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# DIEBACK HYGIENE PRESCRIPTION FOR ALCOA'S FIELD OPERATIONS

## Introduction

Jarrah dieback is a serious forest disease of south-western Western Australia. It is caused by the soil borne fungus Phtyophthora cinnamomi. An effective means of controlling the disease is by the practice of "dieback hygiene". The aim of dieback hygiene is to prevent the transport of the fungus from infected to dieback-free forest.

Field operations are carried out under a range of soil moisture conditions over a wide area of forest which is either dieback-free or infected. This results in a high risk of spreading dieback over a considerable area.

Field operations for ore development is the first phase in mining and can take place several years in advance of mining.

Flexibility is required to best use the most recent knowledge of dieback and it's control.

## 1. Terms of Reference

1.1 The Forests Department dieback policy as outlined in General Working Plan No.86 and approved by the Government, requires the continual improvement and application of hygiene measures according to best current knowledge.

1.2 The Wagerup ERMP recognises that effective hygiene measures during bauxite mining operations are necessary to prevent the spread of jarrah dieback.

1.3 Alcoa is responsbile for implementing hygiene measures contained in this prescription.

## 2. Scope of Prescription

2.1 This prescription represents the best known practical

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hygiene methods as indicated by the most recent research of the physiology and ecology of jarrah dieback.

2.2 This prescription covers all field operations for ore development prior to mining which includes the following phases - geological work, surveying, field mapping, pegging of drill sites and the drilling of each site using drills mounted on rubber tyred tractors.

All types of drilling operations are covered and include grade control, developmental, exploratory and environmental drilling.

2.3 This prescription covers all aspects of field operations from the planning to the operational phase.

2.4 This prescription applies only to areas outside of quarantine within Alcoa's bauxite mining lease on State Forest and Timber Reserves set aside for Water Production, Timber Production and Recreation as the priority land use under Land Use Management Plans developed by the Forests Department.

2.5 This prescription is to have uniform implementation in all Forests Department divisions.

2.6 Terminology - See Appendix 1.

3. Objective of Hygiene

To carry out operations in a manner which does not spread jarrah dieback disease into dieback-free forest.

4. Current Knowledge of the Biology of Phytophthora Cinnamomi

4.1 Effective hygiene measures can only be developed if the biological interactions of the host, pathogen and environment are understood.

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4.2 Phytophthora cinnamomi is an introduced, soil-borne pathogen that has some saprophytic activity. That is, it mainly attacks living plant tissue, but can also survive for a time living on dead plant material.

4.3 Its principal method of attacking plants is through infection of their roots by zoospores; small spores which are able to move toward plant roots when soil-moisture levels are high. Extension of the disease through the soil, by the growth of fungal mycelium, is very slow and can be ignored for all practical purposes.

4.4 An infection expands by downslope movement of spores in overland waterflow at a rate which varies with soil type, steepness of slope, soil moisture conditions and presence of highly susceptible hosts. At present we have no way of preventing this. Upslope extension of an infection is very slow indeed.

4.5 During extended dry periods, few zoospores survive in the soil under Western Australian conditons, but fungal mycelium persists in the roots of infected plants. The infected host may be alive or dead. A special type of spore resistant to desiccation, called a chlamydospore, has not been found to be important in Western Australian soils.

4.6 The zoospores are produced by fruiting structures called sporangia. Sporangia can be very rapidly produced, but only under suitable conditions, that is, in warm, wet soil and when soil temperatures are in the range 15 - 27°C.

4.7 There is marked variation in the behaviour of the disease on different forest sites. On moisture-gaining sites, that is lowland areas and valley floors, soil moisture conditions are suitable for zoospore production for long periods in spring and early summer. On freely-drained upland sites, which constitute about 75% of the jarrah forest, conditions are suitable for zoospore production for a much shorter

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period of one to six weeks each year, depending on rainfall patterns. In certain soil types, such as the red loams found along major river valleys, the disease appears to be suppressed and susceptible plants are apparently unaffected.

4.8 Suitable conditions for zoospore production are found primarily during spring every year. The length of the suitable period varies from year to year with seasonal weather patterns. The build-up of fungal inoculum may also be significant in autumn, and the amount of build-up appears to be determined by the nature of early seasonal rainfall. Rains from the north-west maintain high soil temperatures and permit a rapid increase in inoculum, whereas the cold rains caused by Southern Ocean frontal activity cause a rapid drop in soil temperature which inhibits fungal activity. In autumn, after a build-up of the soil zoospore population, the spores may become encysted or go into a resting stage with the onset of cold weather. These spores become active as soon as soil temperatures rise sufficiently in the following spring.

