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

Secretariat

Brussels, 14 December 2009

COST 284/09

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action TU0904: Integrated Fire Engineering and Response

Delegations will find attached the Memorandum of Understanding for COST Action TU0904 as approved by the COST Committee of Senior Officials (CSO) at its 176th meeting on 1 December 2009.

MEMORANDUM OF UNDERSTANDING
For the implementation of a European Concerted Research Action designated as

COST Action TU0904
INTEGRATED FIRE ENGINEERING AND RESPONSE

The Parties 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 270/07 "Rules and Procedures for Implementing COST Actions", or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to break down the barrier preventing the exchange of information and experience between researchers from different disciplines on the one hand and between academia and practitioners (including fire-fighters) on the other hand. Thanks to the exchange of international experience, ideas and the state-of-the-art on fire risk concepts and assessment methods, the Action aims at providing concrete applications of the performance-based fire safety design methods to practitioners and to introduce the latest research into standards for fire design.

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 EUR 92 million in 2009 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4 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 V of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Fire engineering researchers are specialists working in specific areas, such as fire dynamics, structural fire engineering, active/passive fire protection, environmental protection and human response. Since the background sciences of these disciplines are different at present there is little interaction between researchers. Practitioners, including fire engineers and building/fire control authorities, tend to consider fire safety as a whole, but lack in-depth awareness of recent advances in research. Through encouraging integration of different aspects of fire engineering and response, the Action will enable researchers with different fields of expertise and coming from different countries to understand better the recent advances in research in parallel fields, as well as their limitations, so that they see their own research in context, and identify opportunities in involvement of early-stage researchers and application of the results in national standards. Practitioners, fire fighting authorities and building control authorities will benefit from exposure to advanced research findings, discussion with the research community, and the sharing of best practice and others' experiences. On the other side their input will make researchers aware of real-world constraints, as well as current requirements for new research and for the development of European standards.
Keywords: Fire safety engineering, Fire authorities, Decision processes, New materials, Fire after earthquake and explosion.

B. BACKGROUND

B.1 General background

Construction technologies have a high impact on the global economy, environment and quality of life, because of the scale of projects and the demand for more efficient methods. The normal design criteria of civil engineering structures, such as strength, durability, reliability, sustainability are addressed in design codes. However, safety in use, environment, and quality of life are equally important. To meet all the requirements of buildings a multi-discipline approach to design, using findings from different fields, is necessary. This Action addresses the hazard to occupants, emergency services and property caused by building fires. While disastrous fires continue to occur, the need for fire safety standards, regulations and practice to be based on understanding of the issues and interactions involved is recognized in the civil engineering community.

Fire engineering research may be broadly classified into a collection of discrete areas: fire dynamics, materials science, structural fire engineering, environmental protection and human response. Since these disciplines are based on different underpinning sciences, the researchers in these areas have disparate backgrounds, and disseminate their findings within completely different research communities. Hence there is lack of interaction and coordination between the key researchers in the different aspects of fire safety. On the other hand, practitioners, including fire safety engineers, structural fire engineers and building/fire control authorities, have a clear need to consider fire safety as an integrated whole. In the case of fire engineering, several of the fields involved have experienced considerable progress in research for the last years, and codes of practice do not reflect the knowledge which now exists. It is necessary to create a forum within which practitioners and researchers can discuss the findings of research and the ways in which it should be implemented in practice. However, the communication between researchers and practitioners in such a forum must not be purely one-way; researchers need to know the real-world context in which fire engineering takes place, and this must influence the future directions of their research.

The COST Action will bring together representatives drawn from the various research disciplines of fire engineering, fire safety design engineering, building control and fire services in various countries around the general theme of performance-based integrated fire engineering and response. In Europe, issues of safety are generally subject to national jurisdiction, and controls on fire safety in the built environment are generally exercised either by local or national agencies. Most research is also funded at national level, although the well-established academic dissemination routes via international journals and conferences allow researchers from the same disciplines to keep abreast of current developments. It is therefore more likely that researchers will be aware of developments in other countries in their own field of expertise than that they will know about current research in the fields which complement their own in establishing the fire safety of buildings and their inhabitants.

