European Cooperation in the field of Scientific and Technical Research
- COST -

Secretariat

Brussels, 15 March 2002

COST 225/02

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a concerted European research action designated as COST Action 633 "Particulate Matter: Properties Related to Health Effects"

Delegations will find attached hereto the text of the abovementioned Memorandum signed in Brussels on 6 March 2002 by Austria, Finland, Germany and Greece and on 13 March 2002 by Lithuania and the United Kingdom.

Memorandum of Understanding
for the implementation of a European Concerted Research Action
designated as COST 633
"Particulate Matter: Properties Related to Health Effects"

The Signatories to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the Technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 400/01 "Rules and Procedures for Implementing COST Actions", the contents of which the Signatories are fully aware of.

2. The main objective of the Action is to increase the information on the particulate matter (PM) characteristics throughout Europe, describing the PM-system with respect to geographical and meteorological conditions, particle formation processes and their transport. The results will be used for setting environmental standards in Europe and for defining measures to reduce the particle emission.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at Euro 30 million in 2001 prices.

4. The Memorandum of Understanding will take effect on being signed by at least five Signatories.

5. The Memorandum of Understanding will remain in force for a period of five years, calculated from the date of first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter 6 of the document referred to in Point 1 above.

COST 633

PARTICULATE MATTER: PROPERTIES RELATED TO HEALTH EFFECTS

A. GENERAL BACKGROUND

Atmospheric particles or dust (particulate matter, PM) have been always considered a major component of air pollution. Epidemiological studies in the recent years gave a strong hint on extended morbidity and mortality even due to relatively low PM burdens (e.g. Dockery et al, 1993). The understanding of the corresponding causal chains of various parameters describing PM exposure and the health effects is still very weak. Many research projects on PM-exposure and health related effects due to particles have been initiated in the last years, mainly in the United States but also in Europe and other areas of the world. Consequently, ambient air quality standards for particulate matter are being established or revised in many countries. Several workshops on research priorities within this field (EU, USEPA, HEI) indicated extensive needs for additional information.

In many European as well as other countries extensive monitoring programs focused on PM and special parameters like carbon, acidity, semivolatile components, ultrafine particles and so on are carried out. The research goals of these studies are not always the same in detail, but generally particle properties with respect to effects on the environment and in particular on human health are addressed. Furthermore, epidemiological studies focused on different health endpoints and high risk groups are conducted. Since most of these studies are being done independently at present, intensive exchange of experiences among the participating groups from the exposure as well as from the effects research side would be of great benefit to all participants. A harmonisation of the results available is highly desirable. Therefore, this COST Action is to co-ordinate and promote the research going on in Europe on these issues.

Status of the research in the field: The atmospheric aerosol is a disperse system of solid and/or liquid particles of different size, shape, chemical composition and reactivity. Even the chemical composition of a single particle is not necessarily uniform. Among other heterogeneities the aggregation of soot, the formation of electric double layers, and surface layers of organic compounds may play an important role in the chemistry of a particle, and in the evolution of the aerosol. During their life the aerosol particles are continuously influenced by physical and chemical processes resulting in a permanent change of quality and/or quantity of their parameters.

Basically, the size distribution of atmospheric aerosol reflects the processes of particle formation to quite some extent. The so called coarse range with a maximum at around 10 µm contains particles that are produced by mechanical effects (e.g. erosion, abrasion, disintegration of bulk material). The so called nuclei range with a maximum between 0.01 and 0.1 µm contains particles formed primarily by condensation of supersaturated vapours (Fig.1). Combustion products occur in this size range primarily.

In the accumulation range which covers sizes from 0.1 µm to 1 µm, the particles are formed predominantly by coagulation of finer particles, by condensation of products from gaseous aerosol precursors on pre-existing particles, and by products of chemical reactions proceeding on these particles themselves. Most of the material associated with this accumulation aerosol has been formed and transformed in the atmosphere, and is usually briefly called secondary, in contrast to primary aerosol that is emitted into the atmosphere from natural and anthropogenic sources. It must be noted, that the accumulation aerosol would contain some primary aerosol material, whereas coarse particles may contain secondary aerosol material as well.

