by AGCOGROW Co.

Team leader - Deputy State Forester

Office space & clerical support from State Dep't of Forestry

Suggestions & Special Instructions: Prior investigations of agricultural and timber harvesting residues have shown that specialized materials handling skills needed for improved utilization are not locally available. These investigations have also shown that on an ownership-by-ownership basis, there is an inadequate residue supply for investment in a new utilization outlet. Transportation and stockpiling appear to be major barriers. Regardless, public sentiment appears to be high and deserves a studied response.

For this investigation, include the concept of larger working circles for possible utilization sites and processes. Examine means by which transportation and materials handling costs could be offset as a benefit to air quality.

Public involvement, if any, can be handled independently as appropriate, but should be separately identified from this parent effort for the present.

Report due 9/25.

Continuation PART III, DETAILS

Exhibit 4. Example of documentation for a confirmed issue pertaining to one participating organization which in turn has made a commitment to develop and evaluate alternatives for internal actions that will resolve the issue.

DOCUMENTATION FOR CONFIRMED ISSUE:

Black Gold Airport has been closed on some nights by smoke from land management open burning.

Locale: *Downspout Airshed*

Issue-Resolving Criteria: *The Black Gold Airport will not be closed by smoke from land management open burning.*

Commitments of Technical Specialists & Resources: *Arbor Berry Farms, Inc. has committed itself to hiring a consultant to identify meteorological specifications by which producers can avoid sanitation burning on afternoons when inversions may trap smoke in the vicinity of Black Gold Airport.*

Suggestions & Special Instructions: *Arbor Berry Farms, Inc. representative will report back to Process Panel on accomplishment by 6/8.*

Continuation PART III, DETAILS

DETAILS: ALTERNATIVES DEVELOPMENT & EVALUATION

The work of this Process Segment is mainly done by technical specialists assigned from participating organizations under commitments made by the representing decision-makers. Following the specialists' work, the decision-makers are to reenter the Process in the next main segment on page 34.

Technical specialists are to supply decision-makers with recommendations supported by formal reports as requested. Appendices to these reports may include draft proposals (such as for a residues utilization outlet), draft smoke management operating plans, specially added technical assessments (when needed to determine the extent of a problem underlying an issue), etc.

This segment is not intended to stand alone even though it contains a fair amount of supplementary material, including references to Workbook appendices. It is expected technical specialists will bring to bear the professional skills, personal knowledge, and literature necessary for innovation. The Selected References Section of this Workbook is also provided for their use in starting appropriate literature searches.

Two Types of Alternatives are to be of Concern

The first type of alternative discussed is that of substitutes for land management open burning. The second type of alternative is when open burning is the selected practice.

Alternatives Routinely Evaluated in Selecting a Land Management Practice. It is the purpose of this subsection to review those alternatives routinely evaluated by land managers in order to select the best practice; open burning is one such alternative.

The tabular summaries employed, starting on the next page, must be recognized as generalizations. Evaluation points accorded positive, negative, and negligible effects in these tables must not only be interpreted again for local areas, they must still be viewed as needing site-specific interpretations.4/

It has seemed unnecessary to display the relative effects of foregoing treatment. This alternative is suggested only where tract-by-tract evaluations indicate that the land and the air will both benefit. On such a basis, foregoing treatment is often selected; but in the overall, the net effect of using fire to reduce the air quality and other impacts of wildfires, plus the obvious benefits to the land management goal, do not lead to emphasis for this alternative.

4/ Evaluation Points in the tables are in terms of effects. "Natural Proc's Depend'cy" refers to a dependency upon natural processes in the management of certain lands (e.g., as in Wilderness). "Pest (Non-Disease) Contr." refers to control of insect, plant, and animal pests.

Continuation PART III, DETAILS: ALTERNATIVES DEVELOPMENT & EVALUATION

Alternatives Routinely Evaluated in Selecting a Land Management Practice.

INCREASED RESIDUES UTILIZATION

AVAILABILITY: Subject to markets, materials handling, and transportation $ & energy costs

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	N	–
Air Quality	+	1	Pest (Non-Disease) Contr.	–	–
Capital Investment	2	3	Site Preparation	4	4
Cost/Return	2	3	Soil Erosion	N	N
Disease Control	N	N	Soil Fertility	N	5
Esthetics	+	+	Soil Friability	N	N
Energy Conservation	N	3	Suitabl'ty to Wetlands	N	N
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	N	N
Fire Risk	N	N	Suitabl'ty to Understory	N	–
Native Fauna	N	N	Water Quality	+	+
Native Flora	N	N	Water Quantity	N	0

A = In agricultural lands Z = In all other lands
+ = Effect generally positive – = Effect generally negative
0 = Effect generally negligible N = Not evaluated

1. Timber residues used in home heating may be negative effect; 2. May require subsidy for individual farmer; 3. May call for consideration in wider working circle for timber - net energy units a caution considering fuel for equipment; 4. Can be negligible if needles & twigs and other small material left, then burned...on south aspects may need to leave larger material for shading; 5. Can be negligible if needles & twigs and other small material left, then burned.

MECHANICAL CHOPPING

AVAILABILITY: Subject to suitable equipment being manufactured for type of material to be treated

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	N	–
Air Quality	+	+	Pest (Non-Disease) Contr.	0	+
Capital Investment	–	–	Site Preparation	+	+
Cost/Return	–	–	Soil Erosion	0	0
Disease Control	–	–	Soil Fertility	–	–
Esthetics	–	–	Soil Friability	1	1
Energy Conservation	–	–	Suitabl'ty to Wetlands	–	–
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	–	–
Fire Risk	0	0	Suitabl'ty to Understory	N	–
Native Fauna	0	0	Water Quality	+	+
Native Flora	–	–	Water Quantity	0	0

A = In agricultural lands Z = In all other lands
+ = Effect generally positive – = Effect generally negative
0 = Effect generally negligible N = Not evaluated

1. Soil friability effect is too site-specific to generalize for this practice.

Continuation PART III, DETAILS: ALTERNATIVES DEVELOPMENT & EVALUATION

Alternatives Routinely Evaluated in Selecting a Land Management Practice.

AIR CURTAIN TYPE DEVICES

AVAILABILITY: Some commercially available for trench or pit use. Vat type not known to be on market.

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	N	-
Air Quality	+	+	Pest (Non-Disease) Contr.	0	0
Capital Investment	-	-	Site Preparation	+	+
Cost/Return	-	-	Soil Erosion	0	2
Disease Control	1	0	Soil Fertility	N	3
Esthetics	+	+	Soil Friability	N	N
Energy Conservation	-	-	Suitabl'ty to Wetlands	-	-
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	-	-
Fire Risk	-	-	Suitabl'ty to Understory	-	-
Native Fauna	0	0	Water Quality	0	2
Native Flora	N	-	Water Quantity	0	0

A = In agricultural lands   Z = In all other lands
+ = Effect generally positive | - = Effect generally negative
0 = Effect generally negligible | N = Not evaluated

1. Could have application to burning of diseased orchard clippings; 2. For timber residues & trench type, would call for an excessive amount of trenching in many situations - vat type may have application to some rights-of-way work; 3. Effect on soil fertility would be negligible if needles & twigs not removed from site.

HAUL & INCINERATE

AVAILABILITY: Commercial equip't is available

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	N	-
Air Quality	+	+	Pest (Non-Disease) Contr.	0	-
Capital Investment	-	-	Site Preparation	+	+
Cost/Return	-	-	Soil Erosion	-	-
Disease Control	+	+	Soil Fertility	0	1
Esthetics	+	+	Soil Friability	-	-
Energy Conservation	-	-	Suitabl'ty to Wetlands	-	-
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	-	-
Fire Risk	0	0	Suitabl'ty to Understory	-	-
Native Fauna	0	0	Water Quality	+	+
Native Flora	N	0	Water Quantity	0	0

A = In agricultural lands   Z = In all other lands
+ = Effect generally positive | - = Effect generally negative
0 = Effect generally negligible | N = Not evaluated

1. If needles & small twigs left, then burned, effect is negligible.

Continuation PART III, DETAILS: ALTERNATIVES DEVELOPMENT & EVALUATION

Alternatives Routinely Evaluated in Selecting a Land Management Practice.

B U R Y I N G

AVAILABILITY: Locations to accomplish may be limited due to stumps &/or crop production area needs

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	-	-
Air Quality	+	+	Pest (Non-Disease) Contr.	0	0
Capital Investment	-	-	Site Preparation	1	1
Cost/Return	-	-	Soil Erosion	-	-
Disease Control	-	-	Soil Fertility	-	-
Esthetics	-	-	Soil Friability	-	-
Energy Conservation	-	-	Suitabl'ty to Wetlands	-	-
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	-	-
Fire Risk	0	0	Suitabl'ty to Understory	-	-
Native Fauna	N	0	Water Quality	N	-
Native Flora	N	-	Water Quantity	0	0

A = In agricultural lands Z = In all other lands
+ = Effect generally positive | - = Effect generally negative
0 = Effect generally negligible | N = Not evaluated

1. Site prep can be negative if much area taken out of production and/or if promotes growth of root rot.

C H E M I C A L

AVAILABILITY: Few chemicals available to substitute for fire

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	-	-
Air Quality	-	-	Pest (Non-Disease) Contr.	N	N
Capital Investment	-	-	Site Preparation	+	+
Cost/Return	-	-	Soil Erosion	0	0
Disease Control	+	+	Soil Fertility	+	+
Esthetics	0	0	Soil Friability	N	N
Energy Conservation	-	-	Suitabl'ty to Wetlands	N	N
Fire Hazard	1	1	Suitabl'ty to Steep Terr.	-	-
Fire Risk	0	0	Suitabl'ty to Understory	N	N
Native Fauna	N	N	Water Quality	N	N
Native Flora	N	N	Water Quantity	0	0

A = In agricultural lands Z = In all other lands
+ = Effect generally positive | - = Effect generally negative
0 = Effect generally negligible | N = Not evaluated

1. No chemical known by which flame retardant characteristic is permanent in open. No chemical known & no biologic agent known by which woody materials decay made more rapid.

Continuation PART III, DETAILS: ALTERNATIVES DEVELOPMENT & EVALUATION

Alternatives Routinely Evaluated in Selecting a Land Management Practice.

MOBILE SANITIZER INCINERATOR

AVAILABILITY: Experimental only

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	N	N	Natural Proc's Depend'cy	N	–
Air Quality	+	+	Pest (Non-Disease) Contr.	+	N
Capital Investment	–	–	Site Preparation	+	N
Cost/Return	–	–	Soil Erosion	N	N
Disease Control	+	N	Soil Fertility	+	N
Esthetics	N	N	Soil Friability	N	N
Energy Conservation	–	–	Suitabl'ty to Wetlands	–	–
Fire Hazard	+	N	Suitabl'ty to Steep Terr.	–	–
Fire Risk	–	–	Suitabl'ty to Understory	–	–
Native Fauna	0	N	Water Quality	N	N
Native Flora	+	N	Water Quantity	N	N

A = In agricultural lands; Z = In all other lands
+ = Effect generally positive; – = Effect generally negative
0 = Effect generally negligible; N = Not evaluated

DISCING

AVAILABILITY: Commercial units in use

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	N	–
Air Quality	+	+	Pest (Non-Disease) Contr.	+	+
Capital Investment	–	–	Site Preparation	+	+
Cost/Return	–	–	Soil Erosion	–	–
Disease Control	–	–	Soil Fertility	–	–
Esthetics	0	–	Soil Friability	N	N
Energy Conservation	–	–	Suitabl'ty to Wetlands	–	–
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	–	–
Fire Risk	0	0	Suitabl'ty to Understory	–	–
Native Fauna	–	–	Water Quality	–	–
Native Flora	–	–	Water Quantity	0	0

A = In agricultural lands; Z = In all other lands
+ = Effect generally positive; – = Effect generally negative
0 = Effect generally negligible; N = Not evaluated

Continuation PART III, DETAILS: ALTERNATIVES DEVELOPMENT & EVALUATION

Alternatives Routinely Evaluated Before a Land Management Practice Like Open Burning is Selected.

O P E N B U R N I N G

AVAILABILITY: Widely applied

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	N	+
Air Quality	1	1	Pest (Non-Disease) Contr.	+	+
Capital Investment	0	0	Site Preparation	+	+
Cost/Return	+	+	Soil Erosion	3	3
Disease Control	+	+	Soil Fertility	+	+
Esthetics	+	+	Soil Friability	0	0
Energy Conservation	0	0	Suitabl'ty to Wetlands	+	+
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	+	+
Fire Risk	2	2	Suitabl'ty to Understory	+	+
Native Fauna	N	+	Water Quality	–	–
Native Flora	N	+	Water Quantity	N	+

A = In agricultural lands | Z = In all other lands
+ = Effect generally positive | – = Effect generally negative
0 = Effect generally negligible | N = Not evaluated

1. Generally negative, but tradeoffs are demonstrated where prescribed fire has reduced total emissions when all burning, plus wildfire, has been evaluated;
2. Depends upon area -- certain number of fires are lost from control annually; 3. Effect negligible when parameters are properly specified.

Alternatives Routinely Evaluated When Open Burning Has Been Selected. Once the decision is reached to employ the open burning practice, additional alternatives are routinely evaluated. These impose certain pre-burning requirements which constrain the operation.

The more common of these are here summarized in the same tabular format used in the preceding section. Here again, local factors and site-specificity must be taken into account. These are generalizations.

SCHEDULING

AVAILABILITY: Limited only as to experience & indicated need

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	N	+
Air Quality	+	+	Pest (Non-Disease) Contr.	+	+
Capital Investment	1	1	Site Preparation	+	+
Cost/Return	–	–	Soil Erosion	3	3
Disease Control	+	+	Soil Fertility	+	+
Esthetics	+	+	Soil Friability	0	0
Energy Conservation	0	0	Suitabl'ty to Wetlands	+	+
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	+	+
Fire Risk	2	2	Suitabl'ty to Understory	+	+
Native Fauna	N	+	Water Quality	–	–
Native Flora	N	+	Water Quantity	N	+

A = In agricultural lands Z = In all other lands
\+ = Effect generally positive – = Effect generally negative
0 = Effect generally negligible N = Not evaluated

1. Generally negligible—could be high for very sophisticated program of scheduling; 2. Losses of fires from control would increase in impact if schedule is for higher fire danger; 3. Effect negligible when parameters properly specified.

CHEMICAL DESICCANT PRETREATMENT

AVAILABILITY: Limited number of approved chemicals

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	N	–
Air Quality	1	1	Pest (Non-Disease) Contr.	+	+
Capital Investment	–	–	Site Preparation	+	+
Cost/Return	–	–	Soil Erosion	3	3
Disease Control	+	+	Soil Fertility	+	+
Esthetics	–	–	Soil Friability	0	0
Energy Conservation	–	–	Suitabl'ty to Wetlands	+	+
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	+	+
Fire Risk	2	2	Suitabl'ty to Understory	0	0
Native Fauna	+	+	Water Quality	–	–
Native Flora	–	–	Water Quantity	N	+

A = In agricultural lands Z = In all other lands
\+ = Effect generally positive – = Effect generally negative
0 = Effect generally negligible N = Not evaluated

1. In that hotter fire results, effect is positive;
2. Depends on area—certain number of losses of fires from control annually. 3. Effect negligible when parameters properly specified.

Continuation PART III, DETAILS: ALTERNATIVES DEVELOPMENT & EVALUATION

Alternatives Routinely Evaluated When Open Burning Has Been Selected

PILE OR WINDROW AND BURN

AVAILABILITY: Widely practiced

EVAL'N POINTS	A	Z	EVAL'N POINTS	A	Z
Accessibility	+	+	Natural Proc's Depend'cy	N	–
Air Quality	1	1	Pest (Non-Disease) Contr.	+	+
Capital Investment	–	–	Site Preparation	+	+
Cost/Return	–	–	Soil Erosion	–	–
Disease Control	+	+	Soil Fertility	0	0
Esthetics	–	–	Soil Friability	2	2
Energy Conservation	–	–	Suitabl'ty to Wetlands	+	+
Fire Hazard	+	+	Suitabl'ty to Steep Terr.	+	+
Fire Risk	0	0	Suitabl'ty to Understory	+	+
Native Fauna	0	0	Water Quality	N	N
Native Flora	N	–	Water Quantity	N	N

A = In agricultural lands Z = In all other lands
+ = Effect generally positive – = Effect generally negative
0 = Effect generally negligible N = Not evaluated

1. Effect can be dramatically positive for larger residues materials piled in large piles -- soil admixture must be held to less than 30% — residual smoke can cause problems if pile or windrow is damp and fuels do not burn clean early in same day ignited; 2. Where machine piling and windrowing, must be done during drier cycles to avoid negative effect.

Alternatives Identified for Emphasis Due to Special Potentials To Benefit Air Quality

Although the effects of alternatives in the preceding subsections are generalized, they do point to 2 for special emphasis due to their potentials to benefit air quality.

Increased Utilization Of Residues. Energy and products possibilities from both agricultural and timber harvesting residues have been widely discussed. Those residues which remain unused are accounted for in terms of markets, capital investments in the face of uncertain supplies, logistics, and net energy balances.

Logs which may appear sound to the untrained observer may be worthless as raw material for wood products. This is due to hidden defects, distance to market, or lack of current end-product markets. Handling costs are higher for combinations of large and small sizes of logs and for logs with different end-product suitabilities.

Widened circles of operation, joint ventures, commitments by public agencies to assure supplies, and other innovations have potentials for an acceleration of residues use.

Increased Utilization Of Residues Continued

Marketing of standing timber is dependent upon the installed capacities and capabilities of potential purchasers. Large industrial firms will usually have capabilities for utilization, or for sorting and sales of special materials to others. These capabilities are not available to all potential purchasers of timber. The market for forest products, as affected by both the national economy and locations of processing plants, also bears heavily on utilization.

Particularly on public lands in the Western States, the practice of yarding residues to a central point following harvesting of timber has led to increased interest in the use of these piles of material. With the cost of yarding written off as a public expense to reforest the land due to air quality constraints, an economic incentive has been provided.

Some wood products firms have found it feasible to cogenerate electricity, or to increase utilization of residues for wood-derived energy in other forms (e.g., steam). A broad preliminary investigation of the residues potentials and energy-balance relationships (i.e., the net energy units produced after consumption of all necessary hauling and materials-handling fuel energy units) could delineate new areas where further evaluations are worthwhile. These evaluations would need to deal with marketing, amortization schedules (in particular, where expected changes in age classes of timber to be harvested will mean reduced residues in a relatively short time frame), and other environmental benefits and costs.

If such evaluations are made, they should give consideration to the growing demand for fibre to be used in residential heating. One home in 10 is now burning wood for heating. If this is considered in relation to the increase reported in emissions from woodstoves, fireplaces, and furnaces, it is reasonable to speculate that a new market opportunity could be developed. The challenge of the current situation is that it has the effect of moving a rural problem into an urban area.

Scheduling

The scheduling alternative is employed to different levels of sophistication to meet specified smoke production and dispersion conditions. Sometimes this is merely labeled "Meteorological Scheduling;" but as will be discussed below, the scheduling can include more.

Where appropriate, 2 applications of scheduling will be found within a single smoke managment operating plan: scheduling applied to basic air quality management; scheduling applied to visibility protection. These are discussed separately here to provide a logical progression from the basic need to that which may be found appropriate on a more limited basis.

SCHEDULING APPLIED TO BASIC AIR QUALITY MANAGEMENT. Smoke management planning will usually include an analysis of the climatology for the burning season or seasons. This analysis will be useful in determining how readily the total burning job can be accomplished, based upon the number of days when specifications that have been established for different burning situations can be met.

In areas where analysis shows an ample number of burning days, the job of scheduling on an operational basis is merely one of indicating the maximum number of burns expected to be possible on any one day. The management task is simply one of matching burns with certain specifications to the forecast conditions...then, depending upon need, of setting a limit on the total number of burns to be carried out (for airsheds or other sub-areas).