In this context the COST programme, with its emphasis on networking, dissemination of research findings and the promulgation of best practice across the European nations, is clearly capable of providing useful solutions to the problems of disconnection, both between disparate researchers and between research and practice. There are, of course, still significant detailed research problems across the field of fire engineering for which the research framework programmes would be appropriate sources of funding. However the need to involve practitioners, fire services and control authorities, together with the research communities, fits ideally with the bottom-up structure of COST.

B.2 Current state of knowledge

In Europe, fire safety is a national responsibility, but it is recognised as the main "Exceptional Loading" type in the Construction Products Directive (89/106/EEC). Research and development is dispersed between universities and testing centres. Europe is fortunate in having the greatest concentration of World-leading research groups on fire safety, fire science and structural fire engineering. This is a vibrant research area in Europe, contrasting with isolated pockets in the USA, Canada, the Far East and Australasia. In the USA, even after the events of 11 September 2001 little new research has been started apart from the forensic investigations conducted by the National institute of Standards and Technology (NIST), and the effects of the event on design standards are still not apparent. The completed COST Actions C17, C19 and C22 have shared knowledge of management of various extreme events. Action TU0601 provides advanced models for extreme loading. The current Action C26 has created a network on major events including fire, explosion, earthquake and other extreme loadings. Current national and trans-national research in fire engineering in Europe is focused on the response of buildings to fire. Sub-sets of this include fire modelling, active fire protection, and materials developments:

Fire modelling: In this field recent work has focused on:

- adiabatic temperature-implementation in performance-based design;
- development of design rules for the thermal exposure of external steel structures;

- the economic and structural impacts of localized fires on steel structures;
- risk classification of structures exposed to fire;
- computational simulation of the causes of fire spread for forensic investigation.

Active fire protection: Projects cover subjects such as

- fire suppression;
- Intelligent modular multi-sensor networked false-alarm-free fire detection systems;
- cost-effective, sustainable and innovative upgrading methods for fire safety in existing tunnels;
- development of fire-safety-related simulation programs;
- fire risk evaluation of European cultural heritage;
- fire protection of steel structures using water sprinklers.

Material properties: Subjects include

- the effects of fire on new materials and technologies in civil engineering;
- characterisation of the fundamental fire protection performance of intumescent coatings under realistic fire conditions;
- degradation of the mechanical properties of structural and reinforcing steels in fire;
- pyrolysis of timber;
- new surface-modified flame-retardant polymeric systems to improve safety in transportation and other areas;
- predictive modelling of combustion-induced mechanical property degradation of flame-retardant structural composites;
- constitutive modelling of reinforced concrete members, taking into account concrete creep and shrinkage in the pre-loading stage;
- constitutive modelling of fibre reinforced concrete for structural modelling.

Structural fire engineering:

Research on structural fire engineering has been accelerating in Europe for about 25 years, with a step-change in the mid-1990s. An important stimulus was the programme of fire tests at BRE Cardington (1982-2003) of which the last and most visible internationally were the full-scale test series on a composite building in the mid-1990s, part-funded by ECSC 7210, and the 2003 test funded by CV5535. The tragic events of "9/11" raised significant questions on fire spread, interactions with emergency services, and the response of buildings to multi-storey fires. Robustness (avoidance of disproportionate collapse as a result of local failures) is particularly important both for structural protection and life safety. Recently several projects on the effects of fire on structural elements and connections have been funded both nationally and by EU sources. EU has funded through the call RFCS of the Framework Programme several projects on:

- industrial and low-rise buildings;
- realistic fire design;
- active safety measures;
- post-local failure simulation and external steel structures.

A combination of RFCS, local and industrial funding sources have supported major fire projects on:

- connection behaviour and robustness;
- composite construction systems;
- material properties and innovative structural systems.

Projects which have been funded in performance-based modelling encompass all structural materials. They include:

- behaviour of composite floor plates during the cooling phase of a fire;

- behaviour of damaged structures in fire;
- behaviour of reinforced concrete elements exposed to high temperatures;
- component-based methods for high-temperature modelling of connections.

