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CEN-CLC BT WG 8

Protective textiles and personal protective clothing and equipment

Programming Mandate M/509 : protective textiles and personal protective clothing and equipment

Final report

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Management summary

As one of the consequences of the Lead Market Initiative on Protective Textiles, the EU Commission addressed a programming mandate to the European Standard Organizations (ESOs), which was accepted by CEN and CENELEC in November 2012. ETSI did not accept the mandate, considering it not of relevance to them.

A CEN-CENELEC BT Working Group was created to prepare the response to this mandate by November 2013. Intensive work during this year by the Working Group resulted in a report which provides an overview of the needs for standardization and related topics in relation to Personal Protective Equipment (PPE) during the forthcoming years. The report is intended to be a working document not only to be utilised by standardization groups but for all stakeholders.

As PPE is used both in the professional and consumer (sport & leisure) sectors, a vast amount of products and related services are available on the market which are continuously being developed. Keeping up with these developments is a crucial challenge for standardization, as without standards identifying and describing the performance requirements of the PPE it is very difficult for manufacturers to bring new and compliant products to the market.

At the same time there are no standardised methods available for other PPE related purposes e.g. evaluating if PPE currently in use remains 'fit for purpose', for evaluating a combination of PPE items as a single ensemble or for estimating the total cost of ownership over the lifecycle of the PPE ("whole life cycle cost"). These additional issues remain uppermost in the mind of PPE users, as they are required to characterize and optimise their PPE more thoroughly and allow for more sustainable products.

The report proposes solutions for the different challenges addressed in the programming mandate and outlined briefly above namely:

- integration of both of new technologies and of different parts of a protective system/ensemble;
- comfort and ergonomics with a strong user focus looking from head to toe and from skin to outer layer and
- sustainability and environmental aspects including life cycle costing, selection, use, care and maintenance.

In addition to providing a number of well-founded proposals for standardization projects themselves other proposals are also included looking towards improving the organization of the standardization work itself, improving uniformity of testing and quality of test methods, as well as on the conformity assessment protocols necessary for PPE having to comply with different sets of European legislation.

Attention is also given in the report on how to improve the participation of end users as well as the R&D community into the standardization work. Similarly the cooperation of experts from different but related fields, e.g. textiles, PPE, electronics, ICT and machinery requires some attention in the short term to improve the current situation.

Other important topics identified in the report are the need to look at improvement on handling Intellectual property rights (IPR) and the need to ensure test methods remain robust, sound and repeatable the latter requiring sufficient resource for development and validation purposes.

The programming mandate has created a renewed interest and momentum in the PPE sector as a whole. This situation merits the provision of further effort and resource such that it may be maintained in both a short and medium timeframe.

The PPE Sector Forum together with the CEN-CENELEC management centre (CCMC) and other stakeholders involved in the preparation of the report are committed to this endeavour which will help to ensure the European PPE industry continues to play a leading role in the global market place in the face of ever strengthening competition from outside the European arena.

1 Introduction

On the 18th of September 2012 the programming mandate M/509 EC Protective textiles and personal protective clothing and equipment (Annex 1) was addressed to the European Standard Organisations (ESO's), being CEN, CENELEC and ETSI.

The mandate was approved on the 8th of November 2012 by CEN and CENELEC and a new BT working group, CEN-CENELEC BT WG 8, was established with the objective to develop a work programme in response to the mandate. Mr. Henk Vanhoutte, CEN rapporteur for the Personal protective equipment (PPE) sector, was appointed as convenor with secretarial support from the NBN/Centexbel.

The key challenges addressed in the programming mandate were:

- integration (both of new technologies and of different parts of a protective system/ensemble)
- comfort and ergonomics (with a strong user focus looking from head to toe and from skin to outer layer)
- sustainability and environmental aspects (including life cycle costing, selection, use, care and maintenance)

In order to deal with these challenges in the limited time available for the response to the mandate, it was decided to divide the work of BT WG 8 among four task groups, the first challenge of integration being sub-divided into the integration of new technologies and the different parts of the PPE.

