OPERATIONAL PRESCRIPTIONS FIELD GUIDE

Prescribed Burning in South Australia

Department of Environment and Natural Resources

Government of South Australia

Contents

About this guide

Prescribed burning is the deliberate and safe application of fire under specified environmental conditions in a designated area for the purposes of fuel reduction, ecological management and/or woody weed management objectives.

This guide provides the operational parameters under which a prescribed burn can be conducted in a safe and controlled manner to effectively reduce fuels. It does not cover other aspects of burn planning such as burn season, size and intensity that need to be considered to ensure any specific ecological objectives are met.

This guide aims to assist with:

- identifying the different vegetation types suitable for prescribed burning;
- outlining the preferred range of weather variables that can be used for prescribed burning.

This guide should be used to:

- identify appropriate weather parameters to plan and conduct a prescribed burn.

For further information on the operational prescriptions please refer to the Prescribed Burning in South Australia: Review of Operational Prescriptions 2011.

Using this guide

The recommended process for selecting appropriate burning parameters is:

1. Specify the burn's objectives.
2. Determine the vegetation types and the level of fuel hazard within and adjacent to the prescribed burning area. Where prescribed burning is being performed in mixed vegetation types the selection of appropriate burning prescriptions will need to be based on the most flammable component of the vegetation and/or the component with the highest fuel hazard.
3. Determine the minimum and maximum fire intensity to achieve objectives, fuel modification required, and likely fire behaviour during the burn.
4. Determine whether the overall burn risk rating is acceptable using the Burn Risk Assessment Tool SA (BRAT SA).
5. If necessary, modify the weather and site parameters to reduce the level of fire risk whilst maintaining acceptable levels of fire intensity to achieve the burn's objective.
6. Undertake the burn within the prescription parameters.
7. Undertake post-burn assessments to determine if burn objectives have been met (and develop strategies to address the issue if the objectives have not been met), and record the burn outcomes on appropriate databases.

The integration of the different burning parameters is a critical component of prescribed burning. If burning is conducted with all of the parameters at their maximum values (eg highest wind speed, lowest relative humidity and highest fuel hazard) then fires will burn with rapid rates of spread, high intensities and a high risk of escapes. To minimise this risk, a maximum forward rate of spread has been included into all vegetation type's prescription, except for eucalypt heathy open forest and woodland.

Conversely, if burning is conducted with all of the parameters at their lowest values, then fires may fail to sustain, or if they do sustain, they may burn with insufficient intensity to meet the objectives of the burn.

The BRAT SA is a mandatory component of prescribed burn planning and is used to predict the burn, consequence and benefit risk rating for all vegetation types suitable for prescribed burning in South Australia. Prescribed burns with different burn overall risk ratings profiles require different levels of sign-off and approval prior to undertaking the prescribed burn. The Department for Environment and Natural Resources Fire Policy and Procedure Manual sets out the approval process for the different burn overall risk rating categories.

The use of operational prescriptions for prescribed burning activities should be undertaken by trained and experienced staff.

Fuel and fire behaviour

Planning a prescribed burn should ensure a level of fire behaviour that delivers the burn objective, whilst allowing the burn to remain under control. Fire behaviour is influenced by:

Fuel factors	
Fuel type	Differences in fuel type may mean difference in general arrangement and bark and fuel size characteristics. This will influence flame heights and rates of spread.
Available fuel quantity	In part, determines the fire intensity (I=Hwr) and rate of spread
Fuel arrangement	Influences flame height, intensity and rate of spread. Well aerated fuels will promote taller flames, higher intensities, more rapid rates of spread.
Fuel moisture content (FMC)	FMC is fundamental to determining whether fuels burn, and if so, how rapidly and intensely. The distribution of moisture in fuel beds also determines the portion of fuel available to burn. A good knowledge of FMC is essential to predict likely fire behaviour. FMC can be measured using a fine fuel moisture meter. A direct estimate of the fuel moisture index is derived from the Fuel Moisture Index (FMI) equation $FMI = 10 - \frac{(Temp - RH)}{4}$ (Sharples *et al*. 2009). Fine fuel moisture content can also be estimated by using McArthur's equation • Morning/evening ffmc=12.5 - (0.279-temp) + (0.111 x RH) • Afternoon (1200-1800) ffmc = 6.66 - (0.167 x temp) + (0.111 x RH) (McArthur 1962)