In the near-market area of fire engineering design they include:

- aids for fire-resistant design of hollow section steel and composite members;
- design of joints to composite columns for improved fire robustness;
- efficient structural design of slim-floor beams;
- fire resistance of steel structures;
- improved connections for fire resistance;
- fire resistance of reinforced concrete frame structures;
- robustness of car parks against localised fires;
- robustness of joints in steel-framed structures at high temperatures;
- selected aspects of fire resistance evaluation of steel bar structures;
- structural fire resistance of corrugated steel sheet.

In the very important area of transportation, special attention is being given to:

- fire safety of tunnels;
- concrete rail track panels for tunnel safety;
- safety in common transportation infrastructure;
- safety of rolling stock.

A principal focus of the COST Action is on the challenging problems of fire-resistant design of composite construction technology, a very rapid, efficient and economical method of constructing multi-storey buildings which is becoming common practice, but is not covered adequately by knowledge. Another real problem for structural fire resistance derives from the change of use of existing buildings. This is an area where the research community can learn considerably from the experience of fire fighters and building control authorities.

B.3 Reasons for the Action

Because of the rapid recent growth of research in this field, and the disconnection between research and practice and between different groups of researchers, a network of researchers, designers and authorities is needed. The intention on the one hand is that the new knowledge is not confined to academia, but extends to its natural end-users, and on the other that the barriers which exist between researchers from different disciplines (such as fire science and thermo-structural modelling) should be broken down. It is necessary for practitioners to convey their perspectives and needs to researchers, and for researchers to talk to each other. In European countries where fire-related research is in a low state of development there is a clear need to spread a general awareness of the current state of research, to point out opportunities where gaps in existing knowledge and ongoing research exist, and to make the fire authorities aware of current developments in other countries.

General agreement across the European nations on the requirements for fire safety and improvement of standards for fire-resistant design would be welcomed by industry, stimulate research and facilitate marketing. The common design rules embodied in the Eurocodes should encourage a market extending beyond the European borders. Several Asian and Latin American countries are using the Eurocodes, either generically or as a basis for domestic standards, with obvious potential for Europe firms. This Action will facilitate cooperation between the authorities of Europe countries, as well as between researchers in fire topics. It will help to introduce the latest research into standards for fire design.

The Action is mainly aimed both at European economic/societal needs as well as scientific/technological advance which, by its nature, affects the whole of society; improvements are reached by advanced technical solutions. Its objectives are to utilise the principles of modern performance-based methods for existing and new buildings, for composite building technology and when buildings change their use.

Another objective is to encourage integration of active and passive fire protection systems, new materials and environmental protection. A desirable result would be an increase in the basic fire safety of buildings and of fire fighters during fire events.

The objectives will be realised by:

- Acquiring relevant scientific knowledge from the local projects of the countries involved,
- Upgrading the expertise of constructors by disseminating performance-based approaches for composite building technology,
- In the case of change of building use, discussion of the main perspectives of fire authorities, designers and researchers,
- Propagating the principles of modern performance-based methods and current research to building control authorities,
- Making recommendations for improving national codes from the viewpoint of fire,
- Identification of topics which need further research and/or development as design procedures.

The objectives of the COST Action will be disseminated in state-of-the-art reports, case studies presenting current practice and accumulated knowledge, extracting useful information from fire brigade reports and investigations, and benchmark studies to check performance-based solutions in fire design.

B.4 Complementarity with other research programmes

A harmonisation of the general requirements for fire safety, and an enhancement of the existing standards for fire design with the latest research results, would be very well received by the structural design and fire protection industries, would stimulate research in the field and facilitate marketing. It is clear that the harmonisation of standards for buildings, embodied in the Eurocodes for the design of civil engineering structures, facilitates an open market in Europe, and also opens up an important market beyond the European borders. Countries in Asia, for example, are either planning to adopt the Eurocodes or to base local codes of practice on their procedures, as an excellent set of harmonised standards, and this has obvious potential economic advantages for Europe. This COST Action will facilitate cooperation between the fire authorities of different European countries and between European researchers in fire safety engineering. The objective is to facilitate the harmonisation of legislation and to introduce the latest research results into the standards for fire design in areas where there is still a lack of information, or where the present rules are too general and too conservative due to the lack of appropriate research results, and lead to uneconomic design.

