

Draft Forest Industry Standard for Prescribed Burning Practice

Introduction

This document identifies a standard of practice for the conduct of prescribed silvicultural burning (PSB) in Tasmania. Within this context “prescribed silvicultural burning” means planned burning for the establishment of forest regeneration and plantations and the reduction of fuel after harvesting, commonly referred to as “regeneration burning” and “plantation establishment burning”. It includes the burning of residues from all types of forest harvesting regimes and plantation rotations.

Scope

The standard is defined specifically for burning plans, public notification procedure, smoke management, operational risk assessment and the accreditation of persons responsible for the planning and / or conduct of PSB.

Background

PSB is an essential part of the cycle of forest use and regeneration. It has been practised on a seasonal basis in Tasmania for more than fifty years. Forest management on public and private land has raised community awareness of forestry practices. PSB and particularly the smoke it causes is a seasonal catalyst for public debate. While concerted efforts are made to minimise the impacts of PSB on communities, periodic incidents such as escaped fires and severe smoke events do occur and provoke public concern.

The Forest Practices Authority is proposing that the best of current planning tools and guidelines be collated into a standard which can be endorsed by the Forest Practices Advisory Council and the Forest Practices Board and applied to all relevant Forest Practices Plans. The standard for each area within the scope of the PSB process is defined as a series of actions to be taken. Where appropriate implementation tools are available, they are identified in this document. Other appropriate methods of providing evidence that these standards have been applied to PSB may be used.

1. Standard for PSB Planning

- 1.1 All PSB over 2 hectares will have an Approved Burning Plan.
(This is a condition of a Fire Permit under Section 66 of the Fire Service Act 1979, as amended). It is intended that this condition will apply to PSB regardless of whether or not a Fire Permit Period has been declared.
An “Approved Burning Plan” means a reproducible document which contains specific information:
 - 1.1.1 Business identifying information & contact details.
 - 1.1.2 Name(s) and contact details of the accredited PSB personnel responsible for the operation (see section 5).
 - 1.1.3 PSB type, identifier, area & precise location by map reference.

- 1.1.4 Fire Permit Number (if applicable).
 - 1.1.5 Internal authorisation process (if applicable).
 - 1.1.6 Prescribed weather and fuel dryness parameters.
 - 1.1.7 Description of measures taken to ensure containment of the PSB.
 - 1.1.8 Description of a suppression strategy for escapes from the PSB.
 - 1.1.9 Description of the lighting strategy with a map of the area.
 - 1.1.10 List of resources required at the site to conduct the operation.
 - 1.1.11 Provision to record measured site weather and fuel dryness.
 - 1.1.12 Provision to record time of lighting, fire behaviour and outcome.
 - 1.1.13 A public notification plan (see section 2).
 - 1.1.14 A smoke management strategy (see section 3).
 - 1.1.15 A PSB risk assessment (see section 4).
 - 1.1.16 A description of the risk management strategy to be implemented.
- 1.2 Tools currently available to implement this standard:
- 1.2.1 Tasmania Fire Service Burning Plan (will require additional fields inserted) example provided as Appendix 1.
Appendix 1.
 - 1.2.2 Forestry Tasmania Operational Plan for Burning Created or Modified Fuels (some fields may need to be deleted for general use) example provided as Appendix 2.

2. Standard for Public Notification

The standard acknowledges different levels of public interest and specifies notification protocols for each level:

- 2.1 **Public** notification at the regional level by means of the print media, not less than three weeks prior to the anticipated start of the PSB programme. Further notification on the day planned for PSB by means of public broadcast and website (if available).
- 2.2 **Neighbour** notification in accordance with the conditions of a Fire Permit. It is proposed that this will apply to PSB regardless of the Fire Permit Period.
- 2.3 **Specific Authority** notification. This means the police, Air Services Australia regional control towers and power utilities, notified on the day planned for PSB, where applicable.
- 2.4 **Proprietary Interest** notification (PIN). Different levels of genuine proprietary interest are recognised:
 - 2.4.1 **Health**. This means persons within the anticipated fallout zone who may be severely affected by smoke, have registered their interest and provided contact details.
 - 2.4.2 **Commercial**. This means businesses within the anticipated fallout zone which may be severely affected by smoke, have registered their interest and provided contact details.

2.4.3 **Events.** This means public events within the anticipated fallout zone which may be severely affected by smoke, have registered their interest and provided contact details.

Businesses which conduct PSB should establish a register for PIN, based on their own pre-season community liaison efforts and feed-back from the public during the burning season.

2.5 A business conducting PSB will maintain a notification log which records persons / organisations notified, time and date of notification and means of notification.

2.6 A tool currently available to implement this standard is:

2.7.1 Notification Checklist within the FT burning plan.

3. Standard for Smoke Management

3.1 The standard for smoke management reflects the significance of and the effects and interactions between smoke impact factors i.e. the types of fuel, the fuels' dryness, the stability of the atmosphere and the Bureau of Meteorology's predicted daily smoke dispersion modelling.

3.1.1 Smoke management strategies for PSB will include the application of the Smoke Impact Decision Model (SIDM), a decision-making process which considers the smoke impact factors and determines the amount of burning which may be done in an air-shed for a burning period.

3.2 The tools proposed to implement this standard are:

3.2.1 Draft Smoke Impact Decision Model 2007 Draft 5 (Appendix 3).

3.2.2 Bureau of Meteorology F160 Forecast Aerological Diagram and Ventilation Index. (An explanation of this model, prepared by Forestry Tasmania's Fire Management Branch is provided as Appendix 3.1).

3.2.3 Bureau of Meteorology Smoke Dispersion Modelling. (An explanation of this model, prepared by Forestry Tasmania's Fire Management Branch is provided as Appendix 3.2).

4. Standard for PSB Risk Assessment

4.1 An Approved Burning Plan for PSB will include an operational risk assessment.

4.2 The FT Burn Risk & Consequence Assessment model is the standard. The model is embedded within the Forestry Tasmania Burning Plan. For background information about the model see Appendix 4.

5. Standard of Competency for persons planning and /or conducting PSB

5.1.1 A competent person **planning** PSB will be able to prepare an Approved Burning Plan in the course of which they will:

- 5.1.2 Identify appropriate sites and conditions for PSB.
- 5.1.3 Develop a site specific PSB objective with reference to appropriate silvicultural systems.
- 5.1.4 Within the scope of the plan, ensure the safety of persons, assets and the environment.
- 5.1.5 Consult with other interested parties during the planning process.
- 5.1.6 Develop appropriate burning strategies for different objectives.
- 5.1.7 Specify the resources needed to implement a plan.
- 5.1.8 Specify appropriate fuel dryness and weather parameters for safe and effective burning.
- 5.1.9 Conduct a risk assessment for PSB.
- 5.1.10 Develop a fire suppression plan for PSB.
- 5.1.11 Use the Bureau of Meteorology's Smoke Dispersion Forecasting tools to specify an appropriate smoke management strategy for PSB.
- 5.1.12 Prepare a public notification schedule for PSB.
- 5.1.13 Monitor the implementation of an Approved Burning Plan.
- 5.1.14 Record the results of PSB.
- 5.1.15 Investigate and report on any incidents which arise from PSB.

5.2 A competent person **conducting** PSB will be able to:

- ~~5.1.~~5.2.1 Identify and source an Approved Burning Plan for PSB.
- 5.2.2 Obtain a Fire Permit, if required and any other authorisations for PSB.
- 5.2.3 Implement the notification schedule attached to an Approved Burning Plan.
- 5.2.4 Assemble and brief all personnel involved in PSB.
- 5.2.5 Deploy the resources needed to conduct PSB.
- 5.2.6 Monitor and record site weather in accordance with the Approved Burning Plan.
- 5.2.7 Conduct pre-burning safety checks of the site, personnel and equipment.
- 5.2.8 Confirm that the site weather is within the parameters specified in the Approved Burning Plan.
- 5.2.9 Apply the Bureau of Meteorology's Smoke Dispersion Forecasting tools to implement a smoke management strategy.
- 5.2.10 Implement the lighting strategy specified in the Approved Burning Plan.
- 5.2.11 Monitor and record burning progress.
- 5.2.12 Supervise personnel and ensure that safety is not compromised.
- 5.2.13 Implement mop-up and patrol or suppression tactics as required.
- 5.2.14 Conduct post-burn activities.
- 5.2.15 Assess PSB outcomes.
- 5.2.16 Report incidents.

5.3 Tools currently available to implement this Standard:

- ~~5.1.~~5.3.1 PUA FIR406A (Appendix 5) and PUA FIR407A (Appendix 6) are accredited Units of the Public Safety Training Package.
- 5.3.2 Forestry Tasmania's High & Low Intensity Burning Courses will deliver the Learning Outcomes of these Public Safety Training units.

Attachments:

Appendix 1: Tasmania Fire Service Burning Plan
<http://www.fire.tas.gov.au/mysite/>

Appendix 2: Forestry Tasmania Burning Plan

Appendix 3: Draft Smoke Impact Decision Model

Appendix 3.1: Forestry Tasmania “Using the Bureau of Meteorology’s F160 Aerological Diagram to predict Temperature Inversions”.

Appendix 3.2: Forestry Tasmania “Using the Bureau of Meteorology’s Smoke Dispersion Model”.