When the analysis shows that the number of burning days is limited for the job load to be accomplished, it may be necessary to provide for budgeting and rebudgeting of the burn schedule. Rebudgeting of burn schedules permits sometimes more, and sometimes less, than a predetermined number of burns for a particular day (depending upon the day's departures from the climatological norms for specified conditions). For this purpose, prior agreement between organizations on the priorities to be used is essential. Another essential is to have agreement on ways that rebudgeting negotiations between a smoke management coordinator and the burners is to take place.

With advance agreement on priorites and negotiation procedures, scheduling with provision for rebudgeting is effective in avoiding a rush of too many burns on the first few good days of a season. This can also avoid having to set specifications so that some less than optimum days are lost to getting the job done with a few carefully chosen burns.

Most importantly, good budgeting and rebudgeting of the burning schedule can effectivly utilize those peaks of better-than-average smoke dispersion conditions that are not available to day-in-day-out emmisions sources.

Appendix A to this Workbook contains three sub-appendices (A1, A2, A3) suggested as technical aids to development of a smoke management operating plan by which scheduling is carried out. Where needed, operating plans become the vehicle for developing a full-fledged smoke management program.

Appendix B to this Workbook offers some information on aids available for predicting downwind concentrations of total suspended particulate matter, suggested earlier in this text as the best available emission estimate by which smoke management can be effected at this time.

SCHEDULING APPLIED TO VISIBILITY PROTECTION. The basic concept underlying application of scheduling to visibility protection is that there will usually be times when the responsible Federal land manager will experience variations in the need for affording views. Beyond that basic concept, it is possible that even at peak visitation times, or even at low visitation times, some acceptable or unacceptable visibility characteristics can be specified.

In carrying this concept forward, it is desirable that the smoke manager be provided with an objective measure against which he can make planning predictions. For example, the measure can be a specified visiblity characteristic like values assigned to changes in sky/terrain contrast. Such objective measures simplify quality assurance on the smoke management job being done. opinion, loosely stated about desired visibility, is not apt to serve well for this purpose.

An aid for determining visibility protection needs for Class I Federal Areas is supplied as appendix C to this Workbook. It will be noted that this suggested aid provides for the responsible Federal land managers to carry out their affirmative responsibility, mandated by Congress. A State following the process outlined in this Workbook may find that this aid will supply the necessary inputs from these Federal land managers so that visibility protection through scheduling in smoke management plans can be a reality under the present state of the art.

DOCUMENTATION, IMPLEMENTATION

A documentation checklist supplied under this title in PART II is suggested as a basic tool by which the Lead Agency can carry out the documentation job.

Just as this is made the final process segment and the final section in the main Workbook text, the documentation on hand and the implementation yet to be carried out should be made a final subject of discussion between process participants. Some of the implementation tasks may require a fairly long time period for completion. Some may result in new alternate paths being chosen.

A second checklist of questions for both the Lead Agency and the participants to maintain and consider in their closing discussions is started below. As work progresses through the process, additional items for such a checklist will be identified by participants.

____ Will a promise card file be needed for followthrough?

____ How are commitments to actions to be assured?

____ Will public involvement be needed for any of the proposed actions, and how is this to be coordinated with the public involvment requirements of other organizations?

____ If public involvement results in a need to make revisions to planned actions, how are participating organizations to be brought back to make any decisions or further commitments to technical support?

____ Have any needed authorities been properly identified, and how are they to be assured? What are the alternatives if legislation does not result in needed authorities?

APPENDIX A - AIDS TO DEVELOPING & EVALUATING A SMOKE MANAGEMENT PROGRAM

APPENDIX A - AIDS TO DEVELOPING & EVALUATING A SMOKE MANAGEMENT PROGRAM

At the outset, it must be stressed that SMOKE MANAGEMENT PROGRAMS SHOULD ONLY BE IMPLEMENTED WHERE THERE IS A DEFINITE NEED.

A simplified operating plan may in itself be useful to help field units maintain air quality to acceptable levels, without the formality of a Smoke Management Program. No program, however, should be without an operating plan.

This appendix is in three parts:

Appendices A1 and A2 complement each other, with the latter suggesting the kinds of questions that planners should address. Both appendices should be regarded as the framework by which an operating plan appropriate to a particular situation can be developed. Neither is intended for uniform application.

Where the need is simple, the headings of the outline in appendix A1 may survive, but not all of the content indicated by annotation would be appropriate. Similarly, not all of the questions in appendix A2 would need to be answered; this is why it is called a "checklist."

Having reviewed the questions in appendix A2, the reader will already have a grasp of the degree of sophistication likely to be needed for an area under consideration. Appendix A3 is intended to help with judging this further, and with matching some possibly appropriate management approaches.

A further starting note to users seems appropriate here. Participants in the process suggested by this Workbook are normally advocates from either air quality or land management orientations. As advocates of separate functional specialties, they may see needs differently, even though they may be working together to solve a common problem. In an endeavor with as many areas lacking in rigid guidance as smoke management program development and evaluation, it will be difficult, but beneficial, if those from different specializations recognize the strengths of expertise available in a joint venture. Subjugation of the advocacy roles expected naturally of individuals working daily to advance separate objectives is essential to obtaining the best product.

APPENDIX A1 - ANNOTATED SAMPLE SMOKE MANGEMENT OPERATING PLAN OUTLINE

The following sample outline and annotations are adapted from work toward a plan developed for actual use while testing this appendix. Note that beyond the addition of an introduction, the major headings correspond to the 3 smoke management functions identified in the text.

I. INTRODUCTION

A. Purpose [What the plan is to accomplish.]

B. Background [What led to development of the plan.]

II. APPRAISAL FUNCTION

A. Existing situation

1. Confirmed issues

2. Issue-resolving criteria

3. Supplemental criteria
[Common sense avoidance of other potential problems.]

4. Smoke management & fire use policy
[Identifies both that which supports this plan and that which may require substantial modification.]

B. Technical assessment

1. Analysis of "smoke events"
[Summarizes results of analyses using best available data to reconstruct the fuels, fire, and dispersion conditions leading to events covered by locally relevant and available documentation on the drift, effects, and nature of smoke from open burning.]

2. Analysis of climatologically based weather parameters
[Summarizes results of analyses using available weather records for months when land management open burning may be conducted.]

NOTE: See appendix B to this Workbook for some possible aids to the analyses to be done in B.1 and B.2.

3. Analysis of needs for Class I Federal Areas visibility protection
[See appendix C to this Workbook for a possible approach.]

4. Analysis of indicated level of sophistication
[Summarizes results of matching possible management approaches to the local situation. See appendix A3 to this Workbook for a possible aid.]

APPENDIX A1 continued

C. Alternatives development & evaluation

1. Alternatives to the use of land management open burning

[Briefly localizes the pros and cons of alternatives from the tabular summaries in this Workbook.]

2. When open burning has been selected, alternate ways of preparing for, scheduling, and carrying out this practice

[Briefly localizes the pros and cons of alternatives from the tabular summaries in this Workbook. Summarizes tests of candidate combinations of values to be used in III, below.

See appendix B to this Workbook for some possible aids to the analyses to be done.]

D. Conclusions

[Regarding development of specifications and scheduling function and execution function.]

III. SPECIFICATIONS AND SCHEDULING FUNCTION

A. Specifications when other than land management open burning is the selected alternative

[Developed to encourage employment of alternatives when feasible.]

B. Specifications when land management open burning is the selected alternative

[Tables are used in both A and B to provide specified value ranges by locales, fuel types, and (in the case of those for B) categories of pretreatment and firing patterns For A, the values specify when alternatives to open burning may be preferred. For B, the values specify under what conditions burning may be conducted, as well as when mopup may be needed.]

C. Scheduling of burns

[For critical source locales, developing a schedule of burns, based upon the specifications (in III.B), the burning load, and a burning season(s) climatology. Where visibility protection for Federal Class I Areas is part of the plan, also incorporating any developed specifications and time period provisions.]

IV. EXECUTION FUNCTION

A. Receipt and dissemination of weather information

APPENDIX A1 continued

B. Coordination

1. Internal

   a. Smoke management weather interpretations

   b. Burn schedule rebudgeting
      [Priorities agreed to in advance; use in advancing a "Rebudgeted Schedule;" provisions for negotiation when conditions are limiting and field burners are dealing with factors not considered in rebudgeting analysis.]

   c. Feedback & negotiation

2. External

   a. State air quality - advance notices and special alerts

   b. Adjoining burners (i.e., those organizations which may impact upon the same areas, but which are not currently participants in this plan) [Burn notification, impacts discussions, and negotiation.]

   c.

C. Quality assurance

1. Evaluations of current smoke observations, "smoke events & episodes," complaints

2. Air quality monitoring

3. Accomplishment reporting

D. Steering Group makeup, need for special authorities

[Even if the smoke management program covered by the plan is internal to one organization, it may be desirable to provide for a steering group made up of the line officers of sub units. When more than one organization is participating in the Program, a steering group may be seen as essential. In some cases, new legislation or other authority may be needed for a Smoke Management Program to be carried out.]

E. Staffing, day-to-day direction, and administration of coordinator group

[Especially when more than one organization participates in the Program, the operating plan should set forth not only the staff requirements, but how the staff will be directed and who will be responsible for administration.]

APPENDIX A1 continued

F. Funding

1. Coordinator staff group expense

2. Quality assurance expenses

3. Other overhead and smoke management administration expenses

4. Pretreatment and burn execution expenses as a consequence of meeting air quality objectives
[Discusses monetary and other cost impacts, possible availability of special internal account(s) to be made available when unforseen weather changes force mopup or other emergency actions.]

G. Provision for Plan Updates
[Covers cut-and-fit nature of plan, how any current revisions to the plan are to be effected, and how new plans are to be issued every 5 years.]

DEFINITIONS

APPENDICES [Made part of file copy only...includes analyses summarized in II, above]

SUPPLEMENTAL ANALYSES [Made part of file copy only...covers analyses of possible new alternatives and specifications with promise, but needing further field evaluation or policy changes before these can be made part of the operating plan.]

APPENDIX A2 - CHECKLIST FOR SMOKE MANAGEMENT OPERATING PLAN DEVELOPMENT

Starting with the Appraisal Function of smoke mananagement, this appendix amplifies further the sample outline and notations presented in appendix A1. While the same main headings are used as in the preceeding outline, questions to be answered in developing a plan are given here in sequence. Since not all questions relate to all situations, this permits the user to check off, or separately list, those appropriate to his situation.

Here then, is a checklist for use if a plan is needed.

THE APPRAISAL FUNCTION

Existing Situation

___ 1. Have any issues been formally identified? If issues have been confirmed, what are the issue-resolving criteria established for them? (This will bear directly upon the alternatives and the specifications evaluated in preparing a smoke management operating plan.)

___ 2. What are the supplemental criteria by which alternatives and specifications should be tested? (Besides those issues which have been formally identified, there will be common sense knowledge of the kinds of impacts to avoid in order to resolve in advance other problems that might develop in the absence of a plan.)

___ 3. What is the present policy (or "standard operating procedure") regarding the use of fire and smoke management...are policy changes needed?

Technical assessment

[As indicated in appendix A1, possible aids to technical assessment may be found in appendices A3, B, and C to this Workbook.]

4. Air quality considerations for areas impacted by smoke from land management open burning (LMOB)

___ a. Are National Ambient Air Quality Standards for particulates exceeded or predicted to be exceeded?

___ b. What is the ambient air quality level to which may be added smoke from LMOB?

___ c. Do air quality data indicate concentrations of gaseous pollutants from other sources that could be absorbed or adsorbed on particulates to result in synergistic health effects?

___ d. Does smoke from LMOB cause visibility problems from the standpoint of traveler safety on highways, airports, airport approaches, etc.?

APPENDIX A2 continued

___ e. Is there a need to identify item d locations or other areas as Smoke Sensitive Areas?

___ f. Are there Federal Class I Areas for which visibility protection will be an objective of this plan, and what will be the requirements for protection?

___ g. Does the topography of the area importantly influence smoke dispersion? Will this lend itself to delineation of locales for differing specifications and scheduling treatment under this plan?

___ h. Does the meteorology of the area cause important dispersion or stagnation problems?

___ i. Are both prescribed burning and agricultural burning conducted in the area under consideration? (See 5 and 6, below.)

5. Prescribed burning considerations in the area under study

___ a. Is (are) the season(s) the same for agricultural open burning?

___ b. What is the current level of burning in the area of concern, broken down by:

(1) Burning type - broadcast, pile, etc.

(2) Fuel loading - net available tons/acre

(3) Fuel type

(4) Season of burning

(5) Other

___ c. What is the proposed level of burning in the future, broken down as above. The following should be considered in making these determinations:

(1) Will timber harvest increase, decrease, remain the same?

(2) Will there be increased utilization of residue for chips, hogged fuel, firewood, other?

(3) Will there be an increase in the use of fire for:

(a) silvicultural purposes

(b) range improvements

APPENDIX A2 continued

(c) wildlife habitat improvement

(d) fuels management?

(4) Will there be major construction projects such as reservoirs, ski areas, roads, etc.?

___ d. Are there limitations on the number of days available to do burning because of:

(1) Fire hazard

(2) Fuel moisture (both of living and dead fuels)

(3) Availability of manpower and equipment

(4) Stages of vegetation development

(5) Wildlife calving, nesting, etc., seasons

(6) Periods of heavy visitor use of forested areas, i.e., hunting season, holidays, etc.

(7) Livestock use

(8) Other?

6. Agricultural burning considerations

___ a. Is (are) the season(s) the same for prescribed burning?

___ b. What is the current level of burning in the area of concern, broken down by:

(1) Burning type - broadcast, pile, etc.

(2) Fuel loading - net available tons/acre

(3) Fuel type

(4) Season of burning

(5) Other?

___ c. Will the future (next 5-10 years) level of burning be affected by foreseeable changes in crop types, farming methods, or land use changes?

___ d. Are there limitations on when the burning can be done (such as broadcast burning type, fuel moisture, fire hazard), or can burning be deferred for extended periods?

___ 7. How do the indicated preferred alternatives and specifications test against criteria set forth above, and against a burning season(s) climatology for opportunities to get the job done?

APPENDIX A2 continued

___ 8. What level of sophistication (with what matching management options) will be needed to carry out the execution function?

Alternatives development and evaluation

___ 9. What alternatives to land management open burning are viable in the area under consideration?

___10. What are the alternate categories of pretreatments, firing patterns, and alternative schedules for open burning that are practical in the area under study? Is mopup a likely post-treatment need?

Conclusions

11. From the Appraisal now completed (Questions 1 through 10, above), what conclusions can be reached regarding:

___ a. The need for a Smoke Management Operating Plan...for a formal Program?

___ b. The specifications and scheduling function (to be answered further starting with question 12)

___ c. The execution function (to be answered further, starting with question 16)?

SPECIFICATIONS AND SCHEDULING FUNCTION

Specifications when other than land management open burning is the selected alternative

___12. Have viable alternatives to land management open burning been identified with definable locales, fuel types, and situations lending themselves to specifications which will encourage their employment?

Specifications when land management open burning is the selected alternative

___13. Can land management open burning situations be identified by locales, fuel types, and pre- and post-treatments in order to specify season(s) and conditions under which burning can be expected to be permitted?

Scheduling of burns

___14. Are there critical locales for which a tentative schedule of burns should be developed, using the specificatons above, the burning load, and a burning season(s) climatology?

___15. If visibility protection for Class I Federal Areas is an objective of this plan, have specifications been developed to meet this need?

APPENDIX A2 continued

EXECUTION FUNCTION

Receipt and dissemination of weather information

16. Data processing

___ a. Do topographic influences make smoke management weather interpretations difficult?

___ b. Do specific meteorological conditions make it difficult to develop dispersion forecasts?

___ c. Are suitable dispersion models available for the area?

___ d. What type of meteorological data are currently available in a usable form?

___ e. What additional meteorological data are needed, and how can it be obtained?

___ f. How far in advance is it possible to make smoke management weather interpretations?

___ g. What data specific to the fuels and fire types is needed?

___ h. What type of facility, funding, and manpower commitment is needed for data handling?

Coordination

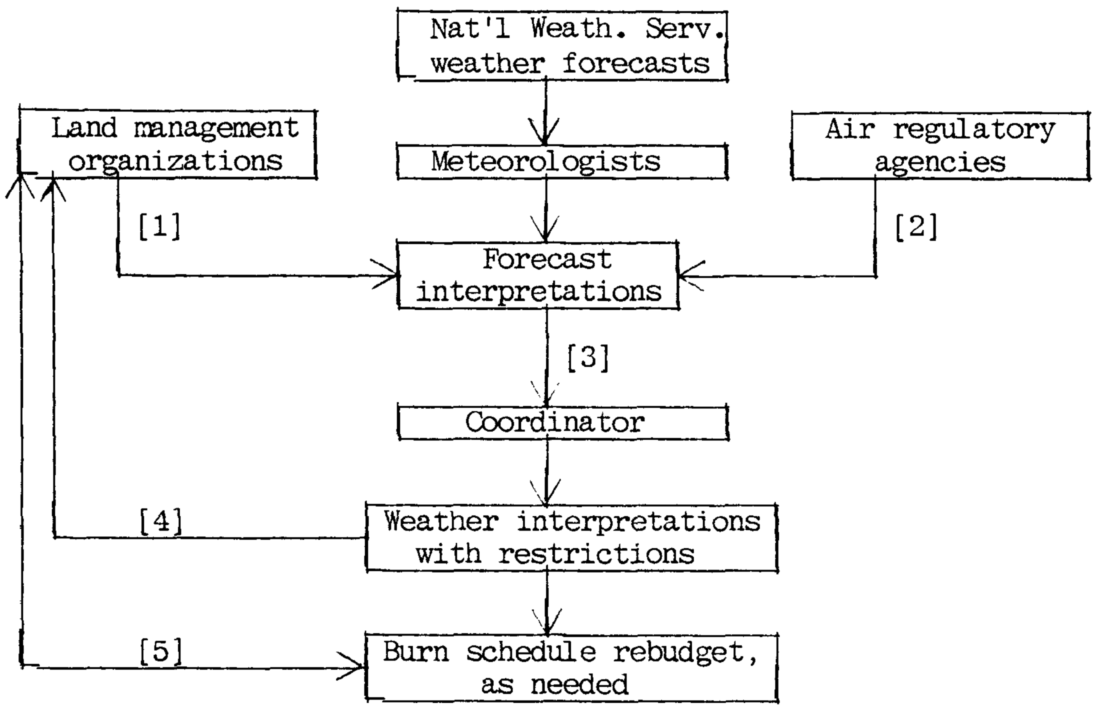
The following supplemental information on smoke management coordination may be useful in answering the questions in this section.

When more than one organization is participating in a Smoke Management Program, member organizations should agree upon how daily coordination will be handled. The lead coordination function may be assigned to one or more member organizations, or to an independent group.

Coordination activities are illustrated by the flow diagram and accompanying notes starting on the next page.

APPENDIX A2 continued

A simplified diagram of the coordinator's daily flow of work is shown below:



Notes on the flow paths of the above diagram, shown as [ ], are as follows:

[1] Burn data should be supplied as far in advance as possible. In many cases this can be months in advance of the burning season. It should come to the Coordinator in a uniform format.

[2] In many cases, real-time air quality data will not be available; but the air regulatory agency should, however, assist with estimates of ambient (i.e., "background") pollutant levels; contact the Coordinator when complaints are received from the public and air pollution alerts are called.

[3] The Coordinator may be the same person (or staff) developing the Smoke Management Weather Interpretations. Meteorological data from all sources should be submitted to the Coordinator in a uniform format.

[4] The Coordinator must develop and communicate the weather interpretations and alerts in a timely fashion.

[5] On a particular day, the dispersion conditions may be either more or less favorable than the climatologically determined schedule of burns anticipates. Where there is a heavy

burning load and burn scheduling has been agreed to, the Coordinator will then have to rebudget the schedule to no more burns than can be accomodated. With favorable conditions and by direct communication with burners, rebudgeting for additional burning may also be possible. NOTE here, that the diagram provides for a flow of communication in both directions, indicating negotiated rebudgeting.

In addition to the above daily work, individuals functioning as Coordinator should be assigned the following general responsibilities:

Maintain records of all smoke management weather interpretations, restrictions, negotiated changes in budgeted schedule (where applicable), and meteorological inputs.

Compile information on the amount and type of burning that is proposed and accomplished.

