Memorandum of Understanding

For the implementation of a European Concerted Research Action designated as
COST Action 730

“TOWARDS A UNIVERSAL THERMAL CLIMATE INDEX UTCI FOR ASSESSING THE THERMAL ENVIRONMENT OF THE HUMAN BEING”

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 the 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 develop and make easily available a physiologically assessment model of the thermal environment in order to significantly enhance applications related to health and well-being in the fields of public weather service, public health system, precautionary planning, and climate impact research*.

3. The overall cost of the activities carried out under the Action has been estimated on the basis of information available during the planning of the Action as EUR 6,500,000 at 2004 prices, over the period 2005 to 2008 inclusive.

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 four years, calculated from the date of the 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.

TECHNICAL ANNEX

ACTION 730

TOWARDS A UNIVERSAL THERMAL CLIMATE INDEX UTCI FOR ASSESSING THE THERMAL ENVIRONMENT OF THE HUMAN BEING

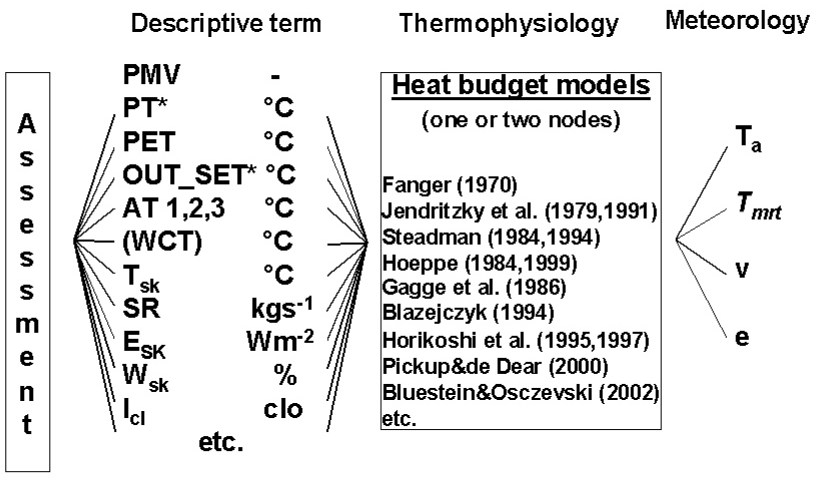
A. BACKGROUND

Everyone is interested in the weather because we all experience it in one way or another. The effect of the weather on our lives has been made particularly interesting in the last few years by the obviously increasing effects of climate variability and climate change. The unprecedented heat wave in Europe in August 2003 which cost 25.000 to 35.000 heat related extra deaths made the vulnerability of the population evident. More endemic is the increase in deaths and illnesses in the winter months in many countries. Daily predictions of the thermal conditions can help to warn people when there is a danger of unusual conditions, but the effect of the weather on people is caused by more than just the air temperature. Humidity and wind speed as well as the intensity of the radiation of the sun all influence how we respond to the outdoor environment. The study of the way in which people are affected by the weather is called human biometeorology. This proposal is for a Universal Thermal Climate Index (UTCI) (similar to the well-known wind chill index, but more complete) which will allow us to predict the likely effect of the thermal environment in terms of the complete energy balance of the body.

One of the fundamental issues in human biometeorology is the assessment and forecast of the thermal environment in a sound, effective and practical way. This is due to the need for human beings to balance their heat budget to a state very close to his/her thermal environment in order to optimise his/her comfort, performance and health. In the past about 150 years more than 100 simple thermal indices - most of them two-parameter indices - have been developed to describe the complex conditions of heat exchange between the human body and its thermal environment. Among them some well-known and still popular examples are the heat index and the wind chill index. Excellent reviews can be found in Fanger (1970), Landsberg (1972), Givoni (1976), Driscoll (1992), and Parsons (2003). However, due to their simple formulation, these indices never fulfilled the essential requirement that for each index value there must always be a unique thermophysiological effect, regardless of the combination of the meteorological input values.