The completed COST actions C17 (Building heritage: fire loss of historic buildings), C19 (Proactive crisis management of urban infrastructure), C22 (Urban floods management) have encouraged sharing of knowledge on the management of catastrophic events; the action TU0601 (Robustness of structures) provided advanced models to be applied for extreme loadings. The time is right to increase the depth of this sharing of good practice and accumulated expertise in designing against the very important hazard of fire. There is an urgent need for application of the today's expertise in fire engineering to the practice of authorities. Research projects in fire safety engineering and structural fire engineering are typically nationally driven, and the new COST Action will allow the sharing of the locally developed knowledge which has come from them. Among the proposing institutes there are 75 current or recently completed national projects, together with a much greater depth of underpinning research which can be presented, so that their outputs can be applied more widely and spin-off research can be generated. The COST C26 Action (Urban habitat constructions under catastrophic events) has created a network linking specialists on major catastrophic events such as fire, explosion, earthquake and other extreme loading conditions.

In COST C26 fire authorities were invited to some workshops, and the practical importance of linking fire research with urban risk management, a relationship which is very important to fire authorities, was emphasised. Current research projects are spread widely due to the nature of their funding schemes, with activities in the fields of timber, concrete, steel and aluminium structures, mainly nationally-funded but with some support at European level. The latter group includes the RFCS projects http://bookshop.europa.eu/eubookshop/publicationDetails.action?pubuid=466221&offset=1http://bookshop.europa.eu/eubookshop/publicationDetails.action?pubuid=471404&offset=2 referred to in Section B2.

C. OBJECTIVES AND BENEFITS

C.1 Main/primary objectives

The overriding mission of the Action is to gather, review and exchange information on solutions for fire safety of civil structures, and to develop benchmark studies to test potential solutions. It will disseminate these methods to the public domain through technical papers, datasheets, reports and an accessible web site. It aims to exchange international experience, ideas and the state-of-the-art on fire risk concepts and assessment methods, and their applications to fire design practice. Performance-based fire safety design methods, and to a lesser extent codes, have been developed in several countries. Fire safety design practice is rapidly shifting from compliance with conventional prescriptive codes to using performance-based design methods. However there is an ever-present concern about whether fire risk aspects have been adequately considered in developing these design methods or codes, although all of them implicitly recognise that sound fire safety design methods should be based on risk analysis. The Action will consider the background to simplified rules, as well as advanced fire modelling, transfer of heat to the structure, development of temperature profiles and structural behaviour in fire. The results of leading-edge research will be shared across Europe, and this will raise awareness among academics and designers. These developments will be explained to national fire brigades and control authorities, and the perspectives of these key stakeholders will be sought.

Explicit primary objectives are:

- Acquisition of relevant scientific knowledge by the academic institutions of the countries involved. This can be transferred to new generations of engineering students.
- Upgrading the expertise of construction professionals by disseminating performance-based approaches.
- Discussion about the different perspectives of fire-fighters, fire authorities, designers and researchers.
- Enhancing researchers' awareness and understanding of real life constraints to their research.
- Propagating the principles of modern performance-based design methods and current research to building control authorities.
- Identification of topics which need further research and/or development as design procedures. Recommendations for improving national codes from the perspective of fire safety.

C.2 Secondary objectives

The Action is intended to stimulate the progression from fundamental and applied research activities to technological innovations, and to improvements in practice and regulations. While the direct participants in research, university education, design, building control and fire-fighting are the immediate beneficiaries, society as a whole will ultimately benefit, acquiring more efficient and safer buildings. The fire safety of buildings, their occupants and fire-fighters will increasingly be established on the basis of validated performance-based models rather than the prescriptive methods currently used.

It provides a good opportunity for fire researchers and fire designers to learn from the performance of real building structures under real fire conditions. Fire-fighting agencies have records of fires which have severely affected building structures. These records could allow researchers and design engineers to learn about real-scale effects which would otherwise be impractical from laboratory-scale testing or modelling. On the fire-fighting response side, fire brigades could benefit in their decision-making and fire-fighting strategies from research into fire and structural behaviour.

Obviously, the principles of decision-making in hazardous situations need to be simple, robust and definitive, so that delays caused to fire fighting activity are not themselves critical. Fire brigades have their own principles based on many years of fire fighting experience. However, building types and materials are changing rapidly, and the optimisation of buildings which have been fire-engineered may itself lead to non-standard behaviour in fire.

