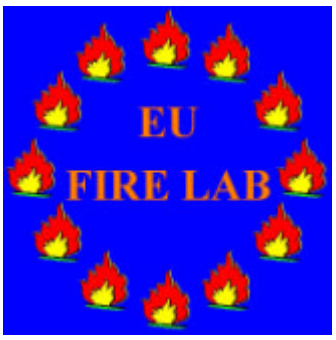

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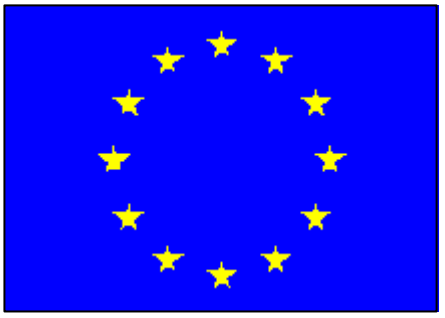

EUFIRELAB:

Euro-Mediterranean Wildland Fire Laboratory, a "wall-less" Laboratory for Wildland Fire Sciences and Technologies in the Euro-Mediterranean Region

Deliverable D-02-02

Physical, chemical and thermal characteristics of the wildland fuel particles

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CONTENT LIST

SUMMARY

This document presents an inventory of the existing quantitative knowledge concerning fuel characteristics of particles. Methodologies and equipments have not been considered as they will be object of Deliverable D-02-03.

This document is divided into three main sections.

- the first includes the objective of this Deliverable and describes the sequence of steps which lead to its preparation.
- the second presents the state of the art in physical, chemical and thermal characteristics of the wildland fuel particles carried out by partner members: this was done through a questionnaire that surveyed members on their own pre-existing data.
  - the questionnaire itself, and
  - a summary of the responses (full responses of each research team are included in D-07-03_A);
- the third and final section of the deliverable presents an overview of the responses, presents some particular cases and draws some general trends, and outlines some conclusions.

LIST OF ASSOCIATED DOCUMENTS

Name of the file	Title of the file	Content of the file
D-02-02_A	Physical, chemical and thermal characteristics of the wildland fuel particles: Answers from the partners	Full responses of each partner to the questionnaire

1 INTRODUCTION

As it was already commented in Deliverable D-02-01, Physical, Chemical and Thermal properties of fuel particles are assessed at the level of the individual particle or element (leaf, spine, stalk, twig, branch, stem, etc.), or of compounded particles belonging to the same biological entity, e.g. the assemblage of leaves and small twigs of a given shrub species.

These properties have a direct effect on moisture relationships, heat transfer, ignition, and combustion.

Consequently, fuel particle characteristics contribute to the prediction of wildland fire intensity and severity, with all its consequences on suppression difficulty and human safety.

Characterisation of fuel particles is therefore required to interpret the results of flammability experiments in the laboratory and as an input to semi-empirical and physical fire behaviour models.

However, the natural variation and effect on fire behaviour of several properties (particle density, mineral content) are so low that they are usually kept constant in fire behaviour modelling.

Consequently, the interest in the evaluation of fuel properties is restricted to fire researchers.

The exception is fuel moisture content, critical to predict the potential for fire ignition and fire behaviour, but this property can be assessed at multiple levels (particle, bed, complex).

The methodology to produce the present deliverable was the following:

1.- A preliminary questionnaire was prepared by P010 and uploaded to the EUFIRELAB web site, and participants were requested not to fill out the questionnaire but to assist in refining the final version.

The questionnaire asked about the different characteristics that are measured, calculated or determined.

2.- After receiving and integrating the comments on improving the questionnaire, its final version was uploaded to the EUFIRELAB web site to be filled out.

3.- The concerned partners downloaded the questionnaire, filled out the relevant information and uploaded their contributions to the same folder in the web site.

4.- Based on these contributions, a draft was prepared and uploaded again for comments and suggestions.

5.- A final version was written, taking into account the feedback received from the interested partners.

Deliverable D-02-02 is divided into three main sections.

The first describes the sequence of steps which lead to its preparation.

The second includes the questionnaire used and a summary of the responses to it (full responses of each partner are included in Annex).

The third section includes some comments about the information collected and draws some conclusions.

2 THE STATE OF THE ART AMONG PARTNER MEMBERS

2.1 THE QUESTIONNAIRE USED TO SURVEY MEMBERS

2.1.1 Introduction

The questionnaire is divided into six tables:

Table 1.- Fuel Classes:
- 1.1.- State of the fuels
- 1.2.- Size class of the fuels

Table 2: Physical Characteristics:
- 2.1.- Measured parameters (Length, Width…)
- 2.2.- Calculated parameters (Surface, Volume...)

Table 3: Chemical Characteristics (Moisture content, Ash content…)

Table 4: Thermal Characteristics (Heat content, Thermal degradation...)

Table 5: Other Characteristics (Flammability…)

Table 6: Studied species

2.1.2 Questionnaire

1) In Table 1, 2, 3, 4 and 5, place an “X” on the appropriate column if you measure, calculate or determine that characteristic. If the information was already included in other deliverables, put the deliverable number in the last column.
2) In Table 6, list the species you have studied and give for each of them mean values or range of values (max-min) obtained of each concerned characteristic.

2.2 TABLE 1: FUEL CLASSES

Ref.		
1	**State**	
1.1	live	
1.2	dead	

2	**Size class**	
2.1	Fosberg and Deeming	
2.2	Fosberg and Deeming modified	
2.3	Other	
2.4		

Ref.	**Observations**

2.3 TABLE 2: PHYSICAL CHARACTERISTICS

Ref. 1	Measured parameters		Data	Previous deliverable
1.1	**Leaves**	Length		
1.2		Width		
1.3		Thickness		
1.4		Diameter		
1.5		Mass		
1.6		Volume		
1.7		Other		
1.8	**Needles**	Length		
1.9		Width		
1.10		Thickness		
1.11		Diameter		
1.12		Mass		
1.13		Volume		
1.14		Other		
1.15	**Twigs**	Length		
1.16		Width		
1.17		Thickness		
1.18		Diameter		
1.19		Mass		
1.20		Volume		
1.21		Other		
1.22	**Barks**	Length		
1.23		Width		
1.24		Thickness		
1.25		Diameter		
1.26		Mass		
1.27		Volume		
1.28		Other		
1.29	**Cones**	Length		
1.30		Width		
1.31		Thickness		
1.32		Diameter		
1.33		Mass		
1.34		Volume		
1.35		Other		
1.36	**Grasses**	Length		
1.37		Width		
1.38		Thickness		
1.39		Diameter		
1.40		Mass		
1.41		Volume		
1.42		Other		
1.43	**Other**	Length		
1.44		Width		
1.45		Thickness		
1.46		Diameter		
1.47		Mass		
1.48		Volume		
1.49		Other		

2 Calculated parameters

			Data	Previous deliverable
2.1 2.2 2.3 2.4	**Surface**	Leaves Needles Twigs Other		
2.5 2.6 2.7 2.8	**Volume**	Leaves Needles Twigs Other		
2.9 2.10 2.11	**Ratios**	**Surface to volume** **Mass to volume** Other		
2.12 2.13	**Other**			
Ref.	**Observations**			

2.4 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Moisture content**		
2	**Ash content**		

3	**Chemical content**	Element	Previous deliverable
3.1 3.2			

4	Other characteristics	Data	Previous deliverable
4.1.			
Ref.	**Observations**		

2.5 TABLE 4: THERMAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Thermal degradation**		
2	**Heat content**		
3	**Specific heat**		
4	Other		
5	Other		
Ref.	**Observations**		

2.6 TABLE 5: OTHER CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Flammability**		
2	Other		
3	Other		
Ref	**Observations**		

2.7 TABLE 6: STUDIED SPECIES

	Parameters									
Species	S/V ratio (m2/m3)	M/V ratio (Kg/m3)	Ash content (%)	Moisture content (%)	Chemical composition (%)	Thermal degradation	Heat content (KJ/Kg)	Specific heat (KJ/Kg)	Flammability	Other

3 SUMMARY OF THE RESPONSES TO THE QUESTIONNAIRE

3.1 INTRODUCTION

Among the members that were solicited to contribute, 8 partners responded: P001, P009, P010, P013, P018, P025, P026 and P033.