Appendix 4: Prescribed Silvicultural Burning risk Assessment Model

Appendix 5: PUAFIR406A Develop Prescribed Burning Plans

Appendix 6: PUAFIR407A Conduct Prescribed Burning



TASMANIA FIRE SERVICE BURNING PLAN

PERMIT NO ISSUED:

A PERMIT HOLDERS DETAILS

Given Name: _____ Surname: _____
Street/Road Number/Name: _____
Suburb/Town/Location: _____
Postcode: _____ State: TAS Contact Phone No/s: _____

B LOCATION OF PLANNED BURN

Is the location of planned fire same as on permit holders details? Yes / No (If No complete details below)

Street/Road Number/Name: _____
Suburb/Town/Location: _____
or
Map Sheet Name: _____ Scale: _____ Grid Reference: _____

C DESCRIPTION OF AREA

Vegetation Type/s: Bush Scrub Grass Slash Logheaps
Years Since Last Burn: _____ Size of Area to be Burnt (Ha): _____
Topography – Predominant Aspects: North East South West
– Predominant Slope: Flat Undulating Moderate Steep
Boundaries/Control Lines: Roads Tracks Raked Lines Stream/Water
Course
Green Crop Cleared/Ploughed Ground Recent Burnt Area

What needs to be done to ensure Control Lines are secure: _____

What is the most vulnerable edge: _____

D WEATHER

Temperature should not exceed 20°. Relative humidity should be above 40%.
Wind speed must be less than 15kph. Wind direction must not be from: _____
Nearest Fire Weather Station _____ Forecast Fire Danger Rating (Day of Burn) _____

Next Three Days	Day 1	Day 2	Day 3
Fire Danger Rating			

E PERSONNEL and RESOURCES

Number of personnel to be on site: _____
Name of person in charge: _____
Firefighting equipment on site: _____

Firefighting equipment available at short notice: _____

F LIGHTING TECHNIQUE

How many people will be physically lighting fire: _____
How long will it take to light fire: _____
What is the most suitable time of day to light fire: _____
How long will the fire burn for: _____
Describe the sequence of lighting: (For example southern boundary 1st, once secure spot lighting down slope/upwind etc.):

G PATROL / MOP UP / EXTINGUISH

Number of personnel available to patrol and extinguish perimeter and hot spots within 100 metres of perimeter over the next three days: _____

What firefighting equipment will be available for this purpose: _____

H RISKS

Identify any assets which may be at risk as a result of the planned burn: _____

I ESCAPES

If the fire escapes or the fire activity is such it appears likely to escape, list your actions: _____

J PERMIT HOLDER'S OBLIGATIONS

This plan forms the primary conditions of your fire permit, it is not valid until approved by the Fire Permit Officer and has the permit number written in the top right hand corner of the front page. This plan must be retained by you and you must be able to produce this plan and your fire permit upon the request of an authorised officer at any time during the duration of the fire. Failure to retain this plan will be deemed to be a breach of the conditions of permit. A copy of the plan must be provided for the permit officer.

Upon the declaration of a Total Fire Ban your permit is revoked. If your fire is alight you must take immediate steps to stop it spreading and extinguish it.

If you need help dial 000 and ask for the Fire Service

K ADDITIONAL INFORMATION

FIRE WEATHER INFORMATION

Listed below are the Fire Weather Forecast Station for which the Bureau of Meteorology issues detailed fire weather forecasts and fire weather outlooks. The information for the fire weather station nearest the planned burn area is available from a number of sources.

Weather by Fax (Bureau of Meteorology) and which can be accessed by Fax Machine

Fire Weather Forecast for next day/or on the day of the planned burn

Phone: 1902 935 803

Fire Weather Outlook for the next three days

Phone: 1902 935 804

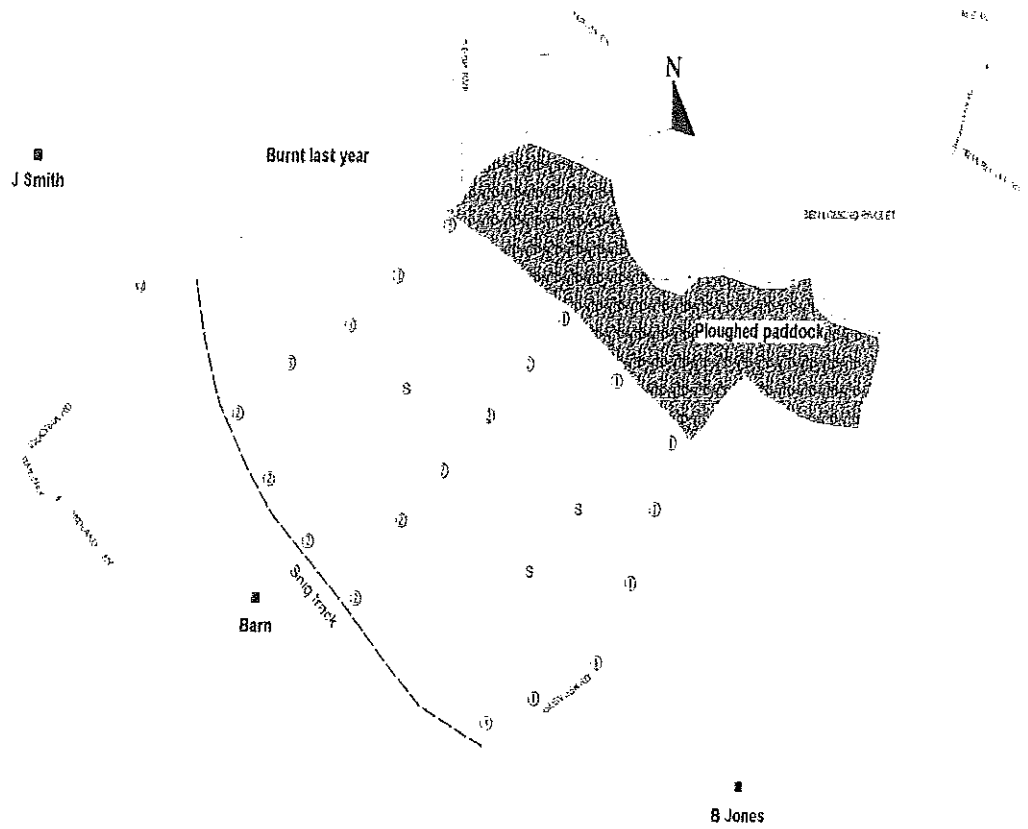
Bureau of Meteorology Ph: (03)62212000 and ask for the Fire Danger Rating for a specific station.

State Fire Management Council Web Site http://www.sfmc.tas.gov.au/part_a/intro_weather_map.htm and follow the link to Fire Danger Index Forecasts and outlooks.

Fire Weather Forecast Stations

Bushy Park, Devonport, Dover, Fingal, Flinders Is Airport, Friendly Beaches, Geeveston, Hobart Airport, Hobart City, King Is Airport, Launceston Airport, Launceston City, Liawenee, Luncheon Hill, Marrawah, Maydena, Moogara, Mt Wellington, Ouse, Palmers Lookout, Scotts Peak, Scottsdale, Smithton, St Helens, Strahan Airport, Tarraleah, Tunnack.

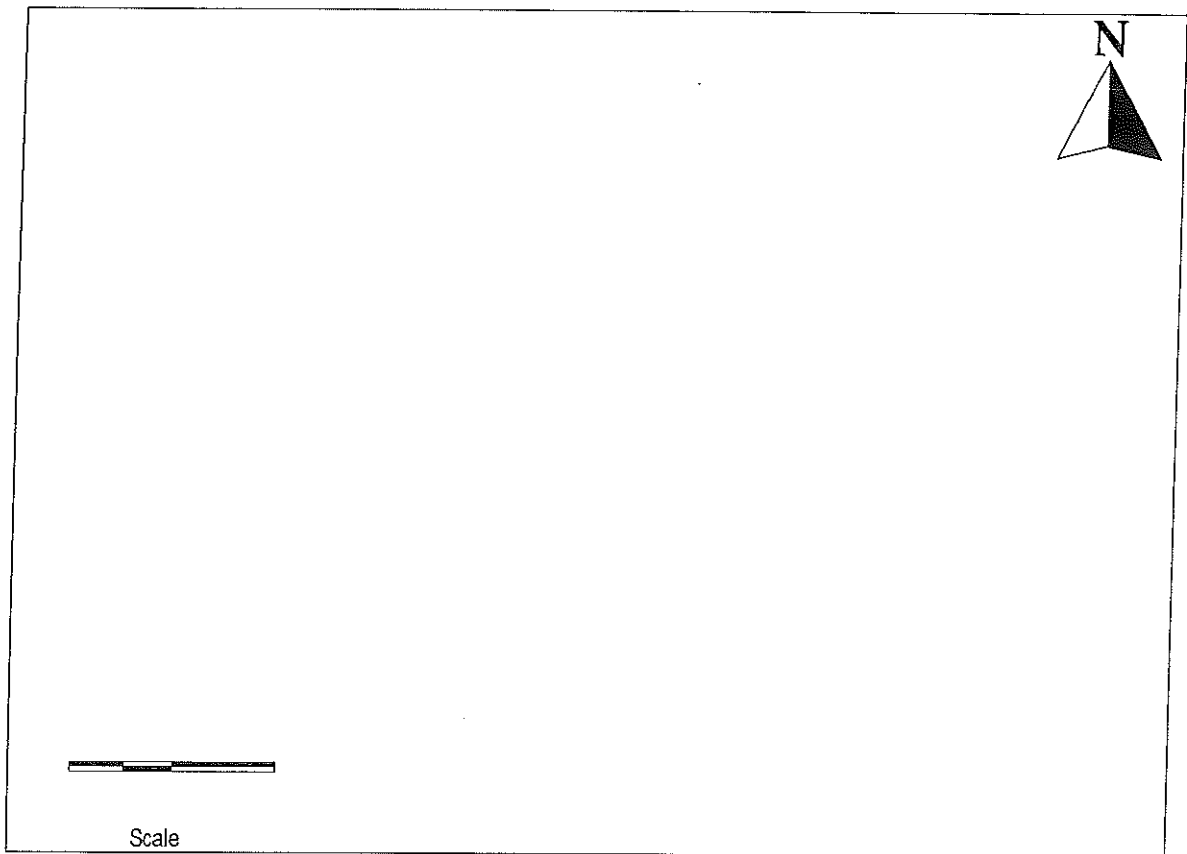
EXAMPLE OF PLAN OF BURNING AREA AND LIGHTING TECHNIQUE






LEGEND FOR BURNING PLAN

(W)	Water Point	—————	Road
(X)	Start Point	-----	Track
(S) →	Down Slope	XXXXXXXXXX>	Control Line
(T)	Tanker	~~~~~	Stream/Creek
■	Assets/Neighbours	①→①→	Lighting sequence & direction
		②→②→	Lighting sequence & direction

PLAN OF APPLICANTS BURNING AREA AND LIGHTING TECHNIQUE



SYMBOLS FOR BURNING PLAN

(W)	Water Point		Road
(X)	Start Point		Track
(S) →	Down Slope	XXXXXXXXXX>	Control Line
(T)	Tanker		Stream/Creek
■	Assets/Neighbours	① → ① →	Lighting sequence & direction
		② → ② →	Lighting sequence & direction

This Plan Approved By: (PRINT)..... (SIGNATURE).....

Position:

Date: .../.../...