The heat exchange between the human body and its environment takes place by sensible and latent heat fluxes, radiation and (generally negligible) conduction. Consequently dealing with the thermophysiologically significant assessment of the thermal environment requires the application of a complete heat budget model that takes all mechanisms of heat exchange into account. Input variables include air temperature, water vapour pressure, wind velocity, mean radiant temperature including the short- and long-wave radiation fluxes of the atmosphere, in addition to metabolic rate and clothing insulation (see Fig.1). Such models possess the essential attributes to be utilised operationally in most biometeorological applications in all climates, regions, seasons, and scales. This is certainly true for MEMI (Höppe, 1984 and 1999), and the Outdoor Apparent Temperature (Steadman, 1984 and 1994). However, it would not be the case for the simple Indoor AT, which is the basis of the US Heat Index, often used in outdoor applications neglecting the addition "Indoor". Other good indices include the Standard Predictive Index of Human Response approach (Gagge et al., 1986), and Out_SET* (Pickup and de Dear, 2000; de Dear and Pickup, 2000), which is based on Gagge's work. Blazejczyk (1994) presented the man-environment heat exchange model MENEX, while the extensive work by Horikoshi et al. (1995, 1997) resulted in a Thermal Environmental Index. Fanger's (1970) PMV- (Predicted Mean Vote) equation can also be considered among the advanced heat budget models if Gagge`s et al. (1986) improvement in the description of latent heat fluxes by the introduction of PMV* is applied. This approach is generally the basis for the operational thermal assessment procedure Klima-Michel-model (Jendritzky et al., 1979; Jendritzky et al., 1990) of the German national weather service DWD (Deutscher Wetterdienst) with the output parameter "perceived temperature, PT" (Staiger et al., 1997) that considers a certain degree of adaptation by various clothing. This procedure is run operationally taking an acclimatisation approach into account quantitatively. Nevertheless, so far DWD is the only national weather service to run a complete heat budget model (Klima-Michel-model) on a routine basis to a larger extent for its applications in human biometeorology.

Fig. 1 Thermophysiological Assessment of the Thermal Environment



Legend: PMV Predicted Mean Vote, PT Perceived Temperature, PET Physiological Equivalent Temperature, OUT_SET* Outdoor Standard Effective Temperature, AT Apparent Temperature, WCT Wind Chill Temperature, Tsk mean skin temperature, SR sweat rate, Esk evaporative heat loss, Wsk wetness of the skin, Icl insulation of clothing, clo clothing value, Ta air temperature, Tmrt mean radiant temperature, v wind velocity, e water vapour pressure.*

Although each of the above mentioned heat budget models are in principle appropriate for use in any kind of assessment of the thermal environment none of the models are accepted as a fundamental standard, neither by modellers nor by users. On the other hand, it is difficult to accept that after more than 30 years experience with heat budget modelling and easy access both to IT and meteorological data, people still use oversimplified and thus unreliable indices or even just air temperature in so various assessment issues, such as:

- Daily forecasts for:
  - Public weather service
  - Warnings on the danger of thermal extremes (wind chill, heat load)
  - Advice (clothing, outdoor activities)
- Climatology:
  - Bioclimatological assessments
  - Urban design and engineering of outdoor spaces
  - Consultancy for home seekers
  - Outdoor recreation and climatotherapy
  - Bioclimate mapping at all scales from micro to global scale
  - Epidemiological studies
  - Climate impact research

So there still is a need to:
(1) introduce the basic idea of such an approach to other users dealing with any kind of thermal assessments and
(2) make use of current scientific progress in thermophysiological modelling for the development and dissemination of a generally accepted health related climatic index.

The International Society of Biometeorology ISB recognised this issue some years ago and established a Commission on the development of a Universal Thermal Climate Index UTCI (see: http://www.dwd.de/UTCI and “Additional Information”). The term “universal” indicates that the UTCI model will meet all demands listed in section B.1.