The results below, based on these responses, are presented in terms of the partners who measure, calculate or determine the concerned characteristic (Tables 1, 2, 3, 4 and 5).

For the Table 6 the results are presented as an inventory of the existing knowledge concerning characteristics of the wildland fuel particles.

The full responses are included in Annex (D-02-02_A)

3.2 VARIABLE OR CHARACTERISTIC MEASURED OR CALCULATED

Ref.			Partners
1	**State**		
1.1	live		P001,P009,P010,P013,P018,P025,P026,P033
1.2	dead		P001,P009,P010,P013,P018,P025,P026,P033
2	**Size class**		
2.1	Fosberg and Deeming		P018,P010,P025
2.2	Fosberg and Deeming modified		P001,P010,P013,P018,P025
2.3	Other	Brown	P033
2.4		Smaller size class <2,5 mm, < 3 mm	P025
2.5		FCC system modified	P026

3.3 TABLE 2: PHYSICAL CHARACTERISTICS

Ref. **1**	**Measured parameters**		Partners
1.1	**Leaves**	Length	P001, P010, P018
1.2		Width	P001, P010, P018
1.3		Thickness	P001, P010, P018, P025, P033
1.4		Diameter	P013, P018
1.5		Mass	P001, P010, P13, P018, P025, P033
1.6		Volume	P001, P013, P018, P025
1.8	**Needles**	Length	P010, P018, P025
1.9		Width	P010, P018, P025
1.10		Thickness	P001, P010, P018, P025
1.11		Diameter	P001, P013, P018, P025, P033
1.12		Mass	P001, P010, P013, P018, P025, P033
1.13		Volume	P001, P013, P018, P025
1.15	**Twigs**	Length	P010, P025
1.16		Width	
1.17		Thickness	
1.18		Diameter	P001, P010, P013, P018, P025, P033
1.19		Mass	P001, P010, P013, P018, P025, P033
1.20		Volume	P001, P013, P018, P025
1.22	**Barks**	Length	P010
1.23		Width	P010
1.24		Thickness	P001, P010, P018, P033
1.25		Diameter	P001, P013
1.26		Mass	P001, P013, P018, P033
1.27		Volume	P013
1.29	**Cones**	Length	P010
1.30		Width	P010
1.31		Thickness	P010
1.32		Diameter	P033
1.33		Mass	P010, P018, P033
1.34		Volume	

1.36	**Grasses**	Length	
1.37		Width	
1.38		Thickness	P033
1.39		Diameter	P025, P033
1.40		Mass	P013, P018, P025, P033
1.41		Volume	P013, P025
1.43	**Mosses**	Length	
1.44		Width	
1.45		Thickness	P033
1.46		Diameter	
1.47		Mass	P026, P033
1.48		Volume	
1.50	**Single tree**	Length	P009, P033
1.51		Width	P009
1.52		Thickness	
1.53		Diameter	P009, P033
1.54		Mass	P009
1.55		Volume	P009, P033
1.56		Crown base height	P033
1.57	**Trunks, slash, litter, lichens, duff**	Length	
1.58		Width	
1.59		Thickness	
1.60		Diameter	
1.61		Mass	P026
1.62		Volume	

2 Calculated parameters

			Partners
2.1	**Surface**	Leaves	P001, P018, P025
2.2		Needles	P001, P010, P018, P025
2.3		Twigs	P001, P018, P025
2.5	**Volume**	Leaves	P001, P013, P018, P025
2.6		Needles	P001, P013, P018, P025
2.7		Twigs	P001, P013, P018, P025
2.9	**Ratios**	**Surface to volume**	P001, P010, P013, P018, P025, P033
2.10		**Mass to volume**	P001, P009(individual tree), P018, P025
2.11		Surface to mass	P025

3.4 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Partners
1	**Moisture content**	P001, P009, P010, P013, P018, P025, P026, P033
2	**Ash content**	P001, P018, P025
3	**Chemical content**	P026 (duff)

3.5 TABLE 4: THERMAL CHARACTERISTICS

Ref.		Partners
1	**Thermal degradation**	P001
2	**Heat content**	P001, P010, P018
3	**Specific heat**	

3.6 TABLE 5: OTHER CHARACTERISTICS

Ref.		Partners
1	**Flammability**	P001, P010, P013, P026
2	**Combustibility**	P013
3	**Live fuel moisture content (Remote sensing)**	P033

3.7 TABLE 6: STUDIED SPECIES

Species	Parameters									
	S/V	M/V	Ash content	Moisture content	Chem. Comp.	Thermal degradation.	Heat content	Specific heat	Flam-mability	Moisture of extinction
Abies alba	X			X						X
Abies cephalonica									X	
Acacia dealbata									X	
Acacia longifolia	X									
Acacia melanoxylon									X	
Agrostis spp.	X									
Alnus subcordata									X	
Anthyllis cytisoides				X			X		X	
Arbutus unedo	X			X			X		X	
Arctostaphylos uva-ursi				X					X	
Atriplex halimus				X			X		X	
Betula celtiberica							X			
Brachypodium pinnatum									X	
Brachypodium ramosum		X	X				X		X	
Brachypodium retusum				X						
Buxus sempervirens				X			X		X	
Calluna vulgaris										
Calycotome spinosa									X	
Calycotome villosa				X			X		X	
Castanea sativa	X			X					X	X
Cedrus atlantica									X	
Chamaespartium tridentatum	X	X	X	X			X		X	
Cistus albidus				X			X		X	
Cistus clusii	X	X								
Cistus crispus				X			X		X	
Cistus ladanifer	X			X			X		X	
Cistus laurifolius				X			X		X	
Cistus monspeliensis	X								X	
Cistus salvifolius				X			X		X	
Cladina spp				X					X	
Corema album	X									
Cupressus arizonica									X	
Cupressus sempervirens									X	
Cytisus scoparius				X			X		X	
Cytisus striatus		X								
Cytisus triflorus									X	
Daboecia cantabrica		X								
Diranum spp				X					X	
Erica arborea	X	X		X			X		X	
Erica australis	X	X		X			X		X	
Erica ciliaris				X			X		X	
Erica multiflora				X			X		X	
Erica scoparia				X			X		X	
Erica umbellata	X	X	X	X			X		X	
Eucalyptus camaldulensis				X			X		X	
Eucalyptus dalrympleana									X	
Eucalyptus globulus	X	X		X			X		X	
Eucalyptus macarthuri									X	
Genista falcata				X			X		X	
Genista scorpius				X						
Halimium alyssoides	X	X		X			X			
Halimium ocymoides	X	X								
Hylocomium splendens				X					X	
Juniperus oxycedrus	X	X		X						
Juniperus sabina	X	X								
Juniperus turbinata	X									
Larix decidua	x			x						X
Lavandula stoechas				X			X		X	
Myrica faya	X									
Myrtus communis	X									
Olea europaea	X			X			X		X	