FOREST OPERATIONAL PLAN

For Burning Created or Modified Fuels

This plan is prepared in accordance with Forestry Tasmania's Safety and Environment Management System (SEMS). It incorporates a Forest Operations Plan (FOP), consistent with the Tasmania Forest Safety Code 2000. A copy of this plan must be available on site during the conduct of the relevant operation. The completed form is to be kept in the relevant District coupe file.

Custodian Manager - Fire Management Authorised by General Manager (Operations)

Asset and Operational Information					
District		FPP number		FPP expiry date	
Coupe name		Location			
FOD operation ID		Finance 1 job number		FOD asset ID	
Mapsheet		Easting		Northing	
		Latitude		Longitude	
Emergency meeting point					
CDMA coverage		GSM coverage			
Planned area	ha	District coupe / operational file number			
Burn Risk Score	(obtained from burning risk matrix)		Burn Type		
Burn Objective					

List Possible Adverse Consequences of this Burn, the Likelihood and Precautions in Place.

Burn Plan Approval (signature and date).					
Plan prepared by		Signature		Date	
Plan reviewed by		Signature		Date	
Plan approved by (FM)		Signature		Date	
Plan audited by		Signature		Date	
Plan audited by		Signature		Date	

Audit Summary (auditors to indicate the appropriate entry).								
Lighting Plan Map	Approved	Modified	Rejected	Weather parameters	Approved	Modified	Rejected	
Lighting Strategy	Approved	Modified	Rejected	Suppression planning	Approved	Modified	Rejected	
Overall Risk of Escape	High risk			Moderate Risk	Low risk			
Impact of Escape on Values	High consequence			Moderate consequence	Low to no impact			
Overall Audit Approval	Not approved in present form			Approved with conditions	Approved - no conditions			

Audit Conditions (refer to pages where additional comments have been written).

Planning Considerations (appropriate issues to be marked on burn map). Refer to Forest Practices Plan.		
Identified special value in/ adjacent burn area	Potential threat to the value	Measures taken to reduce threat and consequences to the special value
FPP Checked by- Name:	Signature	Date

Known Safety and Environment Hazards unique to this operation (not in either the FPP or generic JRA).	
Identified hazard in/ adjacent burn area	Measures taken to reduce hazard to operations

Adjacent Lands.
Identify fire risk of surrounding lands including vegetation, topography and tenure considerations:
List additional issues arising from surrounding lands and identify the constraints on burning:

Smoke Management. General management practices to minimise impact of smoke are considered in burn planning. Consult the Bureau of Meteorology smoke dispersal (print out to be attached).
Name populations centres which may be affected by this burn's smoke:
Name community events which may be affected by this burn's smoke:
Burn specific strategies for limiting smoke related issues are to limit number of burns in an area, select weather and fuels conditions to burn under, allow for the forecast wind patterns, be alert to public events in the area, improve public information / consultation. Additional strategies for the conduction of this specific operational burn shall be:
Identify roads that may be affected by this burn's smoke and traffic control requirements:

Onsite Pre Burn Preparation..

Add additional items from point 8 onwards	Required Prior to Burning Operations	Completed Prior to Burning Operations
1. The area is surrounded by a mineral fireline	Yes / No	Yes / No
2. The fireline is entirely accessible by 4 WD tankers	Yes / No	Yes / No
3. Tanker access to water is available within 500 m of the burn	Yes / No	Yes / No
4. All stags within the planned burn have been felled	Yes / No	Yes / No
5. Stags within 40 m of the planned burn boundary have been felled - within the burn only	Yes / No	Yes / No
6. Stags within 40m of the burn boundary have been fallen in both the burn and adjacent vegetation	Yes / No	Yes / No
7. Heaps of fuel have been pushed as least 10 metres into the burn	Yes / No	Yes / No
8.	Yes / No	Yes / No
9.	Yes / No	Yes / No
10.	Yes / No	Yes / No
11.	Yes / No	Yes / No
12.	Yes / No	Yes / No

Bark Heap Pre-burn Preparation.

1. Are there bark heaps within 40 m of the burn boundary? NB this is a significant escape risk	Yes / No
2. If answer was "yes there are bark heaps within 40m of the boundary" what boundary are they adjacent to ie upwind/ downwind (from the preferred wind direction), is the coupe boundary above or below the barkheaps (coupe edge topography) and detail any barkheap specific escape mitigation practices.	

Additional Pre-burn Preparation.

Works required in addition to above, e.g. waterhole construction, fenceline, burns required in surrounding vegetation:

Additional work required to improve preparation (auditors comments)

All above works completed - Name	Signature	Date
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Lighting Strategy.

1:10,000 lighting plan map attached with burn boundary, ignition pattern [aerial and / or hand], anticipated wind direction and escape routes. The location of crews, tankers, water points, fuel dumps, assembly areas, rain gauge and fuel moisture sticks shall also be marked on the map. Fuel moisture [hazard] sticks & rain gauge will be set up on the block as shown on the lighting plan. A reconnaissance of the coupe must be made prior to lighting.

Ignition Method (indicate method used): Hand ignition only / Aerial ignition only / Hand and aerial ignition.

Lighting plan not approved due to (Auditors comments):

Auditors requirements:

Fire Behaviour and Weather Prescriptions (put NA if the factor is not applicable).

Review the weather forecast and further outlooks (rain or overnight dew is preferred after the burn has been lit).

Temperature (°C):	to	S.D.I. (mm):	to
Humidity (%):	to	Forest F.D.R:	≤ Moderate 6
10m Wind Speed (km):	<15 km/hr	Moorland F.D.R:	≤ Moderate 6
Preferred Wind Direction		Sticks Internal FMC (%)	to
Allowable Wind Direction	clockwise to	Sticks External FMC (%):	to

Other: ie cloud cover or days since rain

Weather prescriptions altered to (Auditor comments)

Sequence of Burning. Complete if applicable otherwise leave blank.

This coupe will not be lit before 14th March and after the following burn(s) have been completed

- 1)
- 2)
- 3)

Alterations to this sequence above or to conduct this burn prior to the 14th of March will require the Forest Manager's approval. Approval is given to light this burn before lighting _____ because

Signed by FM – Name:	Signature	Date
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Onsite Ignition Resources Type	Onsite Ignition Resources Numbers (NB available for initial suppression)
No of onground personnel (including traffic control):	
Class 1/2 Tankers (specify number):	
Class 4/5 Tankers (specify number):	
Helicopter with bambi bucket	
Handheld VHF radios (specify number):	
Handheld driptorches (specify number):	
3:1 Diesel to petrol handheld driptorch mixture (litres):	
Hoses (specify size and lengths):	
Pumps (specify type and number):	

Suppression Strategy.
Perimeter escapes and spot fires will be suppressed as soon as they can be safely accessed. Mop-up and patrol will be determined and thorough until the fire is blacked out or considered safe to be left unattended. Additional suppression strategies are:
Distance to, and location of, nearest water supply:
Auditor requirements for suppression strategy:

Standby Personnel and Secondary Suppression Resources Type available within 2 hours	
No of firecrew personnel (specify number):	
Class 1/2 Tankers (specify number):	
Class 4/5 Tankers (specify number):	
Helicopter with bambi bucket	
Handheld VHF radios (specify number):	
Handheld driptorches (specify number):	
3:1 Diesel to petrol handheld driptorch mixture (litres):	
Hoses (specify size and lengths):	
Pumps (specify type and number):	

Attachments to the Plan	
1.	<input type="checkbox"/> Completed Plan map (essential)
2.	<input type="checkbox"/> Completed Notification Checklist (essential)
3.	<input type="checkbox"/> Onsite Weather and Post Burn Evaluation page
4.	<input type="checkbox"/> Completed Risk Assessment pages (as applicable to this type of burning operation)
5.	<input type="checkbox"/> Other (please specify)

Safety Management: check site specific hazards and risks relating to the safe worksite management.

The following Job Risk Assessments (JRA's) have been identified as relevant to this task. JRA 001 Preparation for slash burning, JRA 004 Ignition of prescribed burns – aerial or hand and JRA 010 Transport of fuels to Forest Operations. Sector Commander to have a copy available prior to operations commencing. In addition to the JRAs, relevant items below are to be discussed by the sector commander with crews prior to operations.

Safety and Environment Management System. To be completed on the day the burn is conducted

S E	Hazard Identified on the day of operations (list specific site hazards)	Rating before Control	Control Measures to be implemented	Person responsible to implement control	Rating after Control

Worksite Briefings (to be completed each day of operations and cover all the above items).

Operations: Operations. Burn type i.e. HIB, LIB, FRB, Windrow, TDB, Heap. Lighting &/or suppression strategy and the influence of weather.

Map and orientation: Location of water points
Firebreak location & trafficability

Safety: Escape routes and safety zones and potential influence of the weather, Hazards e.g. powerlines, dangerous trees, Assembly area, PPE (safety gear), food and drink Visitors & landowners
Smoke across roads and traffic control Chain of command

Communications: Radio usage and Radio channel/s, Visual & audible communication

Resources: Fuel (dumps)
Machinery (type, location and work)
Other crews (nearby wildfires/burns)
Aircraft (safety, type & function)

Onsite Emergency Controls: Fuel / Oil, Chemical Spills, Aircraft Accident procedures: Refer to Sector Commander & SEMS Element 3.7 Procedures

Experience Sector commander to check for inexperienced personnel who require high levels of supervision

Attendees name	Signature	Attendees name	Signature
Sector Commander to confirm that the briefing occurred and included the above personnel		Signature	Date

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COUPE No: _____ FIRE PERMIT No : _____ PROPOSED LIGHTING TIME: _____

COUPE LOCATION DESCRIPTION _____

Person who compiled this list of contacts _____

Person who made first contact _____

Person who made second contact _____

This form must have neighbours who are adjoining and within 1.5km. Add distant neighbours or interested parties as required

NAME	Mailing address	Telephone number	1 st contacted (verbal/ written)		2 nd contacted (verbal/ written)	
			Date	Time	Time	Date
TFS District Officer						
TFS Firecomm						
FT Adjoining District/s						
Radio Stations						
Affected Councils						
Local Police						
Power Companies						
Logging Companies						
Harvesting Contractors						
Neighbours						
Others (Please specify)						
Air Services Australia	Hobart: Tower	6248 3096				
	Launceston: Tower	6391 6993				
	All other areas: Melbourne Supervisor	9235 7402				

Send an email when the burn is confirmed to commence to sdo@forestrytas.com.au

- If roads are likely to be obscured by smoke, police should be asked to attend as the Forest Officer does not have the power to close roads.
- Transend and Aurora Energy should be contacted if the production of large quantities of smoke and heat is likely in the vicinity of high voltage power lines.
- Air Services Australia should be contacted for any major airport likely to be affected by smoke.