4.9 New infections of the disease occur through the transport of soil or plant material from an infected site to an uninfected site. This can only be prevented by all forest users maintaining effective forest hygiene procedures.

4.10 Once a new infection is initiated, it is usually 18 months to three years before the presence of the disease is indicated by the death or decline of susceptible plants, which is the only external indicator of the presence of the disease.

## 5. Principles of Dieback Hygiene

5.1 Disease is spread by movement of overburden containing infected root material, clods of soil containing mycelium or zoospores, or by zoospores moving freely in a water medium.

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5.2 Because of the variable levels of the pathogen in soil particularly and in roots throughout the year there will be varying degrees or levels of risk associated with management activites in the forest. Hygiene prescriptions will need to reflect this.

5.3 The potential to spread disease by transporting infected root material is relatively high all year. In spring and autumn there is likely to be higher levels of inoculum in these roots than at other times of the year.

5.4 The transport of soil (+ roots) in spring (particularly) and autumn presents a risk of moving high amounts of inoculum and gives a greater chance or risk of starting new infections. This will also be a problem in any winter which follows an autumn which allowed rapid build-up of pathogen populations.

5.5 The unpredictability of autumn weather and the continued presistence of mycelium in the soil over winter in favourable seasons is an added complication which has significant planning implications.

5.6 At all times of the year infected lowland and moisture gaining sites are likely to contain high soil population levels of the pathogen.

5.7 Favourable conditions for rapid build-up of inoculum can be caused by unseasonable weather (e.g. extended summer rains).

5.8 The position of the field operation in the terrain affects the biological impact of introducing the disease. The fungus spreads downhill without assistance from man.

5.9 The biological impact of introducing dieback is most damaging in an area of dieback-free forest high in the terrain surrounded by high quality dieback-free forest.

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5.10 The impact decreases as the proportion of dieback increases and the field operation is situated lower in the terrain.

5.11 Dieback symptoms are complex and correct definition and demarcation of the disease on the ground is difficult. Hygiene precautions must take account of this difficulty.

5.12 Areas mapped as dieback-free may have sources of recent infection where symptoms have not shown. Frequent cleandowns in dieback-free forest reduces the probability of picking up dieback infections on areas which are not apparent or which have been incorrently mapped.

5.13 The probability of spreading dieback is reduced if the degree of hygiene is more intense and more frequent and the cleandown more thorough.

5.14 Small quantities of infected overburden down to 1 gram are sufficient as a source of infection.

6. Hygiene Strategy

6.1 All forest will be categorised into either dieback, suspect or dieback-free forest. In the field, management lines demarcated by the Forests Department will separate the three categories.

6.2 Field operations will be confined separately to each category. Transfer from one category to another requires specific hygiene conditions.

6.3 Access to each category will be defined in advance by the Forests Department.

6.4 Vehicle cleanliness is the basis for controlling dieback spread in the field operation. Cleanliness can be achieved by:

- fungicide treated water wash down using high pressure

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low volume pump.
- airhose to either suck or blow by use of vacuum pump or compressor.
- brushing down.

6.5 Soil moisture status will limit drilling operations:

6.5.1. All geological, surveying and drilling operations - exploratory, developmental, grade control - will be possible in all dieback categories during dry soil conditions when the probability of spread is lowest. These soil conditions must also prevail on access roads.

6.5.2. In the event of summer rainfall of 5mm or more, access into dieback-free forest for surveying, exploratory and developmental drilling may be temporarily suspended at the discretion of the local Divisional O.I.C. Where drill rigs are already inside a dieback-free area, drilling may continue provided overburden is not being picked up, however, support vehicles must be left outside the dieback-free boundary.

6.5.3. Grade control drilling is possible in dieback-free and suspect forest during moist soil conditions under the following restrictions:
- drill rigs do not pick up and transfer soil while operating in the drill area or travelling on access roads.
- support vehicles remain outside the dieback-free boundary.

6.5.4. Geological, surveying and drilling operations other than grade control are not possible in dieback-free forest during moist soil conditions.

6.5.5. All geological, surveying and drilling operations are possible during wet and moist soil conditions in dieback forest.

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## 7. Planning for Drilling Operations

7.1 Alcoa will submit to the local office of the Forests Department by September each year proposals for the next 12 months drilling operations showing:

7.1.1 Broadscale plan of proposed drilling areas and type of drilling on 1:50,000 scale based on agreed twenty five year mining plans.