Compile information on air quality and land management complaints and problems that result from the operation of the Program.

Make recommendations on possible modifications to the Program.

Prepare an annual report on the operation of the Program, submitting it to member organizations, cooperators, and the media (the latter possibly following approval of a separate press release).

[End of supplemental information, continue now with checklist, under Coordination.]

17. Internal

___ a. Can the data system (carrying forward from question 16, above) be made available as needed to make timely, accurate smoke management weather interpretations? At what hours will these be needed by field personnel, and how will this fit with weather forecast availability?

___ b. If needed, how can the system (in 17a, above) also handle burn schedule budgeting (i.e. allocations of scheduled burning between several operations, some of which may have the potential to impact upon the same area), and accounting for still-pending burns?

___ c. In consideration of 17a and 17b, is a new type of communication and data processing system needed, or will in-place systems meet those requirements necessary to carry out the following in a timely manner: get the weather

APPENDIX A2 continued

interpretations to the burners; if needed, to handle burn scheduling and burn schedule budgeting; carry out negotiations when field units are dealing with factors not routinely taken into account; provide for rapid feedback on interpretations and scheduling?

18. External

___ a. Are there neighboring organizations which have burning programs but which are not likely to participate under this plan?

___ b. What informal coordination can be developed (e.g., burn notifications, impacts assessments, negotiation between designated cooperators)?

___ c. What arrangements can be made to receive air pollution alert and other key information from air quality agency in a timely manner?

___ d. How should public information be handled?

Quality assurance

The following supplemental information on quality assurance for smoke management may be useful in answering the questions in this section.

Any Program needs to have a built-in system which regularly checks to see that the Program is meeting its objectives. Without quality assurance, it is possible for a Program to either fail to maximize its potential or to totally miss the objectives it was designed for. With the problems and costs associated with smoke management, it is not realistic to only "hope" that a Program meets its needs.

Most Smoke Management Programs are based on meteorological forecasts. The accuracy of the weather forecast and resultant interpretations should be checked regularly to make sure Program needs are met.

Both the unit making the weather interpretation and the people in the field should help check for accuracy and sufficiency. It is important that the people doing the burning regularly report what happens to the smoke from their burns. It is not satisfactory to report back "no smoke problem" or "moderate smoke problem." The reports should document the meteorological conditions during the burn, the plume height and direction, residual smoke, etc. This type of information will help the meteorologist improve future interpretations. Also, the burner should report at-site meteorological conditions when he believes the restrictions were too stringent. (Done as a part of the feedback mentioned under internal coordination.)

In some cases it may be necessary to fly over burns to actually track the smoke plumes. Where possible, air quality samples taken during the burn can be used to assess the accuracy of predictions used in making weather interpretations, assigning restrictions, and, when needed, in making up burn schedule budgets.

Hi-Vol Samplers used in monitoring ambient air quality for total suspended particulate matter (TSP) may provide quality assurance data if arrangements can be made to operate monitoring sites on days when the smoke from land management open burning may impact on downwind locations of importance. In the absence of these, data on TSP concentrations can sometimes be obtained through use of an instantaneous-reading electronic device operated by a cooperator in strategic locations at critical times. The purpose, of course, is to determine if criteria (like NAAQS) are being met.

(End of supplemental information, continue now with checklist, under Quality assurance.)

___19. What type of quality assurance system is needed to check the accuracy of weather forecasts, of smoke management weather interpretations, and of the smoke management being practiced?

___20. What in-place monitoring facilities can be used, and what supplementary methods need to be employed?

___21. How should burner feedback and smoke observations ("smoke event reports") be made a part of this system?

___22. What methods should be used to obtain burn accomplishment reporting to make this a part of quality assurance?

___23. How are quality assurance data to be processed, interpreted, and reported upon...and how are the reports to result in any necessary Program changes?

Steering group makeup, need for special authorities

___24. Will a steering group be needed, and what should be its makeup?

___25. Is this to be a voluntary smoke management effort, or has it been decided that in order to meet the "Enforceable Rules" requirement of U.S. EPA, a mandatory Program will be effected? If the latter, are new legislative or other authorities needed?

___26. If a voluntary Program is being planned, can a steering group provide the basis for quasi-official recognition (possibly necessary to avoid a "bad name" being tagged to the smoke management to be practiced if a nonparticipating burner does not practice adequate smoke management)?

APPENDIX A2 continued

Staffing, day-to-day direction, and administration of coordinator group

The following supplemental information may be useful in answering the questions in this section.

The staffing needs for a smoke management coordinator group will vary in relation to the size of the burning Program, the potential for air quality problems, and the complexity of the smoke management itself.

The key areas in which staff is needed are collection and processing of burn data, collection and processing of meteorological data, and formulation and dissemination of smoke management weather interpretations. Staff effort is also needed to carry out quality assurance.

The options for staffing a smoke management coordinator group include:

Using competent in-place personnel by adding to their existing duties. (In the case of Smoke Management Programs with several participating organizations, this may mean that one organization becomes an agreed-to home base for the coordinator group, with responsibility for day-to-day direction and adminstration.)...

and/or...

Hiring or contracting with individuals to work during the months of the year when land management open burning emissions are important. In only a few cases will it be necessary for the smoke management coordinator group to operate at full capacity on a year-round basis. (Under this arrangement, one participating organization may "contract" to others, or all participating organizations may contract to yet another entity, using the steering group as the contract administering body.)

The need for staffing can be reduced if each burning organization collects and forwards its own information on the amount, location, type, etc. of proposed burning. It is important that this information be transmitted to the smoke management unit in a uniform format, well ahead of the burning season.

Where supplementary meteorological data (i.e., surface winds, fuel moisture, temperatures, and winds aloft) are needed, it may again be possible to use in-place personnel of some of the participating organizations to help collect it. This will depend on whether or not any of them have facilities and operations at the locations where the additional data are needed.

It should be noted here that meteorological data may be collected and processed by technicians. Trained meteorologists are needed to use these data for smoke management interpretations.

(End of supplemental informaton; continue now with checklist, under Staffing, day-to-day direction, and administration of coordinator group.)

___27. What numbers and what specializations of personnel are needed to carry out the work of the coordinator group?

___28. What option fits best for supplying these personnel and providing for their day-to-day direction and administration?

Funding

The following supplemental discussion may be useful in answering the questions in this section.

Smoke management may be regarded by some as an air quality function deserving special appropriations. By others, it may be regarded as merely another cost of carrying out the job of land management. These positions pose policy questions which must be answered on a case-by-case basis. A rationale that may be helpful in reaching decisions is the following.

For those expenses which are necessary to meeting criteria like avoidance of NAAQS violations, a parallel could be drawn with the required installation of pollution control devices at a stationary emissions source. Since those installation expenses are borne by the source industry and its consumers, it might then follow that organizations participating in a Smoke Management Program could be expected to pay for its operation.

When more stringent criteria may result from pressures brought to bear by a limited public, the expenses and the possibly forgone natural resources may become special cases. An example would be the criterion to avoid further complaints from a new community in a mountain area where no amount of smoke is tolerated, and intentional use of fire is not understood. In this example, to meet such a criterion, the costs of carrying out alternatives to burning, or of executing burns with expensive pre- and post-burning measures, could be recognized as neither funded, nor with parallels.

Between the extremes just covered are many less easily categorized issues and criteria. In the development of a smoke management operating plan, the needs are: to recommend funding approaches that seem reasonable; to convey any monetary or other costs to the decision-makers for resolution by other means (such as public information and involvement).

If it is decided that participating organizations are to fund the staffing and related expenses of a Smoke Management Program, options for equalizing the expenses may include:

Charge/acre of material burned,

Charge/ton of material burned,

Charge/required day to get the burning done, and/or

Charge/percent of total area under management.

APPENDIX A2 continued

The first two of the above options might provide incentive for participating organizations to reduce the amount of burning they do. Other funding options (among several possible) would be to:

Split all costs evenly between participating organizations;

Provide for an equitable severance fee on all harvested crops (including timber) for which residues or regeneration treatments include the use of land management open burning;

Obtain State enabling legislation which includes an appropriation to pay for at least the basic Program expense.

(End of supplemental information; continue now with checklist, under Funding.)

___29. Do any criteria established by the decision-makers result in monetary or other costs which warrent making recommendations for resolution by means other than this operating plan?

___30. What are the expenses to be covered for

a. The coordinator staff group

b. Quality assurance

c. Other overhead and smoke management administration

d. Pre-treatment, burn execution, and post-treatment as a consequence of meeting air quality objectives?

___31. How are the expenses in each of the above categories to be met?

Provision for plan updates

___32. Is 5 years a satisfactory life for this plan?

___33. How should intermediate revisions be effected?

DEFINITIONS

___34. What terms used within the plan need to be defined?

APPENDICES

___35. Are analyses summarized under the appraisal function of this plan which should be made part of the record by attachment to the file copy?

SUPPLEMENTAL ANALYSES

___36. In the course of carrying out the appraisal function, were any promising alternatives or specifications brought to light which bear further field evaluation and/or policy changes with an eye to making these part of this plan by subsequent revision?

APPENDIX A3 - AN AID TO DETERMINING AN APPROPRIATE LEVEL OF SMOKE MANAGEMENT SOPHISTICATION

The variation to be expected in answers to the questions in appendix A2 should make obvious the area-specific and individualized nature of smoke management planning. No "cookbook" approach can be devised to adequately cover what can be done better by specialists familiar with a local situation. At the same time, however, there are some general concepts which do lend themselves to systematization. These are presented in this appendix as an aid for possible use in hazarding some first-approximation comparisons with matching management approaches.

The 3 main sections of this appendix will supply information in the following sequence:

> Section 1 has been written to provide either for readers who prefer to assign their own "index" of an indicated level of smoke management sophistication, or to obtain the "index" elsewhere. The "index" is then used to obtain some possible matches with suggested smoke management operating procedure options;
>
> Section 2 is for readers whose preference is to defer section 1, first obtaining an "index" of an indicated level of smoke management sophistication by a state-of-art method here advanced for the first time;
>
> Section 3 discusses the bases for development of this appendix.

1. OBTAINING SOME POSSIBLE MATCHES WITH SUGGESTED SMOKE MANAGEMENT OPERATING PROCEDURE OPTIONS

The table beginning on the following page is to be used. Four "index" levels of smoke management sophistication are available for selection, with level "A" being the lowest level of sophistication. An "M" is shown in each of the four "index" columns where a match with a suggested smoke management operating procedure occurs.

> IT MUST BE STRESSED THAT THESE ARE ONLY POSSIBLE MATCHES ... TO BE TREATED AS NO MORE THAN A FIRST APPROXIMATION OF WHAT MAY BE YOUR FINAL SET OF RECOMMENDATIONS.

Use either your own "index" of smoke management sophistication, or one obtained elsewhere. Trace the corresponding index column in the following table for possible matches with suggested procedures.

[Section 2 of this appendix (pages 58 to 64) has been provided as an approach to obtaining an "index," if your preference is to deter section 1 to obtain the index by the method of Section 2.]

It is suggested you circle any "M" in the table which corresponds to a procedure you believe should be recommended for the situation being analyzed. (If you are tracing more than one index column in order to recommend more than one option, different colors of pencil may help to maintain separation.)

APPENDIX A3 continued

TABLE OF SMOKE MANAGEMENT OPERATING PROCEDURES OPTIONS
AND POSSIBLE MATCHES WITH INDICATED
LEVELS OF SOPHISTICATION

SUGGESTED SMOKE MANAGEMENT OPERATING PROCEDURE OPTIONS	POSSIBLE MATCHES (M) WITH INDICATED LEVELS OF SMOKE MANANAGEMENT SOPHISTICATION 1/			
	A	B	C	D
A. OVERALL MANAGEMENT OPTIONS				
1. Inform open burners - use lay language in "Burner's Handbook" with possibly separate editions for agricultural and prescribed burners. Contents: Tips on when & when not to burn; availability of any specially useful weather forecast information; how to obtain any available stagnation, or other related alerts; effects of major fire types and fuel arrangements; best times of day; how to carry out the "cleanest" burn. Open & close with notes recognizing alternatives to burning...benefits to overall air quality.	M	M	M	M
2. Train open burners. Expand upon A.1, above. Emphasize: alternatives; weather forecast interpretation; carrying out "cleanest" burn.		M	M	M
3. Encourage voluntary Smoke Management Programs among larger landowners and land-managing agencies. Program format for consideration: within each volunteering organization, utilize best available smoke management interpretations of current and forecast weather; make burn-no burn decisions a locale-assigned responsibility; where practical, treat locales under program by subdivisions (airsheds, where definable, otherwise by political or management unit boundaries); use				

1/ The indices A, B, etc. are from step 6 in section 2 of this appendix (see pages 62-64), unless indexed independently by users who prefer their own index.

Please go to the next page.

APPENDIX A3 continued

SUGGESTED SMOKE MANAGEMENT OPERATING PROCEDURE OPTIONS	POSSIBLE MATCHES (M) WITH INDICATED LEVELS OF SMOKE MANANAGEMENT SOPHISTICATION			
	A	B	C	D
(A.3. continued) case-examples of smoke production, downwind concentration predictions, to limit daily open burning smoke production as necessary to remain within NAAQS and/or other locally established criteria.		M	M	*
4. Formally recognize (e.g., by published rule) a self-regulating Smoke Management Program. Program format for consideration: essentially same as A3, above, except open burning to be carried out under a permit system, with permits revocable or suspendable. Revocation to be used to effect meeting of established Program Standards. Suspension to be used when administering agency determines atmospheric conditions unfavorable for transport and dispersion in any locale. Note: Administering organization must have technical staff and weather interpretation capabilities.			M	*
5. Formally recognize (e.g., by published rule) a Smoke Management Program essentially as in A.4, above, except that where technical assessment has shown a need among large ownerships, self-regulation could include rebudgeting between owners (and agency personnel where public lands are involved) of the amount of burning to be done on any day. Burn budgets will be dependent upon use of case-examples. Interactive programs with automated data processing could be developed for use to determine the amount of burning that could be accomodated.			M	M

* NOTE: Match applies but higher level of sophistication needed, see items 5 and 6 below.

Please go to the next page.

APPENDIX A3 continued

SUGGESTED SMOKE MANAGEMENT OPERATING PROCEDURE OPTIONS	POSSIBLE MATCHES (M) WITH INDICATED LEVELS OF SMOKE MANANAGEMENT SOPHISTICATION			
	A	B	C	D
(A. continued) 6. Formally Recognize a smoke management program in which the administering organization could handle burn schedule rebudgeting locale-by-locale, following priorities previously agreed upon between burners. Negotiation procedures worked out in advance would be a requirement. Preplanning should define categories of permit, using technical assessments by burning types and locations to identify defining criteria. In this way, certain types of open burning can be permitted as in A.4, above. For burning types with high impact potentials, an automated data processing system which accomplishes the following might be needed: processes requests for permits on first-come-first-served basis, except as certain well-defined priority-burns are moved ahead in scheduling; is accessible to all open-burners whose operations fall within this permit category (either through field offices of the administering agency, or by direct dial-up); is interfaced with hourly updatable weather data for use in applying smoke management interpretation programs to determine upper limit of the day's budget of burning. Desirable characteristics of the system would be a capability to provide burners upon inquiry: (1) an indication of the week of the season in which their requests for permits are likely to be filled; (2) confirmation permit is to be made				

Please go to the next page.

APPENDIX A3 continued

SUGGESTED SMOKE MANAGEMENT OPERATING PROCEDURE OPTIONS	POSSIBLE MATCHES (M) WITH INDICATED LEVELS OF SMOKE MANANAGEMENT SOPHISTICATION			
	A	B	C	D
(A.6. continued) on next available burning day; (3) tentative confirmation of permitted status planned for next day; (4) confirmation of permitted status, early a.m. of day permitted; (5)smoke management interpretations of current and forecast weather for local area.....Automatic adjustments for cancellations, permits being withheld due to changed forecasts, and missed opportunities can also be seen as a system need.				M
B. MANAGEMENT-SUPPORTING OPTIONS				
1. Current and forecast weather				
a. Narrative, NOAA Radio	M			
b. Narrative, NWS Fire Weather	M	M	M	M
c. Smoke management interpretations, narrative		M	M	M
d. Smoke management interpretations, interactive programs providing downwind concentrations			M	M
e. Input data for models				M
f. Stagnation & related alerts	M	M	M	M
2. Accounting & permits allocation program				M
3. Case examples	M	M	M	
C. IMPLEMENTATION OPTIONS				
1. Smoke management operating plans		M	M	M
2. Rule-making, recognizing formal smoke management operating plans (to be made, or in existence)				M

Please go to the next page.

APPENDIX A3 continued

SUGGESTED SMOKE MANAGEMENT OPERATING PROCEDURE OPTIONS	POSSIBLE MATCHES (M) WITH INDICATED LEVELS OF SMOKE MANANAGEMENT SOPHISTICATION			
	A	B	C	D
D. INCENTIVES OPTIONS				
Under general procedures where permits would be required, exemption from permit, or priority-status, can be recognized when certain requirements are met. This, in turn, can be used as a way of offering incentives to open burners to create less air quality impact. Some examples follow:				
1. Heavy residues treated by yarding to large piles (the YUM practice), and burned... a. While it is raining, may be exempted from required permit.* b. In early morning hours so as to be fully consumed by a specified time, may be given priority status.*			M	M
2. Light fuels such as grasses (which are very subject to poor burning conditions following a short period of rain or high humidity) can be given priority status if a backing fire or strip backing fire is to be employed.			M	M
3. Residues such as orchard prunings, timber-harvest limbs and tops to a specified minimum size, etc., which are in piles covered with an approved material, and are burned while it is raining, may be exempted.			M	M
4. Heavy fuels that would normally burn into the night, but which will be mopped up (i.e., extinguished) may be given priority.			M	M

*Caution here, however, to be dependent upon careful weather interpretations since stable conditions may accompany these periods.

Please go to the next page.

APPENDIX A3 continued

2. OBTAINING AN INDICATED "INDEX" OF NEEDED SOPHISTICATION

This section is for readers who have deferred section 1 to first obtain an "index" of an indicated level of smoke management sophistication for use in the table in that section.

The method suggested here has been tested on only a few actual situations and may bear adjustment with further testing. Artificial values are used to represent descriptions of situations being analyzed. These and the resulting "index" have no directly measured bases, but are used to obtain relative weights. (See further discussion of the concept and how the method was developed in section 3.)

Six steps are to be completed.

Step 1 - Smoke management locales

A decision must be made here to either obtain an indicated index for the entire area under consideration, or to make separate estimates. It is suggested that if there are large portions of the area in which there are likely to be few smoke problems, a first approximation of a logical subarea with the greater problems be delineated, and all steps below completed for this area alone. Later, other locales or subareas can be delineated, and further iterations of these steps be carried out as needed. These subdivisions by locales will also help with setting up appropriately different specifications for different locales.

An example problem area would be a fairly large airshed or drainage where nighttime downslope winds and temperature inversions have resulted in a problem with trapped smoke in the past; upslope areas where burning takes place could then be delineated as a logical smoke management locale.

NOW, THE REMAINING STEPS SHOULD BE APPLIED SEPARATELY TO EACH CATEGORY OF SMOKE MANAGEMENT LOCALE DELINEATED IN STEP 1.

Step 2 - Relation to issue-resolving criteria & added criteria

In this step, you are to match the most stringent criterion being applied to smoke management for the area under consideration with the closest criterion descriptor in the following table...Then circle the corresponding numeric value.

Criterion Descriptor	Numeric Value	Criterion Descriptor	Numeric Value
Relates to a law, regulation, or ordinance that is not fully met.	10	Relates to perceived social need which decision-makers desire to be met.	5
Relates to perceived social pressures which seem strong enough to result in passage of a law, regulation, or ordinance, if criterion is not met.	7	Relates to perceived social pressures which, though not likely to result in law, regulation, or ordinance, will demand administrative time if criterion not met.	2
Any criterion not matching other descriptors	1		

Please go to the next page.