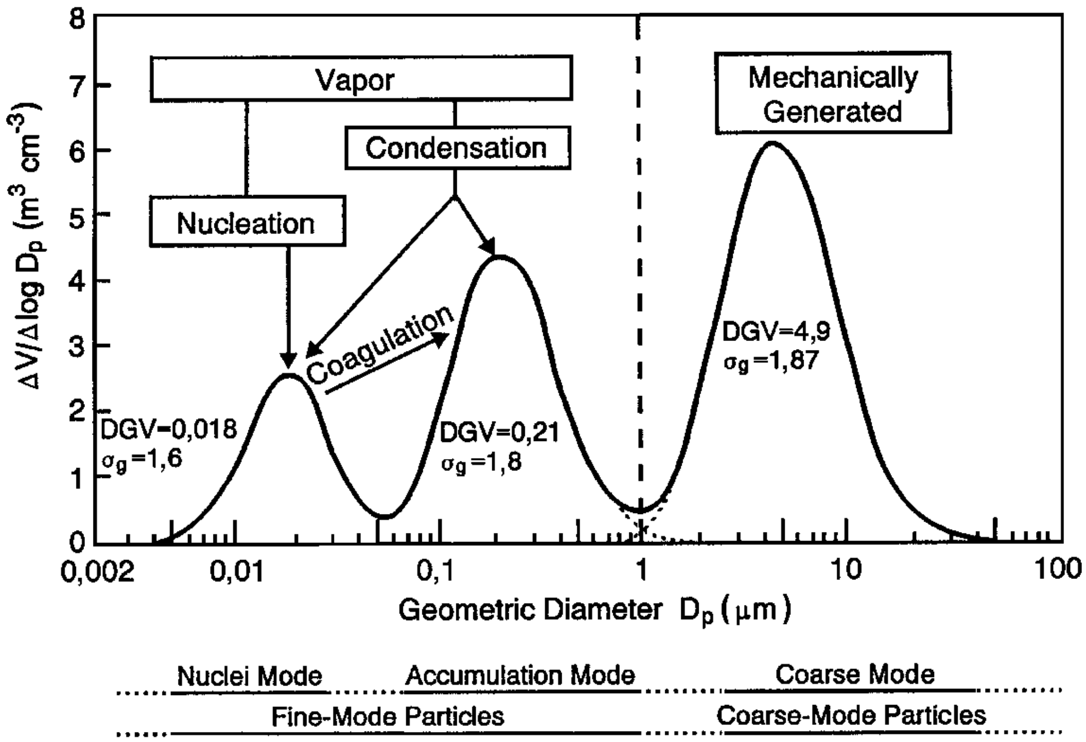

Figure 1: Three modal size distribution of the atmospheric aerosol (Wilson and Suh 1997)

Compared to the coarse and the nuclei aerosols the accumulation aerosol represents the most stable part of the atmospheric aerosol. Life times are thought to span from a couple of days up to weeks depending on the meteorological situation. Wet deposition is much more effective in removing the accumulation aerosol from the atmosphere than dry deposition. It must be noted however that at least part of the accumulation aerosol is chemically active, so a chemical evolution may lead to notable changes of aerosol parameters during the life time. The chemical evolution poses the problem that life times of the individual particles belonging to an active population may become shorter than the life time of the population. This addresses the dynamics of an aerosol population.

Basic constituents of the accumulation aerosol are sulphates, nitrates, ammonium, organic acids, and other organic compounds soluble and insoluble in water. Many of these components originate from atmospheric trace gases or are at least highly influenced by these gases. The organic material forms a considerable part of the secondary aerosol. On a broader basis, research into the organic part of aerosols has started only recently, so data are scarce and there is a need for stepping up the investigations.

The accumulation aerosol plays a major role in health effects as the toxicologically relevant acidic compounds, various heavy metals as well as organic compounds like PAHs, appear in the accumulation aerosol. In addition, soot particles originating from fossil fuel burning are associated with the secondary aerosol and should be addressed in particular.

Log normal distributions are frequently used to decompose the size distribution of the atmospheric aerosol mathematically. Often a set of a few log normal components describes the size distribution quite well. This is the source of the successful trimodal model of the atmospheric aerosol. However, this model may fail under certain circumstances. Local emissions, mixed aerosols from different atmospheric systems, and relevant large scale changes in the aerosol forming processes during extended sampling periods may cause remarkable deviations.

Recently it has been shown that the accumulation aerosol is better represented by two components or modes. Moreover, two classes of particles with different hygroscopic activity can exist in the accumulation aerosol. Hence, at high relative humidity the accumulation aerosol may split in two submodes with different size and composition. The bimodal structure should be addressed in future research, because of implications to health. Hygroscopic particles are growing within the respiratory tract and thus change their deposition characteristics, compared to non-hygroscopic particles of originally the same size. Moreover, the same aerosol growing to full size already in the atmosphere at high relative humidities may give rise to different health effects because the deposition pattern shifts to the upper parts of the respiratory tract.