The report is divided into the following six sections:

- introduction (chapter 1)
- the methodology of work (chapter 2)
- a detailed description of the tasks allocated to the ESOs in the programming mandate (chapter 3)
- the proposals made for solving the key challenges of the programming mandate (chapter 4)
- the conclusions summarising the most important results (chapter 5)
- the Annex (chapter 6) where the reader can find the text of the programming mandate (Annex 1), the list of abbreviations (Annex 2), some more details on the proposals made (Annexes 3 to 8) the list of the participants in BT WG 8 and the different task groups (Annex 9), the list of the standardisation groups related to the PPE sector (Annex 10), current R&D and innovation projects with a potential link to standardisation of PPE & related (Annex 11) and the bibliography (Annex 12)

Whilst many of the conclusions drawn and the proposals made focus on PPE for professional use, it is recognised that these are in many instances also applicable to private or consumer use, e.g. PPE for use in sports & leisure activities.

2 Methodology of work

On the 17th of January the kick-off meeting of the BT WG 8 was organised at the CEN/CENELEC meeting centre. Invitations for this meeting were sent to convenors and secretaries of relevant Technical Committees as well as to representatives of different stakeholder groups and R&D projects. Also the National Standards Bodies (NSB's) received invitations to nominate experts. 35 participants were present. After some introductory information (including a presentation given by Mr Julio Cardoso from DG ENTR on the background for the Programming Mandate), a constructive discussion on how to proceed led to the creation of 4 Task Groups (TG's).

The TG's were assigned the task to make the gap analysis as well as prepare proposals for future work in their specific domain. In order to assure consistency, either the convenor or the secretary of the BT WG 8 is following the work of each TG. At the plenary meetings of the BT WG, the task groups report their progress and discussion with the other TG's makes sure that all aspects are covered by the relevant TG without overlap.

A form was developed to allow the task groups to describe proposals in a uniform way.

It was also recognised from the start that the expertise of ETSI is needed, especially for Task Group 1. The secretary of BT WG 8 contacted ETSI to encourage them to participate and has continued the efforts to integrate their expertise for finalization of the programming work, unfortunately without concrete result.

To make all documents used by the BT WG (including the TG's) transparent, a dedicated electronically group was created for the Working Group on the file sharing platform 'CEN-Livelink'.

The assigned tasks provided to the TG's were as follows:

<u>TG 1: Compatibility of different elements -Technology</u>

- Explore and identify key recent technological developments for the deployment of smart integrated protection systems which integrate ICT, other electronics and other technologies in protective textiles, clothing and equipment.
- Identify cross-cutting barriers and drivers for the integration of technological developments resulting from R&D projects into new standards (or other standardisation deliverables). Among others, such barriers may include differing intellectual property right (IPR) management or protection of personal data (privacy).
- TG 1 met on 18/04 and 03/09/2013

<u>TG 2: Compatibility of different elements -Integration of the complete system</u>

- Identify needs for testing and standardisation of complete PPE systems from the point of view of the user.
- TG 2 met on 08/05 and 22/08/2013

<u>TG3: Comfort and ergonomics</u>

- Explore existing standards in the field of ergonomics and comfort in order to identify whether recent technological developments and smart integrated protection systems would require further standardisation in this field.
- TG 3 met on 27/03 and 27/08/2013

TG 4: Environmental sustainability and total cost of ownership

- Explore existing methodologies to assess the overall lifecycle cost of protective textiles, clothing and equipment as well as the overall environmental impact in order to identify further standardisation needs.
- TG 4 met on 19/04 and 03/07/2013

After the first round of meetings of the different TG's, existing relevant documents (European or other) were identified and proposals for future standardisation work were prepared. The second plenary meeting of BT WG 8 took place on 05/06/2013 and the final plenary meeting on 02/10/2013, at each occasion with a participation of about 30 experts from around Europe and from different stakeholders.