APPENDIX A3 continued

The following table will be used in step 3. While available input data have been in part adjusted to more closely approximate open burning conditions, it is likely that the weighted ventilation factors will somewhat overestimate the actual conditions when smoke may persist into evening or night; this is of particular concern for low terrain, mountain valleys, and canyons where local temperature inversions will occur, but, because of location, not be a part of the National Weather Service (NWS) upper air station observations. (See also section 3 of this appendix for development notes.)

TABLE OF WEIGHTED VENTILATION FACTORS

NWS Station	Location	Factors by Seasons WINTER (Dec.-Feb.)	SPRING (Mar.-May)	SUMMER (Jun. Aug.)	AUTUMN (Sep,-Nov.)
ALABAMA					
MGM	Montgomery	1800	1800	1300	1200
ARIZONA					
TUS	Tucson	1500	1800	1600	1400
INW	Winslow	1100	2000	1400	1000
ARKANSAS					
LIT	Little Rock	1900	2400	1400	1300
CALIFORNIA					
OAK	Oakland	1100	1900	1200	1000
SAN	San Diego	1000	1300	800	800
SMO	Santa Monica	1100	1400	800	900
COLORADO					
DEN	Denver	1600	2200	1500	1100
GJT	Grand Junction	1100	2400	1800	1300
FLORIDA					
JAX	Jacksonville	2100	2300	1700	1700
MIA	Miami	2100	2500	1700	1900
TPA	Tampa	2000	2300	1600	1900
GEORGIA					
AHN	Athens	2100	2200	1400	1500
IDAHO					
BOI	Boise	1400	2100	1200	1400
ILLINOIS					
PIA	Peoria	1900	2600	1600	1600
KANSAS					
DDC	Dodge City	2200	3200	2600	2200
TOP	Topeka	2300	3200	2000	1900
LOUISIANA					
BRJ	Burrwood	2200	2200	1500	1900
LCH	Lake Charles	2200	2200	1500	1500
SHV	Shreveport	2100	2600	1600	1500
MAINE					
CAR	Caribou	2600	2800	2100	2200
PWM	Portland	2400	2800	2000	1900
MASSACHUSETTS					
ACK	Nantucket	3200	3000	2000	2300
MICHIGAN					
FNT	Flint	2400	2600	1600	1800
SSM	Sault Ste. Marie	2000	2300	1700	2000
MINNESOTA					
INL	Internat'l Falls	1800	2300	1700	2000
STC	St. Cloud	1900	2600	1700	1900
MISSISSIPPI					
JAN	Jackson	1700	2000	1200	1200
MISSOURI					
CBI	Columbia	2200	2900	1700	1900

Table continues, next page

APPENDIX A3 continued

TABLE OF WEIGHTED VENTILATION FACTORS (Cont'd.)

NWS Station	Location	Factors by Seasons WINTER (Dec.-Feb.)	SPRING (Mar.-May)	SUMMER (Jun. Aug.)	AUTUMN (Sep,-Nov.)
MONTANA					
GGW	Glasgow	1600	2600	2100	1800
GTF	Great Falls	3300	3200	2000	2600
NEBRASKA					
LBF	North Platte	1900	2800	2100	1700
NEVADA					
ELY	Ely	1400	2300	1100	1300
LAS	Las Vegas	1400	2400	1800	1400
WMC	Winnemucca	1200	1900	900	1200
NEW MEXICO					
ABQ	Albuquerque	1600	2400	1700	1300
NEW YORK					
ALB	Albany	2400	2800	1800	1800
BUF	Buffalo	2800	2700	1800	1800
JFK	New York	3100	3300	2200	2200
NORTH CAROLINA					
HAT	Cape Hatteras	2700	3100	2300	2200
GSO	Greensboro	1900	2300	1500	1500
NORTH DAKOTA					
BIS	Bismark	2000	2800	1800	1800
OHIO					
DAY	Dayton	2400	2700	1500	1700
OKLAHOMA					
OKC	Oklahoma City	2400	3500	2400	2200
OREGON					
MFR	Medford	700	1200	700	600
SLE	Salem	1300	1400	1000	1000
PENNSYLVANIA					
PIT	Pittsburgh	2300	2400	1400	1600
SOUTH CAROLINA					
CHS	Charleston	2000	2200	1700	1500
SOUTH DAKOTA					
RAP	Rapid City	2200	2900	1900	1900
TENNESSEE					
BNA	Nashville	2000	2400	1300	1300
TEXAS					
AMA	Amarillo	2300	3200	2500	2100
BRO	Brownsville	2600	3300	2800	2100
ELP	El Paso	1700	2800	1700	1200
MAF	Midland	2000	3100	2500	2000
SAT	San Antonio	2000	2700	2100	1800
UTAH					
SLC	Salt Lake City	1400	2200	1600	1500
WASHINGTON					
SEA	Seattle	1800	2300	1500	1500
GEG	Spokane	1600	2200	1500	1400
WASHINGTON, D.C.					
DIA	Washington D.C.	2300	2500	1400	1600
WEST VIRGINIA					
HTS	Huntington	2000	2400	1100	1100
WISCONSIN					
GRB	Green Bay	2300	2600	1800	1900
WYOMING					
LND	Lander	900	1900	1300	1100

NOW GO TO STEP 3 ON THE NEXT PAGE

APPENDIX A3 continued

STEP 3 - Relation to management situation

In this step, you are to obtain a set of values which will represent the management situation for the area under consideration.

There are 5 parts to this step.

1. Climatological considerations

SEASONS [Compl. this part for each season in which burning takes place. Use boxes or make entries as appropriate for each entry in a-d. See Part 2 in re SUM (last column).]	a. The Table of Vent. Factors shows a value for the most representative station which is: representative val. of			b. Days avail. to burn, fr. stdpoint L.M. Obj.			c. Enter from note #1 below the value describ'g your situation.	d. Enter from note #2 below the value describ'g your situation.	e. SUM of seas. point values (a+b+c +d=SUM)
	2101 or more	1601 to 2100	1600 or less	Ample	Adeq.	Limtd			
for WINTER	1	4	10	1	2	4			
for SPRING	1	4	10	1	2	4			
for SUMMER	1	4	10	1	2	4			
for AUTUMN	1	4	10	1	2	4			

NOTE #1: For step 3, part 1c, above, select a value from the following table which best describes the management situation for each season, entering these values above.

Burns, incl. smoldering phase will usually...	Last only a few daylight Hours (1-3)	Last the better part of a day	Last into evening	Last for several days & nights
	1	2	4	10

NOTE #2: For step 3, part 1d, above, select a value from the following table which best describes the management situation for each season, entering these values above.

If smoke management were left laissez faire...	It is not likely that A.Q. standards would be violated	A.Q. standards might be violated	It is likely that A.Q. standards would be violated
	1	4	10

2. In part 1e of this step you obtained sums of climatological value points for each season in which burning is done. Now circle the highest number in the part 1e, SUM, column of the table you completed in part 1.

CONTINUE WITH STEP 3, PART 2, ON THE NEXT PAGE

APPENDIX A3 continued

(Part 2 cont.)

You may need to compare the effects of climates in different seasons on the step 6 end product smoke management sophistication "index." This will call for carrying out further iterations, the same as mentioned in step 1 regarding obtaining different "indices" for different sub areas. (As a matter of interest, the range of numeric values possible as entries for part 1e is from 4 to 34.)

3. Terrain in which burning takes place is best described as (circle 1, adding a +2 if influenced by shoreline of sea or of other large water body) —	Flat with few low spots	Rolling or flat with low spots	Hilly	Plateau-like with deep drainages	Mountains
	1	2	3	4	5

4. Burners countributing smoke to the same airshed are generally (circle 1) —	From the same organization		From different organizations
	& only one admin. unit	But from sev'rl admin. units	
	1	3	5

5. Weather forecast difficulties (e.g., as for the shoreline phenomenon, local pockets of temperature inversion, etc.) (circle 1) —	Are seldom experienced	Are experienced occasionally	Are experienced frequently
	1	5	10

Step 4 - "Criteria Value"

Enter here the numeric value that you circled in step 2: _______

Step 5 - "Management Situation Value"

Enter here the sum of all point values circled in step 3: _______

Now divide this sum by 5 to arrive at a "management situation value," and enter the result of division here: _______ *

* For this entry, treat any number greater than 10 as 10.

Step 6 - "Index of needed sophistication

On page 64, a graphic method is to be employed to obtain the sought "index." In order to supply a means by which technical specialists completing this set of steps may provide decision-makers with options, the graph has been constructed to permit weighting of the results to favor criteria, or to favor management, as well as to obtain an unweighted result.

Please go to the next page.

APPENDIX A3 continued

Weightings are shown across the top of the graph. To weight for criteria, use values on this top scale to the left of 50/50. To weight for management, use values on this top scale to the right of 50/50. An unweighted result is obtained by using the 50/50 top scale value as in the example shown on the graph.

(a) From step 4, mark your "Criteria value" on the left numeric scale of the graph below.

(b) From step 5, mark your "Management situation value" on the right numeric scale of the graph below.

(c) A line is now to be projected from the marked value on the left numeric scale to the marked value on the right numeric scale.

(d) At the intersection(s) of the line projected in (c), above, with the vertical line(s) extending downward from the weighting scale weight(s) selected (see explanation at start of this step) make a dot.

(e) Now draw a horizontal line to the right.

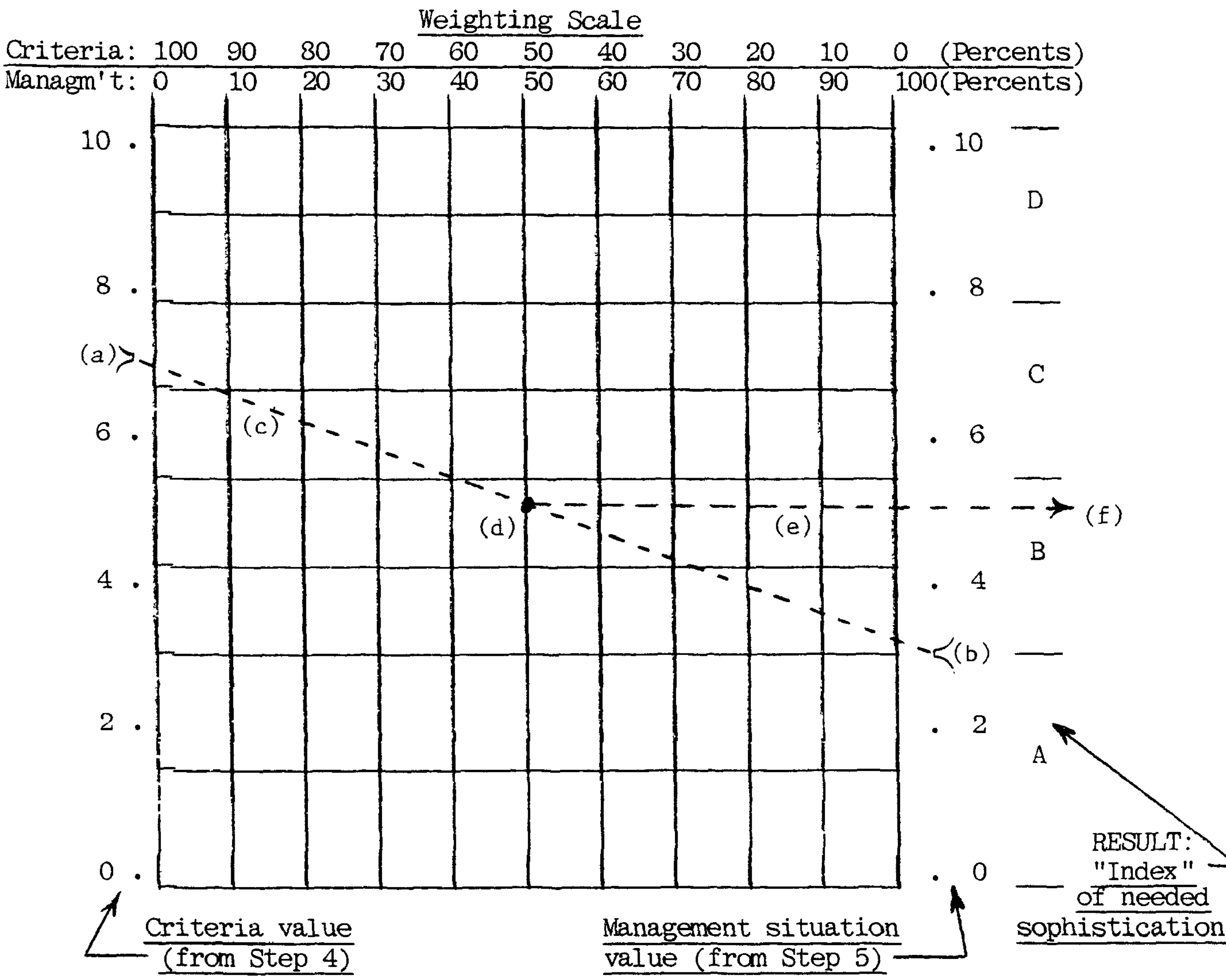
(f) Where the line drawn in (e), above, crosses the alpha scale to the right, read the resulting "Index" of needed sophistication as A, B, C, etc, with A being the lowest possible "index" value.

NOW EMPLOY THE ENTRIES YOU MADE FOR STEPS 4 AND 5 (PAGE 62) WITH THE GRAPH ON THE NEXT PAGE

APPENDIX A3 continued

An example of how each of the substeps from the preceeding page will look is shown in dashed lines, and labeled by substeps, on the graph below.

(In this example, a nonweighted result is obtained by using the vertical line extending downward from 50/50.)



The resulting "index" may now be used in section 1. (Discussion of appendix development begins on next page.)

APPENDIX A3 continued

3. DEVELOPMENT NOTES

The overall concept

Objectives of the aid presented in this appendix are to utilize subjectively rated variables affecting the level of smoke management complexity to:

a. Index the indicated need for sophistication,

b. Provide for different weightings of criteria and situation, and

c. Match the derived index against possible management approaches.

Evolution of the aid presented began with a series of elaborate trial integrations, the labors of completing which were too great for the unsureness of results. By using completely artificial scales obtained by working back from the end result, it has been possible to greatly simplify the process. While the early trials and the now simplified aid have been tested against opinions of what would be needed for sample situations, there are yet too few applied smoke management programs to fully judge the opinions of need. Under the present state of art, both the variability of opinion as to what may be needed and the lack of some apparently needed management methods hamper further development.

The most compelling reasons for advancing this aid now are: to offer a process by which consistency in indexing between different areas can result; to provide a framework by which individuals new to the emerging state of the art can begin to grasp the relative effects of variables influencing needed sophistication. Users must recognize that at best, only a first approximation can be expected.

Bases for table of ventilation factors

Ventilation factor is mixing height times transport windspeed. Transport windspeed used here is the harmonic mean of the day and night transport windspeed given by Holzworth[1/] for "all cases."

Mixing height used here is evaluated similarly to transport windspeed. An adjustment is initially made to the Holzworth "all cases" mixing height at night, which was based on assumptions most appropriate to urban areas.

If this night mixing height is <120 meters, no adjustment is made.

1/ Holzworth, George C. 1972. Mixing heights, windspeeds, and potential for urban air pollution throughout the contiguous United States. U.S. EPA, Off. Air Progs., Publ. No. AP-101, 118 p., Research Triangle Park, N.C.

APPENDIX A3 continued

For other cases,

$$\frac{1}{\text{Adj. MH}} = \frac{b_1}{\text{MH}} + \frac{b_2}{120} \left(+ \frac{b_3}{240} \right)$$

where: b_2 is the expected national seasonal frequency of F and G stability classes, from Holzworth, Doty, & Wallace2/

b_3 is the frequency of E stability class from the same source (this term is considered only if MH is <240 meters)

b_1 is either $.5 - b_2$, or $.5 - (b_2 + b_3)$, depending on whether b_3 term was considered

120 meters is a reasonable effective mixing height for a ground source at 60 miles, for F and G classes

class G is considered the same as class F

240 meters is the effective mixing height for E stability class.

2/ Holzworth, Doty, & Wallace. 1976. A climatological analysis of Pasquill stability class categories based on "star" summaries. U.S. Nat'l Weath. Serv., Nat'l Climat. Ctr. 51 p. Asheville, N.C.

APPENDIX B - AVAILABLE AIDS TO PREDICTING DOWNWIND CONCENTRATIONS OF TOTAL SUSPENDED PARTICULATE MATTER ORIGINATING WITH LAND MANAGEMENT OPEN BURNING

APPENDIX B - AVAILABLE AIDS TO PREDICTING DOWNWIND CONCENTRATIONS OF TOTAL SUSPENDED PARTICULATE MATTER ORIGINATING WITH LAND MANAGEMENT OPEN BURNING

INTRODUCTION & SOME CAUTIONS

The section of the parent text titled, "Smoke And Air Quality" (see page 7) introduces the general state of knowledge regarding production and transport of emissions from land management open burning. In that section it was developed that focus has been strongest upon total suspended particulate matter (TSP) emissions. Also given were some data on the proportion of TSP which is the fine fraction. Models used in predicting transport and dispersion of TSP were there suggested as aids to decision-makers, but not as being suited to independently determining when to burn.

In this appendix, certain models, model input requirements, and model adaptations used in predicting downwind concentrations of TSP from land management open burning will be discussed in more detail. Models can be powerful tools for helping to grasp the consequence of taking different alternatives, specifying different minimum or maximum values. Models will minimize risk taking, provided they are regarded as no more than tools. Any tool in the wrong hands, used in the wrong application, or applied without the realization that there are limitations as well as substitute methods, is better left alone.

If then, the discussions to follow appear to be "pro-model," the reader must bear in mind that they are intended as pro- the best available tool...not the ultimate tool...and not as arguments to lay aside good, common horse sense! At times, the state-of-art may seem to be pressed hard for an application to which, if available, better knowledge would be preferred. As an example of this, the last model adaptation described in this appendix (while a Gaussian adaptation, best suited to flat and rolling terrain) was used in planning for a complex terrain situation. In that use, the local land managers and the person conducting the study benefitted from the information obtained by comparisons with some documented events. They were able to begin the task of setting some trial specifications to avoid repetition of these events; and they were able thereby to recognize help for managing smoke in the admittedly limited, available weather forecast information for the area. But note the underlined "begin" and "trial," in the preceding sentence. These terms convey that a cautious application was made. The byword being spelled out, if not always directly set forth in the material which follows, is C-A-U-T-I-O-N.

BASIC MODELS

Atmospheric Transport & Dispersion

To predict how much dispersing smoke is likely to arrive at a specified downwind location, the characteristics of the atmosphere in which it is to be transported must be represented. Commonly, models used for this purpose will employ values which include: the transport windspeed and direction; an expression for the upper limit of vigorous mixing (mixing height); an expression for both the angle of spread and the margins of error to be expected as the wind direction naturally varies; an expression for the degree of mixing that will take place (atmospheric stability, or stability class). In applications where it is desired to impose limits on the width of spread that approximate the surrounding terrain, and/or where it is desired to make changes in other variables with distance traveled and the passage of time, mathematical expressions are available by which "boxes" or "cells" are treated sequentially. Starting values are also needed for the height to which the smoke is lifted by the buoyant heat from the source fire (plume rise), and for the amount of a specified emission product being produced.

Because both the influencing weather and the fire itself will change with time, predictions must generally be made either as in the "box" or "cell" approach, mentioned above, or for a discrete moment in time (i.e., with the variables at "steady-state"). An approach to adapting the "steady-state" model for adjustments to these variables with time is to accumulate a series of separately incremented predictions.

Data availability and the economies of data collection, as well as of data processing, will often dictate that less sophisticated models be employed, even if more elegant choices are at hand. An example is in the use of a steady-state model without incrementing to predict only a peak downwind concentration (appropriate to very short duration burns with little smoldering following passage of the flaming combustion stage).

One of the most important limitations of models in general is in their construction to reflect only those variables which are most commonly of importance (i.e., sensitive variables). The statistical bases for these models carry with them an expectation that errors will result. Similarly, with weather phenomena being critically important to what takes place, the limitations on weather forecast accuracy must also be recognized in "real-time" applications.

Most air quality models have been developed to predict impacts from sources like smoke stacks. Some are designed for urban areas, while others are best suited to rural areas. Use of available models for predicting impacts from land management open burning, therefore, requires careful evaluation of the assumptions used in the models, and may require adaptations for specific situations. Evaluation and adaptation of air quality models should be done only by experienced modelers. Selections of existing or adapted models should be discussed with personnel of the appropriate air pollution control agency before being employed operationally.