Emission of aerosol precursors and evolution of aerosols are regionally very different over Europe. Especially the profiles met in the Mediterranean as a rather arid and/or maritime zone, must differ from western and central Europe. It is also clear that many of the European profiles do not readily compare to those on the North American continent. Therefore, investigations into regional or even local differences are very important in order to interpret and understand the exposure situation in the European regions.

Health effects assessment of air pollutants depends on a dose-response relation. For PM the dose or the exposure situation is particularly difficult to determine, since a number of parameters must be considered. Ambient air monitoring depends like respirability of particles on wind speed and external air flow patterns. The deposition of inhaled particles is determined by the size of the particles, breathing parameters, type of breathing (mouth or nasal breathing), individual anatomical patterns of the respiratory tract as well as respiratory diseases. The clearance of deposited particles depends on the site of deposition and hence on the particle size, on the shape of the particles, e.g. fibres, on the chemical reactivity (surface) and the functionality of cleaning processes (phagocytosis, ciliary clearance). The chemical composition and reactivity of the particles is not only responsible for the direct chemotoxic effects (e.g. heavy metals) but furthermore determines the fate of the particles in the respiratory tract. Even so called chemically inert particles may cause changes in the lung tissues. Ultrafine particles, i.e. particles with aerodynamic diameters less than 0.1 µm, initiated in animals at high concentrations inflammation of the lungs. Overload phenomena impair clearance processes because of overstrain of the pulmonary clearance mechanisms. These effects may only be significant at very high deposition doses, which can be scarcely found in the free atmosphere.

In addition to animal experiments and controlled inhalation experiments in humans epidemiological studies in industrial and rural environments can contribute to the question of health effects. The classical time series studies of smog episodes in Meuse Valley in 1930, Donora 1948, London 1952, 1956, 1962 showed increased mortality and morbidity rates of the affected population. However, the exposure situation cannot be defined very well retrospectively and in addition the monitoring equipment available at that time cannot compete with today's equipment. Generally, SO_2 and acid components seem to be main factors affecting human health during these episodes. Recent epidemiological papers demonstrate remarkable associations between PM burden and morbidity and mortality in the general population, even at relatively low dust concentrations. The causal chain between PM burden and health effects is not clear, however, until today. Additional confounders like other air pollutants, climate, tobacco smoking, age, social status and harvesting effects (premature deaths) are not always considered correctly and are still a matter of discussion. Meta studies of all these projects show an increase of the relative mortality risk to between 1.03 and 1.17 for a PM increase of 100 $\mu g/m^3$; the average risk comes to 1.10. The strongest associations could be found for the fine mode fraction especially if considering all the confounding factors. WHO too supports this concept in the new edition of the ”Air quality guidelines for Europe”. This risk increase may seem relatively low and sometimes is not even statistically significant but considering the high number of people affected the number of impaired persons is quite high.

The problems discussed above require intensive interdisciplinary approaches. The detailed investigation of chemical, physical, meteorologic, and geographical aspects have to be closely interwoven with health aspects of mortality and morbidity. The projects undertaken within this COST action are to be prepared and performed under these aspects. The Action pronounces the physico-chemical properties of the aerosol and the evolution of this aerosol in the atmosphere. However, the COST Action is also aimed at developing links between the natural science and medical fields. Developing of such links will be an important task within the frame of this COST Action.

Relationship with other European programmes: Since many different studies on PM related problems are carried out throughout Europe and also world wide, a co-ordination and intensive exchange of experiences and results will be of great benefit to all participants. Due to the different approaches and structures of the projects going on, a bottom-up approach of co-ordination as it is the nature of COST would be very adequate. Other activities like projects within the European standardisation process (CEN) related to establishment of EU ambient air quality standards or research initiatives of the European Science Foundation have just been started and links will be established with them. Under the initiative of B. Brunekreef, University of Utrecht, a research network to combine epidemiologic activities in Europe is evolving (AIRNET). Close contacts to this group have shown that there is just enough overlapping between this initiative and the COST Action to establish a close and fruitful cooperation.

Since extended research activities on all PM related issues are conducted in the US (Supersite program, Particle Research Centers) also close links to American institutions should be maintained within the COST Action.