Species	S/V	M/V	Ash content	Moisture content	Chem. Comp.	Thermal degradation.	Heat content	Specific heat	Flam-mability	Moisture of extinction
Phillyrea angustifolia	X			X			X		X	
Phyllirea latifolia										
Pinus eldarica	X	X	X			X			X	
Pinus halepensis	X	X	X	X		X	X		X	
Pinus mugo grex arborea				X						X
Pinus mugo grex prostrata	X			X						X
Pinus pinaster	X	X	X	X		X	X		X	
Pinus pinea	X	X	X	X		X	X		X	
Pinus radiata				X			X		X	
Pistacia lentiscus	X									
Pleurozium shreberi				X					X	
Polypodium sp./Genista sp.	X			X						X
Pteridium aquilinum	X	X		X			X		X	
Quercus coccifera	X	X	X	X		X	X		X	
Quercus ilex	X	X	X	X			X		X	
Quercus pubescens									X	
Quercus pyrenaica				X			X		X	
Quercus suber				X			X		X	
Rosmarinus officinalis	X	X		X			X		X	
Rubus idaeus				X			X		X	
Stauracanthus boivinii				X			X		X	
Stipa tenacissima				X			X		X	
Thymus vulgaris	X	X		X			X		X	
Ulex europaeus	X	X		X			X		X	
Ulex minor	X	X		X			X		X	
Ulex parviflorus		X		X			X		X	

Tabl 6 cont.

4 COMMENTS AND CONCLUSIONS

4.1 FUEL CLASSES

4.1.1 State

All the partners carry out measurements on live and dead fuel.

The state of the fuels is particularly important as it is closely connected with moisture content.

The moisture content of dead material (litter, dead needles and leaves,..) varies fairly quickly according to the ambient conditions.

Nevertheless the moisture content of leaving material varies more slowly according to seasonal variations of the ambient.

4.1.2 Size class

Particle size categories are not standard across the world, which hinders comparability of fuel data and fire behaviour models.

Although it is generally agreed that fine fuels are those with diameters below 6 mm, this is not a universal rule.

Most of the partners (P001, P010, P013, P018 and P025) use the FOSBERG and DEEMING modified classification.

P033 uses the classification of BROWN, P026 the FCC system modified and P025 other.

4.2 PHYSICAL CHARACTERISTICS

Specific physical parameters characterise each fuel family.

These parameters are:

- either determined by direct measurements: measured parameters,
- or calculated and based on the above ones and some geometrical assumptions: calculated parameters.

Length, width, thickness or diameter, mass and volume belong to the first group.

Surface, volume and mass to volume or surface to volume ratios belong to the second group.

4.2.1 Measured parameters

Most partners measure these parameters on leaves, needles, and twigs. Some of them measure also barks, cones and grasses.

P033 and P026 are the partners who measure Mosses, and P009 and P033 take the measurements on individual trees.

P026 measures mass of trunk, slash, litter, lichens and duff as a whole.

4.2.2 Calculated parameters

Surface to volume ratio is an important input for some models of wildland fire behaviour.

So this parameter is calculated by most of the partners.

Mass to volume ratio is also determined by some of them, and P025 calculates surface to mass ratio.

4.3 CHEMICAL CHARACTERISTICS

4.3.1 Moisture content

As it has already been mentioned in Chapter 1 fuel moisture content is critical to predict the potential for fire ignition and fire behaviour.

Consequently all partners measure this characteristic.

4.3.2 Ash content

On the contrary, the ash content varies so slowly that we can consider that it is constant for a given fuel family.

This characteristic is only measured by P001, P018 and P025.

4.3.3 Chemical content

This characteristic is only considered by P026 who determines C; N; Ca, Mg, K, P content and pH on duff.

4.4 THERMAL CHARACTERISTICS

4.4.1 Thermal degradation

The only partner who measures this characteristic is P001.

4.4.2 Heat content

For a given fuel type, the first objective is to obtain a comprehensible measure of the potential thermal energy that can be released during the burning of the fuel.

The heat content of a species varies in accordance with location and collecting season.

So the second objective is to compare results:

- either of different fuel particles of the same species,
- or of the same fuel particles collected in different locations and/or seasons.

Heat content is determined by P001, P010 and P018.

4.5 OTHER CHARACTERISTICS

4.5.1 Flammability

In the studies we have carried out, “flammability” describes the time required until ignition of the fuel occurs (TRABAUD, 1976; DELABRAZE & VALETTE, 1974, VALETTE, 1990).

It is equivalent to the term "Ignitability" found in the Anglo-Saxon literature.

Flammability is determined by P001, P010, P013 and P026

4.5.2 Moisture of extinction and live fuel moisture content

Moisture of extinction is only measured by P033 and is not included in table 5, otherwise this parameter is included in table 6 as species studied data.

This partner also includes in “other characteristics” table, the estimation of live fuel moisture content with remote sensing methods.

4.6 STUDIED SPECIES

Table 6 is a summary of the existing data given by each Partner.

The document D02-02_A (Full responses of each Partner to the questionnaire) shows mean values and/or ranges of values for each parameter and species.

In some cases (Partners P001, P010 and P025) the table also contains data related to state and size class.

The total number of species is 87, 27 among them are trees and the rest are shrubs and grasses.

Trees with larger amount of data are *Pinus*, *Quercus* and *Eucalyptus*; in the case of shrubs, best known species are *Chamaespartium*, *Erica* and *Cistus*.

Thus, species like *Pinus halepensis, P. pinaster, P. pinea* and *Quercus coccifera* are those that have, overall, more studied parameters.

Forest ecosystems more affected by fires and with this kind of species, are also the ecosystems better studied from the point of view of physical, chemical and thermal characteristics of the particles.

The parameters better studied are moisture content, surface to volume ratio, and heat content.

The first and second ones are critical inputs in fire behaviour prediction models.

There are, also, data of flammability in most of the studied species.

On the other hand, the parameters less studied, and therefore with lacks of data in many species or even in all of them, are ash content, chemical composition, thermal degradation and specific heat.

A more detailed analysis, for all species as a whole, shows a lack of physical parameters data (S/V and M/V ratios) in many species that are plentiful in mediterranean ecosystems, like *Cistus* (*C.albidus, C. crispus, C.laurifolius, C.salvifolius*), *Erica* (*E. ciliaris, E.multiflora, E. scoparia*), *Quercus* (*Q.pubescens, Q. pyrenaica, Q.suber*), *Ulex* (*U.parviflorus*), *Calluna vulgaris*, *Cytisus sp., Genista sp., Lavandula sp.*, and *Thymus sp*. among others.

This fact is probably due to problems in data taking process.

4.7 CONCLUSIONS

As it has been shown, a large number of characteristics are measured and calculated for different species by some of the Consortium Partners.

With these collected data, we can come to the following conclusions :

1.- State and size class are basic parameters in order to study forest fuel particles, and they are studied by the whole of the Consortium Partners involved in this topic.

However, the existing diversity of criteria in the size classification requires future standardisation in order to develop common protocols.

2.- The majority of the Partners have studied the physical characteristics of leaves, needles and twigs.