Burn Risk and Consequence Assessment. Complete relevant section of these 2 pages

Coupe Number: _____

Low Intensity Coupe Burning Operations

1. Is the surrounding vegetation going to be flammable at the time of commencing this burn? Yes / No
2. Are there fuels within the coupe burning boundaries, which will be flammable on the day of ignition, and the intent is that these fuels will not to be burnt. Yes / No
3. Are the fuels to be burnt, separated from all other fuels by a mineral earth break > 1 metre? Yes / No
4. Are the maximum allowable FFDR and MFDR in the burn plan set above a rating of 6? Yes / No
5. Does this burn plan comply with all Forestry Tasmania burning policies and procedures? Yes / No

Total Score = number of "yes" answers = _____ (Put this score on page 1 of the burn plan)

High Intensity Coupe Burning Operations

This table will automatically calculate the total risk for the coupe if a "1" is put in the appropriate cell. Where the criteria risk is left blank the calculations will automatically assume is that the risk is high. Please use the explanations on the following page to select the correct risk category.

	High	Moderate	Low	Score
1 fuel type flammability	1			32
2 season prescriptions	1			8
3 10m wind speed prescriptions	1			16
4 age of fuels	1			8
5 FMC% prescriptions	1			8
6 coupe shape	1			8
7 coupe size	1			8
8 coupe topography	1			16
9 fire breaks type	1			4
10 fire breaks width	1			2
11 additional resources response time	1			2
12 ignition technique	1			2
13 number of ignition steps/stages	1			6
14 preparation	1			32
15 time of day of ignition	1			8
16 ignition direction relative to the preferred wind	1			8
17 ignition direction relative to the slope	1			8
18 down wind flammability	1			32
19 up-wind flammability	1			8
20 Slope above harvest boundaries boundaries	1			5
21 FMC% differential with surrounding fuels	1			16
22 down-wind topography	1			4
23 up-wind topography	1			16
24 Barkheaps within 40m of boundary	1			10
25 escape impact on values out of coupe	1			10
26 potential impact on values inside coupe	1			10
27 Burn type (put number in column)				
TOTAL SCORE				100

Put the total score total score is listed in the bottom line of the above table on page 1 of the burn plan.

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<u>Criteria Number</u>	<u>High</u>	<u>Moderate</u>	<u>Low</u>
1. Fuel Type flammability:	All windrows, Wet forest	Pine slash, Dry forest	Light pine slash
2. Season prescriptions:	March	April	May to July
3. 10m wind speed prescriptions:	15 to 20 km/h	10 to 15 km/hr	<10 km/hr
4. Age of fuels	≥ 2 years old	4 months to 1 year old	<4 months old
5. FMC prescriptions	< 12.5%	12.5% to 15%	>15%
6. Coupe shape:	irregular	-	regular
7. Coupe size:	<20 or >150 ha	-	>20 and <150 ha
8. Coupe topography:	steep slope (>40%)	slopes of <40% and >10%	near flat (<10%)
9. Fire breaks type:	not drivable	4wd only	2wd
10. Fire breaks width:	<5 m	5 to 20 m	>20 m
11. Additional resources response time:	>6 hours	1 to 6 hours	<1 hour
12. Ignition technique:	aerial	-	hand
	+ve within 200m	Flat within 200m	-ve within 200m
13. Number of ignition steps/ stages:	Multiple stages	Edge lighting before or after	One stage only
14. Preparation	will not be completed	-	is or will be completed
15. Time of day of ignition:	prior to 13:00	13:00 to 16:00	after 16:00
16. Ignition direction relative to preferred wind	with the wind	across the wind	into the wind
17. Ignition direction relative to slope	lighting up the slope	across the slope	down the slope
18. Down-wind flammability:			
Button grass moorland	>20 years	10 to 20 years	<10 years
Dry eucalypt forest	>15 years	10 to 15 years	<10 years
Heath land and wet scrub	>30 years	15 to 30 years	<15 years
Logging slash and windrows	>10 years old & not burnt	<10 years old & not burnt	burnt
Wet Forest	-	<20 years	>20 years
Plantation	unburnt	burnt >5 years old	burnt <5 years old
19. Up-wind flammability:			
Button grass moorland	-	>20 years	10 to 20 years
Dry eucalypt forest	-	>15 years	10 to 15 years
Heath land and wet scrub	-	>30 years	15 to 30 years
Logging slash	wet forest, windrows	dry forest, pine slash	light pine slash
Wet Forest	-	<20 years	>20 years
Plantation	unburnt	burnt >5 years old	burnt <5 years old
20. Slope above harvest boundaries	+ve within 200m	Flat within 200m	-ve within 200m
21. FMC% differential:	<2%	2 to 6%	>6%
22. Down-wind topography:	positive slope >20%	positive slope <20%	flat or negative slope
23. Up-wind topography:	-	positive slope >20%	+ve slope <20%, flat
24. Barkheaps within 40m of boundary:	≥2 heaps within 40m	1 heap within 40m	No heaps within 40m
25. Consequence outside coupe:	High ie:	Eagle reserve, Karst Fire exclusion zones around coupe, Any land tenure change inc joint venture state forest FPP "will/ shall" statements Visitor/ tourist centres and attractions	
	Moderate ie:	Wildlife habitat strips FPP "should" statements	
	Low ie:	No values impacted by an escape	
26. Consequence inside coupe:	High ie:	Eagle reserve, Karst Fire exclusion zones around coupe, Any land tenure change inc joint venture state forest FPP "will/ shall" statements Visitor/ tourist centres and attractions	
	Moderate ie:	Wildlife habitat strips FPP "should" statements	
	Low ie:	No values impacted by an escape	
27. Burn type:	1 = HIB windrow burning 3 = HIB broadcast burn – plantation	2 = HIB broadcast burn - native forest 4 = HIB bark or waste wood heap burn	

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FOREST OPERATIONAL PLAN

For Burning Natural Fuels

This plan is prepared in accordance with Forestry Tasmania's Safety and Environment Management System (SEMS). It incorporates a Forest Operations Safety Plan (FOS Plan), consistent with the Tasmania Forest Safety Code 2000. A copy of this plan must be available on site during the conduct of the relevant operation. The completed form is to be kept in the relevant District file.

Custodian Manager - Fire Management

District / operational file number ()
Authorised by General Manager (Operations)

Asset Information.				
Coupe / asset name			FOD asset ID	
District				
Location				
Mapsheets	Easting		Northing	
	Latitude		Longitude	
Fire Management Plan				
Emergency meeting point				

Operational Information					
FOD operation ID		Finance 1 job number		Fire Permit number	
Planned area	ha		Planned date		
VHF radio channel			UHF radio channel		
CDMA mobile coverage	Yes / No		GSM mobile coverage	Yes / No	
Forest Type			Burn Type		
Fuels to be burnt					
Burn Objective					
What is the consequence to Forestry Tasmania of an adverse outcome for this operation? - Refer to Operational Matrix Low Consequence or Medium Consequence or High Consequence					

Burn Plan Approval (signature and date).					
Plan prepared by		Signature		Date	
Plan reviewed by		Signature		Date	
Plan approved by (FM)		Signature		Date	
Plan audited by		Signature		Date	
Plan audited by		Signature		Date	

Audit Summary (auditors to select the appropriate entry and cross out other options)							
Lighting Plan Map	Approved	Modified	Rejected	Weather parameters	Approved	Modified	Rejected
Lighting Strategy	Approved	Modified	Rejected	Suppression planning	Approved	Modified	Rejected
Overall Risk of Escape	High risk			Moderate Risk	Low risk		
Impact of Escape on Values	High consequence			Moderate consequence	Low to no impact		
Overall Audit Approval	Not approved in present form			Approved with conditions	Approved - no conditions		

Audit Conditions (refer to pages where additional comments have been written).

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Planning Considerations (appropriate to be marked on burn map). Refer to Fire Management Plans.		
Identified special value located in the burn area	Potential threat to the value	Measures taken to reduce threat and consequences to the special value
Fire Management Plan Checked by-- Name:	Signature	Date

Adjacent Lands.

Identify fire risk of surrounding lands including vegetation, topography and tenure considerations:

List additional issues arising from surrounding lands and identify the constraints on burning:

List Possible Adverse Consequences of this Burn, the Likelihood and Precautions in Place.

Smoke Management.

Name populations centres which may be affected by this burn's smoke:

Name community events which may be affected by this burn's smoke:

General management practices to minimise impact of smoke are to limit number of burns in an area, select weather and fuels conditions burn, allow for the forecast wind patterns, be alert to public events in the area, improve public information / consultation and consult the Bureau of Meteorology smoke dispersal (print out to be attached).

Burn specific strategies for limiting smoke related issues are:

Identify roads that may be affected by this burn's smoke and traffic control requirements:

Burn Boundaries. Include where vegetation boundaries are planned to contain the fire spread.

Boundary Type	Length and Locations	Works required prior to burn	Date Completed

Onsite Burn Preparation.

Refer to the following checklist. For each item, put a "yes" to show that it has been completed or is currently incomplete. If the item is to be completed by the time the burn is planned to be burnt place a "yes" in the "to complete" box. Please add additional items that will be done as part of the preparation process.

	Completed	Incomplete	To complete before burning
1. The area is surrounded by a mineral fireline			
2. The fireline is entirely accessible by 4 WD tankers			
3. Tanker access to water is available within 500 m of the burn			
4. All stags within the planned burn have been felled			
5. Stags within 40 m of the planned burn boundary have been felled - within the coupe only			
6. Stags within 40m of the burn boundary have been fallen in both the burn and adjacent vegetation			
7. Heaps of fuel have been pushed as least 10 metres into the coupe			
8.			
9.			
10.			

Other pre-burn preparation.

Works required in addition to above ie waterhole construction, fenceline, burns required in surrounding vegetation:		Date Completed
Works completed - Name	Signature	Date
Additional work required to improve preparation (auditors comments)		

Lighting Strategy.

A 1:25,000 or 1:10,000 lighting plan map attached with fuel types and loads, burn boundary, ignition pattern [aerial and / or hand], anticipated wind direction, potential hazards and escape routes. The location of crews, tankers, water points, fuel dumps, assembly areas, rain gauge and fuel moisture sticks shall also be marked on the map. Fuel moisture [hazard] sticks & rain gauge will be set up on the block as shown on the lighting plan. A reconnaissance of the coupe must be made prior to any lighting commences.