The development of UTCI requires co-operation of experts from thermophysiology, thermophysiological modelling, occupational medicine, met data handling and in particular radiation modelling, application development etc.. In order to achieve significant progress it is necessary that the relevant scientists join together on a regular basis. It is thus evident that for such a multidisciplinary task a COST Action provides the best framework to derive a health related climate index as a standard.

With respect to the assessment of the outdoor thermal environment no other ongoing or planned activities are known. Arguably in many environmental studies, in particular in climate impact research, scientists usually apply “poor man” approaches.

B. Objectives and benefits

B.1 Objectives

The main objective of the Action is to develop and make easily available a physiologically relevant assessment model of the thermal environment in order to significantly enhance applications related to health and well-being. The core issues of human biometeorology range from daily forecasts and warnings of extreme weather, to bioclimate mapping, urban and regional planning, environmental epidemiology and climate impacts research. This covers the fields of public weather service, the public health system, and precautionary planning. The model to be developed will be based on the-state-of-the-art in the cause-effect related assessments of the outdoor thermal environment.

The Universal Thermal Climate Index UTCI (working title) must meet the following requirements:

1) Thermophysiological significance in the whole range of heat exchange conditions of existing thermal environments
2) Valid in all climates, seasons, and scales
3) Useful for key applications in human biometeorology (see section A).

This will be supported through the following specific objectives:

- To identify and make recommendations on the data requirements for running UTCI in the different applications.
- To develop application oriented parameterisation schemes for the calculation of mean radiant temperature Tmrt based on different data bases.
- To increase the accessibility of state-of-the-art assessment procedures and related information using a web portal and other dissemination platforms.
- To produce open and easy guidance and recommendations for using UTCI within the various applications.

B.2 Benefits

Currently, only few scientists can run cause-effect related assessment procedures in human biometeorology. Most agencies base their applications in this field on oversimplified approaches, mainly due to the lack of skills. The foreseen UTCI, when developed, together with the recommendations on input data requirements will considerably help to solve the problem.

There will be a range of specific benefits, such as:

- The COST Action will provide an authoritative forum for the discussion of an adequate thermal assessment procedure and its applications.
- Recommendations from the Action will encourage European national meteorological and hydrological services (NMHS) to implement and apply a UTCI with a rational assessment procedure.
- Applications will be standardised and communication to the public and/or decision makers will be easier (as too was the case for the UV-Index developed by COST-713).
- Research results will be more easily comparable.
- The provided guidance for employing the UTCI for the various applications will assist users at different levels including universities, research agencies, NMHSs (National meteorological and hydrological services), environmental agencies, city authorities, planners etc.
- Considering the growing concern about heat wave problems in the context of climate variability /climate change, decision makers can base their legislative actions on a state-of-the-art and harmonized UTCI for example.

C. Scientific programme

The process of developing a UTCI will address the following issues:

a) Heat budget modelling of the human body
b) Physiologically relevant assessment of heat budget model outcomes including acclimatisation
c) Testing results against available field data
d) Identification and pre-processing of meteorological input data
e) Estimating radiation quantities
f) Addressing the specific needs of various applications

The interdisciplinary issue of the development of UTCI becomes evident. Topics a), b) refer to thermophysiology, c), d) to atmospheric science (meteorology), and e) to a wide range of meteorological applications listed in B. According to this, the above listed topics will be addressed by three working groups:

WG1 Thermophysiological modelling and testing
WG2 Meteorological and environmental data
WG3 Applications

While the interface between WG1 and WG2 can be (and actually is, see section C.2) exactly defined, possible applications (WG3) might depend on data availability (WG2). So there is not such a specific border between these two WGs and consequently the discussion must provide a reasonable structure.

C.1 WG1 Thermophysiological modelling and testing

In section A, it was already pointed out that (1) an assessment model must be based on the consideration of the complete human heat budget, (2) existing simple indices are basically defective (except for some very particular applications), and (3) some models according to (1) are available, but for various reasons are not generally accepted. The state-of-the-art in thermophysiological modelling is defined by the most advanced multi-node models (4) which have been developed for a series of mainly indoor applications, e.g. for the design of air-conditioning systems in cars, evaluation of thermal comfort conditions in buildings or for various medical applications. The aim of WG1 will be to develop a UTCI model which is comparable to the models noted under (3) with respect to the operating expense, which, however, incorporates the progress in knowledge and the concerns represented by state-of-the-art multi-node models (4).