3 Tasks allocated to the ESOs in the programming mandate

3.1 Integration of technology

To better understand the complexity of integrating novel technology into Personal Protective Equipment, clause 4.2.2 from CEN/TR 16298 (CEN Technical Report - Textiles and textile products — Smart textiles — Definitions, categorisation, applications and standardization needs) is quoted:

> *4.2.2 Occupational safety application: work wear and protective clothing*
> *These systems bring together features such as sensors, connections, transmission systems, power management etc. The integration of intelligent textile technologies into work-wear or protective clothing can result in such systems being able to gather, present and transmit information about the wearer and his or her immediate environment.*
> *For example protective clothing incorporating such textile systems could potentially gather information on:*
> - *Wearer position, either globally by GPS or locally by reference to one or more base-stations*
> - *Wearer activity, monitored by accelerometers integrated into various parts of a garment*
> - *Physiological data including the wearer's body temperature, pulse, blood oxygen level and breathing rate (see also 4.2.1, medical monitoring application)*
> - *Environmental temperature measured using textile sensors. In the case of fire-fighters' PPE this might include information on the direction of sources of radiant heat relative to the wearer*
> - *Chemical hazards in the environment including monitoring of toxic chemicals and detection of explosive atmospheres*
> - *Electromagnetic hazards in the environment, including monitoring of various forms of electromagnetic radiation*
> - *The status of the smart system itself. For example this might include data on the state of charge of an incorporated flexible lithium-ion polymer battery or confirmation that sensors are operating correctly and mutually consistently.*
>
> *Such information can then either be transmitted to a command/control station, e.g. via a low power consumption "Bluetooth" module integrated with a textile antenna, or be presented to the wearer in the form of audible or visible warning signals or smart textile display devices. The wearer might also interrogate the system via a textile keypad incorporated into the garment. Data may also be stored intermittently.*
> *Considering that this textile system is autonomous with respect to energy this intelligent textile system can be categorised "E-Com":*
> - *with energy function: although some parts of this textile system could be based on sensors not requiring an internal energy input, e.g. chromic sensors, the system as a whole relies on an internal energy supply source.*
> - *with communication function: communication with the wearer and with external observers is an essential feature of the system.*

The above citation lists a variety of different technologies that can be integrated also in PPE to enhance the safety of the user. It also clearly shows that the matter of identifying the gaps in standardization is complex. The conclusion is that the strategy used for identifying the standardisation needs of PPE with integrated (novel) technology should be similar to that used in CEN TC 248 WG31 Smart Textiles.

When analysing the standardization needs of PPE with integrated (novel) technology it appeared that:

1. The standardization needs are highly dependent on the technology integrated and will have to be evaluated case by case. It was beyond the capacity of this task group to identify all possible technologies that could be integrated and therefore all standardization needs. In Annex 4 of this report some examples are given to demonstrate how the needs can be identified. Setting the general framework e.g. in the form of a standard or technical report will facilitate the development of specific standards.
2. Integrating technology into PPE results in systems where considering individual standalone components is less relevant as it is the system in its entirety that has to be evaluated. This makes it necessary to distinguish between (a) Personal Protective Equipment, (b) a Personal Protective System and (c) an Ensemble of several elements of PPE. Therefore it is necessary to clearly define these terms to ensure consistency and clarity across standards.
3. A clear definition and understanding of the terms Personal Protective Equipment, Personal Protective System and Ensemble and the distinction between them are necessary for future reference and standardisation work.
4. All personal protective equipment needs to be in conformity with the applicable EU legislation. For conventional PPE it is sufficient to demonstrate conformity with the Directive 89/686/EEC on Personal Protective Equipment. When integrating (novel) technology the products/systems may require demonstrating conformity to other Directives. This factor also needs to be reflected in standards and related documents.
5. Clear indications of the intended use conditions are necessary to be able to set the requirements for PPS. The increased complexity of PPE with electronics means that user risk assessment is closely tied to the manufacturer's claims on the performance and level of reliability. A similar electronic part will need a different product assessment when used in e.g. fire fighting equipment than when used in a chemical protective system. This needs to be reflected in standards and related documents. Defining the users' needs taking into account the different risk scenarios is necessary as a basis for final requirements of the PPE.
6. If conformity with Directives other than 89/686/EEC (PPE) is necessary, several difficulties arise for stakeholders only familiar with the PPE directive, namely (1) how to identify other directives apply, (2) how to handle similar but different requirements in different directives, (3) how to find the appropriate notified bodies and (4) how to coordinate the assessment of the different notified bodies. Currently most notified bodies for PPE are not sure how to handle personal protective equipment with integrated novel technology and as a result refuse EC type certification of these systems. This currently poses an important barrier for the market introduction of innovative Personal protective equipment and systems.
7. In some cases the novel integrated technology may allow to reduce the currently certified protective features. However in order to guarantee the protection of the user in these circumstances, the failure mode of the novel technology needs to be known (with a time delay or immediate) as well as the reliability of the technology. Requirements towards reliability will depend on the failure mode (how much time is there to react) and the risk to the user if the system fails taking into account the requirements of the relevant legislation. It needs to be evaluated if a minimum level of protection by the PPE (component) will still be required if the system fails.

Next to the development of new test methods and specifications the legal framework may possibly have to be re-defined as currently it does not cover the highly cross-sectorial products like personal protective equipment with integrated technology. Additionally, some personal protective systems (especially those monitoring physiological parameters) will require taking account of specific individual users' parameters.

3.2 Compatibility of different elements of the protective system

The tasks were to identify needs for testing and standardisation of complete PPE systems (ensemble/ PPS) and to focus on the point of view of the user. Currently the different elements of an ensemble/ PPS are not necessarily produced by one manufacturer, but the user puts together his complete kit by choosing the different components from different manufacturers. The user relies on his/her own experience to evaluate the test reports and certificates of the components to know whether the kit will function together. Looking at this situation the following gaps in standardisation and related issues were identified. For occupational use the obligations of the employer, as given in Directive 89/656/EEC have to be considered.

1. The current focus on the individual PPE elements is a manufacturer oriented point of view and not a user oriented point of view; As a result the needs of the user are not well taken into account.
2. Currently the individual elements of the personal protective system are viewed for conformity assessment and therefore also during testing. Undergarments are not consistently taken into account or necessarily defined. Different parts of the ensemble may be named similarly in standards but mean different things. Therefore either creating a bias or potentially creating additional risk for the user. PPE should reflect the needs from skin to outer layer and from head to toe. Since the user will be wearing the complete assembly or at least a number of parts (both often referred to as 'Ensemble') during an intervention, including underwear. Testing single items (individual components of PPE or parts hereof) is a potentially serious limitation of material tests.
3. Only limited and partial system testing and evaluation of performance criteria for ensembles (looking at combined effects of some parts) is currently available. Examples are ISO 17492 (multilayer fabrics), ISO 9151 (multilayer fabrics), ISO 6942 (multilayer fabrics), ISO 13506 (Thermal Manikin) and IEC 61482-2 (materials and garments). However these tests have their limitations, including testing only in upright positions, limited compression tests, no prolonged moderate heat, limited number of moisture levels, limited correlation between multilayer material testing and actual PPE testing as well as human physiological properties assessment, and they are not yet sufficient for complete ensembles/Personal Protective Systems.
4. Including all the different elements discussed in item 2 also requires speaking of a personal protective system, which should be included in the terminology already addressed in item 2) discussed in section 3.1. It will be necessary to determine whether the undergarments should be considered part of the system or not.
5. Additional to only considering the individual components of the PPE, these components fall under different technical committees at CEN or CENELEC. In order to facilitate exchange among these different TC's and WG's the PPE sector forum was established. This sector forum thus tries to harmonise the standards development of the components but does not have the executive power to develop standards, e.g. for the complete ensemble or system and their compatibility.
6. In the current PPE standardisation system there is a very little participation of users. As the focus needs to be on user needs, standardisation bodies (both European and national) need to address how end users can be encouraged to attend TC, WG and/or national mirror committee meetings, so that their views are being submitted and considered.