Other particles, like barks, cones, grasses, mosses, trunks, slash, etc., are studied only by some Partners only and with less detail.

The outcome is that, currently, a large amount of S/V ratio data exists for many species in different state and size classes.

Nevertheless, data is lacking for some important species in Mediterranean ecosystems, a fact that future research should address.

3.- Apart from moisture content and, in some cases, ash content, the chemical characteristics are less studied.

Chemical composition data is lacking for all the studied species by the Partners.

4.- Thermal characteristics and flammability have been widely described by some of the research teams.

However, none of the Partners took measurements of specific heat, and therefore information of this property is not available.

In this sense, it is necessary to define the relative importance of this parameter in order to include it in future investigation lines.

5.- Data ranges provided by the Partners appear, for most of the studied species, representative enough to be used in the classification of those species in different states and size classes.

The models generated with such data can be considered as reliable enough, although a database to collect available and future information should be defined and created, in order to facilitate the data input process for fire behaviour modelling.

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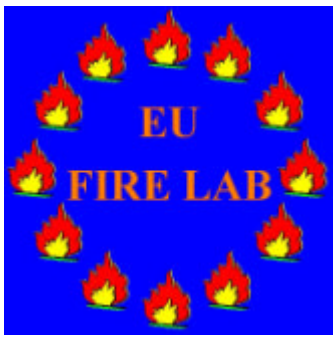

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D-02-02_A

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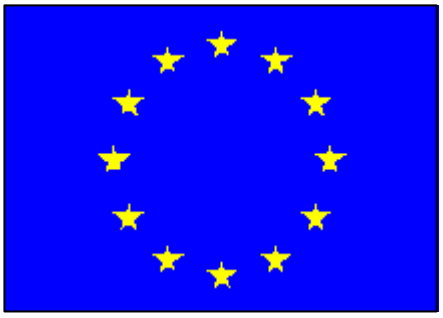

EUFIRELAB:

Euro-Mediterranean Wildland Fire Laboratory, a "wall-less" Laboratory for Wildland Fire Sciences and Technologies in the Euro-Mediterranean Region

Deliverable D-02-02_A

Physical, chemical and thermal characteristics of the wildland fuel particles
Answer from the partners

Compiled by Carmen HERNANDO

May 2004

CONTENT

1 CONTRIBUTION INRA-URFM-PIF (AVIGNON) P001

1.1 TABLE 1: FUEL CLASSES

Ref.			
1	**State**		
1.1	live		X
1.2	dead		X

2	**Size class**		
2.1	Fosberg and Deeming		
2.2	Fosberg and Deeming modified		X

1.2 TABLE 2: PHYSICAL CHARACTERISTICS

Ref.				
1	**Measured parameters**		Data	Previous deliverable
1.1	**Leaves**	Length	X	CF Firestar d6-01
1.2		Width	X	CF Firestar d6-02
1.3		Thickness	X	CF Firestar d6-03
1.4		Diameter		
1.5		Mass	X	CF Firestar d6-01
1.6		Volume	X	CF Firestar d6-02
1.7		Other		
1.8	**Needles**	Length		
1.9		Width		
1.10		Thickness	X	CF Firestar d6-01
1.11		Diameter	X	CF Firestar d6-02
1.12		Mass	X	CF Firestar d6-03
1.13		Volume	X	CF Firestar d6-04
1.14		Other		
1.15	**Twigs**	Length		
1.16		Width		
1.17		Thickness		
1.18		Diameter	X	CF Firestar d6-01
1.19		Mass	X	CF Firestar d6-02
1.20		Volume	X	CF Firestar d6-03
1.21		Other		
1.22	**Barks**	Length		
1.23		Width		
1.24		Thickness	X	Ryan et al, 1993
1.25		Diameter	X	Ryan et al, 1993
1.26		Mass		
1.27		Volume		
1.28		Other		

2	**Calculated parameters**		Data	Previous deliverable
2.1	**Surface**	Leaves	X	CF Firestar d6-01
2.2		Needles	X	CF Firestar d6-02
2.3		Twigs	X	CF Firestar d6-03
2.4		Other		
2.5	**Volume**	Leaves	X	CF Firestar d6-01
2.6		Needles	X	CF Firestar d6-02
2.7		Twigs	X	CF Firestar d6-03
2.8		Other		
2.9	**Ratios**	**Surface to volume**	X	CF Firestar d6-01
2.10		**Mass to volume**	X	CF Firestar d6-02
2.11		Other		

1.3 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Moisture content**	X	Moro C, annual report since 1990 (INRA-PIF)
2	**Ash content**	X	CF Firestar d6-03_A1

1.4 TABLE 4: THERMAL CHARACTERISTICS

Ref.		Data	Previous deliverable
5	**Thermal degradation**	X	CF Firestar d6-03_A1
6	**Heat content**	X	Doat & Valette, 1981
7	**Specific heat**		

1.5 TABLE 5: OTHER CHARACTERISTICS

Ref.		Data	Previous deliverable
8	**Flammability**	X	Valette, 1990
9.1	Other		
9.2	Other		

1.6 TABLE 6: STUDIED SPECIES

			Parameters									
Species	**fuel family**	**state**	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability (mark - in august -)	Others
Brachypodium ramosum	Grass	live		442	11,30				17638			
Pinus eldarica	Needles	dead	5140	642	3,77			x				
Pinus halepensis	2 mm < twigs < 6 mm	live	1000	700								
Pinus halepensis	Needles	live	6998	847	3,41				21130			
Pinus halepensis	Needles	dead	6048	1.6.1.1.1.1	3,88			x	22331			
Pinus halepensis	Needles	dead	6167	706	3,61			x				
Pinus pinea	Needles	dead	4271	554	4,46			x				
Pinus pinaster	Needles	dead	2925	570	2,55			x	21198			
Pinus pinaster	Needles	dead	3061	568				x				
Pinus pinaster	Needles	dead	3017	652	2,45			x				
Pinus pinaster	Needles	dead	3018	567	2,45			x				
Pinus pinaster	Needles	dead	3007	490	1,16			x				
Quercus coccifera	0 mm < twigs < 2 mm	live	2780	900	3,88			x	19212			
Quercus coccifera	2 mm < twigs < 6 mm	live	1070	930	3,89			x	18943			
Quercus coccifera	Leaves	live	5920	810	3,11			x	19994			
Quercus ilex	0 mm < twigs < 2 mm	live	2490	878	5,23				18451			
Quercus ilex	0 mm < twigs < 2 mm	live	2450	935	0,00							
Quercus ilex	2 mm < twigs < 6 mm	live	967	915	4,93				18246			
Quercus ilex	2 mm < twigs < 6 mm	live	959	970								
Quercus ilex	6 mm < twigs < 25 mm	live	412	924	3,97				18079			
Quercus ilex	6 mm < twigs < 25 mm	live	307	962								
Quercus ilex	Leaves	live	4030	614	3,20				20055			
Quercus ilex	Leaves	live	4050	571								
Brachypodium pinnatum											3	
Brachypodium ramosum											5	
Arbutus unedo									20869		3	
Buxus sempervirens											2	
Calluna vulgaris											4	
Calycotoma spinosa											2	
Cistus albidus											2	