7.1.2 A programme for each area indicating times proposed for drilling.

7.2 Local divisional O.I.C. will confirm in writing approval or otherwise of the proposals.

7.3 Changes or additions to drilling operations will be possible throughout the year provided adequate notice is given to allow dieback demarcation to take place.

7.4 Drilling should aim to be sufficiently in advance of mining in order to allow for flexibility which takes into account periods of high probability to spread dieback.

7.5 Plan to minimise access and vehicle movements.

7.6 Prior to the commencement of drilling, Alcoa will provide the Divisional O.I.C. with 2 copies of a drill layout sheet indicating regular drilling information.

The divisional O.I.C. will show on these sheets:

- dieback managment lines.
- access routes.
- points for vehicle cleandown.

One copy of the sheet will be returned to Alcoa.

7.7 Alcoa will provide local divisional office with the location of drilling rigs and survey crews on a weekly basis.

## 8. Field Operations

8.1 Training - Vehicle operators must be trained in the techniques of inspection for vehicle cleanliness and vehicle cleandown, and hygiene principles.

8.2 Prior to departure from the base depot all vehicles must be in a clean condition.

8.3 Access is to be confined to routes approved by the Forests Department. This is important during wet or moist soil conditions.

8.4 Dieback-free forest

8.4.1 Prior to entry into an area every vehicle is to be inspected to ensure no overburden has been picked up in transit. Cleandown is required at the dieback boundary or nominated cleandown point if the vehicle is not clean.

8.4.2. Each vehicle traversing an area must be continually checked to ensure that overburden is not being picked up. If soil conditions deteriorate so that soil is picked up, the operation must cease until soil conditions improve or transfer to dieback forest via an approved access road.

8.4.3 Do not cross moist, low lying flats or creeks. These are normally infected with dieback.

8.4.4 After drilling each hole prior to departure for the next hole, the drill rig must be inspected for cleanliness. If the vehicle is not clean of overburden, cleandown is required.

8.4.5 Cleandown should take place at least once a day as a safety measure. This is important where the biological impact of dieback spread is high.

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8.5 Suspect Forest

8.5.1 Conditions applying to drilling in suspect forest will be the same as those for dieback-free forest above (8.4.1-5).

8.5.2 Prior to leaving suspect forest vehicles are to be free of overburden.

8.6 Dieback Forest

8.6.1 Cleandown between holes is not necessary.

8.6.2 Do not cross moist low lying flats or creeks.

8.6.3 Prior to leaving dieback forest vehicles are to be free of overburden.

9. This prescription will be reviewed in July, 1983.

## APPENDIX I.

## Terminology

Cleandown: the process by which soil and other material is removed from vehicles and machinery. Water, air or brushing may be used as an agent for cleaning down, depending upon whether mud or dust is to be removed.

Dieback forest: forest in which dieback symptoms are present in the understorey and/or overstorey.

Dieback-free forest: forest apparently free of dieback.

Suspect forest: forest in which the evidence for dieback presence is inconclusive.

Dieback management line: a blazed and painted (yellow) line, in the field which separates dieback forest from dieback-free forest. (The line is blazed so that the yellow blazes face towards dieback forest).

Drilling operations: includes exploratory, developmental, grade control and environmental drilling. The surveying in of drill sites and pegging is also regarded as being part of the drilling operation.

Drilling area: area designated on the drill layout sheet including designated access routes.

Drill rigs: drill mounted, rubber tyred tractors.

Support vehicles: light vehicles (4 x 2 or 4 x 4), small trailer units, etc.

Field Operations: All ore development and environmental operations carried out in the field prior to mining.

Fungus: one of the lower forms of plant life which, lacking chlorophyll and being incapable of manufacturing its own food, derives its energy from dead or living plant or animal matter.

Forest hygiene: forest management activites designed to prevent

transport of fungal inoculum from an infected area to an uninfected area.

Inoculum: portions of any pathogen capable of being spread to uninfected areas and initiating a new infection of the disease.

Moisture-gaining site: an area, that due to local topographic or soil factors, tends to be more moist than the surrounding area.

Mycelium: the vegetative parts of a fungus, as distinct from the reproductive parts such as sporangia.

Overburden: soil and roots above the laterite but does not include ore material.

Pathogen: any living entity (in this case a fungus) capable of causing disease.

Sporangium: a plant organ that produces spores.

Zoospore: a mobile spore of some algae and fungi.