7. A major issue identified by the CEN PPE Consultants and several CEN TC's & WG's is the present lack of confidence and/or reliability in current specific published test methods. This is the case for both individual tests for items of PPE and also more complex testing, for instance on complete garments or ensembles or material assemblies. Consequently a comprehensive evaluation and scoping study needs to be conducted to identify those published test methods that require revision and/or replacement by far more accurate and reproducible test methods to ensure the confidence of manufacturer's, notified bodies, end users and National Standards Bodies and will also better reflect the use of the PPE. Some examples for standards that need to be re-evaluated are given in Annex 5.
8. In order to develop and verify test methods and evaluation of PPE it is essential to be able to perform such tests at different test houses (both test house that are or not accredited to e.g. ISO 17025) in a coordinated manner and to evaluate the results against each other (inter-laboratory testing). Currently reliance is placed upon voluntary participation of the test houses and the same samples for all provided by manufacturers. As a result these inter-laboratory tests are not always performed with the required accuracy or priority. Consequently different test houses produce quite significant variations in the results and, as a consequence conformity assessment is not as coherent across Europe as is desirable. Consequently some tests may not be well recognised or accepted.
9. The current test methods as well as virtual simulations of workplace situations are both not accurate enough to simulate such realistic situations nor do they show good correlation. For example, limitations in the known tests for thermal protective performance (firefighters) are:
    - adequate thermal sensors and a variety of skin burn translation models,
    - test methods and performance criteria for evaluating the potential for stored thermal energy and moisture absorption in materials (risk on skin burns),
    - effect of moisture in the different layers of the assembly and the impact on thermal protection (particularly sub flashover conditions),
    - ability to retain strength in exposure to flash fire conditions, instrumented manikin for evaluating protection in a wide range of different thermal conditions and postures.

3.3 Comfort and Ergonomics

Specific tasks in this field were:

- Determine the essentials for targeted level of safety, health and well-being in intended operating conditions.
- Ensure that the PPE does not create hindrance with respect to safety.
- Define the needs for comfort and ergonomics testing with respect to the relevant Directives (89/686/EEC, 89/656/EEC, 89/391/EEC).
- Analyse the current assessment methods for comfort and ergonomics on cost effectiveness and subjectivity.
- Identify the present gaps in comfort and ergonomics assessment in the present standards.
- Explore and develop simple, objective and cost-effective test methods.
- Take modelling, simulation and/or virtual testing into account and compare these methods.
- Testing on complete systems instead of different elements of the PPE.
- Write a work program based on the results of the above tasks.

When doing a risk assessment the employer needs to take into account a number of factors in addition to the outside risk, the employer needs to balance the protection requirements that might reduce the ergonomics and comfort (e.g. thermal stress) and the risk that the reduction in ergonomics and comfort might bring due to reduced cognitive capability of the wearer of the PPE. Therefore defining the right PPE for a specific use is a balance of design, ergonomics, comfort, protection and durability requirements. A matrix was developed to identify the needs in test methods for ergonomics and comfort and the existing standards in relation to the different parts of the body. Gaps can be identified as: missing test methods/requirements = needed test methods/requirements minus existing test methods/requirements.

A separate task was to fit existing standards into the matrix. To reach this goal, all standards from three TC's (CENELEC TC 78, CEN TC 79 & CENTC 162) were scanned on ergonomic and comfort testing. All work was combined in a complete matrix (see Annex 7).