C.3 How will the objectives be achieved?

This is an open and flexible network whose main task concerns dissemination of very recent research knowledge and to propagate it in building design and control. The interest of building and fire control authorities in the application of research knowledge is a key element of the success of the COST Action. Thanks to the promotion the use of performance-based rather than prescriptive methods of fire resistance design, the interest of building and fire control authorities will be guaranteed.

C.4 Benefits of the Action

The Action will address the most typical problems of structural fire engineering design: the need for robustness, high-rise buildings, new construction materials, composite building types, fires following earthquake or explosions, protection of the environment, change of use of buildings and demands of fire fighting. It is intended to minimize risk as a result of fires by encouraging the application of new knowledge and technology in methods of fire protection, and to promote the use of performance-based design across Europe. Another area where such a network can help society is in informing fire-fighters' decision-making and in post-fire forensic investigation.

The direct goal of the Action is focused on active and passive fire protection of buildings, and on mitigation of the social and economic effects of fires. Considerable longer-term benefits could derive from the spirit of cooperation which it is intended to achieve between academia, civil authorities, fire fighters, and industry. This potential cooperation could be influential in creating demand for new materials and technologies, and in the longer perspective could have a positive economic impact.

C.5 Target groups/end users

Specialised researchers in subjects such as fire dynamics, structural fire engineering, and active/passive fire protection will be able to explore the interfaces and the areas of overlap between their different sub-disciplines of fire engineering, including where new interdisciplinary research is needed. Fire engineering practitioners, including fire engineers and building/fire control authorities will be able to tap into the cutting-edge knowledge of World-leading specialist researchers in order to understand and take advantage of the current advances in fire engineering. The research specialists in return will be able to learn from the practitioners the real-world circumstances, and the associated opportunities and limitations, of the context in which advances have to be applied. This is an important task for engineering research, for which applicability must always be a relevant issue.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

In scientific terms the COST Action will be based on current national projects, focused on the most typical problems of contemporary structural fire engineering. For example:

- Change of use or reconstruction of buildings,
- The performance of new construction materials in fire,
- Composite construction technologies,
- Protection of the environment,
- Fire following earthquake damage,
- Fires following explosions,
- The fire protection of high-rise buildings,
- Robustness of buildings, particularly their connections in fire,
- The requirement for innovative materials and technologies.

It is recognised by researchers that different protection technologies, both active and passive, are currently used rather arbitrarily in construction, and that they should be used in future where they are most appropriate, and on the basis of an understanding of real structural response to fire. In terms of fire fighting, an appreciation of the factors which influence the behaviour of structures under attack by fire would be a valuable adjunct to the information technology which supports fire fighters' decision-making and post- fire investigation.

D.2 Scientific work plan methods and means

The methods and means of the scientific work plan will be based on Work Packages whose activities are largely sequential:

WP1. State-of-the-Art Report to summarise of the current level of knowledge will be the initial task, to be finalised at a Workshop, held after the first year.

WP2. Case Studies presenting current practice and accumulated knowledge. These will be prepared and disseminated during the second year of the Action. They will cover fire engineering applications including clear explanations of the decision processes, the scientific assumptions and the practical constraints, as well as how different aspects of fire engineering are integrated.

WP3. Fire brigade reports and investigations are one of the most important sources of information, which are at present largely unavailable to researchers. The Action will focus in this work package on devising a method of extracting useful information from fire brigade reports and investigations in the Action's member states.

WP4. Benchmark Studies will enable validation of different solutions, and establish appropriate levels of investigation. The quality of the Benchmark Studies is expected to be checked by invited international experts. Sharing of the knowledge will be promoted by creating short-term scientific missions, which will allow Early-stage researchers to spend short periods with leading research groups at partner organisations.

WP5. Dissemination will be concentrated to technical and non technical information outside of the Action. The technical dissemination will be conducted by three main traditional proved methods: (a) Local Seminars will be held by local parties; (b) A complete Web Site, based on a content management system, will make all materials freely available, with facilities for feedback, amendment and a discussion forum. This will ensure that the products are shared as widely as possible; (c) A Conference at the end of the Action will summarise all aspects of the work and consider future needs.