Weather factors	
Wind	Major influence on rate of spread. Any prescribed burn must take account the expected wind strength and direction. All prescriptions used in this guide use the wind speed measured at 10m above the ground surface. The wind speed predicted or measured by the Bureau of Meterology is the 10m wind speed. If the wind speed is being measured at 2m it needs to be transformed to the equivalant of the 10m wind speed by multiplying by 1.5.
Temperature Relative Humidity	In part, determines the fire intensity (I=Hwr) and rate of spread. Strongly influences the dryness of fine fuels. The drier the fine fuels are the more intensely they will burn.
Atmospheric Stability	Affects convection activity over any fire. The stronger the convection is the more intense the fire is likely to be. Prescribed burning under unstable conditions will generate erratic and unpredictable fire behaviour.
Soil Dryness Index (SDI) or Drought Index (KBDI)	The SDI is a measure of soil dryness and will reflect the dryness of heavy fuels, living vegetation, and deep litter beds. At high drought indices, burning intensities and scorch height will be higher, reflecting higher available fuel loads, and greater moisture stresses in living vegetation.
Drought Factor (DF)	DF is the predicted proportion of fine fuels that are expected to be consumed in the flaming front of the fire. DF is based on recent rainfall and the KBDI.
McAthur's Fire Danger Index (FDI) for forest and grassland	FDI is an assessment of the potential fire behaviour for a given day evaluating rate of spread, and suppression difficulties for specific combinations of fuel, fuel moisture and wind speed. The FDI is calculated using the degree of fuel curing, air temperature, relative humidity and wind speed.

Topographical factors	
Slope	Influences rate of spread. In prescribed burning may be able to use downslope spread (that is, a backing fire) as a factor to make the burn more controllable.
Aspect	Influences fuel type, available fuel quantity and fuel moisture content. Different aspects are likely to have different wind conditions. Expect differences in fire behaviour on different aspects.
Elevation	Big differences in elevation will have similar influences on fuel characteristics as differences in aspect.

Ignition factors	
Ignition Patterns	Ignition (or lighting) patterns such as spot or strip ignition (Figure 1) will govern: rate of spread and intensity by determining whether fires will spread up or downslope, or run with the wind or back against the wind. This will influence the overall intensity of the fire and important consequences such as scorch and spotting.
Ignition Techniques	Influences the rate at which fuels are ignited, which will affect the overall burn out time and the overall burn intensity.
Elevation	Big differences in elevation will have similar influences on fuel characteristics as differences in aspect.

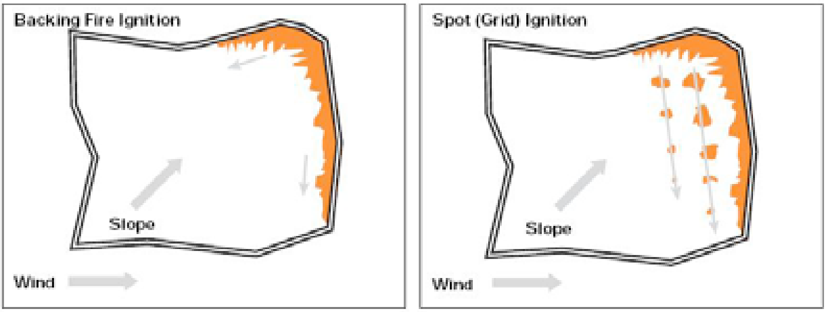

Figure 1. Some common ignition patterns used for prescribed burning (Tolhurst and Cheney 1999).