Mathematical modelling of the human thermal system goes back 70 years. Most of the work has been done in the framework of occupational medicine or indoor climate conditions design. Numerous procedures have been published as ISO- or ASHRAE standards. In the past four decades more detailed, multi-node models of human thermoregulation have been developed, e.g. Stolwijk (1971), Konz et al. (1977), Wissler (1985), Fiala et al. (1999 and 2001), Huizenga et al. (2001), and Tanabe et al. (2002). Parsons (2003) gives a comprehensive overview. These models simulate phenomena of the human heat transfer inside the body and at its surface taking into account the anatomical, thermal and physiological properties of the human body. Heat losses from body parts to the environment are modelled in detail considering the inhomogeneous distribution of temperature and thermoregulatory responses over the body surface. Besides overall thermophysiological variables, multi-segmental models are thus capable of predicting 'local' characteristics such as skin temperatures of individual body parts (which are the critical variables in the risk of frostbite and skin damage). Validation studies have shown that recent multi-node models reproduce the human dynamic thermal behaviour over a wide range of thermal circumstances (Fiala et al. 2001; Huizenga et al. 2001). Verification and validation work using independent experiments revealed good agreement with measured data for regulatory responses, mean and local skin temperatures, and internal temperatures for the whole spectrum of moderate environmental conditions. Also, some initial validations specifically for boundary conditions characterising outdoor environments have been carried out. However, a full validation for the spectrum of thermal circumstances found outdoors including e.g. extreme cold has not yet been conducted.

The Commission on UTCI of the International Society of Biometeorology (ISB) has defined that, when fully developed, the UTCI should feature the following:

- The most advanced multi-node thermophysiological models as reference to obtaining the key results from systematic simulations.
- Include the capability to predict both whole body thermal effects (hypothermia and hyperthermia; heat and cold discomfort), and local effects (facial, hands and feet cooling and frostbite).
- Represent a temperature-scale index, (i.e. the air temperature of a defined reference environment providing the same heat exchange condition).

This COST Action will follow this reasonable convention.

Considering the above specified requirement that UTCI has to refer to the most advanced multi-node thermophysiological models (but without their complexity with respect to applicability), there are basically two possible approaches: (1) comparison of simulation results obtained using multi-node models with available much more simple heat budget models such as specified exemplarily in Fig 1 (which were useful predictive tools over many years in various biometeorological applications but often with an unknown range of reliability) and (2) validation against experimental data. This COST Action will employ both approaches to ensure the highest possible validity and applicability of the new index.

It is important to ensure that the multi-node model is able to reproduce the human thermal and regulatory behaviours over a wide spectrum of atmospheric environments. In the second stage of the validation exercise, the multi-segmental model will therefore be validated against appropriate experimental observations obtained for human exposures to non-moderate boundary conditions. The test conditions will include (but not be restricted to) cold and extreme cold ambient temperatures, increased air velocities, hot dry and humid environments, and conditions in which the human heat balance and the perceived outdoor temperature is dominated by solar radiation.

Each selected experiment will be simulated by accurately modelling the experimental boundary conditions and the exposed persons. A 'library' of appropriate experimental data sets has already been established. During the course of the project, further data sets for validating the model will be gathered. For this purpose a comprehensive literature survey will be conducted. The COST Action is furthermore in a unique position as various members of the group will be able to provide appropriate experimental data obtained in their laboratories.

The predicted quantities subject to validation will include physiological variables (mean and local skin temperatures, body core temperatures, skin evaporation rates, and metabolic cost of shivering, etc). WG1 will discuss other variables of importance for human exposure to atmospheric environments (such as perceptual responses) to be included in the validation exercise.