E. ORGANISATION

E.1 Coordination and organisation

A COST framework is the natural mean of achieving the objectives, bringing together scientific knowledge, design, building control and field experience from different European countries for the benefit of fire engineering design in Europe in general. COST coordination is important; research tasks will continue in separate countries with their own funding.

While the Working Group activities are concurrent throughout the life of the project, they will contribute to the Work Packages whose activities, as outlined above, are essentially sequential. The direction of the project will be overseen by a Management Committee composed of one representative of each of the participating nations, which will meet twice per year on an extra day added to schedule Working Group meetings. It will receive reports from the Working Groups, and will then coordinate further activities on the basis of these reports. Since the Work Packages are sequential the milestones of their completion follow an approximately annual schedule, but detailed control will have to be managed responsively. This group is responsible for initiating the major events of the Action: conferences, training events for early-stage researchers, data-sheets and publications, setting up and arranging maintenance of the open-access website for public information and dissemination, as well as the secure website to be used for control ands editing of published materials.

One further Management Committee meeting will be held each year, when a more strategic view of the project's aims and activities will be taken; in the first year this will be the Action's start-up meeting. The most important, and the most challenging, objective of the Management Committee will be to coordinate the interaction between the engineering researchers and the representatives of fire services, building control authorities and fire engineering designers. This relationship, which is particularly important to the overall aims of the project, will be particularly difficult to facilitate with the public authorities, whose imperatives tend to be legal rather than technical. It is important that the Management Committee includes imaginative and open-minded representatives of this group.

E.2 Working Groups

Three Working Groups are anticipated:

- WG1. Fire Behaviour and Life Safety
- WG2. Structural Safety
- WG3. Integrated Design

These constitute three different levels on which the issues arising from the fire hazard can logically be considered.

WG1 – Fire Behaviour and Life Safety will focus on the behaviour and the effects of building fires, and will combine this research-based knowledge with the most effective means of protecting human life against the occurrence of fire in the built environment. The latter combines active measures in fire-fighting with the effects of architectural issues of building form on the inherent risk to building inhabitants.

In the context of fire-fighting and rescue, the following issues should be considered in case of an actual emergency:

- the effectiveness of communication between the first responders and their managers,

- the organization of rescue operations,
- virtual training for rescue operations,
- how to facilitate a rescue operation,
- how rescue operations function, considering human behaviour as victims and responders,
- how structural stability may be assessed to adapt fire fighting strategy.

Rescue operations are most affected by the behaviour and movement of the fire itself, together with movement of the smoke which is generally the most important threat to the lives of building inhabitants. Computational fluid dynamics is at the forefront of the research which is increasingly able to predict smoke movements in a building, although the spread of fire itself from compartment to compartment still presents a considerable challenge, given the uncertainties about local failure of internal walls, windows and the effects of atria in buildings. There is still a very significant role for simplified fire and smoke modelling, and a considerable task in interfacing between the rather complex discipline of fire science and the practical interests of the fire brigades and building control authorities. This in return needs to be reflected in building design, and so the opportunity for the practitioners to enter into a debate with the researchers will be valuable.

WG2 - Structural safety will cover the passive measures, classical findings of the structural fire engineering, but also the new materials and technologies. Here will be the crucial problem of the fire engineering, the changes of the purpose of the buildings and the today new questions rising with energy saving and protection of the environment the solutions of the structures after fire.

WG3 – Integrated Design will focus on bringing together design and research across the disciplines of fire in the built environment. In common place structural design this must cover the requirement to integrate fire resistance with all the other functional requirements of a building from conceptual design onwards, rather than the conventional process of adding fire protection after all other processes are complete. The issue of sustainability in all aspects of design has become a front-line criterion in recent years, and this will affect fire resistance design in the same way that it has affected ultimate and service ability design. A further aspect of integration is the recognition

that fires are often the most devastating consequence of other accidental or malicious actions, such as earthquake and terrorist attacks. In this context the outbreak of fire can trigger disproportionate collapse, as in the "9/11" events, or can cause widespread fires which cause considerable loss of life. It is necessary to take further the current initiative to design robustness into structures so that local damage is mitigated rather than amplified by the outbreak of fires.