Lighting Strategy description:

Lighting plan not approved due to (auditors comments):

Auditors requirements:

Lighting Plan Checklist.**Aerial Ignition**

Lighting pattern indicated on lighting plan map

Lighting plan and lighting strategy are indicating the same burning pattern

Aerial edge lighting can be performed safely and accurately

A fire free exit route will be maintained during ignition operations

Hand lighting of edges required (review the hand ignition section)

Helitorch groundcrew briefed by Operations Officer

Helitorch bombardier and pilot briefed by Operations Officer and Sector Commander

Plans and maps are available for operational supervision and lighting personnel

Hand Ignition

Number of personnel lighting

Number of drip torches and litres of drip torch fuel required

Plans and maps are available for operational supervision and lighting personnel

Number of VHF handheld radios

Refuelling points identified and located on ignition map

Lighting routes and clear escape routes indicated on ignition map

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Fire Behaviour and Weather Prescriptions (put NA if the factor is not applicable).			
Max Flame Height (m) :	≤	Max Rate of Spread (m/min):	
Temperature (°C):	to	S.D.I. (mm):	to
Humidity (%):	to	Forest F.D.R:	≤ Moderate 6
10m Wind Speed (km):		Moorland F.D.R:	≤ Moderate 6
Preferred Wind Direction		Sticks Internal FMC (%)	to
Allowable Wind Direction	Clockwise to	Sticks External FMC (%):	to
Other ie cloud cover or days since rain.			
Outlook: Review the weather forecast and further outlooks (rain or overnight dew is preferred after the burn has been lit).			
Weather prescriptions altered to (auditor comments).			

Sequence of Burning. Complete if applicable otherwise leave blank.		
This burn will not be lit until burn(s) – have been completed:		
1)		
2)		
3)		
Alterations to this sequence will require the Forest Manager's approval. Approval is given to light this burn before lighting _____ because		
Signed by FM -- Name:	Signature	Date

Seasonal Prescription. Complete if burning between October 14th and March 14th, otherwise leave blank.		
This burn is only to be lit between October 14 th and March 14 th if the express approval of the Forest Manager is obtained. Approval is given to light this burn before 14 th March due to the following reasons:		
Signed by FM – Name:	Signature	Date

Suppression Planning. Indicate the need for the role below. Names to be added on the day of the burn.					
	Required	Name		Required	Name
Sector Commander (name):	Yes		Operations Officer:	Yes	
Pilot:			Helitorch Bombardier:		
Aerial Incendiary Machine Navigator:			Aerial Incendiary Machine Operator:		

Resources Type	Onsite	At call within 2 hours
No of firecrew personnel (specify number):		
Class 1/2 Tankers (specify number):		
Class 4/5 Tankers (specify number):		
Aircraft (specify helicopter or fixed wing):		
Handheld VHF radios (specify number):		
Aerial Ignition Equip (specify type):		Not applicable
Aerial Ignition Fuel (litres) or capsule (numbers):		Not applicable
Handheld driptorches (specify number):		Not applicable
3:1 Diesel to petrol handheld driptorch mixture (litres):		Not applicable
Hoses(specify size and lengths):		
Pumps (specify type and number):		

Suppression Strategy.
Perimeter escapes and spot fire will be suppressed as soon as they can be safely accessed. Mop-up and patrol will be determined and thorough until the fire is blacked out or considered safe to be left unattended. Additional suppression requirements are:
Distance to and location of nearest water supply
Auditor requirements for suppression strategy

Weather Observations. Details must be completed or the weather observations note pad to be attached.

Date							
Time							
Rainfall							
Temp °C							
RH %							
10m wind speed km/h							
10m wind speed km/h							
Wind Direction							
Sticks (Open)							
Sticks (Shade)							
Peat/ Soil - wet /dry							
Lower Litter - wet /dry							
Top of litter - wet /dry							
Near surface fuel - wet /dry							
Pre-burn Weather Outlook: Review the forecasted outlook (rain or dew is preferred soon after the burn has been lit).							

Lighting Details. The following must be entered for all planned burns.

Date commenced		Method of ignition	
Time commenced		Time completed	FDR

Post-burn Evaluation (refer to operational plans and procedures and the planned burn objectives).

Unburnt (BO)	%	Moderate Burn (B1)	%	Hot Burn (B2)	%	Scorch	%
Total created seedbed (inc. disturbed ground)		%	Damage to retained stems		%		

Comments And Recommendations Include any variations to the above plan approved during operations.

Has the burn been satisfactorily carried out including protection of the special values and all planning considerations.

Signature: Sector Commander

Date

Did Burn Escape	Yes / No	If yes, TFS Incident Number	
------------------------	----------	------------------------------------	--

Events that led to escape weather, boundary, fuel type where escape occurred

Recommended changes to avoid future potential escapes:

Burn Operations Sign Off. Verify the fire boundary is extinguished and reignition could not occur

Sector Commander Name	Signature	Date
-----------------------	-----------	------

Safety Management: check site specific hazards and risks relating to the safe worksite management.					
S E	Hazard Identified on the day of operations (list specific site hazards)	Rating before Control	Control Measures to be implemented	Person responsible to implement control	Rating after Control

The following Job Risk Assessments (JRA's) have been identified as relevant to this task. JRA 001 Preparation for slash burning, JRA 004 Ignition of prescribed burns – aerial or hand and JRA 010 Transport of fuels to Forest Operations. The items listed below must be discussed by the sector commander with crews onsite prior to commencing work. Sector Commander to have a copy available prior to operations commencing.

- Objective and Operations:** Excavator heap burn type - target fuel, lighting &/or suppression strategy and the influence of weather
- Map and orientation:** Location of water points, firebreak location & trafficability
- Safety:** Assembly area, escape routes and safety zones and potential influence of the weather, hazards e.g. powerlines, dangerous trees, PPE (safety gear), food and drink, smoke across roads and traffic control, visitors & landowners
- Communications:** Chain of command, radio usage and channel/s, visual & audible communication
- Resources:** Fuel (dumps), machinery (type, location and work), other crews (nearby wildfires/burns), aircraft (safety, type & function)
- Onsite Emergency Controls:** Fuel / Oil, Chemical Spills, Aircraft Accident procedures: Refer to Sector Commander & SEMS Element 3.7 Procedures
- Experience** Sector commander to check for inexperienced personnel who require high levels of supervision

Worksite Briefings (to be completed each day of operations and cover all the above items).			
Attendees name	Signature	Attendees name	Signature
Sector Commander to confirm that the briefing occurred and included the above issues		Signature	Date

Attachments to the Plan	
1.	<input type="checkbox"/> Plan map (essential)
2.	<input type="checkbox"/> Other (please specify)
3.	<input type="checkbox"/> Other (please specify)

COUPE No: _____ FIRE PERMIT No : _____ PROPOSED LIGHTING TIME: _____

COUPE LOCATION DESCRIPTION _____

Person who compiled this list of contacts _____

Person who made first contact _____

Person who made second contact _____

This form to have all neighbours who are adjoining and within 1.5km. Add distant neighbours or interested parties as required

NAME	Telephone number	1 st contacted		Contact made	2 nd contacted		Contact made
		Date	Time	Yes/No	Time	Date	Yes/No
TFS District Officer							
TFS Firecomm	6230 8420						
FT Adjoining District/s							
Radio Stations							
Affected Councils							
Local Police							
Power Companies							
Logging Companies							
Harvesting Contractors							
Neighbours							
Others (Please specify)							
Air Services Australia							
Hobart: Tower	6248 3096						
Launceston: Tower	6391 6993						
All other areas: Melbourne Supervisor	9235 7402						

Send an email when the burn is confirmed to commence to sdo@forestrytas.com.au

- If roads are likely to be obscured by smoke, police should be asked to attend as the Forest Officer does not have the power to close roads.
- Transend and Aurora Energy should be contacted if the production of large quantities of smoke and heat is likely in the vicinity of high voltage power lines.
- Air Services Australia should be contacted for any major airport likely to be affected by smoke.

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Draft Smoke Impact Decision Model for Prescribed Silvicultural Burning

The management of smoke from prescribed silvicultural burning (PSB) must account for the effects of and interactions between the main factors which influence the amount of smoke experienced by communities within the fallout zone, down wind from PSB. The factors are the types of fuel, the fuels' dryness, the stability of the atmosphere, daily smoke dispersion forecasts and inversions predicted by the Bureau of Meteorology.

In this model only areas with significant populations (200 or more persons) are considered to be impacted. This corresponds with cities and towns shown on the Tasmania 1:500,000 map. Sparsely populated areas are not considered impacted unless there are special circumstances which pertain to the locality.

The following is a decision-making guide for competent PSB practitioners which incorporates all the issues identified and allows for trade-offs where there are compensating factors. The reference numbers in brackets refer to the factors shown in the model.

Fuels are classified as either "heavy" or "light".

(Forestry Tasmania's Prescribed Burning manuals for both High Intensity (FFFOP402A/FT016R) and Low Intensity (FFFOP401A/FT016R) are the relevant references for information on fuel types).

Examples of "heavy fuels" (1) which can be recognised by competent burning practitioners are:

- wet and dry forest type old growth broadcast slash;
- wet forest type regrowth broadcast slash;
- any types of windrows, log heaps and heaped wet forest type slash.

Examples of "light fuels" (2) which can be recognised by competent burning practitioners are:

- all plantation broadcast slash (1st and 2nd rotations);
- dry forest type heaped slash from variable retention harvesting.

These are examples based on weight and density. The burning duration of fuel types must be considered as well as the fuel weight.

Fuel dryness.

(Forestry Tasmania's Prescribed Burning manuals for both High Intensity (FFFOP402A/FT016R) and Low Intensity (FFFOP401A/FT016R) are the relevant references for information on fuel dryness).

For heavy fuels, use the Soil Dryness Index (SDI) as an indicator (3). Above 30mm is considered dry enough to burn.

For light fuels, use the Drought Factor (DF) (4) which is derived from the number of days since the last rain and the amount of rain, correlated with the local SDI. A DF of 5 and above means that at least half the total fuel load is dry enough to burn, including all of the fine fuel component (up to 6mm diameter).