Species	**fuel family**	**state**	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability (mark - in august -)	Others
Cistus montpelliensis											3	
Cistus salvaefolius											1	
Cytisus triflorus											1	
Erica arborea									24058		5	
Erica scoparia											5	
Phyllirea latifolia											5	
Quercus coccifera									19990		4	
Rosmarinus officinalis											3	
Thymus vulgaris											5	
Ulex parviflorus									20902		3	
Abies cephalonica											2	
Acacia dealbata											4	
Acacia melanoxylon											4	
Alnus subcordata											5	
Castanea sativa											5	
Cedrus atlantica											1	
Cupressus arizonica											1	
Cupressus sempervirens											2	
Eucalyptus dalrympleana											5	
Eucalyptus Macarthuri											5	
Pinus halepensis									22212		4	
Pinus pinaster											3	
Quercus ilex									20279		5	
Quercus pubescens											5	
Quercus suber											4	

2 CONTRIBUTION CEAM (VALENCIA) P009

2.1 TABLE 1: FUEL CLASSES

Ref.		
1	**State**	
1.1	live	X
1.2	dead	X

Ref.	**Observations**
	These data refer to complete individuals of 3 (n=71) and 9 (n=44) years old

2.2 TABLE 2: PHYSICAL CHARACTERISTICS

Ref.				
1	**Measured parameters**		Data	Previous deliverable
1.43	**Other**	Length	X	
1.44		Width	X	
1.45		Thickness		
1.46		Diameter	X	
1.47		Mass	X	
1.48		Volume	X	
1.49		Other		

2	**Calculated parameters**		Data	Previous deliverable
2.5	**Volume**	Leaves		
2.6		Needles		
2.7		Twigs		
2.8		Other individual	X	
2.9	**Ratios**	**Surface to volume**		
2.10		**Mass to volume**	X	
2.11		Other		

2.3 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Moisture content**	X	
2	**Ash content**		

2.4 TABLE 6: STUDIED SPECIES

Species	Parameters									
	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability	Others
Brachypodium retusum live 3 years-old				46,7						
Brachypodium retusum dead 3 years-old				16,3						
Cisus albidus 3 years-old				68,1						
Cisus albidus 9 years-old				40						
Erica multiflora 3 years-old				90,4						
Genista scorpius 9 years-old				30,6						
Juniperus oxycedrus 3 years-old				92,6						
Pinus halepensis 3 years-old (Needles)				122,2						
Quercus coccifera 9 years-old				58,7						
Rosmarinus officinalis 3 years-old				107,9						
Rosmarinus officinalis 9 years-old				87,1						
Ulex parviflorus 3 years-old		5,11		72,9						
Ulex parviflorus dead 3 years-old				7,3						
Ulex parviflorus 9 years-old		9,59		30,9						
Ulex parviflorus dead 9 years-old				7,6						

3 CONTRIBUTION INIA-CIFOR (MADRID) P010

3.1 TABLE 1: FUEL CLASSES

Ref.		
1	**State**	
1.1	live	X
1.2	dead	X

2	**Size class**	X
2.1	Fosberg and Deeming	X
2.2	Fosberg and Deeming modified	
2.3	Other	
2.4		

3.2 TABLE 2: PHYSICAL CHARACTERISTICS

Ref.				
1	**Measured parameters**		Data	Previous deliverable
1.1	**Leaves**	Length	X	
1.2		Width	X	
1.3		Thickness	X	
1.4		Diameter		
1.5		Mass	X	
1.6		Volume		
1.7		Other		
1.8	**Needles**	Length	X	
1.9		Width	X	
1.10		Thickness	X	
1.11		Diameter		
1.12		Mass	X	
1.13		Volume		
1.14		Other		
1.15	**Twigs**	Length	X	
1.16		Width		
1.17		Thickness		
1.18		Diameter	X	
1.19		Mass	X	
1.20		Volume		
1.21		Other		
1.22	**Barks**	Length	X	
1.23		Width	X	
1.24		Thickness	X	
1.25		Diameter		
1.26		Mass	X	
1.27		Volume		
1.28		Other		
1.29	**Cones**	Length	X	
1.30		Width	X	
1.31		Thickness	X	
1.32		Diameter		
1.33		Mass	X	
1.34		Volume		
1.35		Other		

2	Calculated parameters		Data	Previous deliverable
2.1	**Surface**	Leaves	X	
2.2		Needles		
2.3		Twigs		
2.4		Other		
2.5	**Volume**	Leaves		
2.6		Needles		
2.7		Twigs		
2.8		Other		
2.9	**Ratios**	**Surface to volume**	X	
2.10		**Mass to volume**		
2.11		Other		

Ref.	Observations
2.9	Hernando *et al.*, 1955

3.3 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Moisture content**	X	
2	**Ash content**		

3.4 TABLE 4: THERMAL CHARACTERISTICS

Ref.		Data	Previous deliverable
5	**Thermal degradation**		
6	**Heat content**	X	D-02-01
7	**Specific heat**		

3.5 TABLE 5: OTHER CHARACTERISTICS

Ref.		Data	Previous deliverable
8	**Flammability**	X	D-02-01
8.1	Other		
8.2	Other		

Ref.	Observations
6&8	Elvira L and Hernando C, 1989 Hernando C, 1989

3.6 TABLE 6: STUDIED SPECIES

			Parameters									
Species	**Fuel family**	**State**	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability (Jul-Sep)	Others
Anthyllis cytisoides	Leaves&twigs	Live				X			18741		0-5	
Arbutus unedo	Leaves&twigs	Live				X			21403		2-4	
Arctostaphylos uva-ursi	Leaves&twigs	Live				X			21545			
Atriplex halimus	Leaves&twigs	Live				X			15376		0-1	
Buxus sempervirens	Leaves&twigs	Live				X			21445		1-2	
Calluna vulgaris	Leaves&twigs	Live				X			22504		4-5	
Calycotome villosa	Leaves&twigs	Live				X			21005		0-3	
Chamaespartium tridentatum	Leaves&twigs	Live				X			22341		3-4	
Chamaespartium tridentatum	Twigs:2-6mm	Live				X			20220		0	
Chamaespartium tridentatum	Twigs:2-6mm	Dead				X					2	
Chamaespartium tridentatum	Twigs:6-25mm	Live				X			19938		0	
Cistus albidus	Leaves&twigs	Live				X			19515		3	
Cistus crispus	Leaves&twigs	Live				X			18791		3-4	
Cistus ladanifer	Leaves&twigs	Live				X			20974		3-4	
Cistus laurifolius	Leaves&twigs	Live				X			20084		0-2	
Cistus salvifolius	Leaves&twigs	Live				X			19201		0-3	
Cytisus scoparius	Leaves&twigs	Live				X			21106		2-4	
Erica arborea	Leaves&twigs	Live				X			23674		4	
Erica arborea	Leaves	Live				X			23558			
Erica arborea	Twigs:<2mm	Live				X			22175			
Erica arborea	Twigs:2-6mm	Live				X			20571			
Erica arborea	Twigs:6-25mm	Live				X			20329			
Erica arborea	Twigs:>25mm	Live				X			20331			
Erica australis	Leaves&twigs	Live				X			24710		3-5	
Erica australis	Twigs: 2-6mm	Live				X			19624			
Erica australis	Twigs:6-25mm	Live				X			19427			
Erica ciliaris	Leaves&twigs	Live				X			21612			
Erica multiflora	Leaves&twigs	Live				X			24120		0-4	
Erica scoparia	Leaves&twigs	Live				X					4-5	