Each working group will meet twice per year. The first meeting will be devoted to the preparation of the Action's current Work Package and the second to the presentation of contributions to this Work Package. Management Committee meetings will be organised to coincide with these, in order to save time and to progress the work. It is anticipated that an extra Management Committee meeting will be needed in each year, to take a more strategic view of the project as a whole and its future direction.

E.3 Liaison and interaction with other research programmes

It will be possible for the Action to utilise the results of the Action TU0601 ("Robustness of structures"), which ends in April 2011. It is expected that it will be possible to participate in its final activity and organize a common conference to introduce the latest developments in probability and European models of structural safety. The COST C26 action ("Urban habitat constructions under catastrophic events"), ending in June 2010, has created a network of specialists focused on major catastrophic events (fire, explosion and earthquake, as well as other extreme loading conditions). Its major results, which are part of a performance-based approach, for different catastrophic events in characterizing catastrophic actions on buildings, in analysis of structural behaviour in catastrophic events, the evaluation of vulnerability and damageability of constructions, strengthening and repair, and strategies and guidelines for damage prevention, will be adopted and developed in the area of the fire load. WG2 will focus on enhancing the knowledge summarised in the COST C26 work. The Action will also continue the work initiated in action C25 ("Sustainability of constructions: Integrated approach to life-time structural engineering"), ending in December 2010. WG3 will focus particularly on developing this knowledge.

The Action will integrate the results of national projects as a priority. Direct cooperation is expected with the project “Nordic safety and security”, which is unique in that the end users, scientists, and companies are all represented within the same network. This will bring Scandinavian research results to the agenda of WG1, and a joint meeting with WG1 is planned.

Cooperation with complementary EU Framework projects related to the fire hazard is expected. The results of the call will be known by the end of 2009. This will also apply to finished EU Research Fund for Coal and Steel projects; from RFS2-CT-2003-00048 (“Dissemination of structural fire safety engineering knowledge”), from RFSR-CT-2003- 00030 (“Integrating advanced three-dimensional modelling methodologies for predicting thermo-mechanical behaviour of steel & composite structures subjected to natural fires”), and from RFSR-CT-2003-00034 (“Prefabricated composite beam-to-concrete filled tube or partially reinforced-concrete-encased column connections for severe seismic and fire loadings”), as well as from the project RFSR-CT-2009-00021, (“Design of composite joints for improved fire robustness”), which is currently in its initial stage.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve early-stage researchers. This item will also be placed as a standard item on all MC agendas.

Gender balance: The gender balance will be taken into account during running of the entire action. The participation of women will be emphasised in the COST Action despite the historically male dominance.

Early-stage researchers: Short-term scientific missions will be organised to involve Early-stage researchers in the experimental and numerical work. A training school will also be organised in order to make them benefiting from the experience of fire-fighting in the training facilities of a fire

service of one of the participating countries, so that they have some first-hand experience of fire-fighting, and so that they can provide some feedback to fire authorities about more effective use of their training facilities. In the organisation of conferences the Management Committee will place emphasis on supporting the participation of Early-stage researchers and PhD students, inviting poster presentations on work in progress and offering prizes for the best of these. In the aftermath of the conferences proceedings will be published which will include reviewed contributions by Early-stage researchers and PhD. students.

F. TIMETABLE

The Action is expected to last four years. The first year will focus on WP1: State-of-the-Art Report to summarise of the current level of knowledge, to be finalised at a Workshop.

The second and third years will focus on WP2: Case Studies presenting current practice and accumulated knowledge. These will be initiated, and dissemination will start, during the second year of the Action. These will cover fire engineering applications, clear explanations of decision processes, scientific assumptions, practical constraints, and how different aspects of fire engineering are integrated.

In the second and third years WP3 Fire brigade reports and investigations will be organised to devise a method of extracting useful information from fire brigade reports and investigations.

The third and fourth years will concentrate on WP4 Benchmark Studies and will enable the validation of different solutions, and establish appropriate levels of investigation. Sharing of the most appropriate knowledge will be promoted by creating Short Term Scientific Missions, which will allow Early-stage researchers to spend short periods with leading research groups at partner organisations. The quality of the Benchmark Studies is expected to be checked by invited international experts.