The UTCI model will be developed by conducting various series of parametric studies. The simulation series should be conducted by 'exposing' the validated multi-node model to combinations of the prevailing atmospheric environment conditions. This requires that a file matrix with various combinations of air temperature Ta, mean radiant temperature Tmrt, relative humidity rh , and (relative) wind speed v must be created to be used as input data into the models for wide-ranging outdoor thermal conditions. The predictions will include the mean skin temperature, Tsk,m; the (head) core temperature, Thy (hypothalamus); the total evaporative heat loss from the skin, Esk; skin wetness; and local skin temperatures, Tsk, of bare body parts such as of hands and face. In addition to the 2 hour results, in severe cold, also the time after which any local skin temperature fall below 0°C will be indicated.

The degree of sophistication of the complete UTCI model should focus on the objectives of the main requirements 1) to 3) listed in section B in order to obtain reliable results. Nevertheless certain standardisations - which also mean simplifications - are necessary. With this regard, personal characteristics of individuals such as age, gender, specific activities (i.e. unusual) and clothing will be ‘standardised’ to obtain representative results. This will be subject to prior expert discussions within WG1.

Of importance for the predicted results are also the non-meteorological variables such as the metabolic rate MET (which is a function of the activity performed) and the thermal resistance of clothing that accounts for different 'seasonal outfits'. The ISB Commission on UTCI has defined representative conditions both for the meteorological input data (see Fig.1 Meteorology) and for MET and clothing. These will be considered in the work of WG1.

Another issue is how the physiological outcome of the multi-node models as, e.g. skin temperature Tsk or evaporative heat loss from the skin Esk, is to be thermophysiologically assessed in terms of an air temperature like UTCI. The COST Action will address this issue by reviewing the corresponding literature.

Finally, the important problem of human adaptation and acclimatisation has to be addressed quantitatively as the effect of the prevailing thermal environment depends to a certain degree on the conditions people are accustomed to. WG1 will address this aspect by reviewing existing approaches.

Deliverables

Key deliverables of WG1 will be:

1) Validate state-of-the-art multi-node model(s) for boundary conditions relevant to atmospheric environments.
2) Establish and review a data base of simulated physiological data based on multi-node models and comparable atmospheric environments.
3) Establish and assess a systematic comparison of selected existing “simple” assessment procedures.
4) Develop a UTCI model derived from deliverables 1 to 3.
5) Provision of the UTCI model in parameterised form.
6) Establish recommendations on how to deal with human adaptation and acclimatisation.
7) Assess the range of applicability, strengths and weaknesses of the new UTC-index based on documented and reviewed experience.
8) Suggest a better name for the index instead of the artificial UTCI.
9) Guideline Part I on “UTCI”

C.2 WG2 Meteorological and environmental data

The atmospheric variables determining the complex heat exchange conditions are air temperature, wind velocity, water vapour pressure, and short-wave (solar) radiation and the long-wave (infrared) radiant fluxes emitted by the surroundings including the sky. Difficulties in obtaining the required meteorological input data are often underestimated, particularly with respect to wind and radiation. The data issue is closely related to the various applications in space and time. Basically we can distinguish between observational (SYNOP, climate) data, model data (e.g. weather forecast, climate simulation), and additionally environmental data, such as geophysical data including land use.

Depending on various applications (WG3) there are a series of specific problems with different data types considering information content, resolution in time and space and availability. Consequently, special approaches will be developed to meet the needs addressed by WG3.

The most complex challenge is dealing with radiant fluxes. The human heat budget is very sensitive to radiation, especially when wind velocity is low. Representative data are more often than not unavailable. They must be parameterized, e.g. from observational data from first order weather stations (in spite of the fact that cloud information is becoming more difficult to obtain due to the automatisation of meteorological monitoring) and then be related to the special geometry of an upright standing person. Calculation of solar radiation even for a plain area (no limits to horizon) is quite complex. Sun elevation, turbidity, cloudiness, altitude and - for the reflected portion - albedo are input variables. Direct and diffuse fluxes must be distinguished due to the deviation of an upright standing person from a horizontal receptor area. The infrared radiation of the ground depends on surface temperature (rarely measured) and emissivity, while sky IR radiation on air temperature, water vapour pressure and also clouds (VDI, 1994). Appropriate procedures will be developed which allow to calculate the required radiant fluxes based on different data sets of easily available observed meteorological data.