B. OBJECTIVES AND BENEFITS

The main objective of the Action is to increase the information on the particulate matter characteristics throughout Europe, describing the PM-system with respect to geographical and meteorological conditions, particle formation processes and their transport. The results will be used for setting environmental standards in Europe and for defining measures to reduce the particle emission.

The European data should be assessed within a worldwide context. Particular benefits could be drawn in setting and enforcing environmental standards in Europe and in developing techniques and policies to achieve this goal. PM-pollution data in a continental context are also useful for political decisions in planning of land use, main traffic routes, energy supply policies etc.

This information should in particular comprise parameters describing the PM-system with respect to geographical and meteorological conditions like size distribution and chemical composition. Formation of particles, atmospheric reactions, transport mechanisms, measurement techniques and particle related effects should be addressed in particular. Due to the different economic situations in the past, and still at present, as well as to the geographic and climatic diversity from north to south and west to east the general pollution situation which also influences PM-pollution is different in the various regions of Europe.

Though health effects related to particle exposure are evaluated world wide, it is important to conduct area specific projects in order to define relevant health endpoints related to specific exposure situations and to specific health status of the general population. As base for epidemiological studies specific exposure data should be provided from the results of this COST Action.

Sub-topics:

- PM measurement methods

Mass concentration measurement of PM is done by various techniques and therefore the results are not easily comparable. Applying air quality standards, however, requires comparable data all over Europe.

- Carbon detection

Carbonaceous compounds in particles (soot and organic compounds) are considered a possible major health hazard. Various methods for measurement are applied in Europe and elsewhere, however, the results are difficult to compare. Evaluation of these methods, as e.g. already started in Austria, should be promoted.

- Aerosol characterisation

With regard to the climatic diversity over Europe, PM properties linked to health effects are expected to vary by composition, size distribution and/or modal structure, size dependent hygroscopicity, and by evolution in the atmosphere. Work in this area should lead to a better understanding of what might be called “aerosol diversity”.

- Standardisation of environmental data as input into epidemiological studies

For conducting meta studies or for combining data into a broader data-base standardisation of health and exposure data is essential and should be promoted within Europe.

- Detection and quantification of sources for particulate air pollution

Modelling of pollution transport over greater distances needs reliable information about the relevant sources and emission data.

- Economic aspects of particulate air pollution.

All parties involved in activities to reduce PM burden should be made aware of the economic benefits (e.g. health costs) if pollution is reduced. Models describing these relationships can help for better understanding.

C. SCIENTIFIC PROGRAMME

The programme shall focus on the links between natural science and health effects research of atmospheric aerosols. Figure 2 explains this idea making use of both existing and up to now scheduled projects. The shaded area indicates the area of main interest of this COST Action. Scientific work within the COST Action is suggested to strongly support these objectives. The scientific programme in detail will also depend on further projects submitted by the participating working groups.

For achieving the main goal, the body of scientific material contributed by the individual working groups, should comprehend

- Time series of local aerosol data (PM10, PM2.5, PM1, ultrafines) related to mass, surface area and number concentration, local aerosol precursors, and local meteorological data including relative humidity, on a long-term basis.
- Mass size distributions and size distribution of organic and inorganic aerosol constituents over the whole size range during intensive short term sampling periods.
- Number and surface size distributions of the aerosol and hygroscopic behaviour of the aerosol as a function of size during the intensive sampling periods.
- Chemical composition of atmospheric particles with appropriate time resolution (at least 24 hours) on a long term basis.

Special tasks as summarised in the subtopics may require additional data sets of better time resolution, accuracy or greater variety of components. In these cases however, just a few sampling locations may be sufficient.

Close cooperation with groups working in the health effects area (toxicology, epidemiology), in economics, in instrumentation design and manufacturing, or in regulators politics, could result in better understanding which type of data and what kind of additional information would be useful.

As a result of COST Action 633, answers or at least much better insight for the following questions will be gained:

- How is at present the PM burden over Europe with regard to the parameters which seem important for health effects. What are the differences regarding geographic and meteorologic influences.
- Do the measurement methods presently available comply with the needs of health effects research and regulatory intentions of the EU.
- How is the emission situation influencing the ambient air quality regarding PM. What would be good means to reduce PM burden from this side. What can models contribute to this question.
- What is the cost effect relation for health related PM reduction strategies.