The 0900 SDI and DF data are provided on a daily basis by the BOM, and are made available on the web as isopleth maps and tabular data for individual locations. This

information is provided on the Tasmania Fire Service web page on <http://www.fire.tas.gov.au/mysite/enter.jsp>

Atmospheric stability.

The next thing to consider is atmospheric stability and the potential for smoke dispersion. This will involve looking at the Bureau of Meteorology's F160 Aerological Diagram to predict temperature inversions and the accompanying Ventilation Index as an indicator of the potential for prescribed burning smoke to disperse – refer to Appendix 3.1.

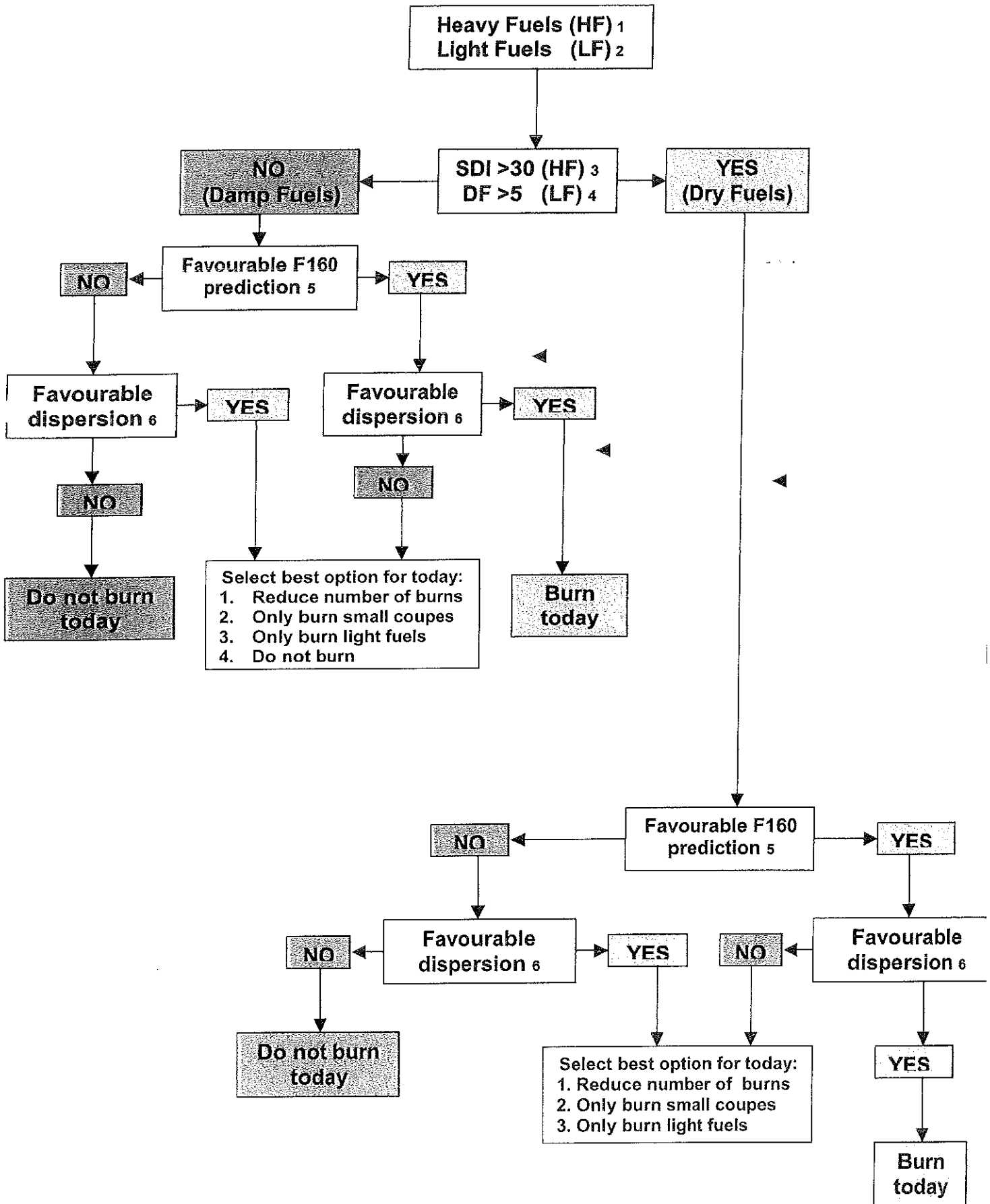
For fuel which is damp, if the F160 prediction is unfavourable, then no burning should be done under those conditions. If the F160 prediction is favourable (5) (high level >1500m inversion and a Ventilation Index >7000) then the next step will be to look at the smoke dispersion model, available on the same website <http://www.fire.tas.gov.au/mysite/enter.jsp> Refer to Appendix 3.2 for a brief explanation of the Smoke Dispersion Model.

Smoke Dispersion

A favourable dispersion (6) means that the smoke plume will not impact on a population centre i.e. upper level winds will take the smoke in the opposite direction or at a tangent sufficient to avoid the population centre.

Note that for damp fuels, if the combined F160 and smoke dispersion models are favourable, burning can be done. Where dispersion is predicted to be unfavourable i.e. impacting on a major population centre, burning should be restricted in line with the options indicated because the damper fuels, particularly the heavier types, are likely to produce more smoke.

Similarly for dry fuels, when the combined F160 and smoke dispersion models are unfavourable, then no burning should be done under those conditions. If the F160 is favourable but dispersion will impact on a major population centre, burning should be restricted in line with the options indicated.



Purpose of this Guideline

This Guideline is intended to enable the reader to recognise the existence of a predicted temperature inversion on a F160 forecast when scheduling prescribed burning, so as to avoid burning under atmospheric conditions likely to contribute to the development of a smoke nuisance.

Important Note

The information in this Guideline has been copied from, or draws very heavily upon, the material in the Smoke Dispersion Forecasting - Training Module prepared by Alan Wain of the Bureau of Meteorology (BoM) as part of a project sponsored by the Bushfire Cooperative Research Centre (CRC)

The material in this Guideline is a very much simplified and abbreviated version of the training package. For a comprehensive treatment of Atmospheric Stability and Temperature Inversions the reader should refer to the complete Smoke Dispersion Forecasting - Training Module, available in the Smoke Dispersion pages of the BoM Severe Weather Registered User website.

Instructions for accessing this site are provided in this guideline.

Introduction

In general, the air temperature in the atmosphere decreases with increasing height above the earth's surface. Levels or layers in the atmosphere where relatively warm air overlies cool air, are known as inversions.

Because any air ascending from the cooler zone beneath the inversion is going to be cooled further during its ascent, inversions are relatively stable. They provide an effective "lid" on the atmosphere below, inhibiting vertical air motion.

Smoke rising in a column in still air will generally begin to spread out horizontally when it encounters an inversion. This can be a problem in prescribed burning when a large quantity of smoke becomes trapped beneath an inversion layer.

The exception to this is when the fire provides enough energy to heat the air in the fire column to the point where it is still warmer than the air in the inversion layer. In these situations the smoke will continue to rise after penetrating the inversion layer, often for some considerable distance.

There are two main types of inversion:

1. Radiation (or Surface) Inversions, and,
2. Subsidence Inversions

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Guideline: Minimising Smoke Nuisance #1
Using the BoM F160 Aerological Diagram to predict Temperature Inversions

Radiation (or Surface) Inversions

- Occur when land cools overnight and the lowest layer of air becomes colder than the air above.
- Are commonly experienced on cold clear nights and strengthen overnight to be strongest around dawn.
- Result in a "de-coupling" or "shutting off" of winds aloft, so local winds dominate over synoptic (broad area) winds.
- Are the most common cause of overnight "smoke-logging" or fumigation in low lying areas during autumn and winter.
- May be accentuated in valleys and "frost hollows" as cold air pools overnight.
- This is a very stable situation, very resistant to vertical air movement.
- As the day heats up after sunrise, air warmed at the ground rises and "mixes" with the air above. This weakens the strength of the inversion.
- This reverses the overnight "de-coupling" and the air stream aloft which was "shut off" overnight may now become evident at ground level.
- This process is often observed with calm conditions in the evening and overnight being replaced by more gusty conditions during the morning as the inversion is eroded.

Subsidence Inversions

- Exist beneath high pressure systems and high pressure ridges.
- Form as air from above subsides, warms and dries forming a "cap" at between 1,000-2,000 metres above sea level.
- Result in a layer of warm air above cooler air close to the surface.
- Are normally strongest near the centre and eastern edge of a high pressure centre, strengthen as a high centre approaches, and weaken as the high centre moves away to the east.
- Can be enhanced by sea breezes introducing cooler air below the inversion level.

F160 Forecasts

The vertical structure of the atmosphere is important in determining atmospheric stability. One method of describing this structure is through the use of an aerological diagram, a plot of air temperature versus air pressure.

In Australia the aerological diagram produced by the Bureau of Meteorology is often referred to by its printed form number, "F160".

The F160 diagram can be thought of as showing a vertical cross-section through the atmosphere, from ground-level to the upper limit of the atmosphere, and provides an enormous amount of information on a single sheet. For smoke management purposes the lowest part of the atmosphere, and hence of the F160 diagram is most important.

The information required to prepare a F160 diagram is obtained by releasing a meteorological balloon, carrying an instrument pack from selected locations across Australia twice a day. As the balloon rises through the atmosphere the instrument pack reports pressure, air and dewpoint temperatures. F160 diagrams derived from balloon flights can only provide information on past conditions.

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Guideline: Minimising Smoke Nuisance #1
Using the BoM F160 Aerological Diagram to predict Temperature Inversions

However, F160 forecasts, derived from the Bureau of Meteorology's mesoLAPS model are available on the Smoke Dispersion pages of the Bureau's registered user site. These forecasts are useful in predicting the conditions likely to be encountered when conducting a prescribed burn.

Accessing the Model F160 Forecasts

Open the Bureau of Meteorology's home page, <http://www.bom.gov.au>

Click on "Registered User Services" at the lower left hand side of the page. This opens the "Registered User Internet Services" page. Click on the "Login Here" icon.

User Name is bomw0154, Password is TasSev07 Both are case sensitive. The *Severe Weather Online* page will open.

Click on "Smoke Dispersion Pages", 5th row down, right hand box, to open the "Smoke Dispersion Forecasting Home Page". Click on "Tasmania" to open the "Smoke Dispersion Forecasting – Tasmania" page.

Click on the green "Model F160s" button on the left hand side of the page to display the F160s output as part of the current run of the mesoLAPS model.