Prescribed burning prescriptions

The main vegetation (fuel) types in South Australia suitable for prescribed burning are:

- Semi-arid mallee
- Semi-arid mallee-heath
- Spinifex grassland
- Eucalypt heathy open forest and woodland
- Native grasslands
- Grassy eucalypt woodlands
- Coastal mallee
- Coastal mallee heathland
- Non-eucalypt woodland and heathland
- Woody weeds.

Each vegetation type has been allocated prescriptions with a series of parameters.

1. Semi-arid mallee

Description: Low open eucalypt dominated vegetation with an understorey of smaller shrubs, grasses and herbs (Figure 2). The fuel array is typically highly discontinuous.

Distribution: Occupies large areas of central to northern Eyre Peninsula and Murraylands and smaller areas of Yorke Peninsula.

Fire behaviour: Relatively high wind speed and low fuel moistures are required for flames to cross fuel discontinuities and sustain burning.

Model: Fire behaviour can be predicted using the fire prediction models in Cruz *et al*. (2010).

Figure 2. Semi-arid mallee

Semi-arid mallee prescribed burning prescriptions

Parameter	*Range*
Adjusted surface fuel hazard	**L or M**
Max. FROS (km/hr)	1.5
Wind (km/h)	25 to 50
RH (%)	10 to 60
Temp (° C)	20 to 40
NSF FMC (%)	5 to 10
Adjusted surface fuel hazard	**H**
Max. FROS (km/hr)	1.5
Wind (km/h)	20 to 45
RH (%)	20 to 70
Temp (° C)	20 to 40
NSF FMC (%)	7 to 12
Adjusted surface fuel hazard	**VH or E**
Max. FROS (km/hr)	1.5
Wind (km/h)	15 to 35
RH (%)	20 to 70
Temp (° C)	20 to 40
NSF FMC (%)	8 to 13
Overnight weather: bounded burns	
Wind (km/h)	<25
RH (%)	>60
NSF FMC (%)	>15
Overnight weather: unbounded burns	
Wind (km/h)	<15
RH for at least 5 hours (%)	>85
NSF FMC (%)	>15

2. Semi-arid mallee-heath

Description: Heathy-shrub dominated vegetation under patches of overstorey mallee (Figure 3). The near surface fuel array is typically discontinuous.

Distribution: Occupies large areas of central to northern Eyre Peninsula and Murraylands and smaller areas of Yorke Peninsula.

Fire behaviour: Wind speed and fuel moisture are the major influences on fire behaviour.

Model: Fire behaviour can be predicted using the fire prediction models in Cruz *et al*. (2010).

Figure 3. Semi-arid mallee-heath

Semi-arid mallee-heath prescribed burning prescriptions

Parameter	*Range*
Adjusted surface fuel hazard	**L or M**
Max. FROS (km/hr)	1.5
Wind (km/h)	25 to 50
RH (%)	10 to 60
Temp (° C)	20 to 40
NSF FMC (%)	5 to 10
Adjusted surface fuel hazard	**H**
Max. FROS (km/hr)	1.5
Wind (km/h)	20 to 45
RH (%)	20 to 70
Temp (° C)	20 to 40
NSF FMC (%)	7 to 12
Adjusted surface fuel hazard	**VH or E**
Max. FROS (km/hr)	1.5
Wind (km/h)	15 to 35
RH (%)	20 to 70
Temp (° C)	20 to 40
NSF FMC (%)	8 to 13
Overnight weather: bounded burns	
Wind (km/h)	<25
RH (%)	>60
NSF FMC (%)	>15
Overnight weather: unbounded burns	
Wind (km/h)	<15
RH for at least 5 hours (%)	>85
NSF FMC (%)	>15

3. Spinifex grassland

Description: Hummock grasslands dominated by *Triodia* spp. with a variable density overstorey of *Acacia* spp., shrubs and/or mallee (Figure 4). The fuel array is typically highly discontinuous.

Distribution: Occur across large areas of Eyre Peninsula and Flinders Ranges and smaller areas of Northern Mount Lofty Ranges and Murraylands.