Numerical weather forecast models currently operational in various national weather services should facilitate direct access to the necessary radiant fluxes, but the use of post-processed data as MOS (model output statistics) data must also be considered. Similar approaches are necessary to make use of climate simulation results in climate impact research. In more complex environments such as street canyons modelling of radiant fluxes becomes even more difficult and needs the application of meso- and micro-scale urban climate modelling approaches. So, besides meteorological data, other environmental data might be required.

In human heat budget modelling, the radiant fluxes are usually related to the human body by a mean radiant temperature Tmrt, an approach described comprehensively by Fanger (1970). WG2 will principally follow this approach but make eventually necessary changes in order to improve accuracy.

So the COST Action must find solutions to the problem of the input data referred to as "Meteorology" in Fig.1 for every key application specified in the list in section A and dealt with by WG3. The Action will also assess in every special case the loss of accuracy and limitations linked to the use of subsidiary data.

Deliverables

1) Definition of the necessary meteorological and environmental data and identification of data availability.
2) Supply of appropriate methods for the calculation of the radiant fluxes based on various meteorological input data sets (coordinated with WG3) including validity assessments.
3) Provision of parameterization schemes for the calculation of Tmrt
4) Deriving schemes on how to reduce the wind velocity from the actual height to 1.1 m.
5) Guideline Part II on "UTCI".

C.3 WG3 Application

The key issues of human biometeorology are specified in section A. There is a wide range of applications to be developed in a way that meets the needs of potential users. So the basic task of WG3 is to bridge the gap between science and application. Every field needs specific meteorological and environmental data which will be addressed in close collaboration with WG2. Almost all applications described below are already dealt with anywhere, but generally without using relevant thermal models such as UTCI.

WG3 will focus on the following fields of applications which are considered as in particular significant for users. Close interrelationship between the various issues is obvious.

(1) Public weather service. The issue is how to inform and advice the public on thermal conditions at a short time scale (weather forecast) for outdoor activities, appropriate behaviour, climatotherapy.
(2) Public health system. In order to mitigate adverse health effects by extreme weather events (here heat waves and cold spells) it is necessary to implement appropriate disaster preparedness plans. This requires warnings about extreme thermal stress so that interventions can be released in order to save lives and reduce ill-health.
(3) Precautionary planning. UTCI assessments provide the basis for a wide range of applications in public and individual precautionary planning such as urban and regional planning, in the tourism industry, for climate researchers. This is true for all applications where climate is related to human beings. The increasing reliability of ECMWF (European Centre for Medium-Range Weather Forecasts) monthly or seasonal forecasts will be considered to help develop appropriate operational UTCI products.
(4) Climate impact research in the health sector. The increasing awareness of climate change and therewith related health impacts requires epidemiological studies based on cause-effect related approaches. UTCI will be the appropriate assessment model. So also scenario based calculations and down-scaling methods in the climate change and human health field need appropriate UTCI based procedures.

In all recommendations for the above listed issues statements will be made on representativeness, time-/ space-resolution, data needs, uncertainties and coverage.

Deliverables

1) Survey and assessment of each application including user needs and benefits, specific data needs (with WG2) and possible other requirements.
2) Guideline Part III on "UTCI".