Use the buttons to move between Group 1 and Group 2, and the Time+ and Time- buttons to move backwards and forwards once a location has been selected.

The model F160s are provided for the 8 Tasmanian locations used for the smoke dispersion forecasts, for times ranging from real-time to up to 48 hrs in the future.

You should choose the location closest to that at which you intend to burn. Pay attention to the conditions to be expected during the 48 hrs following lightup, not just the conditions forecast at the intended light-up time.

The Simple Guide to the F160 Forecast

(See "Understanding The F160 Aerological Diagram" below for a more comprehensive explanation).

With the "Model F160s" page open the screen will show two graphs or charts, the left-hand one titled "mesoLAPS Model". Ignore the right-hand chart, headed "Observations".

Check the date and time for which the forecast is valid. This is shown in small text under the centre of the chart, eg "1800 UTC 20070205".

The date is given in the format: YYYYMMDD, so 20070205 is 5 February 2007.

The time, 1800, is given in Universal Coordinated Time (UTC). To convert to Tasmanian time add 11 hours during Daylight Saving Time, and 10 hours when Tasmania is on Eastern Standard time during the winter. This will mean that the 1800UTC forecast is valid for the day after the date shown., so in this example the forecast is valid for 0500 on 6 February 2007.

The foot of the chart is sea-level, the top of the chart is the top of the atmosphere..

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Guideline: Minimising Smoke Nuisance #1

Using the BoM F160 Aerological Diagram to predict Temperature Inversions

Ignore the left-hand blue line, look at the right-hand blue line.

If the air temperature cools evenly from sea-level to the top of the atmosphere this line will lie back to the left as it runs from sea-level to the top of the atmosphere.

If the line kinks back to the right at some point this means that the temperature has ceased decreasing with altitude and started to increase. At the point where the line again leans back to the left, the temperature has again started to decrease.

If there is a kink to the right in the line, and if the kinked line lies pretty flat, an inversion is predicted.

If the flat section of the line is just a twitch, the inversion is weak, if the flat section is long, the inversion is strong, and MAY be a problem.

If the inversion is strong, and below the third horizontal (brown) line line up from the foot of the chart (marked 800 on the left-hand axis) it IS a problem and you should NOT plan to burn without first consulting FT Fire Management Branch.

The Ventilation Index

Diagram

Time of forecast: 12:00
Date of forecast: 12/01/07
Depth of ML (m) above sea level: 211.2
Ventilation Index: 1205.7
ref: 1000 = very poor ventilation
1000 < VI < 4700 = poor ventilation
4700 < VI < 7000 = fair ventilation
7000 < VI = good ventilation

The Ventilation Index for the time of forecast is found in the top right hand corner of the F160 Diagram.

The ventilation index is an indicator of the degree of motion and lifting within the atmosphere at the forecast location, at the forecast time, and in consequence, an indicator of the degree to which smoke produced by burning will be dissipated and replaced by smoke-free air.



VI < 2350: very poor smoke dissipation
2351 < VI < 4700: poor smoke dissipation
4701 < VI < 7000: fair smoke dissipation
7001 < VI: good smoke dissipation

It is possible to have a low Ventilation Index figure even if there is no low-level temperature inversion predicted.

If the Ventilation Index forecast for, or after the proposed time of light-up is less than 4700, prescribed burning should not be commenced without first consulting FT Fire Management Branch.

Points to note

Pay particular attention to indications of the overnight development of surface inversions as these are very common in Tasmania in autumn.

The closer to the ground the inversion, the more likely that smoke accumulation will be a problem.

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Guideline: Minimising Smoke Nuisance #1
Using the BoM F160 Aerological Diagram to predict Temperature Inversions

As a guide, if the inversion is above the 800 hPa level (approximately 2000 m altitude) then smoke-logging is unlikely to occur below the inversion. If the inversion is below the 850 hPa level (approximately 1500 m altitude) then it will be relatively easy to noticeably increase smoke concentrations below the inversion.

The temperature change across the inversion is a good indicator of the strength of the inversion and therefore the ease with which it will be penetrated by the heated air of a smoke column (which will allow smoke concentrations to decrease).

A large temperature change indicates a strong inversion, resistant to penetration and very likely to trap smoke. A small temperature change indicates a weaker inversion, likely to be penetrated or disrupted by the column of hot air and smoke above a prescribed burn.

It is also worthwhile thinking about the likely persistence of an inversion over an area for more than one day. This will cause smoke concentrations to increase below the inversion because the smoke from smouldering heavy fuels will continue to accumulate. Light surface winds may occur, but these may just move the smoke from one place to another beneath the inversion.

Understanding The F160 Aerological Diagram

A section from the lower part of the F160 diagram for Albany WA at time 2300UTC on 31 October 2001 is reproduced below.

In this small section of the chart there are several important things to note.

- Location (bottom left) Albany Airport
- Date and Time (bottom centre) 31 October 2001, time 2300 UTC (GMT) = 0700 1 November WA time



Albany Ap (009741)

31/10/2001 2300 UTC

Australian Government 2004, Bureau of Meteorology

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Guideline: Minimising Smoke Nuisance #1

Using the BoM F160 Aerological Diagram to predict Temperature Inversions

- Temperature scale in $^{\circ}\text{C}$ (x axis)
- Wind speed and direction barbs (right hand axis) These represent the wind speed at various levels. The tail of the wind barb is plotted point towards the direction the wind is coming from, north being vertically upwards. The number of ticks and flags on the tail of the wind barb indicate the wind speed in KNOTS (1 knot is approximately 1.8 km/hr). A half tick represents 5 knots, a full tick 10 knots, while a flag represents 50 knots.
- The horizontal (brown) grid lines indicate constant pressure (measured in hectoPascals, hPa). The change in pressure between grid lines is 100 hPa. For the purposes of this guideline:
 - 1000 hPa is sea level,
 - 850 hPa is approximately 1500m altitude
 - 700 hPa is approximately 3,500m altitude.
- The left-hand red line is the dewpoint temperature (measured in $^{\circ}\text{C}$), changing with altitude
- The right-hand red line is the air (dry-bulb) temperature (measured in $^{\circ}\text{C}$), also changing with altitude.

Consider the dry-bulb temperature trace (right-hand red line) on this diagram.

- The surface level temperature is approximately 16°C and this decreases with altitude to 11°C at a pressure of approximately 880 hPa, perhaps 1200 m altitude.
- At 1200 m a temperature inversion has formed, and the air temperature increases from 11°C below the inversion to 20°C above the inversion before falling away again as the altitude increases.
- At the same time as the air temperature increases, the dewpoint (left-hand red line) suddenly decreases from 10°C to -8°C .
- The sudden increase in air temperature shown at the 880 hPa (1200 m) level is absolutely characteristic of a temperature inversion.
- Note also that at the 880 hPa level the dewpoint and air temperature traces are within 2°C of each other. This indicates that a layer of cloud is likely to form at the inversion height.
- Finally note the wind speed and direction barbs, and the change in wind direction from light NE – SE below the inversion to stronger SW-NW winds immediately above the inversion layer.

Further Reading

1. Smoke Dispersion Forecasting - Training Module, (Version 1.1 September 2006). Available on the Bureau of Meteorology's Registered User site and accessible directly at:
<http://www.bom.gov.au/general/reg/smoke/training/index.shtml> , or from the Tasmanian Smoke Dispersion Forecasting – Tasmania page at:
<http://www.bom.gov.au/general/reg/smoke/tas/index.shtml>
2. FT Guideline:Minimising Smoke Nuisance #2 - BoM Smoke Dispersion Model. Available on the FT Intranet at Operations > Fire Management > Smoke Management

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Purpose of this Guideline

This Guideline is intended to enable the reader to utilise the Bureau of Meteorology's Smoke Dispersion model forecast when scheduling prescribed burning, so as to avoid burning under atmospheric conditions likely to contribute to the development of a smoke nuisance.

Important Note:

This guideline is intended for occasional users of the Bureau of Meteorology's smoke modelling forecasts. The information is presented, so far as is possible, in simple non-technical terms.

To take a more technical approach would require familiarity with the forecast construction, the assumptions made, and some ability to interpret the forecast output. It would also require some interaction with Bureau of Meteorology (BoM) forecasters who are in the best position to assess the validity of the models used in preparing the smoke forecast. This level of application is beyond the scope of this Guideline.

For a more rigorous coverage of the uses and limitations of the smoke dispersion modelling forecasts see the Smoke Dispersion Forecasting - Training Course on the BoM "Registered User" page at: <http://www.bom.gov.au/general/reg/smoke/training/index.shtml>

Introduction

The combustion of biomass fuels, which occurs during prescribed burning operations and bushfires, releases a number of compounds into the atmosphere. Many of these are relatively harmless but several may pose a risk to human health. Burning also releases particulate into the atmosphere which can restrict visibility and adversely affect road and air traffic.

One of the main aims of the smoke dispersion forecasting project is to assist land managers in minimising the effects of smoke and particles on the wider population. This is achieved by providing a forecast of where the smoke from a burn is likely to go. If the forecast indicates population centres are likely to be affected the land manager may elect to postpone the burn until suitable conditions can be achieved.

As with all forecasts the prediction of the path of a smoke plume makes a number of assumptions. Some of these may not in fact come to pass, introducing errors into the forecast.

The production of a smoke dispersion forecast is achieved through the use of two computer based models. The first model, mesoLAPS, takes all available observations of several meteorological variables (wind, temperature etc), performs a series of calculations, and produces a hourly forecasts of the values of each one on a rectangular grid which covers the whole of Australia.

The mesoLAPS forecast data is used by the second model, HYSPLIT, to calculate the amount of smoke dispersion occurring from a nominated source point at a nominated time.

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Guideline: Minimising Smoke Nuisance #2
Using the Bureau of Meteorology's Smoke Dispersion Model

The calculations used in the model are based upon the premise that a vertical smoke source, extending from the surface to 1500 metres, is located at each source point. Smoke is assumed to be emitted from these sources for the entire duration of the forecast.

The dispersion maps represent the pollutant concentration distribution averaged from the ground level up to 1500 metres. If the smoke column is significantly higher or lower than 1500 m the conditions for dispersion may be much different introducing large errors into the smoke forecast. Consequently, while the smoke dispersion model output is useful for predicting the dispersion of smoke from high intensity regeneration burns and wildfires it should not be relied upon for low intensity burns, eg windrows, top disposal and general fuel reduction burning.