Fire behaviour: Relatively high to moderate winds and low humidity are required for flames to cross fuel discontinuities and sustain burning.

Model: Fire behaviour can be predicted using the fire prediction models in Burrows *et al*. (2006, 2009).

Figure 4. Prescribed burning in spinifex grasslands.

Spinifex grassland prescribed burning prescriptions

Parameter	*Range*
Adjusted surface fuel hazard	**L or M**
Max. FROS (km/hr)	1.0
Wind (km/h)	20 to 50
NSF FMC (%)	12 to 30
Adjusted surface fuel hazard	**H**
Max. FROS (km/hr)	0.9
Wind (km/h)	10 to 40
NSF FMC (%)	12 to 30
Adjusted surface fuel hazard	**VH or E**
Max. FROS (km/hr)	1.3
Wind (km/h)	10 to 30
NSF FMC (%)	12 to 30
Overnight weather: bounded burns	
Wind (km/h)	<15
RH (%)	>60
NSF FMC (%)	>15
Overnight weather: unbounded burns	
Wind (km/h)	<15
RH for at least 5 hours (%)	>85
NSF FMC (%)	>15

4. Eucalypt heathy open forest and woodland

Description: Dominated by 10 to 30m high eucalypt trees with understoreys ranging from litter, sedgy, heathy and/or bracken (Figure 5 and 6).

Distribution: Occupies areas of Mount Lofty Ranges, Southern Flinders Ranges, South East, Kangaroo Island, southern Eyre Peninsula and southern Murraylands.

Fire behaviour: Tree height and density will influence the effective wind speed, with taller and/or denser sites having lower wind speeds on the fireline. Thus, wind will have greater influences in woodland than in forest.

Model: Fire behaviour can be predicted using the McArthur Forest Fire Danger Meter (McArthur 1967).

Figure 5. Eucalypt heathy open forest (Southern Mount Lofty Ranges)

Eucalypt heathy open forest and woodland prescribed burning prescriptions

Parameter	*Range*
Overall fuel hazard rating	**L or M**
Wind (km/h)	20 to 40
RH (%)	10 to 60
Temp (° C)	20 to 40
FMC (%)	5 to 15
FFDI	7 to 15
Overall fuel hazard rating	**H**
Wind (km/h)	10 to 35
RH (%)	20 to 60
Temp (° C)	15 to 40
FMC (%)	7 to 15
FFDI	5 to 12
Overall fuel hazard rating	**VH or E**
Wind (km/h)	5 to 20
RH (%)	20 to 80
Temp (° C)	15 to 40
NSF FMC (%)	10 to 15
FFDI	4 to 10

Figure 6. Eucalypt heathy open forest (Northern Mount Lofty Ranges)

5. Native grasslands

Description: Dominated by closely-spaced tussocks of native grasses and grass like perennials, 0.5 to 1m high, with range of low shrubs and herbs scattered between the tussocks (Figure 7). Trees and tall shrubs are generally absent or very sparse.

Distribution: Occupies areas of Eyre Peninsula, Murraylands and the Mount Lofty Ranges.

Fire behaviour: The critical factors influencing fire behaviour in native grassland burning are wind speed, curing (i.e. percentage of dead fuel) and fuel continuity.

Model: Fire behaviour can be predicted the using grassland fire prediction models in Cheney and Gould (1995); Cheney *et al*. (1993, 1998) and Cheney and Sullivan (2008).

Figure 7. Iron-grass grassland

Native grassland prescribed burning prescriptions

Parameter	*Range*
Adjusted surface fuel hazard	**L or M**
Max. FROS (km/hr)	1.5
Wind (km/h)	10 to 40
RH (%)	20 to 80
Temp (° C)	15 to 40
Curing (%)	90 to 100
GFDI	≤5
Adjusted surface fuel hazard	**H**
Max. FROS (km/hr)	1.5
Wind (km/h)	5 to 20
RH (%)	20 to 80
Temp (° C)	15 to 40
Curing (%)	80 to 90
GFDI	≤5
Adjusted surface fuel hazard	**VH or E**
Max. FROS (km/hr)	1.2
Wind (km/h)	0 to 10
RH (%)	20 to 80
Temp (° C)	15 to 40
Curing (%)	60 to 80
GFDI	≤5

6. Grassy eucalypt woodlands

Description: Dominated by eucalypt species with an open or dense tree layer and an understorey of a varying mixture of grasses, herbs, sedges and shrubs (Figure 8). Shrubs are sparse, with up to 30% cover.