While several types of atmospheric transport and dispersion models have possible application, only the 3 most commonly associated with land management open burning will be covered here. Of these, the Gaussian Model has been most widely adapted to air quality work, and is the model presently in greatest use for land management open burning predictions. Its name is derived from the assumed Gaussian (normal) distributions of concentration in the horizontal and vertical planes perpendicular to the mean wind direction. Gaussian Model adaptations in several automated data processing programs (available under acronyms like CDM, for Climatological Dispersion Model, and AQDM, for Air Quality Display Model) are generally well accepted for flat and rolling terrain, but have serious limitations in mountains (as do most other models due to a general lack of adequate terrain-affected input variables, even when the model can accomodate these).

The Box Model, so named because in use it treats the atmosphere as though it were divided into separate boxes of specified dimensions, has been given only limited use in predicting concentrations from land management open

APPENDIX B continued

burning within mountainous areas. Within each box, the concentration is assumed to be uniform. By solving budget equations for each increment of time at which material in transport crosses the boundary of a box, it is possible to account for such differences as the narrowing of a mountain canyon.1/

Grid Models are named for the predictions of concentrations to grid points. Within each grid cell, the concentration is treated the same as in the Box Model. The large number of grid models available differ in treatments of variables, but they have in common a great need for input data and computational effort. (But in this need, have the potential to deal more exhaustively with important meteorological differences in complex terrain; a feature that has led to some studies related to open burning in mountain and mountain-valley situations. The promise may be to obtain case examples for more simplified operational use.)

Plume Rise

In all the above dispersion models, the height of release of the emissions to the atmosphere is an important variable (i.e., as the effective height at which dispersion begins to occur). Because of their buoyant nature, hot gases rising from a stack or from an open burning fire (in all but the coolest stages of combustion) continue to rise in a convection column. This column functions much like a chimney. Because emissions are entrained by these "chimneys," the effect of the heat released to the atmosphere from the combustion source must be accounted for. The temperature of the surrounding atmosphere, its stability, and the wind profile, further affect the rise of the smoke plume, both as to rate and as to the position of release of emissions. These are treated collectively as the phenomenon of plume rise.

Although there are several plume rise models, that of Briggs2/ alone has been adapted to open burning. This is also the method preferred by the National Commission on Air Quality.3/

In work with prescribed fires in the Southeastern United States, the Briggs' equation was adapted to fires of relatively low intensity (i.e., low in relation to fires such as those in heavy residues) by including an

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1/ For an example of Box Model use with a daily time scale, see Reiquam, H. 1970. An atmospheric transport and accumulation model for airsheds. In: Atmospheric Environment, vol. 4: 233-247.

2/ See Briggs, Garry A. 1969, 1971, and 1972 cited in references 3/, 4/, and 5/, below.

3/ Fox D.C. & J.E. Fairobent, 1981. NCAQ panel examines uses and limitations of air quality models. In: Bul. Amer. Met. Soc. vol. 62: 218-221.

APPENDIX B continued

adjustment for the percentage of smoke entrained versus the percentage unentrained.4/ Another application of the Briggs' equation to open burning is air quality work with the grass seed crop stubble in the Willamette Valley of western Oregon.5/

The importance of plume rise to resultant downwind ground level emissions concentrations has made it necessary to recognize two fire phases for open burning. Where there is any appreciable time period when fuels continue to burn without contributing to plume rise, these have been initially identified as the convective lift and no convective lift fire phases,4/ and more recently by some, as merely the "active" and "nonactive" fire phases.

Regardless of terminology, the key concepts and potential sources of error are: (1) NOT ALL SMOKE IS ENTRAINED ... theoretically, the proportion of unentrained smoke increases as fire intensity decreases; (2) IN FIRES WITH PERIODS OF CONTINUED EMISSION PRODUCTION AND WITH LITTLE RELEASE OF HEAT CONTRIBUTING TO PLUME RISE, A NO-RISE CONDITION MUST BE ACCOUNTED FOR.6/

Heat Release Rate & Emission Rate

Both heat release and emission rates are determined by the rate at which the fuels in an open burning fire are consumed.

Expressions of the behavior of open burning fires have long included values for the rates of fire spread (e.g., the forward spread of an advancing line of fire in linear units per unit of time) and of fire intensity (e.g., the units of energy released per linear unit of an advancing fire front). The convenience of using these conventional and available means of arriving at rates of fuel consumption (and thus of heat release rate and emission rate) is appealing and has been applied to open burning prescribed fires in the Southeastern United States.7/ Unfortunately, the combustion continuing after an advancing flame front has passed will take different forms and must be accounted for separately.

4/ Pharo, James A., Leonidas G. Lavdas, & Philip M. Bailey, 1976. Smoke transport and dispersion. In: Southern Forest Fire Laboratory Personnel, Southern forestry smoke management guidebook. USDA, Forest Service, Southeastern For. Exp. Sta., Asheville, N.C. (p. 45-55).

5/ Craig, Charles D. & M. A. Wolf, 1980. Factors influencing particulate concentrations resulting from open field burning. In: Atmospheric Environment, vol. 14: 433-443.

6/ For a more detailed discussion of the involved phenomena, see Lavdas, Leonides G., 1978. Plume rise from prescribed fires. In: Proc. 5th Joint Conf. on Fire and Forest Meteorology, March 14-16, 1978, Atlantic City, N.J. Publ. by Amer. Meteorol. Soc. (p. 88-91).

7/ Johansen, Ragnar W., W. Henry McNab, Walter A. Hough, and M. Boyd Edwards, Jr., 1976. Fuels, fire behavior, and emissions. In: Southern Forest Fire Laboratory Personnel, op. cit. (p. 29-44).

Further, to account for the commonly applied composite of different firing patterns with differing behaviors for the open burning pile and for a technique known as "area ignition," linear values become difficult to use. Unit-area of fire has been suggested as the best substitute because it permits conversions from linear units where available, yet still will serve these special types. (This approach can be additionally appealing when dispersion models are employed which project area emissions into a line source prediction. This can mean that line source models may have wide applicability for open burning, if adjusted and used with care.)

Because rate of fuel consumption changes with time, both heat release and emission rates change with time. These changes will occur for the open burn area as a whole, and will change for portions of the fire area after an advancing flame front has passed. Where means can be found to adjust these rates for the fire as a whole, it is possible to more properly account for differences from the period of start-up, through peak intensity, and decline of the fire, including thereby, the no-rise condition. In practice, it may be reasonable to assume that the time from start-up to peak intensity is sufficiently short to neglect the differences between these two times. The much more gradual decay of heat release and emissions following the peak is, however, of great importance in many open burning situations. Little data are available for this type of adjustment, but an exponential decay rate is suggested.

INPUTS TO MODEL ADAPTATIONS

In this subsection, heat release and emission factors will be discussed as inputs to adapted transport and dispersion models. Since both of these inputs are employed in relation to the mass of fuel consumed over time, the discussion in the preceding subsection concerned with changes in rate of fuel consumption, and with the possible use of a decay rate, is again stressed as important to their proper use.

Heat release. Heat release (or the technically more proper, "heat released to the atmosphere") may be either an input value or, in some packaged programs, a "default value" which will determine heat release rate, and thus bear upon plume rise. Heat release is expressed in units of heat energy (or net heat flux) released per unit-mass of fuel consumed. The routinely published values of heat yield for different fuels cannot be used directly for heat release. This is because of heat losses such as those of radiant heat. For example, a net sensible heat flux of 3500 cal gm^{-1} (or 1.4665 X 10^7 Joules/kg) has been suggested for prescribed burning in the Southeastern United States.[8/] Local fire behavior experts should be consulted for values appropriate to other situations.

Emission factors. Emission factors are expressed as unit-mass of emissions produced per unit-mass of fuel consumed (whereas emission rate is the unit-mass of emissions produced per unit-mass of fuel consumed per unit of time).

8/ See for example, Johansen, Ragnar W., W. Henry McNab, Walter A. Hough, and M. Boyd Edwards, Jr., 1976. op. cit.

APPENDIX B continued

Although many important compounds have been identified in the smoke from open burning fires,9/ attention has been focused upon particulate matter as the basic emission by which smoke can be managed. That focus will be maintained here.

Fire behavior and fuel type are known to change the unit-mass of particulate matter produced per unit-mass of fuel consumed. Flame interaction is believed to be one of the principal effects causing differences such as those reported between heading fires (which generally produce relatively greater amounts of TSP), and backing fires. Smoldering combustion is reported to be a larger producer per unit-mass of fuel consumed than is flaming combustion. These differences account for some of the major differences in emission factors reported from different studies, particularly those from more heterogeneous fuel types and firing patterns.

Most of the currently available data are the result of empirical studies. Because these studies are very costly, recent effort has turned to work with the carbon balance equation with the intent that emission factors for TSP can be predicted from models that are able to more readily relate measured emissions to fuel consumption.

In place of the usual compilations of emission factors,10/ the suggestion is made that the current literature for the area of concern be used as a source of TSP emission factors. This is due to the need for the best available local factors to be employed. Examples of literature sources would be those for specific crops11/ and those for prescribed burning in specific geographic areas.12/

9/ See for example: Chi, et al. 1979. Source assessment: prescribed burning, state of the art. EPA-600/2-79-01h. Monsanto Res. Corp. and U.S. Dept. Agric. For. Serv. Southeastern For. Exp. Sta., Dayton, Ohio, and Asheville N.C., resp. (122 p.); and Tangren, C.D., Charles K. McMahon, and Paul W. Ryan, 1976. Contents and effects of forest fire smoke. In: Southern Forest Fire Laboratory Personnel, op. cit. (p. 9-22).

10/ See for example, Anon. (latest ed'n - periodically updated). Compilation of air pollutant emission factors. AP-42, parts A & B. U.S. Environmental Protection Agency, Office of Air & Waste Mg't, Office of Air Quality Planning & Standards, Research Triangle Park, N.C. (477 p. total.)

11/ See for example, Carroll, John J., George E. Miller, James F. Thompson, & Ellis F. Darley, 1977. The dependence of open field burning emissions and plume concentrations on meteorology, field conditions and ignition technique. In: Atmospheric Environment, vol. 11: 1037-1050.

12/ See for example, Johansen, Ragnar W., W. Henry McNab, Walter A. Hough, and M. Boyd Edwards, Jr., 1976. op. cit.

APPENDIX B continued

Lacking these, another possibility is to use those emission factors for the most comparable fuel and fire types available. An example of how this might be done is illustrated by the figure reproduced on page 74. Before any use is made of the "safe-sided" values suggested by this figure, the cited reference should be reviewed for the accompanying discussion of weaknesses and strengths.

Other inputs. In addition to the heat release and emission factor inputs, model adaptations will call for a variety of other inputs affecting emmissions and heat production, as well as transport and dispersion of pollutants. These include:

information on the fuels, usually the fuel type (e.g., the name of the species association), and the "available fuel," (i.e., the net fuel available to burn after adjusting for fuel moisture);

rate of fuel consumption, or other data leading to this variable;

decay adjustment for emissions production and heat release;

size of area to be burned;

firing pattern to be employed;

mixing height, and/or thickness of the mixing layer;

Pasquill stability classes, or other data leading to these;

the transport windspeed; and

the surface windspeed.

Although used in the accompanying analysis to determine where the impacts may occur, wind direction is not usually required as an input to the model adaptations themselves. [An exception is an algorithm called SMKLCR (for smoke locator), not covered here, but available to users of the Forestry Weather Interpretations System, discussed in the model adaptations section of this appendix.]

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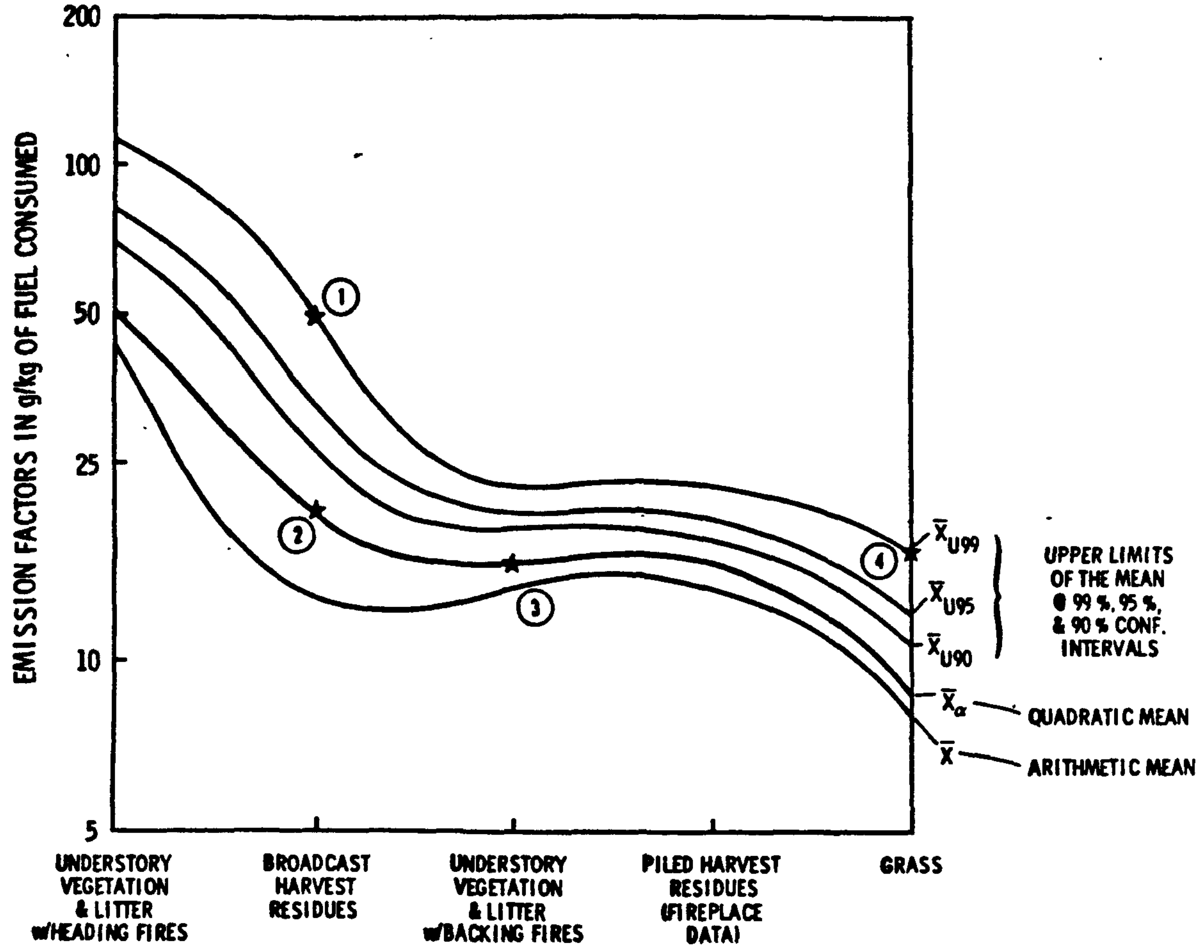
Family of curves showing "safe-sided" TSP emission factors and giving conjectural examples of how these may be used in the absence of more reliable local data.13/ [Note that 2(g/kg) converts graphic values to pounds (avdp)/ton (short).]



1 Because of an unusually large amount of fresh pine needles still readily available with the residues, and because of uncertainty about the effect of fuel moisture in the larger fuels, 50-g/kg, the upper limit of the mean at the 99 percent confidence interval,@ is selected for conservatism.

2 Noting a seeming departure of the arithmetic mean from the general shape of the family of curves, the apparently safer quadratic mean value of 19.5-g/kg is selected for use.

3 A selection of this moderately "safe-sided" 15.9-g/kg value might result from the belief that while the planned burn is fairly typical, fuel moisture is not adequately known.

4 For the values presented, a combination of heading and backing fires is assumed since neither is specified; since only heading fires will be used, a high, "safe-sided" 16.5-g/kg value is selected.

@ Strictly, the confidence interval implies that for the population represented by the sample, the average is expected to fall between the upper and lower limits of the mean that percent of the time. In this example, the upper limit of the mean, X_{U99}, is read 50-g/kg, and it is implied that the population average should not be greater more than 1 percent of the time.

13/ From Chi et al., op. cit., with correction.

APPENDIX B continued

MODEL ADAPTATIONS

It can be seen that practical compromises in the models themselves, the need to reflect changes over time when these changes may be only imperfectly known, natural variability, and the lack of "sure" input values (like suitable emission factors) will result in errors. Open burning fires do not always conform to the dimensions idealized for them. Meteorological values, in particular wind flow in mountains or from bodies of water, localized temperature inversions, and variability of wind direction with lower windspeeds (even in flat terrain), will also introduce errors. When used operationally on a "real-time" basis (e.g., on the day of a proposed burn) a weather forecast used as a source of inputs may itself be in error.14/

A well-grounded knowledge of these sources of error can lead to more confidence in the results obtained through use of models (again, as best-available tools).15/ It is thus that the basic models described earlier in this appendix have been adapted to managing smoke from land management open burning. With them, and with adaptations and supporting programs yet to be developed, competent meteorologists and fire behavior experts can supply decision-makers with interpreted information that will lead to choices that can be regarded sound, even when predictive errors do occur.

Two types of adaptations are to be covered here. The first of these recognizes that not all situations will demand sophistication calling for automated data processing. The other type recognizes that where available, automated data processing adaptations can offer management options to both preplanning and management of daily operations.

Adaptations suited to uses without automated data processing. While developing smoke management procedures for southern prescribed burners16/, it became evident that in addition to procedures employing models directly, there was a need for screening aids, as well as for case examples, to be used as guidance for burning under different field conditions. The following 2 examples are based upon results of applying the Gaussian model, Briggs' plume rise equations, and related fire and fuel models. The first of these is an example of how a screening aid can be constructed. The second illustrates use of case examples as guidance tools for burners.

14/ In addition to providing an example of a modeling application, the following reference is suggested for its more technical review of certain important sources of error and what can be done about them. See Lavdas, Leonidas G. 1980. Aspects of a system for predicting prescribed fire impact on air quality. In: Proc. Second Joint Conf. on Applications of Air Pollution Meteorology, 24-28 March, 1980, New Orleans, La. Publ. by Amer. Met. Soc., Boston, Mass. (p. 29-36)

15/ A reference suggested as appropriate to obtaining the recommended grounding is: Fox, D.G. 1981. Judging air quality model performance. In: Bul. Amer. Met. Soc. vol. 62: 599-609.

16/ Pierovich, J.M. et al. 1976. How to manage smoke. In: Southern Forest Fire Laboratory Personnel, op. cit. (p. 57-131).

APPENDIX B continued

Example of screening aid developed for management of smoke from individual prescribed burning operations.17/

SCREENING SYSTEM FOR MANAGING SMOKE

By following a written prescription and all directions on page 23 [i.e., of the cited source text], a forest manager will reduce the production of smoke and ensure good dispersion. Smoke will still be produced, however, and the forest manager needs to determine the impact it might have on the safety and welfare of people or the environment. The Southern Forestry Smoke Management Guidebook includes a system for predicting smoke concentrations at any distance downwind. This prediction system is available through a computer program where terminals are available. The whole system cannot be discussed here, but we will present an Initial Screening System based on the Guidebook. This system has five steps: (1) plotting trajectory of the smoke plume, (2) identifying smoke sensitive areas, (3) identifying critical areas, (4) determining fuel type and, (5) minimizing risk.

Step 1. Plotting Trajectory of the Smoke Plume

A. Use maps showing improvements that are sensitive to smoke for: 10 miles downwind from the burn for backing fires, 20 miles for heading fires or large burns (1000 acres or more), and 30 miles if fuel will be logging debris. Smoke Sensitive areas that can be adversely affected by smoke are: airports, highways, communities, recreation areas, schools, hospitals, and factories. Locate burn on map and draw a line representing the centerline of the path of the smoke plume for the distance indicated (direction of wind). If burn will last 3 hours or more, draw another line showing predicted direction at completion of burn.