HYSPLIT outputs for Tasmania

For Tasmania the HYSPLIT model uses 8 nominated source points, each with 3 projected ignition times:

North	South - Central	Ignition Times
South Arthur	Mt Tooms	1200
Surrey Hills	Repulse	1400
Goulds Country	Wielangta	1600
Miena	Huon Valley	

The HYSPLIT model output is usually run twice per day, with the first edition of the next days forecast available at approximately 1415 each afternoon and an updated forecast available at 0215 the following morning.

The duty BoM forecaster will provide a comment on the validity of the mesoLAPS model forecast. This appears within the smoke forecast page, and above the map of Tasmania on the graphics page.

Points to remember and to consider:

- The smoke forecasts are provided as an aid to the land manager. They are a forecast and so not guaranteed to come to pass!
- The model is only a model, and the output is only as accurate as the predictive inputs. If the model shows the smoke going in a different direction to the direction you would expect, be nervous.
- You can get an idea of real world wind directions at remote locations by going to the *Severe Weather Online* page and opening the latest Weather box, 4th right top row. This will bring up the records for a range of Tasmanian reporting stations. Click the station name to bring up the weather record for the past 24 hours.
- If the smoke column from the fire did not reach 1500 m, or went significantly higher, the conditions for dispersion may be much different introducing large errors in to the smoke forecast.
- If there is a wind shear, with higher altitude winds going in a different direction to lower altitude winds you may see the model predicting the smoke will move in more than one direction.
- Light winds will generally result in the smoke plume spreading sideways whereas stronger winds will produce a long narrow plume.
- The contours show qualitative results not quantitative. Experience using HYSPLIT has shown that the 2 darkest colour bands most often reflect the extent of the visible smoke plume. HOWEVER this is not always the case.

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Guideline: Minimising Smoke Nuisance #2
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- Do not assume that because the edge of the forecast plume misses a population centre by a hair's breadth that it will not experience any smoke. The scale of the forecast maps and uncertainties within mesoLAPS and HYSPLIT mean that the positional accuracy of the forecast plume is insufficient to be able to make such fine judgements.
- Once the column from a high intensity burn has collapsed, HYSPLIT cannot predict where any subsequent smoke will go, eg smoke trapped beneath overnight inversion layers.
- HYSPLIT (as at January 2007) assumes that there is no pre-existing smoke in the forecast domain. There are situations where this is obviously incorrect. In these cases be aware that the area of smoke may in fact be much greater than forecast by HYSPLIT.
- Note that the Smoke Dispersion model forecast will usually update at between 1400 and 1500 each afternoon. This means that by the time complaints start to come in, you may find yourself looking at the forecast for the following day, not the conditions predicted for the afternoon on which the complaint is received. To see if this has happened, check the update time, given on the "Smoke Dispersion Forecasting – Tasmania" page below the buttons.
- If this happens phone Fire Management Branch and the current day's model output can be e-mailed to you.

Accessing the Smoke Dispersion Forecast

Open the Bureau of Meteorology's home page, <http://www.bom.gov.au>

Click on Registered user Services, lower left hand side of the page, this opens the "Registered User Internet Services" page. Click on the "Login Here" icon.

User Name is bomw0154, Password is TasSev07 Both are case sensitive. The *Severe Weather Online* page should open.

Click on "Smoke Dispersion Pages", 5th row down, right hand box to open the "Smoke Dispersion Forecasting Home Page". Click on "Tasmania" to open the "Smoke Dispersion Forecasting – Tasmania" page.

Click on the green "Smoke" button on the left hand side of the page to bring up a map of Tasmania and display the output from the current run of the model.

Further Reading

1. Smoke Dispersion Forecasting - Training Module, (Version 1.1 September 2006). Available on the Bureau of Meteorology's Registered User site and accessible directly at:
<http://www.bom.gov.au/general/reg/smoke/training/index.shtml> , or from the Tasmanian Smoke Dispersion Forecasting – Tasmania page at:
<http://www.bom.gov.au/general/reg/smoke/tas/index.shtml>
2. FT Guideline: Minimising Smoke Nuisance #1 - Using the BoM F160 Aerological Diagram to predict Temperature Inversions. Available on the FT Intranet at Operations > Fire Management > Smoke Management

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Guideline: Minimising Smoke Nuisance #2
Using the Bureau of Meteorology's Smoke Dispersion Model

1. Smoke Dispersion Forecasting Tasmania Home Page,

<http://www.bom.gov.au/general/reg/smoke/tas/index.shtml>

2. Typical Smoke dispersion Forecast for Northern Tasmanian sites

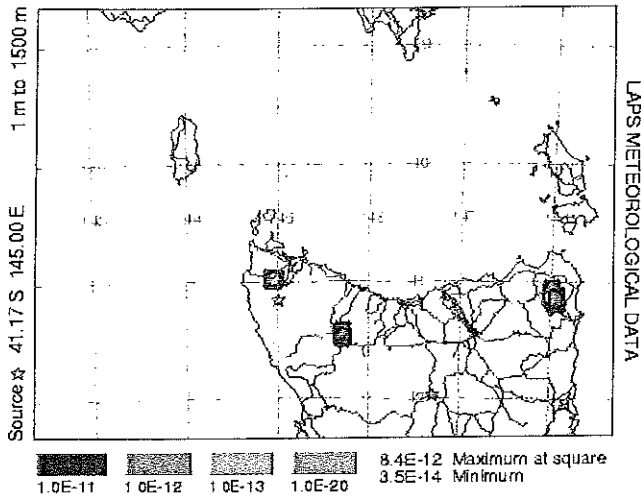
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Guideline: Minimising Smoke Nuisance #2
Using the Bureau of Meteorology's Smoke Dispersion Model

3. Predicted Smoke Dispersion from fires lit in Northern Tasmania at 1200 on 08/02/07

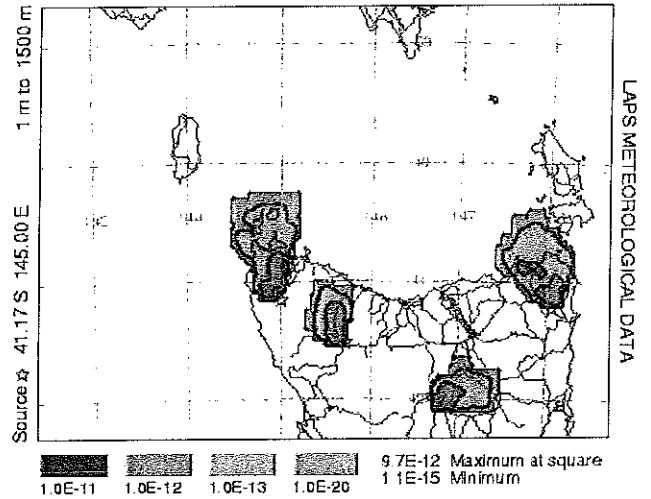
Predicted plumes at 1300 08/02/07

Australian Bureau of Meteorology (RSMC - Melbourne)
 Concentration (mass/m³) averaged between 0 m and 1500 m
 Integrated from 1200 08 Feb to 1300 08 Feb 07 (EST)
 GRP1 Release started at 1200 08 Feb 07 (EST)



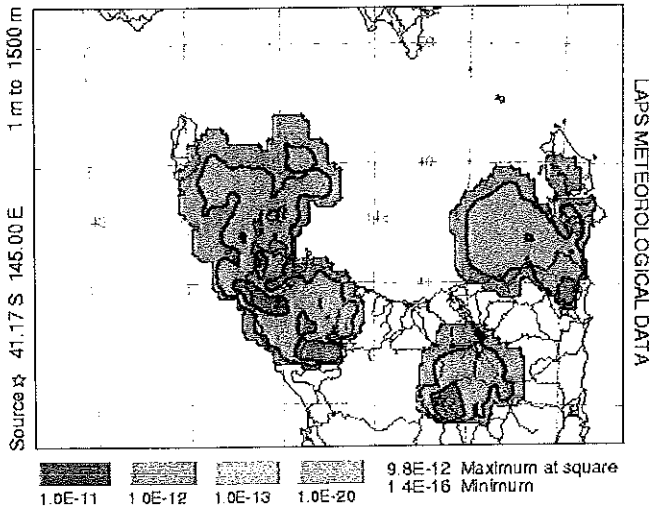
Predicted plumes at 1600 08/02/07

Australian Bureau of Meteorology (RSMC - Melbourne)
 Concentration (mass/m³) averaged between 0 m and 1500 m
 Integrated from 1500 08 Feb to 1600 08 Feb 07 (EST)
 GRP1 Release started at 1200 08 Feb 07 (EST)



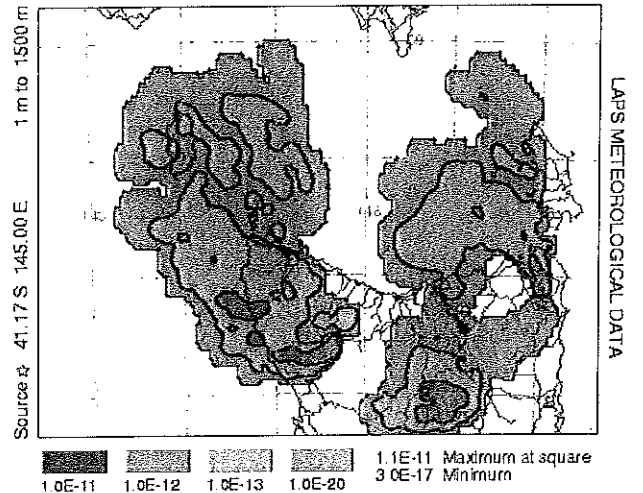
Predicted plumes at 1900 08/02/07

Australian Bureau of Meteorology (RSMC - Melbourne)
 Concentration (mass/m³) averaged between 0 m and 1500 m
 Integrated from 1800 08 Feb to 1900 08 Feb 07 (EST)
 GRP1 Release started at 1200 08 Feb 07 (EST)



Predicted plumes at 2200 08/02/07

Australian Bureau of Meteorology (RSMC - Melbourne)
 Concentration (mass/m³) averaged between 0 m and 1500 m
 Integrated from 2100 08 Feb to 2200 08 Feb 07 (EST)
 GRP1 Release started at 1200 08 Feb 07 (EST)



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Guideline: Minimising Smoke Nuisance #2 - BoM Smoke Dispersion Model