Species	Fuel family	State	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability (Jul-Sep)	Others
Eucalyptus camaldulensis	Leaves&twigs	Live				X			20109		5	
Eucalyptus camaldulensis	Bark	Live				X			15823		5	
Eucalyptus globulus	Leaves&twigs	Live				X			22663		5	
Eucalyptus globulus	Leaves	Live				X			23458		5	
Eucalyptus globulus	Leaves	Dead				X			24062		5	
Eucalyptus globulus	Twigs: 2-6mm	Live				X			19717		3	
Eucalyptus globulus	Twigs: 2-6mm	Dead				X			19604		3	
Eucalyptus globulus	Bark	Live				X			18870			
Genista falcata	Leaves&twigs	Live				X			21432		5	
Halimium alyssoides	Leaves&twigs	Live				X			19747			
Junipres oxycedrus	Leaves&twigs	Live				X			22571		0-3	
Lavandula stoechas	Leaves&twigs	Live				X			20737		3-5	
Olea europaea	Leaves&twigs	Live				X			20746		0-3	
Phillyrea angustifolia	Leaves&twigs	Live				X			22851		4-5	
Pinus halepensis	Needles	Dead	7973			X			22075		5	
Pinus halepensis	Twigs:0-2mm	Dead				X			20587			
Pinus halepensis	Bark	Live				X			19469			
Pinus pinaster	Needles	Live				X			21487		3	
Pinus pinaster	Needles	Dead	4824			X			21302		5	
Pinus pinaster	Twigs:0-2mm	Dead				X			22071		3	
Pinus pinaster	Twigs:2-6mm	Dead				X			21374		2-3	
Pinus pinaster	Twigs:6-25mm	Dead				X			21030			
Pinus pinaster	Bark	Live				X			20549			
Pinus pinaster	Bark	Dead				X			21508			
Pinus pinaster	Cone scales	Dead				X			20737			
Pinus pinea	Needles	Dead	5780			X			21800		4-5	
Pinus pinea	Twigs:0-2mm	Dead				X			20185			
Pinus pinea	Bark	Live				X			20040			
Pinus pinea	Cone scales	Dead				X			20151			
Pinus radiata	Needles	Live				X			21419			
Pinus radiata	Needles	Dead				X			22542		5	
Pinus radiata	Bark	Live				X			21583			
Pinus radiata	Cone scales	Dead				X			20189			
Pteridium aquilinum	Leaves	Live				X			19596		0	
Pteridium aquilinum	Leaves	Dead				X			19762			

Species	Fuel family	State	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability (Jul-Sep)	Others
Quercus coccifera	Leaves&twigs	Live				X			20285		0-3	
Quercus coccifera	Leaves	Live				X			19679			
Quercus coccifera	Twigs:0-2mm	Live				X			19545			
Quercus coccifera	Twigs:2-6mm	Live				X			19051			
Quercus coccifera	Twigs:6-25mm	Live				X			18254			
Quercus ilex	Leaves&twigs	Live				X			19950		5	
Quercus ilex	Leaves	Live				X			19697			
Quercus ilex	Twigs:0-2mm	Live				X			18448			
Quercus ilex	Twigs:2-6mm	Live				X			18243			
Quercus ilex	Twigs:6-25mm	Live				X			18075			
Quercus pyrenaica	Leaves	Live				X			20013			
Quercus pyrenaica	Leaves	Dead				X			18824			
Quercus pyrenaica	Twigs	Dead				X			19669			
Quercus suber	Leaves&twigs	Live				X			20457		2-4	
Rosmarinus officinalis	Leaves&twigs	Live				X			22669		3-4	
Rosmarinus officinalis	Leaves	Live				X			22090			
Rosmarinus officinalis	Twigs:0-2mm	Live				X			19997			
Rosmarinus officinalis	Twigs:2-6mm	Live				X			19770			
Rosmarinus officinalis	Twigs:6-25mm	Live				X			19812			
Rubus idaeus	Leaves&twigs	Live				X			17133		0-5	
Stauracanthus boivinii	Leaves&twigs	Live				X			21441		3-4	
Stipa tenacissima	Grasses	Dead				X			19955		5	
Thymus vulgaris	Leaves&twigs	Live				X			20876		4	
Ulex europaeus	Leaves&twigs	Live				X			20647		3	
Ulex minor	Leaves&twigs	Live				X			20712			
Ulex parviflorus	Leaves&twigs	Live				X			21072		3-4	

4 CONTRIBUTION CONTRIBUTION ADAI (COIMBRA) P013

4.1 TABLE 1: FUEL CLASSES

Ref.		
1	**State**	
1.1	live	X
1.2	dead	X

2	**Size class**	
2.1	Fosberg and Deeming	
2.2	Fosberg and Deeming modified	X
2.3	Other	
2.4		

4.2 TABLE 2: PHYSICAL CHARACTERISTICS

Ref.				
1	**Measured parameters**		Data	Previous deliverable
1.1	**Leaves**	Length		
1.2		Width		
1.3		Thickness		
1.4		Diameter	X	
1.5		Mass	X	
1.6		Volume	X	
1.7		Other		
1.8	**Needles**	Length		
1.9		Width		
1.10		Thickness		
1.11		Diameter	X	
1.12		Mass	X	
1.13		Volume	X	
1.14		Other		
1.15	**Twigs**	Length		
1.16		Width		
1.17		Thickness		
1.18		Diameter	X	
1.19		Mass	X	
1.20		Volume	X	
1.21		Other		
1.22	**Barks**	Length		
1.23		Width		
1.24		Thickness		
1.25		Diameter	X	
1.26		Mass	X	
1.27		Volume	X	
1.28		Other		
1.36	**Grasses**	Length		
1.37		Width		
1.38		Thickness		
1.39		Diameter		
1.40		Mass	X	
1.41		Volume	X	
1.42		Other		

2	Calculated parameters		Data	Previous deliverable
2.5	**Volume**	Leaves	X	
2.6		Needles	X	
2.7		Twigs	X	
2.8		Other		
2.9	**Ratios**	**Surface to volume**	X	
2.10		**Mass to volume**		
2.11		Other		

4.3 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Moisture content**	X	
2	**Ash content**		

4.4 TABLE 5: OTHER CHARACTERISTICS

Ref.		Data	Previous deliverable
8	**Flammability**	X	
8.1	Other combustibility	X	
8.2	Other		

4.5 TABLE 6: STUDIED SPECIES

Species	Parameters									
	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability	Others
Chamaespartium tridentatum		x		x					x	
Erica australis		x		x					x	
Erica umbellata		x		x					x	
Pinus pinaster	x	x		x					x	
Eucalyptus globulus		x		x					x	
Ulex sp		x		x						

5 CONTRIBUTION XG-CIFL (LOURIZÁN) P018

5.1 TABLE 1: FUEL CLASSES

Ref.		
1	**State**	
1.1	live	X
1.2	dead	X

2	**Size class**	
2.1	Fosberg and Deeming	X
2.2	Fosberg and Deeming modified	X
2.3	Other	
2.4		

