Appendix D
Emission Reduction Techniques
SMP I – Voluntary
SMP II – Required (Wildland fire use is exempt from the required use of ERTs)

Emission Reduction Techniques (ERTs) are any burning techniques that reduce the actual amount of emissions produced from fire. Generally ERTs are methods that minimize the area burned, reduce fuel loading, reduce the amount of fuel consumed, or otherwise minimize emissions. ERTs are used with fire, and are not considered alternatives to fire if used within three years of a prescribed burn on the same piece of land or burn project.

Through the use of ERTs, emissions from fire can be reduced. Reducing fire emissions to the maximum extent feasible is the intent of the Annual Emission Goal, as required by the Regional Haze Rule. Burners giving both planned ERT use and actual ERT use on the Registration and Tracking Forms will enable the AQB to set the Annual Emission Goal each year. For more information on Annual Emission Goals, see Appendix L.

To meet the requirements of this element, ERTs must be considered, with at least one incorporated into the burn project (SMP II). This must be documented and kept in the burners' file. The consideration of ERTs is subject to the feasibility criteria of economics, efficiency, law, emission reduction opportunities, land management objectives, reduction of visibility impact, burner and public safety, and tribal traditional and cultural activities.

Wildland fire use is not required to employ ERTs, since there may be instances when there are no ERTs available. However, the use of ERTs is encouraged, and when utilized, ERTs should be indicated on the Registration and/or Tracking Forms.

A waiver from the ERT requirement may be considered by the AQB if the burner satisfactorily explains why no ERTs are feasible. A request for waiver should be submitted no later than two weeks prior to ignition (i.e., at the time of the registration deadline). Once the AQB staff receives the waiver request, they have seven days to consider the waiver and inform the burner of an approval or denial. The burner must receive written confirmation of the waiver to initiate the burn. See Appendix H for information on waivers and Appendix P for the Waiver Form and Instructions.

D.1. List of Possible Emission Reduction Techniques

The following list gives some possible ERTs. This list is not all-inclusive nor is it intended to suggest that any of these methods are preferable. References are listed below and provide additional information.

ERTs commonly used for broadcast burning.

- Burn Concentrations – sometimes concentrations of fuels can be burned rather than using fire on 100 percent of an area requiring treatment. The fuel loading of the areas burned

using this technique tends to be high. This can also apply to areas that have "jackpots" of fuels or broadcast slash burns (slash that has not been piled).

- Isolate fuels – large logs, snags, deep pockets of duff, sawdust piles, squirrel middens, or other fuel concentrations that have the potential to smolder for long periods of time can be isolated from burning (reducing the area burned). This can be accomplished by several techniques including: 1) constructing a fireline around fuels of concern, 2) not lighting individual or concentrated fuels, 3) using natural barriers or snow, 4) scattering the fuels, and 5) spraying with foam or other fire retardant material. Eliminating these fuels from burning is often faster, safer, and less costly than mop-up, and allows targeted fuels to remain following the prescribed burn.
- Mosaic burning – landscapes often contain a variety of fuel types that are noncontinuous and vary in fuel moisture content. Prescribed fire prescriptions and lighting patterns can be assigned to use this fuel and fuel moisture non-homogeneity to mimic natural wildfire and create patches of burned and non-burned areas or burn only selected fuels. Areas or fuels that do not burn do not contribute to emissions.
- Grazing – grazing and browsing live grassy or brushy fuels by sheep, cattle, or goats can reduce fuels prior to burning or reduce the burn frequency.
- Site Conversion – natural site productively can be decreased by changing the vegetation composition lessening the need to burn as often.
- Land use change – changing wildlands/shrublands/rangelands/croplands to another land use category may result in elimination of the need to burn and vice versa.
- Having high moisture content in non-target fuels – this can result in only the fuels targeted being dry enough to burn.
- High moisture in large woody fuels – burning when large-diameter woody fuels (three-plus inch diameter or greater) are wet can result in lower fuel consumption and less smoldering.
- Mass ignition/shortened fire duration/aerial ignition – "mass" ignition can occur through a combination of dry fine-fuels and rapid ignition, which can be achieved through the use of a helitorch. The conditions necessary to create a true mass ignition situation include rapid ignition of a large open area with continuous dry fuels.
- Burn before large fuels cure – living trees contain very high internal fuel moistures, which take a number of months to dry after harvest. If an area can be burned within 3-4 drying months of timber harvest many of the large fuels will still contain a significant amount of live fuel moisture.
- Rapid mop up – rapidly extinguishing a fire can reduce fuel consumption and smoldering emissions somewhat, although this technique is not particularly effective at reducing total emissions and can be expensive.
- Burn before precipitation – scheduling a prescribed fire before a precipitation event will often limit the consumption of large woody material, snags, stumps, and organic ground matter, thus reducing the potential for a long smoldering period and reducing the average emission factor.
- Burn before green up – burning in cover types with a grass and/or herbaceous fuel bed component can produce fewer emissions if burning takes place before these fuels green-up for the year.
- Burn before litter fall – underburning before deciduous trees and shrubs drop their leaves reduces ground litter that contributes extra volume to the fuel bed.