Distribution: Occupies large areas of Eyre Peninsula, Mount Lofty Ranges, Murraylands, Yorke Peninsula and the upper South East.

Fire behaviour: Wind speed and curing (i.e. percentage of dead fuel) influence fire behaviour. Taller and/or denser sites of tree will reduce the wind speed on the fireline.

Model: Fire behaviour can be predicted the using grassland fire prediction models in Cheney and Gould (1995); Cheney *et al*. (1993, 1998)and Cheney and Sullivan (2008).

Figure 8. Grassy woodland

Grassy eucalypt woodland prescribed burning prescriptions

Parameter	*Range*
Adjusted surface fuel hazard	**L or M**
Max. FROS (km/hr)	1.5
Wind (km/h)	10 to 40
RH (%)	20 to 80
Temp (° C)	15 to 40
Curing (%)	90 to 100
GFDI	≤5
Adjusted surface fuel hazard	**H**
Max. FROS (km/hr)	1.5
Wind (km/h)	5 to 20
RH (%)	20 to 80
Temp (° C)	15 to 40
Curing (%)	80 to 90
GFDI	≤5
Adjusted surface fuel hazard	**VH or E**
Max. FROS (km/hr)	1.2
Wind (km/h)	0 to 10
RH (%)	20 to 80
Temp (° C)	15 to 40
Curing (%)	60 to 80
GFDI	≤5

7. Coastal mallee

Description: Dominated by 1 to 4m high mallee with a dense understorey of coastal shrubs and heath (Figure 9).

Distribution: Occupies large areas of the western Eyre Peninsula, southern Yorke Peninsula, southern Murraylands, Kangaroo Island and upper South East.

Fire behaviour: Density, arrangement of elevated fuels, wind speed, slope and fuel moisture influence fire behaviour.

Model: Fire behaviour can be predicted using the heathland fire model in Catchpole *et al*. (1998; 1999).

Figure 9. Coastal mallee

Costal mallee prescribed burning prescriptions

Parameter	*Range*
Elevated fuel height	**0 - 0.5 m**
Max. FROS (km/hr)	0.9
Wind (km/h)	15 to 40
RH (%)	10 to 70
Temp (° C)	20 to 40
NSF FMC (%)	7 to 10
Elevated fuel height	**0.5 - 2 m**
Max. FROS (km/hr)	1.5
Wind (km/h)	5 to 30
RH (%)	25 to 75
Temp (° C)	15 to 40
NSF FMC (%)	10 to 15
Elevated fuel height	**>2 m**
Max. FROS (km/hr)	1.5
Wind (km/h)	0 to 15
RH (%)	25 to 75
Temp (° C)	15 to 40
NSF FMC (%)	10 to 20

8. Coastal heathland

Description: Dominated by a variety of shrubs and heath, 1 to 3m high, typically in a dense layer (Figure 10).

Distribution: Occupies large areas of the western Eyre Peninsula, southern Yorke Peninsula, southern Murraylands, Kangaroo Island and upper South East.

Fire behaviour: Density, arrangement of elevated fuels, wind speed, slope and fuel moisture influence fire behaviour.

Model: Fire behaviour can be predicted using the heathland fire model in Catchpole *et al*. (1998; 1999).