WP5: Dissemination over the three final years of the Action will be by three main methods. Local Seminars will be held. A complete website, based on a content management system, will make all materials freely available, with facilities for feedback and amendment, and a discussion forum. This will ensure that the products are shared as widely as possible. A conference at the end of the Action will summarise all aspects of the work and consider future needs.

The activity is described in the following three tables:

Table 1: Work packages of the Action Integrated Fire Engineering and Response

	Year 1	**Year 2**	**Year 3**	**Year 4**	**After the Action**
WP1	State-of-the-art report				
WP2	Case studies				
WP3		Fire brigade_reports and investigations			
WP4			Benchmark studies		
WP5		Dissemination			

Table 2: Key activities of the Action Integrated Fire Engineering and Response

	Year 1	**Year 2**	**Year 3**	**Year 4**	**After the Action**
Workshop	10th month				
Conference		10th month			
Training school		3rd month			
Seminars			10th month		
Conference				10th month	
Conference					Each two years

Table 3: Deliverables of the Action Integrated Fire Engineering and Response

	Year 1	Year 2	Year 3	Year 4	After the Action
Webpage	Production	Upgrading/maintenance			Maintenance
Individual papers	State-of-the-Art Workshop			Conference on future needs	
Proceedings		Conference		Conference	
Journal papers			Action teamwork		
Technical sheets		Case studies			
Publications			Benchmark studies		

G. ECONOMIC DIMENSION

The following 24 COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: AT, BE, CZ, FI, MK, FR, DE, EL, HU, IT, LT, LU, NL, PL, PT, RO, SK, SI, ES, SE, CH, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 92 Million € for the total duration of the Action. 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.

H. DISSEMINATION PLAN

H.1 Who?

The dissemination will be oriented towards:

- Researchers working in the fields of the Action (deliverables WP1);

- Practitioners in the fields of active and passive fire protection, which is about 10% of the construction industry, (deliverables WP2 and WP3)
- Fire fighting authorities and building control authorities (deliverables WP2 and WP3).
- The general public. In many European countries fire loses are successfully minimised by public information, and there is clearly role for promoting public awareness of the latest developments in fire research (deliverables WP2 and WP3).

H.2 What?

All general information will be published on the Action's website which will have an appropriate range of metadata to ensure that it is easily found on standard search engines. The working documents of the Action will be on a password-protected part of the website, which will create a working area for participants in the Action. This will use a content management system so that different versions of working documents are held securely, editing and commenting are facilitated, and feedback can be logged.

Publications of the Action will start with State-of-the-art reports from all members to set the scene and these will be published during an Action workshop. In the second year of the project these reports will be merged into proceedings, which will summarise the extent of knowledge in the field.

Interim reports will follow after the end of each of the other Work Packages. A collection of Case Studies will be published at the end of Work Package 2, as well as a summary of the findings from WP3 ("Fire brigade reports and investigations"), and a collection of Benchmark Studies from WP4. The Work Package 5 will publish the proceedings of the final Conference of the Action.

Attention will be paid to public relations, which will be related to the Action's events. The Action's Workshops and Seminars will be organised in at least nine countries of the Action's members, and these will be publicized locally. Two Conferences organised by the Management Committee will invite not only European but also the most prominent overseas researchers. In order to create a fruitful discussion the audience number will be limited, and the Conferences will be based on maximising panel discussion of the major questions.

A special form of the publication to be produced is a collection of data-sheets. These condense the knowledge for the wider audience, which needs to upgrade its knowledge. In the case of this Action this audience is composed of practitioners and Early-stage researchers. The format, which allows fruitful cooperation by all partners in the Action, will also be used for Case Studies.

Each partner will contribute twice during the Action to other national or international conferences and symposia not organised within the Action. In the last two years of the Action articles in peer-reviewed technical Journals will be prepared based on the cooperation which has taken place. The members from practice, fire fighting bodies and fire authorities will use articles in non-technical publications to popularise the main objectives. The colleagues from research will prepare the background materials to assist them with the latest research data.

H.3 How?

The schedule of the technical publications is described under paragraph H2 above. The dissemination plan will be updated at the end of each year by the Management Committee.

The non-technical publications will take advantage of the PR activities of the fire brigades, which are at a high level, and cooperation at a national level is expected, which should give access in most countries to TV and press coverage.