D. Organisation

Because the Action deals with a multidisciplinary issue being performed at NMHSs, research centres and universities in Europe a sufficient period is required to establish procedures for co-operation and to identify and prioritise the various activities and needs. The three focal points (1) thermophysiological modelling, (2) meteorological data, in particular radiation quantities computation, and (3) applications will be dealt with by three separate WGs. The overall time plan for the main phases will be as follows:

Phase 1	Planning, operational arrangements, establishment of WGs and inventory (Year 1)
Phase 2	Main scientific work to be conducted by each WG (End of Year 1 to Year 3)
Phase 3	WGs to conclude work with emphasis on reports and final publications (Year 4)

During the first year, the Management Committee (MC) will supervise the establishment of the WGs based on a survey of models, procedures and activities to be considered within the Action. The participants would specify their contribution and goals through the Expression of Commitment scheme developed by the Technical Committee for Meteorology. It is envisaged that three WGs would be established broadly developing the research areas described in section C.

By the beginning of the second year a Workshop will be held at which preliminary results and plans will be discussed and the activities and membership of WGs will be finalised. At this stage, the detailed work programme for the Action will be established by the participants. The opinions of the wider community will be sought through the initial Workshop about setting up the detailed work programme. Over the main period of work (2.5 years), interactions between the WGs will be firmly established so that they work in synergy rather than independently, and eventually coming together in the final phase (last year) during which the research will be completed, integrated, peer reviewed and published. During the final phase joint recommendations of the WGs will be published as a final report for wide dissemination.

The MC and WGs will meet twice a year, usually in conjunction with each other. Each WG will be coordinated by a chairperson who will report back to the MC. Coordinators will also be allocated for each sub area of the WGs. When required, external experts will be invited to some of the MC-meetings to seek advice and/or enlarge the application basis of the Action. The MC will supervise the overall progress of work, coordinate WG-activities, and will ensure wide dissemination of results. For that very purpose, one partner will set up a website and update it in a timely and continuous manner.

The three phases of the Action with the main milestones of the envisaged WGs activities are described below.

<u>Phase 1: Inventory</u> (Year 1, 9 months)

- MC: Establish initial WGs and membership and define initial work. Identification of users, and planning and organisation of 1st workshop
- WG 1/2/3 All WGs will jointly prepare inventory of existing relevant models with details description as well as detailed work plans

- WG 1 Review critically the strategy followed till now on UTCI development based on knowledge of thermophysiological modelling and define the needs.
- WG 2 Identify the requirements in meteorological data, in particular with respect to radiant fluxes, in order to produce appropriate input data.
- WG 3 list applications, respective data requirements and users.
- WG 1/2/3 Report to MC

<u>Phase 2: Development, Assessment, Applications and Evaluation</u> (Years end 1-3, 27 months)

- 1st workshop with proceedings and conclusions of the work for the Action.
- Establish final WGs and preparation of detailed plan of work based on outcomes of phase 1.
- WGs: Regular WG-meetings for planning, implementing, reviewing and synthesising the work.
- Report to the MC every 6 months on the progress of work
- MC: Short Term Scientific Missions as appropriate.
  Preparation of 2nd Workshop
  Monitoring of WG activities and advances in the field outside the Action

<u>Phase 3: Synthesis and Dissemination of Action results</u> (Year 4, 12 months, overlapping with Phase 2)

- WGs: Finalisation of the expected outputs
- WGs: Contributions to the final report
- MC: Organisation of the Final Workshop
- MC: Completion of the final report
- MC: Dissemination of results through publications and participation to International conferences

E. Timetable

The overall duration of the Action is 4 years.

Figure 1. Overall timetable of the Action

	Year 1				Year 2				Year 3				Year 4				
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
Phases	1	1	1	2	2	2	2	2	2	2	2	2	3	3	3	3	
MC-meetings	x		x		x		x		X		x		x		x		
WG-meetings			x		x		x		X		x		x		x		
Workshops					W					W				W			
WG reports					R		R		R		R		R		R		
Reports to TC				x				x				x				x	
Final report																	x
WWW-info pages	←			———		———	———			———	———			———		→	
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	

F. Economic dimension

The following COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: Austria, Finland, France, Germany, Italy, Poland, Slovenia, Sweden, United Kingdom. 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 2004 prices, at roughly Euro 6,500,000. 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.