B. To allow for horizontal dispersion of the smoke, as well as shifts in wind direction, draw two other lines from the fire at an angle of 30° from the centerline(s). If fire is represented as a spot, draw as in figure A. If larger, draw as in figure B.

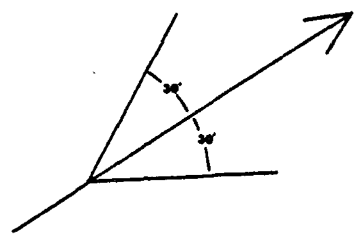


FIGURE A

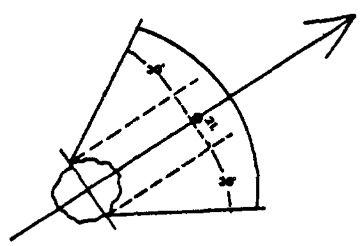


FIGURE B

Step 2. Identify Smoke Sensitive Areas

Identify and mark any smoke sensitive areas within the 30° lines plotted above. These areas are potential targets for smoke from your burn.

A. If in the rare case no potential targets are found - you may burn as prescribed.

B. If any targets are found - continue this screening system.

Step 3. Identify Critical Targets

Critical targets are:
Any potential targets identified in step 2 that are within 3/4 mile of your planned burn.
Potential targets that already have an air pollution or visibility problem.
Any potential targets where emission of sulfur dioxide (SO_2) will merge with the smoke plume. (Present research indicates that SO_2 in the presence of particulate matter might be a health hazard.) Likely sources are smelters, electric power plants and factories where coal is burned.

Identify and mark critical targets within the smoke trajectory on your map:

A. If there are any critical targets, do not burn under present prescription!
1. Prescribe a new wind direction that will avoid such targets and return to the beginning of this screening system, or -
2. Use some alternative other than burning.

B. If there are no critical targets, continue the screening system.

Step 4. Determine Fuel Type

The effect of smoke on sensitive areas will vary by type and amount of the fuel consumed.

A. From the list below, determine your fuel type or one that is reasonably comparable.
1. Grass (with pine overstory)

17/ Adapted from: Mobley, H.E. et al. 1977 (rev.). A guide for prescribed fire in southern forests. USDA, Forest Service, SE Area S&PF, Atlanta, Ga. (40 p.) For citation of Southern Forestry Smoke Management Guidebook referenced, see Pierovich, et al, 1976, op. cit.

APPENDIX B continued

Continuation of example of screening aid developed for management of smoke from individual prescribed burning operations.

2. Light brush
3. Pine needle litter
4. Palmetto-gallberry
5. Scattered logging debris (unpiled)

B. If your fuel type is not comparable to any of those listed above, the rest of the system does not apply. Present research is not adequate to judge the effects of other fuels. If you have identified targets, proceed with EXTREME CAUTION.

C. If the type is scattered logging debris, (and you have identified targets) DO NOT BURN under present prescription. Smoke production is much greater and will last for days.

1. Prescribe a new wind direction to avoid all targets and return to the beginning of this system.
2. If you cannot avoid all targets - you will need a better procedure than this simple screening system. See first paragraph.

D. If your comparable fuel type is one listed, determine if your total fuel loading is less than 10 tons in the fuel types listed below when age of rough is:

1. Grass (with pine overstory): any age......
2. Light brush: 7 years or less (10 years if basal area is under 100)..
3. Pine needle litter (loblolly): 7 years or less (10 years if basal area is under 100)........
4. Pine needle litter (slash): 5 years or less (8 years if basal area is under 100)................
5. Palmetto-gallberry: 3 years or less (5 years if basal area is under 70 and understory is less than 4 feet).

Step 5. Minimize Risk

To meet your smoke management obligations when any smoke sensitive area may be affected by your burn, you must meet all of the following criteria to minimize any possible adverse effects.

¶ Height of mixing layer (mixing height) is 500 meters (1,640 feet) or greater

¶ Transport windspeed@ is 4 meters per second (9 mph) or greater

¶ Background visibility is at least 5 miles within the plotted area

¶ Fuel loading is less than 10 tons per acre

¶ Rough older than two years; backing fire is prescribed (backing fires generally produce less particulate matter)

¶ At identified targets, other sources of smoke are displaced to the side of your burn by a least one-half the downwind distance

¶ If there are targets in the overlapping trajectories from two sources of smoke, they should be farther than 1 mile from either source (more if either one is a large burn or will produce a lot of smoke)

¶ For night burns, backing fires and surface windspeeds greater than 4 mph should be prescribed.

Numerous variables affect the fire behavior and resulting smoke from a prescribed burn. This system does not attempt to consider all the variables - it can only offer you broad sideboards. If you have close "targets," some that are extra sensitive, a burn that will produce large amounts of smoke, or if some of your results were marginal, then use the prediction system mentioned in the first paragraph. If the necessary information is not available or you do not wish to use the prediction system, consider some alternative other than burning to accomplish your objectives.

@ Transport windspeed is the average of the windspeed from the ground to the top of the mixing layer.

APPENDIX B continued

Illustration of the type of table that can be developed to provide case example guidance on short term peak (instantaneous) concentrations to be expected from individual burns. 18/

Type of fire	Pasquill stability class	Mixing height, km	Heat release rate, megacal/sec	Length of fired line or equiv., m	Transport windspeed, m/sec	Emission rate, mg/m-sec
Palmetto-gallberry: backing fire	C	1.5	37.632	800	8	168
Palmetto-gallberry: heading fire in 2-year-old rough	C	1.5	137.984	800	8	616

Particulate matter concentrations at various distances downwind, µg/m³

Distance downwind, km	Backing fire	Heading fire in 2-year-old roughs
0.10	901	3,302
.13	730	2,675
.16	591	2,167
.20	479	1,756
.25	388	1,422
.32	314	1,152
.40	256	933
.50	206	756
.63	167	612
.79	135	496
1.00	110	402
1.30	90	325
1.60	72	261
2.00	57	206
2.50	45	157
3.20	37	116
4.00	31	83
5.00	25	59
6.30	19	43
7.90	14	32
10.00	10	25
13.00	7	20
16.00	5	15
20.00	3	10
25.00	2	8
32.00	2	7
40.00	1	6
50.00	1	5
63.00	1	4
79.00	1	3
100.00	1	3

18/ In this example, for certain prescribed fires in the Southern United States. Taken from Chi et al., op. cit., as an adaptation from Pierovich et al., op. cit.

APPENDIX B continued

Adaptations suited to uses where automated data processing is available. The large number of variables to be employed in fairly complex equations makes automated data processing a must for most direct applications of adapted models. In this type of adaptation, there are currently two basic kinds of data processing programs available. One is the UNAMAP series of programs developed by U.S. EPA and available as tapes, aided by user manuals, through the National Technical Information Service (NTIS). (See Selected References Section of this Workbook regarding NTIS.) These have not been adapted for direct use with land management open burning, but the needed further adaptations can be made locally. The other kind of data processing program adaptation is that available for interactive uses through pilot test users of the Forestry Weather Interpretations System (FWIS). These interactive programs are directly adapted to land management open burning.

1. Programs available through NTIS

Presented here by the acronyms used to identify the U.S. EPA developed models are those programs available through NTIS with which experience in making adaptations to land management open burning has been reported. In addition, certain programs are listed that have been recommended for trial with land management open burning, even though no experience in making such adaptations is currently reported. These are Gaussian and steady-state model adaptations except as noted. Neither the list, nor the experience in making adaptations to land management open burning (which underlies the accompanying discussions) is exhaustive.

PAL. Of all the UNAMAP programs to be listed here, PAL has been found to result in concentrations believed to most closely resemble the smoke impact from open burning, if used with caution. A fairly wide range of source configurations may be used, resembling different open burning types (e.g., a hotly burning pile, a point, a moving, low intensity line of fire, a smoldering zone during the no convective lift fire phase, an area of fire). Plume rise from line or area sources is not handled in a manner compatible with open burning (i.e., gradual plume rise is calculated only for stacks). This difficulty can be partially compensated for through careful specification of such parameters as source location and height. PAL should be particularly effective in calculating impact from irregular shaped smoke sources with little plume rise.19/

CDM. This program is designed for application to seasonal or annual data use. It assumes a more unstable atmosphere than seems reasonable for rural areas. An open burn can be treated as an area source; but for more reliable results, a program which can handle plume rise associated with the convective lift fire phase should be utilized.20/

19/ Petersen, William B., 1978. User's guide for PAL - a Gaussian-plume algorithm for point, area, and line sources. EPA-600/4-78-013. U.S. Environmental Protection Agency, Res. Triangle Pk., N.C. (163 p.).

20/ Busse & Zimmerman, 1973. User's guide for the Climatological Dispersion Model. EPA-RA-73-024. U.S. Environmental Protection Agency, Res. Triangle Pk., N.C. (144 p.)

CDMQ. An extended version of CDM. The program listing is reportedly somewhat easier to follow. The same cautions apply as for CDM.21/

ISC. As the acronym (for Industrial Source Complex) implies, this is currently the recommended program for difficult source configurations, and may have application to certain types of land management open burning. Either polar or cartesian receptor grids may be used; sequential hourly meteorological data may be used. As yet, no adaptations to land management open burning have been reported. (Note: incorporates an updated version of the CRSTER program.)22/

RAM. This model is designed for urban areas and does not work well in rural situations. Source options are more restrictive than for PAL, but computations should be more rapid. The narrow plume assumption hurts its potential applicability to detailed analysis of smoke from open burning fires. RAM could posibly be used, however, to predict the annual impact of open burning in an area, provided one can specify hourly emission rates for each fire, ignore plume rise, and accept the Gaussian steady-state.23/

MPTER. Despite maximum terrain elevation being limited to actual stack height, it has been suggested that terrain adjustments may offer more flexibility than in other UNAMAP programs. Experience with adaptation to open burning is limited.24/

2. Programs available for interactive uses through Pilot Test users of FWIS

The FWIS Pilot Test is being carried out cooperatively between the USDA, Forest Service, the National Weather Service, and using organizations in the Eastern United States (within the area roughly bounded on the west by the western State boundaries for Minnesota, Iowa, Missouri, Oklahoma, and

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21/ Brubaker, K.L., P. Brown, & R.R. Cirillo, 1977. Addendum to user's guide for climatological dispersion model. EPA-450/3-77-015. U.S. Environmental Protection Agency, Res. Triangle Pk., N.C. (134 p.)

22/ Bowers, J.F., J.R. Bjorklund, & C.S. Chenny, 1979. Industrial source complex (ISC) dispersion model user's guide, Vols 1 and 2. EPA-450/4-79-030 & -031. U.S. Environmental Protection Agency, Res. Triangle Pk., N.C. (367 p. and 470 p. resp.)

23/ Turner, D. Bruce, & Joan Novak, 1978a & 1978b. User's guide for RAM, vols 1 & 2. EPA-600/8-78-016a and EPA-600/8-78-016b. U.S. Environmental Protection Agency, Res. Triangle Pk., N.C. (70 p. and 232 p., resp.).

24/ Turner, D. Bruce, & Thomas F. Pierce, 1980. User's guide for MPTER, a multiple point Gaussian dispersion algorithm with optional terrain adjustment. EPA-600/8-80-016. U.S. Environmental Protection Agency Res. Triangle Pk., N.C. (242 p.)

Texas). Primary concerns of the pilot test are to develop and test methods of making currently updated observational and forecast weather products available in products that are effective for forest management.25/ Several automated data processing programs for smoke management have resulted from work for FWIS. The discussion here will be limited to the program HRSMOK, although others now available and being developed may be found useful.

HRSMOK. This algorithm uses the Gaussian Model and Briggs' plume rise equations to provide hourly estimates of the predicted downwind centerline concentrations that will result at distances of up to 60 miles. The option is provided to use either default values or user inputs for: emission factor; duration of convective lift phase; duration of constant emissions; an exponential decay constant. Other initial inputs include the total tons of fuel consumed and the total acres burned. For each hour, the user interactively enters the numerical value of the Pasquill Stability Class, the transport windspeed, and the mixing height; the program then returns centerline concentration estimates at various preselected downwind distances.

As a Gaussian model, HRSMOK is best suited to flat and rolling terrain situations. Lacking other directly usable programs, it has been used to obtain first approximations for smoke management planning in complex terrain. Intimate knowledge of the downslope wind pattern, local formation of temperature inversions not easily recognized from forecast or observed upper air data, and the general shape of the terrain had to be accounted for. (This is where, if available to help, experienced local meteorologists can be of invaluable assistance.) In one such application, comparisons with documented reports on smoke "episodes" made it possible to proceed with some cautiously advanced specifications.

As presently programmed, HRSMOK will only yield estimates of the predicted impact at the time the emissions are produced. To be used further, it is necessary to "transport" the smoke, using available windspeed and wind direction data in hand calculations. With this approach, estimates can be made of the hour of peak impact, the degree of this impact, and the 24-hour average concentrations at key locations.

25/ For additional information on FWIS, and adaptations other than that discussed here, see: Paul, James T. & Joe Clayton, 1978. User manual - Forestry Weather Interpretations System...(FWIS). USDA, Forest Service, Southeastern For. Exp. Sta. & SE Area S&PF (in coop'n with U.S. Nat'l Weath. Serv.) Atlanta, GA.(83 p.)

APPENDIX C - METHODS SUGGESTED FOR DETERMINING VISIBILITY PROTECTION NEEDS

APPENDIX C - METHODS SUGGESTED FOR DETERMINING VISIBILITY PROTECTION NEEDS

This appendix suggests methods by which the present state-of-art in visibility protection may be applied to determine the smoke management needs, where land management open burning and designated Class I Federal Areas coexist.

Relation to Workbook for Estimating Visibility Impairment

Principles detailed in the Workbook for Estimating Visibility Impairment 1/ are here adapted to open burning. Familiarity with that text is recommended, even though the adaptation to be presented is a simplification.

The basis for simplification lies in the nature of smoke plumes from open burning fires. Little need exists for analysis of these plumes for opacity or coloration effects while they remain well defined. As they disperse, however, the haze potentials are essentially the same as those considered in the referenced text.

On the one hand then, we have simply a question of the presence or absence of usually quite evident and opaque smoke plumes. On the other, we have the question of the presence or absence of a noticeable effect of haze from open burning. The concept to be followed here is to determine if, and when, either of these two conditions make any difference.

For the purposes of this Workbook, it is suggested that a procedure be followed which asks the responsible Federal land managers to respond with their own appraisals of what makes a difference under the 2 conditions: (1) the presence of a noticeable smoke plume from land management open burning; (2) the presence of a noticeable effect of haze from land management open burning.

Because a "noticeable effect" of haze would provide no objective measure to which the smoke from land management open burning could be managed, it may be desirable to examine the same haze-causing primary and secondary aerosol relationships covered in the referenced Visibility Impairment Workbook. The sky/terrain contrast treatment there-in may provide a parameter by which Federal land managers can establish a useful effect/no effect benchmark. Where an objective measure is needed, this will call for investigation on a case by case basis.

1/ Latimer, Douglas A. & Robert G. Ireson. 1980. Workbook for estimating visibility impairment. EPA-450/4-80-031. U.S. Env. Prot. Agency, Office of Air Quality Planning & Standards. Research Triangle Park, N.C. (373 p.)

APPENDIX C continued

A Further Element of Analysis

A further element of analysis must be introduced. That is to recognize that many Federal Class I Areas are established for both their natural and scenic features. In some of these areas and their environs, fire is a natural agent in shaping ecosystems. In nature, one expects to see flames, the products of combustion, and an aftermath.

This leads to the suggestion that the Federal land managers responsible for these areas must determine the extent to which fire and the products of combustion will be accepted; they must also provide increasing numbers of vistors with enjoyment of views that may be temporarily obscured or changed by smoke. Open burning as a substitute for the naturally occurring fires of the past offers some possibilities for a scheduling compromise. In making this compromise, there are likely to be tradeoffs beyond those of naturalness and scenery. These will of course fall to the Federal land managers to evaluate within their own management systems.

Federal Land Manager Inputs

The relationships introduced above suggest that for the Federal land managers to make useful inputs to the analytical processes of this Workbook, 2 categories of potential visibility effect must be examined. One is the presence, or absence, of well-defined smoke plumes from open burning. The other is the effect of the haze resulting from dispersion of these same plumes.

Because the new element of analysis must be added, these visibility categories should be integrated with the Federal land manager's own appraisal of acceptability from the standpoint of a mission to provide both for naturalness and for opportunities to enjoy the scenic values of the Federal Class I Areas of concern.

A two-part inquiry form is suggested for obtaining the needed Federal land manager inputs. Made an exhibit to this appendix, and found on the last 2 pages hereof, the suggested form first provides what is believed to be the necessary starting information. The second part is the Response Sheet.

Uses of The Federal Land Manager Inputs

Indexed to correspond with column numbers shown on the Response Sheet of the exhibit to this appendix, the following is a summary of suggested uses for the inputs to be made by Federal land managers.

(1)-(3) These columns are intended to yield location information which can be used to plot any viewing areas for which special visibility protection measures may need to be specified in a smoke management operating plan.

APPENDIX C continued

(4)-(9) Use of this information would be in recommending scheduling as a possible constraining specification in any smoke management operating plan which may need to be developed. NOTE that respondents are instructed to supply supplemental information when "PARTLY ACCEPTABLE" is used. Objective measures may include: numbers of plumes, sizes of plumes, special features for which it is desired obscuration be avoided during certain times of especially high use, or visibility values such as sky/terrain contrast. (See additional discussion under scheduling, below.)

Scheduling

It is suggested that scheduling be considered for recommendation where the Federal land manager inputs indicate visibility effects to be either "PARTLY ACCEPTABLE" or "UNACCEPTABLE."

For example:

Given, a Federal land manager's column (8) input indicates "PARTLY ACCEPTABLE" and an objective measure of this condition is specified.

Then, a smoke management planner might recommend the following for the operating plan:

> "Burning within the plotted view area to be protected, and within areas expected to produce smoke dispersing toward the plotted view area, be scheduled so as to remain below a specified emission production level on Fridays through Sundays of the peak visitor season."

Possible Specification

In the above example, we have seen a possibility for specifying emissions production. Where available burning days are limited and even a smaller than normal amount of burning will help to meet land management objectives, it is possible such a specification will be found useful. Two approaches to specification are suggested.

The approach with the likely greatest appeal will be to follow a cut-and-fit process in which adjective terms describing the effects of haze levels are used.

An alternate approach will be to define a scale of values that permits the smoke manager to test specifications against some measurable objective or objectives. Here, the relationship to the Visibility Workbook has been shown to offer promise. Methods set forth by Latimer and Ireson in that workbook will have appeal in that numeric values are obtained, and in that the enjoyment of protected visibility is related to changes in contrast that can be both modeled and measured.2/ Other methods are also available.

If the alternate, measurable objective approach is followed, natural variability, model limitations, and newness of methods by which physical phenomena are related to human visual experiences, will all point to tentative values being used.

Now please go to the Federal land manager input form starting on the next page.

2/ See in particular: the suggested procedures (p. 4) and (p. 7) of Latimer and Ireson (1980), op. cit., for their "Level 1" equations used in obtaining sky/terrain contrast; their pages 58-60; and their Appendix A, "Characterizing General Haze," pages 147-160. [Note that the term Q_{SO} (p. 4), may be dropped for the open burning source.]

APPENDIX C continued (Exhibit to Appendix C, Sheet 1 of 2)

FEDERAL LAND MANAGER INPUTS REQUEST,
OPEN BURNING VISIBILITY PROTECTION ANALYSIS

TO: Federal Land Manager
Responsible for the: ______________________________
(Name of Class I Federal Area)

FROM: Visibility Analysis Task Group,
______________ State Smoke Management Review Committee

This is to request that you or your authorized representative supply certain information needed by our Task Group. Your reply will be used as an important input to our analysis of the smoke management needs for visibility protection for Federal Class I Areas.

Please complete and return the enclosed form. The following instructions are numbered to match the columns on the form.

(1) Use a formally recognized identification for the observation point associated with each view. (If other than coordinates are used, please also supply a map showing locations of observation points.)

(2) Supply the overall distance included within the view (miles).

(3) Supply the degrees of azimuth included within the view.