- Backing fire – flaming combustion is cleaner than smoldering combustion. A backing fire takes advantage of this relationship by causing more fuel consumption to take place in the flaming phase than would occur if a heading fire were used.
- Dry conditions – burning under dry conditions increases combustion efficiency and fewer emissions may be produced.
- Chemical Pre-Treatments – broad spectrum and selective herbicides can be used to reduce or remove live vegetation, or alter species diversity respectively. Herbicides can be applied before burning to kill vegetation, which can create a much drier fuel, which in turn burns more efficiently.

ERTs commonly used for pile burning.

- Removal – this can include 1) firewood sales/gathering – firewood sales/gathering may result in sufficient removal of woody debris making on site burning unnecessary. This technique is particularly effective for piled material where the public has easy access.2) whole tree harvesting – whole trees can be removed through harvesting or thinning techniques and virtually eliminate the need for burning.
- Processing – this can include 1) mulch/chips – mechanical processing of dead and live vegetation into wood chips or shredded biomass is effective in reducing emissions if the material is removed from the site or biologically decomposed. 2) composting/mulch – the act of removing the biomass and creating a mixture of decayed organic material off the site.
- Utilization – this can include 1) fuel for power generation – vegetative biomass can be removed and used to provide electricity in regions with cogeneration facilities. 2) biomass utilization – vegetative material can be used for many miscellaneous purposes including pulp for paper, methanol/ethanol production, wood pellets, garden bedding, furniture, specialty crafts, fiberboard/particleboard, etc.
- Land use change – changing wildlands/shrublands/rangelands/croplands to another land use category may result in elimination of the need to burn and vice versa.
- Having high moisture content in non-target fuels – this can result in only the fuels targeted being dry enough to burn.
- Moist litter or duff – the organic layer that forms from decayed and partially decayed material on the forest floor often burns during the inefficient smoldering phase. Consequently reducing the consumption of this material can be effective at reducing emissions.
- Piles or windrows – keeping piles dry and free of dirt and other debris generates greater heat and therefore, the piles burn more efficiently. The piles or windrows can be made mechanically or by hand.
- Plastic on piles – placing polyethylene sheeting over the piles for at least one month allows the material to dry and thus burn hotter and burn more efficiently. The smoke management regulation (20.2.65 NMAC) allows only polyethylene sheeting to be used for this purpose; the sheeting must be in place for at least one month prior to burning.
- Dry conditions – burning under dry conditions increases combustion efficiency and fewer emissions may be produced.

- Rapid mop up – rapidly extinguishing a fire can reduce fuel consumption and smoldering emissions somewhat, although this technique is not particularly effective at reducing total emissions and can be expensive.

Air Curtain Incinerator (ACI) – use of an air curtain incinerator improves combustion and reduces emissions by introducing high velocity air into a combustion environment. As the air continuously rotates in and over the environment, a "curtain" is created over the fire thus trapping smoke and particulate matter. Constant airflow into and over the combustion environment allows temperatures to remain high, resulting in relatively complete combustion of all emission products. ACIs can burn a wider variety of materials from green fuel to red slash and produce lower smoke emissions compared to pile or broadcast burning. They also reduce risk from an escaped fire since the fire is contained and can be quickly extinguished if necessary.

D.2. Definitions

Aerial ignition – ignition of fuels by dropping incendiary devices or materials from aircraft.