G. Dissemination plan

The results of the Action will be disseminated using a range of methods. These will include a dedicated web site, COST reports, conference presentations, peer reviewed publications, and advanced training for users. Particular attention will be paid to informing decision makers and to transmitting results to the scientific community. This will apply to both those using these methods and those who might have an application for these methods. So the dissemination will not be limited on the presentation of what has been achieved during the COST Action but will focus rather on the benefits (see sector B.2) users will achieve when applying UTCI.

The final workshop of this Action will also be used for disseminating, the results especially among potential users and for promoting COST-activities in Europe and worldwide. Special efforts will be made to invite external keynote speakers and publicise the Workshop outside the Action. In particular direct links will be established with existing European networks and bodies, and also with World Meteorological Organisation WMO, World Health Organisation WHO, and the International Society of Biometeorology ISB which had the initial idea on UTCI. Collaboration with the ISB Commission 6 on UTCI will provide benefits from ongoing activities in other areas of the globe (in particular Canada, USA, Australia, and Japan) and facilitate the introduction of UTCI as an international standard. The activities of WG3 will ensure that dissemination channels and procedures of end users are used.

Wherever possible the Action will host workshops jointly with other international meetings. These will include:

- European Meteorological Society annual meeting
- International Congress on Biometeorology (next 2005 in Garmisch, DE)

The target audiences are national weather services; environmental protection agencies; public health agencies, researchers working in these fields including environmental epidemiologists, regional and urban planners; the general public. Besides the standard means as web site, reports, workshops, scientific publications the basic intention is to provide a (possibly WMO) guideline on the “Assessment of the Thermal Environment” that covers also the complete software necessary to run the models, exemplified by applications. In particular at least in the interdisciplinary field of applications, training seminars will be essential.

The Joint Action Group on Thermal Indices (JAG/TI) of the two North-American National Meteorological Services are involved as observers in the ISB Commission 6 from the very beginning and envisaged to consider the results of the UTCI development when updating their thermal assessment procedures.

Additional Information (Part II of the proposal):

- *History of the proposal:* Based on current scientific progress, and with increased international travel and easy access to information, there is a need for global harmonisation of the development and dissemination of various weather and climatic indices. Considering the recent successful experience with the worldwide introduction of a universal UV-index under the umbrella of the WHO and the WMO (for Europe see COST-713), the idea came up by the International Society of Biometeorology ISB (President at that time: P. Höppe) to review what has been achieved in the past 30-40 years in thermophysiological modelling. Consequently, ISB established a Commission (Chair: G. Jendritzky) to integrate new knowledge and concerns into a Universal Thermal Climate Index, UTCI, for assessments of the outdoor thermal environment, see: http://www.dwd.de/UTCI . From 13 Core Group members, 7 are from Europe (all on the list of experts for this COST Action), 3 from Canada, 2 from Australia, and one from USA. So this COST Action can easily interact with ISB and both will benefit from international co-operation. As already mentioned in section G the North-American JAG/TI belongs also to this network. It can be expected that when this COST Action is implemented other scientists will join the activities, in particular from the European research projects cCASHh (Climate Change and Adaptation Strategies for Human Health in Europe) and PHEWE (Assessment and Prevention of acute Health Effects of Weather conditions in Europe) including WHO. Meanwhile WMO-CCI (Commission for Climatology) became interested in the problems related to thermal environment of the human being and asked to provide a guideline on UTCI in the framework of the activities of an expert team on „the development of health related climate indices“ (Lead: G. Jendritzky). Since that time WMO-PWS (Public Weather Service) signalled strong interest. So the international platform is ensured.

- *Areas of research (domains):* Meteorology, environment, medicine and health.

- *List of Experts:*

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- *Recent publication*

Jendritzky, G., Maarouf, A., Fiala, D., Staiger, H., 2002. An Update on the Development of a Universal Thermal Climate Index. 15th Conf. Biomet. Aerobiol. and 16th ICB02, 27 Oct – 1 Nov 2002, Kansas City, AMS, 129-133.

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