(4)-(9) Many Federal Class I Areas were established for their natural as well as scenic features. It is the purpose of these columns to provide for your inputs regarding the way that the natural fire history of your area and its environs may have been given weight in providing both for preservation of naturalness, and for scenic views. Note that these columns are headed, "SCHEDULING CONSIDERATIONS," and that in each of the two subsets, dates are to be supplied when visibility effects of open burning may be "FULLY ACCEPTABLE," "PARTLY ACCEPTABLE," or "UNACCEPTABLE." (If "PARTLY ACCEPTABLE" is used in responding, please supply a supplemental specification. For example, giving hours of the day or days of the week during the date period when "UNACCEPTABLE" would apply.)

(4), (5), & (6) In these input form columns, the presence or absence of a WELL-DEFINED SMOKE PLUME may be all that is considered (i.e., "yes/no"). On the other hand, the more clearly time periods and other means by which smoke can be managed are set forth, the more easily will land management and air quality objectives both be met.

(7), (8) & (9) In these input form columns, incomplete knowledge and wide variability must be met with something more than an adjective type of rating if smoke is to be managed in many situations. For these, see the note at the bottom of the enclosed response form.

Thank you for your assistance,

Sincerely,

Chairman

APPENDIX C continued (Exhibit to Appendix C, Sheet 2 of 2)

VISIBILITY PROTECTION WORKSHEET
FOR FEDERAL LAND MANAGER INPUTS
TO SMOKE MANAGEMENT FOR LAND
MANAGEMENT OPEN BURNING

FEDERAL CLASS I AREA: ____________________

COMPLETED FOR RESPONSIBLE FEDERAL LAND MANAGER BY: ____________________, TITLE: ____________________

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VIEW TO BE PROTECTED			SCHEDULING CONSIDERATIONS					
			Specify begin & end dates					
			WHEN PRESENCE OF WELL-DEFINED OPEN BURNING SMOKE PLUMES IS			WHEN PRESENCE OF HAZE FROM OPEN BURNING (See below for option for local specif'n)		
OBSERVATION POINT IDENTIFICATION	DISTANCE INCLUDED	AZIMUTH INCLUDED	FULLY ACCEP'L	PARTLY ACCEP'L	UNACCEPTABLE	FULLY ACCEP'L	PARTLY ACCEP'L	UNACCEPTABLE

Columns (7)-(9) provide an option to specify an objective measure for smoke management to work against. If it is desired to supply such a specification for the terms "ACCEPTABLE," "PARTLY ACCEPTABLE," and "UNACCEPTABLE," reference to attached specifications by asterisk (*) or other symbol(s). Sky-terrain contrast offers one posibility for such a specification; see the reference: Latimer, Douglas A. & Robert G. Ireson, 1980. Workbook for estimating visibility impairment. EPA-450/4-031. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, N.C. (In particular, pages 58-60 and 147-160, noting that the term Q_{SO} may be dropped for the land management open burning source.)

PLEASE RETURN THIS PORTION TO:

SELECTED REFERENCES

SELECTED REFERENCES

Purpose

To ease reading in the main text of this Workbook, literature citations have been used only as needed to credit sources. It is now the purpose of this section to supply selected examples of references that may encourage supplemental reading. Where locally oriented examples are given, it is intended that their presence here will suggest a search for similar local references in the area where the reader is located.

Many of the fields covered will soon include references more current than those listed here, especially in newly emerging technologies like smoke management itself. While these newer sources of information should be diligently sought out, those which are now listed may serve both to point to the bibliographies they contain, and to suggest names of investigators to watch for.

Selection Of Periodicals & References

Selected periodicals and references listed in this section are only examples of the literature currently available in several fields. A selection is not an endorsement, nor is the absence of a familiar reference meant to be a lack of endorsement. Many good references have been passed over merely because those chosen seem to fit a particular need, contain excellent bibliographies, or are believed to be more readily available.

Some, but not all, of the selected references have also been cited within the main text and appendices. Those citations standing alone as footnotes elsewhere are not only suggested for their pertinence to the immediate subject area where used, but are also worthy of additional supplemental reading.

Locating Copies of Selected References

Most U.S. Environmental Protection Agency (U.S. EPA) publications are available for on-site use at the reference libraries in the regional offices of that agency, and in those of its State counterparts. Many of these same publications will be found available in the documents divisions of State university libraries which are part of the Federal Documents Library System. Copies of U.S. EPA publications are available for purchase through the National Technical Information Service (NTIS) of the U.S. Department of Commerce.

Publications of the U.S. Department of Agriculture, Forest Service (USDA, Forest Service) are filed with the same Federal Documents Library System, as above, but often on only a regional basis. Copies have also been distributed regionally to land managing agencies, and to forest industries. Those still in print are available through the publishing Experiment Station or other office shown.

SELECTED REFERENCES continued

Journals are most easily obtained through State university libraries. Frequently, authors will have a supply of separate reprints available. Proceedings from society meetings are usually available at cost through the societies, or separately cited publishers, and often can be obtained from the authors as separate reprints.

Air Quality Protection

Abstracting services & related:

The following article is suggested as a starting place: Douville, Judith A., 1981. Indexing and abstracting services in the air pollution field. In: Jour. Air. Pol. Contr. Assoc., Vol. 31: 361-364.

Applied Science and Technology, Chemical Abstracts, and Engineering Index, are examples of other journals which include air pollution titles among subjects covered regularly.

APTIC (Air Pollution Technical Information Center) is maintained by the U.S. EPA for titles entered prior to October 1978. This is a contract service available interactively using ADP terminals, or by mail. Inquiries should be made to specialists in the air pollution control field, or to U.S. EPA.

The EPA Cumulative Bibliography 1970-1976 covers reports generated by the U.S. EPA and is available through the NTIS as order number PB-265920. Beginning in March, 1977, NTIS issues a quarterly EPA Publications Bibliography. The quarterly is available by subscription. Published Searches is another service available through NTIS. Inquiries should be directed to U.S. EPA, NTIS, or specialists who receive these services.

The ORD Publications Announcement is issued by the Office Of Research & Development to announce the availability of publications categorized as: project summaries; research summaries; decision series; program summaries and plans; other publications. Announcements may be received by writing to Center for Environmental Research Information, Cincinnati, Ohio, 45268.

Pollution Abstracts is a general abstracting service published bimonthly, and available in most major libraries.

Selected periodicals:

Atmospheric Environment
JAPCA - Journal of the Air Pollution Control Association
ES&T - Environmental Science & Technology
Environment Reporter

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Air Quality Protection articles and texts continued

Selected articles and texts:

ANON.,
(Current Year). Code of federal regulations, title 40, parts 50 to 59 (of Ch. 1 - Environmental Protection Agency, Sub Ch. C - Air Programs. U.S. Government Printing Office, Washington, D.C.)

BUDNEY, LAURENCE J.,
1976. Guidelines for air quality maintenance planning and analysis volume 10 (rev.): procedures for evaluating air quality impact of new stationary sources. EPA-450/4-77-001 (OAQPS No. 1.2-029 R) U.S. Environmental Protection Agency, Office of Air & Waste Management, Office of Air Quality Planning & Standards, Research Triangle Park, N.C. (50 p.)

GREENWOOD, D.R., G.L. KINGSBURY, & J.G. CLELAND,
1979. A handbook of key Federal regulations and criteria for multimedia environmental control. EPA-PC-A12/MF A01 Research Triangle Inst., Triangle Park, N.C. for U.S. Environmental Protection Agency, Research Triangle Park, N.C. (273 p.)

KRAMER, BRUCE M.,
1976. Economics, technology, and the Clean Air Act Amendments of 1970; the first six years. Ecology Law Quarterly, vol. 6: 161-230.

PORTNEY, PAUL R., ed., et al,
1978. Current issues in U.S. environmental policy. Johns Hopkins Univ. Press, Baltimore, M.D. for Resources for the Future. (207 p.)

U.S. CONGRESS (95th),
1977. The Clean Air Act as amended August 1977. Serial No. 95-11 Committee Print, Senate Commitee on Environment and Public Works. U.S. Government Printing Office, Washington, D.C. (185 p.)

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Open Burning and Smoke Management

Abstracting services & related:

Biological Abstracts covers many titles in this field.

FIREBASE is a bibliographic information retrieval system employing automated data processing suited to interactive terminal searches by authorized users. As the acronym conveys, this USDA, Forest Service-maintained system is oriented to forest fire management and related subjects. For information on access and search procedures, contact Forest Service fire specialists, or see the following reference: Eckels, Karen L. & Alan R. Taylor, 1979. FIREBASE - wildland fire bibliographic information system. In: Environmental Management, vol 3: 21-27.

Selected Periodicals:

Atmospheric Environment
Journal of Forestry
Forest Science
Southern Journal of Applied Forestry

Periodicals Special Note:
For some specialized and general views of current directions in fire management, see entire issue: ENVIRONMENTAL MANAGEMENT, vol. 3, No. 1, January, 1979.

Selected articles and texts, general:

HESTER, NORMAN E.,
1979. Field and slash burning particulate characterization, final project report. Rockwell International for Oregon Department of Environmental Quality, Portland, Ore. (131 p.)

Selected articles and texts, agricultural open burning:

CARROLL, JOHN J., GEORGE E. MILLER, JAMES F. THOMPSON, & ELLIS DARLEY,
1977. The dependence of open field burning emissions and plume concentrations on meteorology, field conditions and ignition technique. Atmospheric Environment, vol 11: 1037-1050.

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Open Burning and Smoke Management Continued

CHI, C.T., & D.L. ZANDERS,
1977. Source assessment: Agricultural open burning state of the art. EPA-600/2-77-107a Monsanto Research Corp. for U.S. Environmental Protection Agency, Washington, D.C. (66 p.)

CRAIG, CHARLES, & M.A. WOLF,
1980. Factors influencing particulate concentrations resulting from open field burning. Atmospheric Environment, vol. 14: 433-443.

Selected articles and texts, prescribed burning:

CHI, C.T., et al,
1979. Source assessment: prescribed burning, state of the art. EPA-600/2-79-019h Monsanto Research Corp. for U.S. Environmental Protection Agency & USDA, Forest Service, Washington, D.C. (107 p.)

COOK, JONATHAN D., JAMES H. HIMEL, RUDOLPH H. MOYER, and others,
1978. Impact of forestry burning upon air quality - a state of knowledge characterization in Washington and Oregon. EPA-910/9-78-052 GEOMET Corp. for U.S. Environmental Protection Agency, Seattle, Wa. (253 p.)

MARTIN, ROBERT E., & JOHN D. DELL,
1978. Planning for prescribed burning in the inland northwest. Gen. Tech. Rept. PNW 76. USDA, Forest Service, Pacific NW Forest & Range Exp. Sta., Portland, Ore. (275 p.)

MOBLEY, HUGH E., et al,
1977. (rev) A guide for prescribed fire in southern forests. USDA, Forest Service, Southeastern Area, Atlanta, Ga. (40 p.)

PAULSON, NEIL R., et al,
1980. Wildland fires, air quality, and smoke management. Journal of Forestry, vol. 78: 3-11.

SLAUGHTER, C.W., R.J. BARNEY, & G.M. HANSEN, eds.,
1971. Fire in the northern environment - a symposium. USDA, Forest Service, Pacific NW For. & Range Exp. Sta., Portland, Ore. (275 p.)

SOUTHERN FOREST FIRE LABORATORY PERSONNEL,
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Open Burning and Smoke Management Continued

VOGL, RICHARD J.,
1979. Some Basic Principles of Grassland Fire Management. Environmental Management, vol. 3: 51-57.

Alternatives Evaluation, General Technology

Selected periodicals:

TIMS/ORSA Bulletin
Management Science
Management Review & Digest

Selected articles and texts:

BRAVERMAN, JEROME D.,
1980. Management decision making. AMACOM, New York. (241 p.)

BRILL, E. DOWNEY, JR.,
1979. The use of optimization models in public-sector planning. Management Science, vol. 25: 413-422.

CORNELL, ALEXANDER H.,
1980. The decision-maker's handbook. Prentice-Hall Inc. Englewood, N.J. (262 p.)

LIEBMAN, JON C.,
1976. Some simple-minded observations on the role of optimization in public systems decision-making. Interfaces, vol. 6: 102-108.

PANIK, MICHAEL J.,
1976. Classical optimization: foundations and extensions. North-Holland Publ. Co., Amsterdam-Oxford, American Elsevier Publ. Co., N.Y. (312 p.)

SINDEN, JOHN A. & ALBERT C. WORRELL,
1979. Unpriced values - decisions without market prices. John Wiley & Sons. New York, N.Y. (511 p.)

STEWART, THOMAS R.,
1975. Appendix E, policy capture. In: McMillan, Claude, Jr. Mathematical programming, 2d ed. Wiley, N.Y. (650 p.)

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Selected articles and texts, alternate treatments:

ADAMS, THOMAS C.,
1976. Economic availability of logging residue in the Douglas-fir region. Resource Bul. PNW-64. USDA, Forest Service. Pac. NW Forest & Range Exp. Sta., Portland Ore. (9 p.)

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1978. Increased energy from biomass: 1985 possibilities and problems - working papers for planners, Pacific Northwest Bioconversion Workshop. RLO-78-5 U.S. Dept. Commerce, National Technical Information Service, Springfield, Va. (176+ p.)

BUDIANSKY, STEPHEN,
1980. Bioenergy: the lesson of wood burning? Environmental Science & Technology, vol. 14: 769-771.

HALL, R.E., AND DARYL G. DEANGELIS,
1980. EPA's research program for controlling residential wood combustion emissions. Jour. Air Pollution Control Assoc., vol. 30: 862-867.

PIEROVICH, JOHN M., EDWARD H. CLARKE, STEWART G. PICKFORD, AND FRANKLIN R. WARD,
1975. Forest residues management guidelines for the Pacific Northwest. General Tech. Report PNW-33. USDA, Forest Service, Pacific NW Forest & Range Exp. Sta., Portland, Ore. (273 p.)

Selected articles and texts, ambient air quality and monitoring:

ANON.,
1978. Ambient monitoring guidelines for prevention of significant deterioration (PSD). EPA-450/2-78/019, OAQPS-1.2-096 U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, N.C. (71 p.)

CUSHING, KENNETH M. & WALLACE B. SMITH,
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1978. Air monitor siting by objective. EPA-600/4-78/036 California Institute of Technology, Pasadena, Ca. for U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Las Vegas, Nev. (89 p.)

SMITH, W.B.,
1980. Proceedings: advances in particle sampling and measurement (Daytona Beach, Fla., Oct., 1979). Rept. for Apr.-Nov., 1979. EPA-600/9-80-004 Southern Research Institute, Birmingham, Ala., for U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Research Triangle Park, N.C. (419 p.)

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COWHERD, CHATTEN, et al,
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SCHRAG, M.P.,
1978. Fine particle emissions information system user guide. Report for Jan.- May, 1978. EPA-600/8-78/006 Midwest Reseach Institute, Kansas City, Mo. for U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Research Triangle Park, N.C. (308 p.)

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Selected articles and texts, environmental assessments and cost analyses:

COOPER, D.W., J.S. SULLIVAN, MARGARET QUINN, R.C. ANTONELLI, AND MARIA SCHNEIDER,
1979. Setting priorities for control of fugitive particulate emissions from open sources. Final Report. Sep., 1977 - May, 1979. EPA-600/7-79/186 Harvard School of Public Health, Boston, Mass. for U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Research Triangle Park, N.C. (136 p.)

SERTH, R.W., T.W. HUGHES, R. E. OPFEKUCH, AND E. C. EIMUTIS,
1978. Source assessment: analysis of uncertainty - principles and applications. Final report Nov., 1976 - Mar., 1978. EPA-600/2-78-004U Monsanto Research Corp., Dayton, Ohio, for U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Research Triangle Park, N.C. (181 p.)

SEXTON, N.H., F.W. SEXTON, L.I. SOUTHERLAND, AND T.D. HARTWELL,
1979. Interpretation of environmental assessment data. Final Report, Mar., 1978 - Sep., 1979. EPA-68-02-2156 Research Triangle Institute, Research Triangle Park, N.C., for U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Research Triangle Park, N.C. (242 p.)

UHL, VINCENT W.,
1979. A standard procedure for cost analysis of pollution control operations, vols 1 & 2. EPA-600/8-79/018A & 018B, resp. U.S. Environmental Protection Agency, Industrial Environmental Research Laboratory, Research Triangle Park, N.C. (65 p. & 164 p., resp.)

Selected articles and texts, fire effects:

DELL, JOHN D., AND LEONARD A. VOLLAND,
1981. Fire effects on Pacific Northwest forest and range vegetation. USDA, Forest Service, PNW Region. (25 p.)

HARDISON, JOHN R.,
1976. Fire and flame for plant disease control. Annual Review of Phytopathology, vol. 14: 355-379.

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SANDBERG, D.V., J.M. PIEROVICH, D.G. FOX, AND E.W. ROSS,
1979. Effects of fire on air - a state-of-knowledge review. Gen. Tech. Report WO-9. USDA, Forest Service, Washington, D.C. (40 p.)*

TIEDEMANN, ARTHUR R., et al,
1979. Effects of fire on water - a state-of-knowledge review. Gen. Tech. Report WO-10. USDA, Forest Service, Washington, D.C. (28 p.)*

WADE, DALE, JOHN EWEL, AND RONALD HOFSTETTER,
1980. Fire in south Florida ecosystems. Gen. Tech. Report SE-17. USDA, Forest Service, Southeastern Forest Exp. Sta., Asheville, N.C. (125 p.)

Selected articles and texts, long range transport:

NUBER, JOHN A., ARTHUR BASS, MICHAEL T. MILLS, AND CHARLES S. MORRIS,
1978. A review of regional-scale air quality models for long distance dispersion modeling in the Four Corners Region. Environmental Research and Technology, Inc., Concord, Mass. for U.S. Environmental Protection Agency, Office of Energy, Minerals and Safety. Washington, D.C. (85 p.)

Selected articles and texts, meteorology and climatology:

DOTY, STEPHEN R., BRIAN L. WALLACE, AND GEORGE C. HOLZWORTH,
1976. A climatological analysis of Pasquill stability categories based on 'star' summaries. Environmental Data Service, National Climatic Center, National Oceanic and Atmospheric Admin., Asheville, N.C. (51 p.)

HOLZWORTH, GEORGE C.,
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GLOSSARY

GLOSSARY

Definition of technical terms is an almost continual challenge among the professional societies and organizations representing disciplines included in the text of this Workbook. An example is the effort within the Society of American Foresters to publish an updated glossary of fire management terms.

The following terms are defined as used in this Workbook. Some definitions are more narrow than will be found in common use, but all conform as closely as possible to usages in the literature of the technologies from which they are drawn. SMOKE MANAGEMENT is an exception; the definition advanced here is an expansion of that in common current use, including here 3 functional components believed needed to better communicate that this activity entails more than carrying out a burning operation to minimize air quality impacts.

Not all terms included in this glossary have been used in the Workbook text and appendices. Those added here are included to help speed communications between individuals from the diverse disciplines which may become involved in suggested Workbook procedures.

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Abbreviations used in this glossary include: cf = compare to; CFR = Code of Federal Regulations; e.g. = for example; i.e. = that is.

****

ACTIVE FIRE PHASE
That period of burning when the heat of combustion is sufficient to result in appreciable lift of smoke or plume rise. [One of several terms used more or less interchangeably by some but not all technologists in this field. (cf: Convective Lift Fire Phase; Plume Rise Fire Phase).] Antonyms: Nonactive Fire Phase; No Convective Lift Fire Phase; No Plume Rise Fire Phase.

AIR CURTAIN DEVICE
Any device which forces air so as to form a "curtain" about a mass of fuel and result in more nearly complete combustion than if left unaided. Usually employed with trenches, pits, or portable bins.

AMBIENT
That which surrounds or encompasses. In an air quality regulatory sense, that portion of the atmosphere, external to buildings, to which the general public has access.

ANTHROPOGENIC
Induced or altered by the presence and activities of man. Used in air quality to label those emissions originating with the presence and activities of man.

APPRAISAL
As used here, primarily the act of estimating or evaluating in the broader sense, including thereby an assessment of the existing or resultant situation, and of both monetary and other costs and benefits as appropriate to making decisions on alternatives.