Air Curtain Incinerator (also known as Air Curtain Destructor) – an incinerator that operates by forcefully projecting a curtain of air across an open chamber or pit in which combustion occurs. This results in a more complete combustion process that produces little smoke and reduces emissions and particulates.

Alternatives to burning – treatments employing manual, mechanical, chemical, or animal methods to manage vegetation and/or fuel loads or land management practices that treat vegetation (fuel) without using fire. For the purposes of the NM Smoke Management Program, if a technique is used and the area is fire free for three years or more, the technique is an alternative to burning; if fire is used within three years, the technique is considered an emission reduction technique.

Backing fire – fire spreading, or ignited spread, into (against) the wind or downslope.

Burn project – in prescribed burning and wildland fire use, an area that is contiguous and is being treated for the same land management objective(s).

Clean piles – piles that have little to no (less than 10%) dirt or other debris mixed in with the vegetative material.

Combustion efficiency – the relative amount of time a fire burns in the flaming phases of combustion, as compared to smoldering combustion. A ratio of the amount of fuel that is consumed in flaming combustion compared to the amount of fuel consumed during the smoldering phase, in which more of the fuel material is emitted as smoke particles because it is not turned into carbon dioxide and water.

Compost – a mixture that consists of layers of decayed organic matter and is used for fertilizing and conditioning the land

Deciduous – a plant that loses all its leaves or needles during the fall and winter.

Duff – the partially decomposed organic material above the mineral soil that lies beneath the freshly fallen twigs, needles, and leaves and is often referred to as the F (fermentation) and H (humus) layers. Duff often consumes during the less efficient smoldering stage and has the potential to produce more than 50% of the smoke from a fire.

Emission factor – the mass of particulate matter produced per unit mass of fuel consumed (pounds per ton, grams per kilogram).

Emission Reduction Technique (ERT) – a strategy for controlling smoke from prescribed fires that minimizes the amount of smoke output per unit of area treated or other objective unit of accomplishment. This strategy is used in conjunction with fire and is not a replacement for fire. For the purposes of the NM Smoke Management Program, if a technique is used within three years of a burning operation, the technique is considered an ERT; if the technique replaces fire for three years or more, the technique is considered an alternative to burning.

Equilibrium moisture content – moisture content that a fuel particle will attain if exposed for an infinite period in an environment of specified constant temperature and humidity. When a fuel particle reaches equilibrium moisture content, net exchange of moisture between it and its' environment is zero.

Fine fuels – fast drying dead fuels generally characterized by a comparatively high surface area-to-volume ratio, which are less than 1/4inch in diameter and have a time lag of one hour or less. These fuels (grass, leaves, needles, etc.) ignite readily and are consumed rapidly by fire when dry.

Fire line – the part of a control line that is scraped or dug to mineral soil.

Flaming combustion phase – luminous oxidation of gases evolved from the rapid decomposition of fuel.

Fuel continuity – the degree or extent of continuous or uninterrupted distribution of fuel particles in a fuel bed that affects a fire's ability to sustain combustion and spread. This term applies to aerial fuels as well as surface fuels.

Fuel moisture content – the quantity of moisture in fuel expressed as a percentage of the weight; derived by weighing fuel sample both before and after thorough drying at 212 ° F (100 °C).

Glowing combustion phase – oxidation of solid fuel accompanied by incandescence.

Green up – when vegetation has started sprouting and/or growing leaves.

Head fire – fire spreading or set to spread with the wind.

Helitorch – an aerial ignition device hung from or mounted on a helicopter to disperse ignited lumps of gelled gasoline.

Humus – layer of decomposed organic matter on the forest floor beneath the fermentation layer and directly above the soil.

Litter – the top layer of forest floor, composed of loose debris of dead sticks, branches, twigs, and recently fallen leaves or needles.

Moisture of extinction – the fuel moisture content, weighed over all the fuel classes, at which the fire will not spread.

Mop up – extinguishing or removing burning material near control lines, felling snags, and trenching logs to prevent rolling after an area has burned to reduce the chance of fire spreading beyond control lines, or to reduce residual smoke.

Mosaic – the central spatial characteristic of a landscape. The intermingling of plant communities and their sucessional stages, or of disturbance (especially fire) in such a manner as to give the impression of interwoven, "patchy" design.