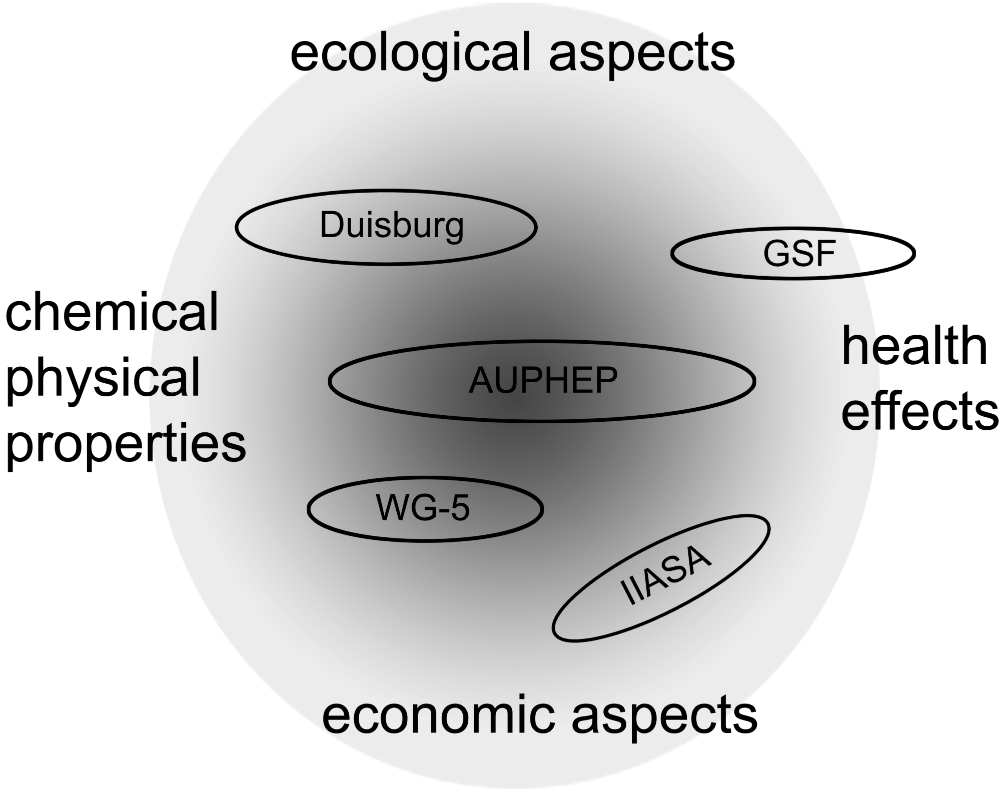

Figure 2: Area of main focus of COST Action 633 (shaded) and position of related projects

D. ORGANISATION AND TIMETABLE

The Management Committee (MC) is responsible for developing and implementing a scientific programme aimed at accomplishing the objectives of the Action within five years. The MC is also responsible for setting up an Action web page, producing annual reports, compiling the network database, for organising working group meetings, implementing a programme of short term scientific missions, co-organising scientific and technical workshops and reporting the results of the Action. Emphasis will be placed on the participation of young scientists.

The Action will adopt a working group structure to address the following tasks.

T1 Ambient data for PM: All accessible ambient air quality data for PM shall be collected, qualified and structured to build a database for further evaluation. Characterisation of European pollution situation regarding PM. Needs for future monitoring networks for PM (continental representativity, background versus conurbations, time resolution).

T2 Measurement Methods for PM and related compounds: evaluation of the various methods to monitor parameters to describe PM, advantages and disadvantages, comparison of data for the same parameter but achieved with different methods. Subgroups may work on special tasks like carbon detection.

T3 Sources of PM, atmospheric transport of PM: emission inventories, long range transport, available models.

T4 Economic aspects of air pollution, in particular PM: health expenses due to PM-pollution, cost effectivity of emission reduction measures.

T5 Requirements from health effects research (epidemiology, toxicology): relevant parameters to be monitored and regulated.

The Management Committee has responsibilities for:

1. Drawing up the inventory during the first year, organisation of workshops and start of the activity; existing contacts will be used, which should greatly facilitate this task.

2. Information exchange with COST administration bodies (TCE); coordination of the joint activities with other COSTS Actions and external programs (joint meetings are likely to result from this activity).

3. Exploration of wider participation and exchange of information with EU specific programmes, (e.g. ESF, CEN, JRC Ispra, AIRNET); Connections to International Institutions (e.g. WHO, IIASA) and national Institutions outside Europe (e.g. US-EPA)

4. Coordinating the information exchange between the Tasks within the working period;

5. The planning of the intermediate report and the final report; organisation of the intermediate workshops and the concluding symposium.