GLOSSARY continued

AREA SOURCE
In an air quality regulatory sense, an aggregate source of emissions, its individual sources being too small to be considered as point sources; examples are small residential fuel combustion operations, any mobile source such as cars or aircraft. In common usage, an emissions source comprised of more than one individual point of emissions to the atmosphere. (cf: Emissions Source; Line Source; Point Source.)

ATMOSPHERIC DISPERSION
The distribution of a given quantity of pollutant throughout an increasing volume of atmosphere.

ATMOSPHERIC STABILITY
The degree to which the atmosphere resists turbulence and small "random" vertical motions.

ATMOSPHERIC TRANSPORT
The movement of a mass of emissions borne in the air above the earth from a point of origin to other points. (cf: Atmospheric Dispersion; Long Range Transport.)

AVAILABLE FUEL
The net amount of combustible material not limited from burning by moisture and other factors. (cf: Total Fuel Loading.)

BACKGROUND
Ambient (which see) pollutant concentrations due to natural sources and distant, unidentified, Anthropogenic (which see) sources.

BACKING FIRE
Any fire which literally backs against the wind, and/or downslope. Also used to descriptively name a firing pattern set to behave in this manner. The term is not applied to fires advancing rapidly downslope with a downslope wind; these are usually refered to as "downslope runs." A synonym in most of the Southeastern United States, "Backfire" is used in most of the Western United States only for fires set against an advancing fire front, usually in controlling wildfires. Antonym: Heading Fire.

BURNING DAY
In general use, a day upon which objectives of open burning may be met.

CASE EXAMPLE
Results of a limited study for a specialized case, or set of cases, suggested for cautious use with similar cases (sometimes including adjustment factors), when more broadly adaptable models are not available.

CEILING HEIGHT
In strict U.S. weather observation station usage, merely, Ceiling. The distance above the surface to the lowest cloud layer which obscures more than half of the sky. (cf: Mixing Height)

GLOSSARY continued

CHAPARRAL
A plant association of shrubs, and at times low (to about 8 meters) trees, occurring in California and Arizona, and regarded as a highly flammable fuel type during certain seasons of the year. Common names of species usually identified with Chaparral include ceanothus, chamise, manzanita, and certain of the oaks.

CHOPPING
Mechanically altering the original structure of residues and vegetation by means such as rotary flails or drums.

CLIMATOLOGY
The scientific study, or the results of such a study, of long term meteorological variables (affecting the climate of an area and/or special operations such as agriculture, aviation, open burning, etc.).

COMPLEX TERRAIN
Primarily mountains and large bodies of water which affect local circulation patterns, making it difficult to use generalized models for atmospheric transport and dispersion.

CONTROLLED BURNING
The intentional use of fire to meet agricultural land management objectives, and in a manner which assures the fire will not escape from the area of open burning. Also an archaic term of occasional use in other forms of land management open burning, but in the main replaced by the preferred term, Prescribed Burning. (cf: Open Burning; Land Management Open Burning; Prescribed Burning; Natural Prescribed Fire.)

CONTROLLED INCINERATION
Burning within a combustion chamber in which the airflow and rate of combustion can be regulated for more complete combustion than would take place in an open burning environment.

CONVECTION COLUMN
A smoke plume rising in the atmosphere due to the thermally induced motion resulting from the heat of combustion.

CONVECTIVE LIFT FIRE PHASE
That period of burning when the heat of combustion is sufficient to result in appreciable lift of smoke, or plume rise. [One of several terms used for essentially the same meaning by some, but not all, technologists in this field. (cf: Active Fire Phase; Plume Rise Fire Phase).] <u>Antonyms</u>: Nonactive Fire Phase; No Convective Lift Fire Phase; No Plume Rise Fire Phase.

CRITERION
A characteristic used in basing a decision or judgement. Often preestablished for subsequent evaluation of a performed task. (cf: Standard.)

CROWN SCORCH
Dieback of the foliage of trees resulting from the heat of fires burning in the understory vegetation and/or litter.

GLOSSARY continued

DECAY RATE
Adjustment over time for a decline, as for the decline of fuel consumed in combustion as it affects emissions production and heat released to the atmosphere.

DECISION-MAKER
An individual responsible for determining the action to be taken. In the procedures of this Workbook, specifically a participant responsible for making decisions on the actions to be taken.

DESICCANT
A substance used to induce drying of living vegetation in preparation for open burning.

DISPERSION
The distribution of a given quantity of a substance (in this text, of a pollutant) throughout an increasing volume (in this text, of atmosphere). (cf: Atmospheric Dispersion.)

EMISSION
A pollutant released to the atmosphere.

EMISSION FACTOR
The mass of a specified pollutant released to the atmosphere per unit-mass of dry fuel consumed during combustion.

EMISSION RATE
The mass of a specified pollutant released to the atmoshere per unit-mass of dry fuel consumed per unit of time.

EMISSION PRODUCTION
A generalization usually referring to the pollutants released to the atmosphere by a specified process. (cf: Emission Rate.)

EMISSION SOURCE
Any process resulting in pollutants being released to the atmosphere.

ENTRAINMENT
The phenomenon of air, and airborne materials such as emissions, being drawn into the convection column of a fire.

ESCAPED FIRE
Here specifically, an open burn which has not remained within the intended control boundaries. More generally, both the preceding and a wildfire which results in a control action beyond that of the initial attack force capability.

ESCAPES
Common expression for the plural of Escaped Fire (which see).

FEDERAL LAND MANAGER
In an air quality regulatory sense, "...with respect to any lands in the United States, the Secretary of the Department with authority over such lands." (40 CFR 52.21) In this Workbook and in common usage, the official of a Federal land managing Department or agency to whom has been delegated responsibility for visibility protection and enhancement.

GLOSSARY continued

FIRE DANGER
A generalization commonly applied to the degree of fire control difficulty expected. Also applied to the more precise, Fire Danger Rating, a measure both of the likelihood of a wildfire occurring and of fire control difficulty.

FIRE HAZARD
The amount of fuels subject to ignition.

FIRE RISK
The extent of exposure to sources of ignition.

FLAME INTERACTION
The movement of emissions through the glowing portion of the gases in the combustion process, with the result that oxidation and/or reduction reactions take place.

FLAMING COMBUSTION
Burning with a noticeable incandescence emitted from the glowing portion of the gases above fuels being consumed. In more generalized usage, the combustion stage in which flames are characteristically present, discounting such intermittent or limited flaming as may take place during the smoldering combustion fire stage. Antonym: Smoldering Combustion.

FRIABILITY
The ease of crumbling, pulverizing, or powdering.

FRONT-END MODEL
Commonly, the mathematical expressions representing Emission Production (cf), employed in adapting atmospheric dispersion models to use with open burning.

FUEL
Combustible material.

FUEL MOISTURE
The amount of water present in fuel, usually expressed in percent (determined on the basis of the weight of the fuel in a given natural condition compared to its ovendry weight). (cf: Timelag)

FUEL TYPE
The name for a given kind of combustible material, often taking on the name of the dominant vegetation species or species association.

GOAL
The end to which an effort is directed. A condition or state to be brought about. In planning, usually distinguished from Objective (cf) by its longer-term expectations and less well defined dimensions.

HEADING FIRE
A fire which advances with the wind and/or upslope. Headfire is a synonym in most of the Southeastern United States. Antonym: Backing Fire.

GLOSSARY continued

HEAT RELEASE
In this text, a shortened form of the technically more correct, Heat Released to the Atmosphere. The net sensible heat rising above an area of combustion.

HEAT RELEASE RATE
Heat released to the atmosphere per unit-mass of fuel consumed per unit of time.

HEAT VALUE
The total heat energy released during combustion, usually published as units of heat energy produced per unit-mass of ovendry fuel consumed.

HIDDEN DEFECT
As used in this Workbook, a concealed flaw (such as rot, wind shake, breakage, a pitch pocket) rendering a log, or portion of a log, unmarketable, or of lessened value.

INDIGENOUS PLANT COMMUNITY
An association of vegetational species believed to be native to the area under consideration.

ISSUE
A point of controversy, of dispute, or of seemingly conflicting goals or objectives. Also, one of such issues confirmed by the process suggested by this Workbook.

LAND MANAGEMENT OPEN BURNING
Fire applied to vegetative fuels in order to meet a definite objective (i.e., by bringing about desired effects).

LINE SOURCE
An Emission Source (which see) for which the emissions are not from a single point or several points within an area, but rather from a line. (cf: Area Source; Point Source.)

LITTER
The uppermost layer of mostly undecomposed material on the forest floor. Comprised mainly of fallen leaves, needles, flowers, fruit, bark fragments, twigs, and branchwood.

LOFT
To lift, as smoke, to the atmosphere.

LONG RANGE TRANSPORT
The atmospheric suspension and movement of pollutants that, because of their size and chemical composition, remain in the atmosphere over a long period of time (e.g., greater than 24 hours) and, thus, are transported over long distances (generally considered to be greater than 100 kilometers).

GLOSSARY continued

METEOROLOGICAL SCHEDULING
A major tool of smoke management by which land management open burning is scheduled, based upon weather variables affecting fire behavior, plume rise, and smoke transport and dispersion. (Because of its overall importance in the scheduling process, this term is sometimes misapplied to include other bases for scheduling that are also a part of smoke management.)

MIXING HEIGHT
The distance above the surface of the earth to which relatively vigorous exchange of fluid "parcels" takes place. (In some areas mixing height is provided as an elevation above mean sea level in order to permit adjustments for different surface elevations.)

NATURAL PRESCRIBED FIRE
A form of land management open burning in which naturally ignited fires (i.e., from lightning) are permitted to burn in certain predetermined areas, and under predetermined conditions.

NO CONVECTIVE LIFT FIRE PHASE
That period of burning when the heat of combustion is not sufficient to result in appreciable lift of smoke, or plume rise. [One of several terms used more or less interchangeably by some but not all technologists in this field. (cf: Nonactive Fire Phase; No Plume Rise Fire Phase).] Antonyms: Convective Lift Fire Phase; Plume Rise Fire Phase; Active Fire Phase.

NONACTIVE FIRE PHASE
That period of burning when the heat of combustion is not sufficient to result in appreciable lift of smoke, or plume rise. [One of several terms used more or less interchangeably by some but not all technologists in this field. (cf: No Convective Lift Fire Phase; No Plume Rise Fire Phase).] Antonyms: Convective Lift Fire Phase; Plume Rise Fire Phase; Active Fire Phase.

NONATTAINMENT
Used to denote an area in which the National Ambient Air Quality Standard for a specific pollutant is exceeded. Nonattainment is determined by either direct monitoring data, or, when that data is not available, calculated by air quality modeling. An area is designated nonattainment when violations of the standard occur, or are expected to occur, more than once per year.

NO PLUME RISE FIRE PHASE
That period of burning when the heat of combustion is not sufficient to result in appreciable lift of smoke, or plume rise. [One of several terms used more or less interchangeably by some but not all technologists in this field. (cf: No Convective Lift Fire Phase; Nonactive Fire Phase).] Antonyms: Convective Lift Fire Phase; Plume Rise Fire Phase; Active Fire Phase.

OBJECTIVE
The result expected of an action or practice, often intermediate to other objectives [all of which may be directed toward attainment of a Goal (cf), from which term it is usually distinguished in planning by shorter-term expectations and more narrow dimensions].

OPEN BURNING
Any manner of burning, not in a device or chamber designed to achieve or approach complete combustion. Where the products of combustion are emitted directly or indirectly into the open air. (cf: Land Management Open Burning.)

PARTICULATES
Solid particles or liquid droplets small enough to be suspended in the air. Examples include dust, soot, smoke, and fumes. (cf: Total Suspended Particulate Matter.)

PILE & BURN
A common practice in which fuels are arranged in piles prior to burning, and which may be considered as an alternative constraint when the piles are constructed so as to promote more complete combustion. (cf: "PUM;" "YUM")

PLUME RISE
The phenomenon of smoke being entrained (see Entrainment) by the convection column of a fire with sufficient heat to accelerate lofting of the air above the area of burning. (cf: Plume Rise Fire Phase.)

PLUME RISE FIRE PHASE
That period of burning when the heat of combustion is sufficient to result in appreciable lift of smoke, or plume rise. [One of several terms used more or less interchangeably by some but not all technologists in this field. (cf: Convective Lift Fire Phase; Active Fire Phase).] Antonyms: Nonactive Fire Phase; No Convective Lift Fire Phase; No Plume Rise Fire Phase.

POINT SOURCE
An individual location from which emissions are produced, such as a single smoke stack. (cf: Area Source; Line Source.)

POLLUTANT
Any substance foreign to, or exceeding an amount expected naturally in the medium under consideration.

PRESCRIBED BURNING
The application of fire to fuels in either their natural or modified state (usually on lands managed for other than agriculture), under conditions of weather, fuel moisture, soil moisture, etc., so that the fire will be confined to a predetermined area, and at the same time so planned objectives of such activities as silviculture, wildlife habitat management, grazing management, and fire hazard reduction will be met. In some organizations, the term is employed to include preplanned fires similar in purpose to those which are separately defined in other organizations as Natural Prescribed Fire (which see). (cf: Controlled Burning.)

GLOSSARY continued

PRIMARY AEROSOL
Particulates (which see) directly emitted from a source; the emission remains unchanged in chemical composition and structure. (cf: Secondary Aerosol.)

PROBLEM RECEPTOR
Any downwind location for which it has been determined that an intrusion of a specified amount of pollutant will be undesirable. (cf: Smoke Sensitive Area.)

PUM
The acronym for piling unmerchantable material, a practice in which the piles are generally more scattered and smaller than those of "YUM" (cf). Often done as a part of prescriptions calling for Pile & Burn (cf) treatment.

RADIANT HEAT
Heat which is transmitted as a wave motion rather than that which is conducted or is carried by convection (these being known as conductive heat and convective heat, respectively).

ROUGH
A term used in the Southern United States to name the competing understory vegetation and litter found in timber stands in that area.

SAFE-SIDED
An adjective term used to indicate that, while knowledge is incomplete, values so described should be reasonably safe, or erring to the conservative.

SANITATION BURNING
The use of fire to remove pests and undesirable hosts (e.g.: plants, disease, insects, including disease vectors) likely to otherwise unfavorably affect the productivity of crops (including timber).

SECOND GROWTH
Commonly employed to name timber which has become established following destruction of the predecessor trees (as by fire or insects), or following harvesting.

SECONDARY AEROSOL
Particulates (which see) that are changed in structure and/or chemical composition while in the atmosphere. (cf: Primary Aerosol.)

SHORELINE PHENOMENON
A possibly better name for what is more commonly known as the Seabreeze Phenomenon. An example of the effect of complex terrain where there are large bodies of water, this is generally an on-shore wind confined to areas proximate to coastlines, and resulting from certain predictable weather variables. It is particularly troublesome to maintaining control of open burning and to predicting the direction of smoke transport and dispersion, unless accounted for.

GLOSSARY continued

SHORT-TERM PEAK CONCENTRATION
The maximum downwind concentration of a pollutant originating from a source such as open burning which is frequently characterized by a gradual decay of heat release and emissions production. Usually expressed as an instantaneous quantity.

SKY/TERRAIN CONTRAST
The difference in light intensity of the sky relative to that of the terrain.

SMOKE MANAGEMENT
Most commonly, the actions taken to minimize the possible air quality impacts of smoke from open burning. In this text it is suggested that the term embraces 3 main functions: APPRAISAL; SPECIFICATIONS AND SCHEDULING; EXECUTION.

SMOKE MANAGEMENT OPERATING PLAN
Written specifications and procedures to be followed in carrying out smoke management.

SMOKE MANAGEMENT WEATHER INTERPRETATION
Consequences specific to smoke management, as expected in view of information contained in an official forecast from the National Weather Service.

SMOKE SENSITIVE AREA
Any area recognized in smoke management as one where the National Ambient Air Quality Standards or locally determined criteria are to be met. Examples are hospitals, highways, etc.

SMOLDERING COMBUSTION
Burning without flames.

SOURCE
Any process resulting in pollutants being released to the atmosphere. Synonym: Emissions Source.

SPECIES ASSOCIATION
A community of flora or fauna with definite composition and dominant members in a uniform habitat.

SPECIES DENSITY
The population per unit-area of a species.

STAGNATION
Lack of movement in an air mass for extended periods of time (e.g., 24 hours or more) which traps and concentrates pollutants in a specific area.

STANDARD
The measure by which something may be judged. (e.g., The National Ambient Air Quality Standards.)

STEADY-STATE
A condition that does not change with time.

SUCCESSION
The natural progression in development and composition of vegetation.

GLOSSARY continued

SURFACE WIND
The wind direction and speed measured close to the surface of the earth. To avoid interfering objects, this is usually measured at a distance above the actual surface. [A 20-foot standard above open terrain usually applies to this distance, and to forecasts of surface wind in forested areas. This may mean that special adjustments in forecasts and observations are necessary; (e.g., under standing timber, or where the wind at mid-flame height is needed in fire behavior predictions).] (cf: Transport Wind.)

TECHNICAL ASSESSMENT
In this Workbook, the determination of impact.

TEMPERATURE INVERSION
A layer in the atmosphere in which temperature increases with altitude.

TIMELAG
The time it takes for a fuel particle to lose approximately 63 percent of the difference between its starting moisture content and its moisture content if left exposed for an infinite time in an environment of specified constant temperature and humidity (i.e., equilibrium moisture content). Important differences in timelag constants for different fuel types must be accounted for in determining rates of fuel consumption, and thus emission rates, at different time intervals since measureable precipitation.

TOTAL FUEL LOADING
The total weight of fuel per unit-area, disregarding fuel moisture and other factors affecting its availability to burn. (cf: Available Fuel.)

TOTAL SUSPENDED PARTICULATE MATTER (TSP)
The general term used for particles found in the atmosphere.

TRANSPORT WIND DIRECTION
The weighted average of the directions from which all winds within the mixing layer originate. [i.e., below the Mixing Height, (which see).] (cf: Surface Wind.) NOTE: In some cases, when wind directions change greatly within the mixing layer, the transport windspeed has little value for downwind concentration predictions because smoke travels in several directions at the same time.

TRANSPORT WINDSPEED
The arithmetic average of all windspeeds (including surface windspeed) within the mixing layer [i.e., below the Mixing Height, (which see)]. (cf: Surface Wind.)

UNDERBURNING
The use of a low intensity surface fire (compared with fires in cleared areas or on open range) as a management practice under a stand of timber. Used in treating Understory (which see) vegetation and litter, and for Sanitation Burning (which see).

UNDERSTORY
Vegetation beneath the canopy formed by dominant members of the Species Association (which see).

GLOSSARY continued

UNENTRAINED
Smoke which is not drawn into the convection column of a fire. (cf: Entrainment.)

WILDFIRE
Any fire burning out of prescription. (cf: Prescribed Fire; Natural Prescribed Fire.)

WINDROW
A fuel arrangement resulting when residue or other debris is treated by machines so as to form an elongated pile.

YARDING
The transport of harvested materials or residues to collection points within an area being logged.

YUM
The acronym for yarding unmerchantable material. (See Yarding.) Piles resulting from "YUM" are generally larger than those from "PUM" (cf), and are dependent upon tractor or cable logging systems.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT A process is given for balancing air quality and land management goals through smoke management. The process has application wherever land management open burning has the potential to affect air quality, or wherever air quality restrictions may affect the use of fire as a land management practice. Primary focus of the process is upon confirmation of related public and technical issues, then upon developing issue-resolving criteria. This leads to development and evaluation of alternatives. Two are emphasized. One is increased utilization of residues in place of burning. The other emphasized alternative is scheduling of open burning to meet conditions specified for maintaining downwind concentrations of emissions to acceptable levels. Scheduling may also be employed to favor visibility protection and enhancement. Process supporting technical appendices cover development and evaluation of a smoke management program, predicting downwind concentrations, and determining visibility protection needs. Selected references and a glossary are provided.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Agricultural residues, air quality protection, alternatives, evaluation, atmospheric emissions, forest residues, goals-balancing, impact analysis, land management open burning, open burning, prescribed fire, smoke management, visibility protection.		6F

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