Care must be taken to ensure that improvements in ergonomics and comfort of Personal Protective Equipment and/or Personal Protective systems do not jeopardise overall protection and durability. This is a complex balance, as improvements in ergonomic design aspects can increase the wearability, acceptability and therefore correct use of PPE, thereby resulting in a net benefit even where technical performance might be reduced.

As a result the following limitations and gaps towards standardisation and related issues were identified:

1. Various (inter)national tests (e.g. Havenith and Heus, 2004) with human subjects in Personal Protective Systems /ensembles in heat/fire containers were used as alternative to obtain objective thermal protection or heat stress data. Limitations of these tests include the lack of international standardised protocols and ethical issues.
2. Current methods for heat (and cold) stress and comfort measure the different parameters separately and not on the final product, e.g. for a multilayer jacket only on the individual textile substrates are measured, including heat and moisture transport of fabrics, (e.g. sweating hot plate), air permeability, penetration resistance and liquid repellency. Some improved methods for determining the heat (and cold) stress and comfort are
    - heat and moisture transport of garments (e.g. instrumented manikin, sweating torso)
    - a large variety on human subject tests/practical performance tests
    - human wear trials/field tests

    However there is a lack of validation studies for translating these measurements to the human physiological properties, and therefore there is a need to establish such standard protocols for physiological testing.
3. Perceived thermal comfort and acceptability of the PPS should be evaluated, however standard protocols are lacking. The main challenge is that the human reaction to physical stimuli (thermophysiological and sensorial) is subjective. The physiological impacts of PPSs can be determined objectively whilst comfort elements, by definition, are subjective. The current theoretical models for integrating various comfort related physical properties of fabrics into the predictions of human comfort limits are still under development.
4. There are currently no adequate test methods available for evaluating the impact of fit and size on comfort and ergonomics. Here the development of virtual models is necessary and would be cost effective in the product development phase. In order to take human physiological properties into account these models should integrate the metabolic rate and activity duration.

5. Models for predicting the performance/hindrance of PPE are useful tools for predictions of the effects on performance of new materials, design and combinations of PPE and PPS (ensembles). Currently no sufficient test methods are available to create e.g. a database on the effects of external factors such as intense heat exposure on material properties.
6. PPE for chemical (including particles), biological and radiation protection or used in (emergency) situations where chemical, biological and radiation contamination can occur often requires specific adaptations which can compromise ergonomics and comfort. They also bring with them contamination issues and the need to protect the user during and after use as well as the issue of hygiene, decontamination and/or disposal. No testing of suits is required post decontamination, nor do standards require reusable garments to show that they still provide the protections requirements post decontamination. Currently chemical, biological and radiation protective suits often have a distinct design that can raise anxiety in the general population.
7. Use and maintenance can have an important impact on thermophysiological properties and should be taken into account in test methods. The same is valid for the effect of tear, loosening seams, degradation of water repellence decreased reflectivity, corrosion etc. These can adversely affect physical performance and consequently have an impact on the wearer.
8. A variety of national or even local test methods and standards concerning ergonomics and comfort are available, but due to the variations in protocol it is difficult or impossible to compare their results.
9. Suitable standardized test methods for physical hindrance of Personal Protective Equipment and/or Personal Protective Systems are lacking at the moment although some methods are contained in existing CEN and national standards.

3.4 Sustainability

The topic of sustainability was sub-divided into the following topics

- Total cost of ownership
- Correct selection, use, care and maintenance (SUCAM)
- Environmental aspects

3.4.1 Total cost of ownership

By taking into account the total life cycle of PPE the following topics were identified. The “total” life cycle would include the production, use and disposal of the PPE. When tackling the “whole life cycle cost of PPE” the life of the PPE after production is addressed specifically. A more extended literature survey on this subject can be found in Annex 6. For the purpose of this report the life cycle has been limited to the cycle starting with the purchase of the product and ends with the disposal of the product. During this life cycle the PPE remains fit for purpose, meaning that the PPE maintains the protection requirements through the cycles of care and maintenance. All aspects before the purchase by the user of the product are not taken into account as we consider those to be part of the production and distribution cycle.