5.2 TABLE 2: PHYSICAL CHARACTERISTICS

Ref.				
1	**Measured parameters**		Data	Previous deliverable
1.1	**Leaves**	Length	X	
1.2		Width	X	
1.3		Thickness	X	
1.4		Diameter	X	
1.5		Mass	X	
1.6		Volume	X	
1.7		Other		
1.8	**Needles**	Length	X	
1.9		Width	X	
1.10		Thickness	X	
1.11		Diameter	X	
1.12		Mass	X	
1.13		Volume	X	
1.14		Other		
1.15	**Twigs**	Length		
1.16		Width		
1.17		Thickness		
1.18		Diameter	X	
1.19		Mass	X	
1.20		Volume	X	
1.21		Other		
1.22	**Barks**	Length		
1.23		Width		
1.24		Thickness	X	
1.25		Diameter		
1.26		Mass	X	
1.27		Volume		
1.28		Other		
1.29	**Cones**	Length		
1.30		Width		
1.31		Thickness		
1.32		Diameter		
1.33		Mass	X	
1.34		Volume		
1.35		Other		

1.36	**Grasses**	Length	
1.37		Width	
1.38		Thickness	
1.39		Diameter	
1.40		Mass	X
1.41		Volume	
1.42		Other	
1.43	**Other**	Length	X
1.44		Width	X
1.45		Thickness	
1.46		Diameter	X
1.47		Mass	X
1.48		Volume	X
1.49		Other	

2	**Calculated parameters**		Data	Previous deliverable
2.1	**Surface**	Leaves	X	
2.2		Needles	X	
2.3		Twigs	X	
2.4		Other		
2.5	**Volume**	Leaves	X	
2.6		Needles	X	
2.7		Twigs	X	
2.8		Other: individual	X	
2.9	**Ratios**	**Surface to volume**	X	
2.10		**Mass to volume**	X	
2.11		Other		
2.12	**Other**			
2.13				
Ref.	**Observations**			
	Barks and cones are measured when they appear as part of the litter layer			

5.3 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Moisture content**	X	
2	**Ash content**	X	

5.4 TABLE 4: THERMAL CHARACTERISTICS

Ref.		Data	Previous deliverable
5	**Thermal degradation**		
6	**Heat content**	X	

Ref.	**Observations**
	Heat content determined is the high heat value

5.5 TABLE 6: STUDIED SPECIES

	Parameters									
Species	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability	Others
Ulex europaeus	8088	679 - 774					20533			
Ulex minor		780 - 854					20227			
Chamaespartium tridentatum	4632	669 - 669					21827			
Erica australis	6724	432 - 831								
Erica umbellata		362 - 888					22341			
Calluna vulgaris		626 - 718					21414			
Daboecia cantabrica		605 - 693								
Halimium alyssoides		582 - 729								
Cistus clusii	1391	879 - 985								
Rosmarinus officinalis	1111	639 - 693								
Thymus vulgaris	2561	693 - 693								
Eucalyptus globulus		720 - 784					23943 - 20321			
Juniperus oxycedrus	10210	808 - 752								
Juniperus sabina	1121	786 - 787								
Pteridium aquilinum	9662	411 - 427					18613 - 18162			
Pinus pinaster							21593 - 20950			
Pinus radiata							21159 - 20502			
Betula celtiberica							20969 - 20600			
Rubus sp.							19039			
Cytisus scoparius							20540			

6 CONTRIBUTION UTAD-DF (VILA-REAL) P025

6.1 TABLE 1: FUEL CLASSES

Ref.			
1	**State**		
1.1	live		X
1.2	dead		X

2	**Size class**		
2.1	Fosberg and Deeming		X
2.2	Fosberg and Deeming modified		X
2.3	Other	Smaller size class:<2.5mm	X
2.4		Smaller size class:<3.0mm	X

6.2 TABLE 2: PHYSICAL CHARACTERISTICS

Ref.				
1	**Measured parameters**		Data	Previous deliverable
1.1	**Leaves**	Length		
1.2		Width		
1.3		Thickness	X	
1.4		Diameter		
1.5		Mass	X	
1.6		Volume	X	
1.7		Other		
1.8	**Needles**	Length	X	
1.9		Width	X	
1.10		Thickness	X	
1.11		Diameter	X	
1.12		Mass	X	
1.13		Volume	X	
1.14		Other		
1.15	**Twigs**	Length	X	
1.16		Width		
1.17		Thickness		
1.18		Diameter	X	
1.19		Mass	X	
1.20		Volume	X	
1.21		Other		
1.36	**Grasses**	Length		
1.37		Width		
1.38		Thickness		
1.39		Diameter	X	
1.40		Mass	X	
1.41		Volume	X	
1.42		Other		

2	Calculated parameters		Data	Previous deliverable
2.1	**Surface**	Leaves	X	
2.2		Needles	X	
2.3		Twigs	X	
2.4		Other		
2.5	**Volume**	Leaves	X	
2.6		Needles	X	
2.7		Twigs	X	
2.8		Other		
2.9	**Ratios**	**Surface to volume**	X	
2.10		**Mass to volume**	X	
2.11		**Surface to mass**	X	

6.3 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Moisture content**	X	
2	**Ash content**	X	

6.4 TABLE 6: STUDIED SPECIES

			Parameters									
Species	**Fuel family**	**State**	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability	Others
Acacia longifolia	Leaves	live	7080									
Acacia longifolia	0-6 mm twigs	live	1865									
Agrostis spp.	0-6 mm twigs	dead	8000									
Arbutus unedo	Leaves	live	4500									
Arbutus unedo	0-6 mm twigs	live	1900									
Calluna vulgaris	2-6 mm twigs	live	1000	227								
Calluna vulgaris	Leaves + <2 mm twigs	live	9560			X						
Calluna vulgaris	Leaves + <6 mm twigs	live	8810	440								
Chamaespartium tridentatum	2-6 mm twigs	live	9600	765		X						
Chamaespartium tridentatum	Leaves + <2 mm twigs	live	4710	613	1.62	X						
Chamaespartium tridentatum	Leaves + <2 mm twigs	dead		489		X						
Chamaespartium tridentatum	Leaves + <6 mm twigs	live	4260	640								
Cistus ladanifer	Leaves	live	4550			X						
Cistus ladanifer	Leaves	dead				X						
Cistus ladanifer	Leaves + <6 mm twigs	live	1800			X						
Cistus monspeliensis	0-6 mm twigs	live	2600									
Cistus monspeliensis	Leaves	live	3500									
Corema album	Leaves	live	9469									
Corema album	0-6 mm twigs	live	1969									
Corema album	0-6 mm twigs	dead	2970									
Cytisus striatus	Leaves + <2 mm twigs	live		696		X						
Cytisus striatus	Leaves + <2 mm twigs	dead		379		X						
Erica arborea	0-6 mm twigs	live	4500									
Erica arborea	Leaves	live	13000									
Erica arborea	Leaves + <2 mm twigs	live	7200	253		X						
Erica arborea	Leaves + <2 mm twigs	dead	9200	324		X						
Erica arborea	Leaves + <6 mm twigs	live	6690	500								
Erica australis	2-6 mm twigs	live	9300	782		X						
Erica australis	2-6 mm twigs	dead		856		X						
Erica australis	6-25 mm twigs	dead		844								
Erica australis	Leaves + <2 mm twigs	live	7950	434		X						
Erica australis	Leaves + <2 mm twigs	dead		364		X						
Erica australis	Leaves + <6 mm twigs	live	6330	580								