Figure 10. Coastal heathland

Costal heathland prescribed burning prescriptions

Parameter	*Range*
Elevated fuel height	**0 - 0.5 m**
Max. FROS (km/hr)	0.9
Wind (km/h)	15 to 40
RH (%)	10 to 70
Temp (° C)	20 to 40
NSF FMC (%)	7 to 10
Elevated fuel height	**0.5 - 2 m**
Max. FROS (km/hr)	1.5
Wind (km/h)	5 to 30
RH (%)	25 to 75
Temp (° C)	15 to 40
NSF FMC (%)	10 to 15
Elevated fuel height	**>2 m**
Max. FROS (km/hr)	1.5
Wind (km/h)	0 to 15
RH (%)	25 to 75
Temp (° C)	15 to 40
NSF FMC (%)	10 to 20

9. Non-eucalypt woodland and heathland

Description: Dominated by non-eucalypt trees and temperate shrubs consisting of either tea-tree, paperbark, and/or Callitris, typically ranging from 1 to 8m tall (Figure 11).

Distribution: Occupies large areas of the Eyre Peninsula and moderate areas of Kangaroo Island, Southern Mount Lofty Ranges, Murraylands, lower South East and Yorke Peninsula.

Fire behaviour: Density, arrangement of elevated fuels, fuel continuity, wind speed, slope and fuel moisture influence fire behaviour.

Model: Fire behaviour can be predicted using the heathland fire model in Catchpole *et al*. (1998; 1999).

Figure 11. Tea tree non-eucalypt woodland

Non eucalypt woodland and heathland prescribed burning prescriptions

Parameter	*Range*
Elevated fuel height	**0 - 0.5 m**
Max. FROS (km/hr)	0.9
Wind (km/h)	15 to 40
RH (%)	10 to 70
Temp (° C)	20 to 40
NSF FMC (%)	7 to 10
Elevated fuel height	**0.5 - 2 m**
Max. FROS (km/hr)	1.5
Wind (km/h)	5 to 30
RH (%)	25 to 75
Temp (° C)	15 to 40
NSF FMC (%)	10 to 15
Elevated fuel height	**>2 m**
Max. FROS (km/hr)	1.5
Wind (km/h)	0 to 15
RH (%)	25 to 75
Temp (° C)	15 to 40
NSF FMC (%)	10 to 20

10. Woody weeds

Description: Non indigenous and native plants that invade natural areas, ranging from small, soft plants to large trees (Figure 12).

Distribution: Many parts of South Australia.

Fire behaviour: Density, arrangement of elevated fuels, wind speed, slope and fuel moisture influence fire behaviour.

Model: Fire behaviour can be predicted using the heathland fire model in Catchpole *et al*. (1998; 1999), with additional information from the gorse fire model in Anderson and Anderson (2010); Fernandes (2001) and Baeza *et al*. (2002).

Fire Response: Woody weeds rapidly regenerate after fire and integrated pre and post fire treatments are essential.

Figure 12. Gorse thicket managed by prescribed burning

Woody weed prescribed burning prescriptions

Parameter	*Range*
Elevated fuel height	**0 - 0.5 m**
Max. FROS (km/hr)	0.9
Wind (km/h)	15 to 40
RH (%)	10 to 70
Temp (° C)	20 to 40
NSF FMC (%)	7 to 10
Elevated fuel height	**0.5 - 2 m**
Max. FROS (km/hr)	1.5
Wind (km/h)	5 to 30
RH (%)	25 to 75
Temp (° C)	15 to 40
NSF FMC (%)	10 to 15
Elevated fuel height	**>2 m**
Max. FROS (km/hr)	1.5
Wind (km/h)	0 to 15
RH (%)	25 to 75
Temp (° C)	15 to 40
NSF FMC (%)	10 to 20

Acronyms used in the field guide

Listed here are most acronyms/ abbreviations used in the Operational Prescriptions Field Guide and what they stand for.

Term	Stands for
FFDI	Forest Fire Danger Index
FFMC	Fine fuel moisture content
FMC	Fuel moisture content
GFDI	Grassland Fire Danger Index
Max. FROS	Maximum Forward Rate of Spread
NSF FMC	Near surface fuel, fuel moisture content
RH	Relative Humidity
Temp	Air Temperature
Wind	Average wind speed at 10m

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