6. Management of the website for internal and external information exchange

Progress in each of the projects of the working groups will also be reported by the respective participants in their own countries within the framework of existing programmes and international scientific journals.

Reports:

The progress of the programme will be monitored by brief annual reports from each of the participating scientists which will describe the results of research obtained through concerted action. A milestone report will be prepared by the Management Committee after 3 years of joint activities. The report will be presented to the COST Technical Committee for Environment for their review.

A final report will be published to inform non participating scientists and research workers interested in the results about the scientific achievements of the Action. It is expected that some reviews by participants, which describe the progress made and state of the field, will be published in International Journals. To conclude the COST Action, a symposium will be held after 5 years which will be accessible to other scientists.

Timetable:

The Action will last five years. The five-year period is necessary because:

- The Action is dealing with a wide multidisciplinary topic. Special attention will be paid to the collection of all accessible ambient data in order to build a database for evaluating the present status of the knowledge and will be used as a basis for further study. This multidisciplinary topic requires also careful selection of all relevant specialists and special attention will be given to building up the working groups and their working teams.

- The evaluating of measurement methods for PM and related compounds, the testing of new approaches and the comparison of the results require a long period because it is based on field measurements and long-lasting monitoring of the seasonal dynamics of air quality parameters.

- Some works related to data evaluation cannot advance until sufficient data sets from field measurements are gained.

The timetable comprises of the following four stages:

Stage 1: After the first meeting of the Management Committee, a detailed inventory of ongoing research and existing plans of the participating groups to begin joint projects will be made. This will result in a discussion document which will allow further planning.

It will be evident which projects are closely related and would benefit from joint activities. Researchers (and co-workers) will set up (and continue) joint collaborative projects and exchange their recent research results. It may be appropriate to explore wider collaboration with other European countries during this stage.

Stage 2: Working period for the Tasks; permanent information exchange between the Tasks and Working groups to be organised by the MC.

Stage 3: An intermediate progress report will be prepared after 3 years of work for review by the COST Technical Committee for Environment and by the COST Senior Officials Committee.

Stage 4: This final phase will begin after 4 years and will involve the evaluation of the results obtained. It will include the organisation of a symposium for all the participants and co-workers including outside scientists.

Timetable of COST Action 633

Stage	Year	Quarter	Actions	Workshop
1	1	1	formation of final Tasks	
		2	workshop of WG-leaders, exploration of wider participation	
		3	definition of final program	
2		4	working period for Tasks	x
	2	1		
		2		
		3		
		4		x
	3	1		
		2		
		3		
		4		x
3	4	1	Intermediate Progress Report to TCE&CSO	
		2	continue work of Tasks, consideration of comments of TCE	
		3		
		4		
4	5	1	start of evaluation of results	x
		2		
		3		
		4	concluding symposium	

E. ECONOMIC DIMENSION

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest:

- Austria
- Germany
- United Kingdom
- Greece
- Hungary
- Italy
- Slovenia
- Switzerland.

On the basis of national estimates provided by the representatives of these countries, the economic dimension of the activities to be carried out under the Action has been estimated, in 2001 prices, at roughly Euro 30 million.

This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

F. DISSEMINATION PLAN

All publications arising from research carried out under COST Action 633 will credit COST support and the Management Committee will encourage and promote all co-authored papers. Results of research carried out by the working groups under COST Action 633 will be submitted to international scientific journals and reviews. Since the reports and results will be of importance for the process of setting environmental standards (e.g. with respect to EU Council Directive 1999/30/EC), a strong connection to the authorities of the EU-Commission (DG Environment, JRC Ispra)) will be established.

A good part of the information exchange will be done by internet connections. A COST Action 633 related Web page may be set up with public and secured user access.

Joint meetings among different working groups in COST Action 633 and with working groups from other COST Actions, particularly with those of COST Action D15, will be organised in such a way as to best promote interdisciplinary communication.

Special sessions dealing with the results of COST Action 633 may be organised within established scientific meetings to attract a broader audience and encourage wide discussion of the results.

The Management Committee (MC), in conjunction with the working groups (WG) of the Action, will meet once every year with the main aim of presenting results to the MC as a whole and, where possible, the MC will invite potential users and interested parties to this meeting. The MC will, during the first year of the Action, also set up a work-plan for interdisciplinary events for the dissemination of results of the COST Action 633.