Species	Fuel family	State	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability	Others
Erica umbellata	2-6 mm twigs	live	1180	788		X						
Erica umbellata	Leaves + <2 mm twigs	live	1010	318	2.39	X						
Erica umbellata	Leaves + <2 mm twigs	dead		244		X						
Erica umbellata	Leaves + <6 mm twigs	live	8680	490								
Eucalyptus globulus	Leaves	dead	5690	650								
Halimium alyssoides	Leaves + <2 mm twigs	live		261								
Halimium ocymoides	2-6 mm twigs	live	1380	750								
Halimium ocymoides	Leaves + <2 mm twigs	live	4780	278								
Halimium ocymoides	Leaves + <2 mm twigs	dead		453								
Halimium ocymoides	Leaves + <6 mm twigs	live	4440	470								
Juniperus turbinata	Leaves	live	5634									
Juniperus turbinata	0-6 mm twigs	live	2145									
Juniperus turbinata	0-6 mm twigs	dead	5238									
Myrica faya	Leaves	live	6349									
Myrica faya	0-6 mm twigs	live	1435									
Myrica faya	0-6 mm twigs	dead	1961									
Myrtus communis	0-6 mm twigs	live	2100									
Myrtus communis	Leaves	live	6500									
Olea europaea	0-6 mm twigs	live	2400									
Olea europaea	Leaves	live	6000									
Phillyrea angustifolia	0-6 mm twigs	live	2200									
Phillyrea angustifolia	Leaves	live	7500									
Pinus halepensis	Needles	dead	8740	790								
Pinus pinaster	Needles	dead	4990	660		X						
Pinus pinea	Needles	dead	6470	690								
Pistacia lentiscus	0-6 mm twigs	live	1800									
Pistacia lentiscus	Leaves	live	6000									
Pteridium aquilinum	Leaves + <6 mm twigs	live	9400	300		X						
Pteridium aquilinum	Leaves + <6 mm twigs	dead				X						
Quercus coccifera	Leaves	live	6000									
Quercus coccifera	0-6 mm twigs	live	2100									
Rosmarinus officinalis	0-2 mm twigs	live	3760	680								
Rosmarinus officinalis	0-6 mm twigs	live	2200									
Rosmarinus officinalis	Leaves	live	5500									
Rosmarinus officinalis	Leaves + <2 mm twigs	live	4860	540								

Species	Fuel family	State	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability	Others
Ulex europaeus	Leaves + <2 mm twigs	live		651		X						
Ulex europaeus	Leaves + <2 mm twigs	dead		356		X						
Ulex minor	Leaves + <2 mm twigs	live		474		X						
Ulex minor	Leaves + <2 mm twigs	dead		317		X						
Ulex minor	Leaves + <6 mm twigs	live	5540									

7 CONTRIBUTION METLA (VANTAA) P026

7.1 TABLE 1: FUEL CLASSES

Ref.			
1	**State**		
1.1	live		X
1.2	dead		X

2	**Size class**		
2.1	Fosberg and Deeming		
2.2	Fosberg and Deeming modified		
2.3	Other	FCC system (Sandberg et al 2001) modified	X
2.4			

7.2 TABLE 2: PHYSICAL CHARACTERISTICS

Ref.	**Observations**
	Cones, bark, twigs etc combined to “litter” class
	Following fuel class (measured by mass): trunks, slash, litter, mosses, lichens, duff

7.3 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Moisture content**	X	
2	**Ash content**		

		Element	Previous deliverable
3			
3.1	**Chemical content**	C.N	
3.2		Ca, Mg, K	
3.3		K, P	
3.4		pH	

7.4 TABLE 5: OTHER CHARACTERISTICS

Ref.		Data	Previous deliverable
8	**Flammability**	X	
9.1	Other		
9.2	Other		

7.5 TABLE 6: STUDIED SPECIES

Species	Parameters									
	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability	Others
Pleurozium shreberi				X					X	
Hylocomium splendens				X					X	
Cladina spp				X					X	
Diranum spp				X					X	
"Duff"				X	X				X	

8 CONTRIBUTION GIUZ (ZURICH) P033

8.1 TABLE 1: FUEL CLASSES

Ref.

1	State	
1.1	live	X
1.2	dead	X

2	Size class	
2.1	Fosberg and Deeming	
2.2	Fosberg and Deeming modified	
2.3	Other	Modified method according to Brown et al. for the use within Rothermel's mathematical fire spread model, http://www.geo.unizh.ch/gis/research/edmg/fire/papers/minerve/fuel.pdf
2.4		

8.2 TABLE 2: PHYSICAL CHARACTERISTICS

Ref.

1	Measured parameters		Data	Previous deliverable
1.1	**Leaves**	Length		
1.2		Width		
1.3		Thickness	X	
1.4		Diameter		
1.5		Mass	X	
1.6		Volume		
1.7		Other		
1.8	**Needles**	Length		
1.9		Width		
1.10		Thickness		
1.11		Diameter	X	
1.12		Mass	X	
1.13		Volume		
1.14		Other		
1.15	**Twigs**	Length		
1.16		Width		
1.17		Thickness		
1.18		Diameter	X	
1.19		Mass	X	
1.20		Volume		
1.21		Other		
1.22	**Barks**	Length		
1.23		Width		
1.24		Thickness	X	
1.25		Diameter		
1.26		Mass	X	
1.27		Volume		
1.28		Other		
1.29	**Cones**	Length		
1.30		Width		
1.31		Thickness		
1.32		Diameter	X	
1.33		Mass	X	
1.34		Volume		
1.35		Other		

1.36	**Grasses**	Length		
1.37		Width		
1.38		Thickness	X	
1.39		Diameter	X	
1.40		Mass	X	
1.41		Volume		
1.42		Other		
1.43	**Mosses**	Length		
1.44		Width		
1.45		Thickness	X	
1.46		Diameter		
1.47		Mass	X	
1.48		Volume		
1.49		Other		
1.50	**Single trees**	Length (Heigh)	X	
1.51		Width		
1.52		Thickness		
1.53		Diameter	X	
1.54		Mass		
1.55		Volume	X	
1.56		Height of the base of crown	X	

2	**Calculated parameters**		Data	Previous deliverable
2.1	**Surface**	Leaves		
2.2		Needles		
2.3		Twigs		
2.4		Other		
2.5	**Volume**	Leaves		
2.6		Needles		
2.7		Twigs		
2.8		Other		
2.9	**Ratios**	**Surface to volume**	X	
2.10		**Mass to volume**		
2.11		Other		

8.3 TABLE 3: CHEMICAL CHARACTERISTICS

Ref.		Data	Previous deliverable
1	**Moisture content**	X	
2	**Ash content**		

8.4 TABLE 5: OTHER CHARACTERISTICS

	Observations
9.1	Ceccato, P., Flasse, S. and Gregoire, J. M. (2002), Designing a spectral index to estimate vegetation water content from remote sensing data - Part 2. Validation and applications. Remote Sensing of Environment, 82(2-3), 198-207.
9.2	Carlson, J. D. and Burgan, R. E. (2003), Review of users' needs in operational fire danger estimation: the Oklahoma example. International Journal of Remote Sensing, 24(8), 1601-1620.

8.5 TABLE 6: STUDIED SPECIES

Species	Parameters									
	S/V ratio (m2/m3)	M/V ratio (kg/m3)	Ash content (g/hg)	Moisture content (%)	Chemical composition	Thermal degradation	Heat content (kJ/kg)	Specific heat (J/K/kg)	Flammability	Moisture of extinction
Larix decidua	7809			x						35,99
Pinus mugo grex arborea (Mountain Pine)	6499			x						36,50
Pinus mugo grex prostrata	4764			x						44,12
Abies alba	7215			x						32,00
Polypodium sp. and Genista sp.	10851			x						16,00
Castanea sativa	10383			x						18,00