Mulch - a protective covering (as of sawdust, compost, or paper) spread or left on the ground to reduce evaporation, maintain even soil temperature, prevent erosion, control weeds, enrich the soil, or keep fruit (as strawberries) clean

Natural barrier – any area where lack of flammable material obstructs the spread of wildfires.

Pile – materials that have been relocated either by hand or machinery and heaped together.

Piling-and-burning – piling slash resulting from logging or fuel management activities and subsequently burning the individual piles.

Pyrolysis – the thermal or chemical decomposition of fuel at an elevated temperature.

Red slash – a condition of the logging/thinning slash usually conifers, reached when the needles turn reddish-brown while still attached to the limbs.

Residual smoke – smoke produced by smoldering material. The flux of smoke originating well after the active flaming combustion period with little or no vertical buoyancy, and therefore, most susceptible to subsidence inversions and down-valley flows.

Slash – debris resulting from such natural events as wind, fire, or snow breakage; or such human activities as road construction, logging, pruning, thinning, or brush cutting. It includes logs, chunks, bark, branches, stumps, and broken understory trees or brush.

Smoldering combustion phase – combined process of dehydration, pyrolysis, solid oxidation, and scattered flaming combustion and glowing combustion, which occur after the flaming combustion phase of a fire; often characterized by large amounts of smoke consisting mainly of tars.

Snag – a standing dead tree or part of a dead tree from which at least the leaves and smaller branches have fallen.

Time lag – time needed under specified conditions for a fuel particle to lose about 63 % of the difference between its natural moisture content and its equilibrium moisture content. If conditions remain unchanged, a fuel will reach 95% of its equilibrium moisture content after four time lag periods.

Understory burn – a fire that consumes surface fuels but not overstory trees (in the case of forest or woodlands) and shrubs (in the case of shrublands).

Wildland – an area in which development is essentially non-existent, except for roads, railroads, power lines, and similar transportation facilities. Structures if any are widely scattered.

Windrow – slash that has been piled into long continuous rows.

D.3. References

Regional Haze Rule
Published in the Federal Register on July 1, 1999, 64 FR 35714.
http://www.epa.gov/ttn/oarpg/t1/fr_notices/rhfedreg.pdf

EPA Prescribed Burning Background Document and Technical Information Document for Prescribed Burning Best Available Control Measures
EPA-450/2-92-003, September 1992. http://www.epa.gov/ttncaaa1/t1bid.html (go to PM BACM Tech Guid Doc - Prescribed Burning)

EPA Interim Air Quality Policy on Wildland and Prescribed Fires
EPA, Office of Air Quality Planning and Standards, Interim Air Quality Policy on Wildland and Prescribed Fires, April 23, 1998. http://www.epa.gov/ttn/oarpg/t1/memoranda/firefnl.pdf

Smoke Management Guide for Prescribed and Wildland Fire
National Wildfire Coordination Group. PMS420-2. 226 pages. December 2001.
http://www.nwcg.gov/pms/pubs/large.html (large document – long download time)

The Use of Air Curtain Destructors for Fuel Reduction. Fire Management Tech Tips
USDA Technology Development Program. 0251 1317-SDTDC. September 2002.
http://www.fs.fed.us/eng/pubs/html/02511317/02511317.htm

Understory Biomass Reduction Methods and Equipment
USDA Forest Service Technology and Development Program Missoula, Montana. Tech Rep. 0051-2826-MTDC. 2000.
http://www.fs.fed.us/vegtools/techniques/mtdc.php

WRAP Policy on Enhanced Smoke Management Programs for Visibility
Approved by the Western Regional Air Partnership, November 12, 2002.
http://www.wrapair.org/forums/fejf/documents/esmptt/policy/030115_ESMP_Policy.pdf

Non-burning Management Alternatives on Agricultural Lands in the Western United States
Western Regional Air Partnership, 2000.
http://www.wrapair.org/forums/fejf/tasks/FEJFtask4.html

Nonburning Alternatives to Prescribed Fire on Wildlands in the Western United States
Western Regional Air Partnership, February 2004.
http://www.wrapair.org/forums/fejf/tasks/FEJFtask3.html