1. Determining the total cost of ownership (TCO) could use the approach used in the life cycle assessment (LCA) of a product. LCA is considered to be the suitable scientific base for an environmental product declaration and labelling to be applied to communicate towards consumers. However, a LCA study is usually very complex and focuses on production rather than the service provided by the PPE – providing protection during its use. For PPE determining the useful life span is even more complex as the protection level offered by the product is the most important issue, but this is highly influenced by the use conditions as well

as the care and maintenance of the PPE during its life. Therefore the LCA approach could be used to calculate the whole life cost from purchase and during the use of the garment.

2. The purpose of "whole life cycle cost of PPE" is to empirically compare different PPE based on their longevity during which they meet or exceed the protective requirements for a specific use. For PPE, the cheapest, one when procuring, does not mean the cheapest one when using. Additionally, PPE users are risking their health and safety and sometimes their lives when looking only at the purchasing price, the PPE needs to be *fit for purpose* during its whole life. It is important to be able to maintain the protection level needed during the whole life cycle. The result can be that a more expensive PPE at the time of procurement may last longer and perform better, making it on long term the more interesting one to purchase.

3.4.2 Selection, use, care and maintenance

1. Several documents have been developed with the purpose to assist the users in the process of the correct selection, use, care and maintenance of PPE (in some cases these considerations are part of product standards). Those documents are currently not always available in the national language of the PPE user, and the different stakeholders are not always aware of their existence.
2. Currently SUCAM (Selection, Use, Care and Maintenance) technical reports or standards with the purpose of assisting the user in the selection and use of PPE are not sufficiently written for the user (lacking is input) or more just an outline of information. These documents should provide greater guidance to the user with respect to understanding the function and limitations of the various tests and requirements but also a better understanding of how to ensure the right fit and compatibility as well as appropriate use of the PPE.
3. Besides this, they are mostly written from the point of view of the type of PPE grouping the PPE in various types such as respiratory protection, fire fighters, chemical protection, while the intended users expect documents from their own point of view and their (work) situation and environment.
4. On the services related to care and maintenance of PPE/PPS no standardisation documents exist at this moment (e.g. rental laundries). All stakeholders would welcome such documents as it will help in the evaluation of products but are also necessary for the life cycle approach as mentioned above. These documents also need to address the issue of decontamination, hygiene and disposal of the PPE/PPS, which in some cases are contaminated with potential hazardous substances.
5. Setting a European standard for the minimum knowledge of the different stakeholders (e.g. PPE advisors, suppliers and service providers as well as purchasers, safety managers and market surveillance authorities) will increase the level of professionalism and harmonisation throughout Europe.

3.4.3 Environmental aspects of PPE and their testing

While for the life cycle costing the life cycle has been limited, in the case of environmental aspects, the life cycle is the complete cycle as defined for instance in CEN Guide 4.

1. In some of the PPE standards, limited information and requirements are included on environmental aspects. Certain standards (e.g. EN ISO 13688) cover certain environment aspects such as to minimize the environmental impact of production and disposal of PPE, or restricting the content of certain chemicals such as heavy metals, azo dyes, unreacted components to ensure the innocuousness of the PPE. However, in most PPE performance standards this is not the case. Even if the protection of the user is the first priority of PPE,

consideration should also be given to other aspects as far as they have no negative impact on the protection of the user.

2. In most cases very different materials are used in one piece of PPE, therefore considerations on reuse and recycling of products would be beneficial for manufacturers and users. Contamination of PPE may limit the possibilities for re-use or recycling.
3. The test methods used for the conformity assessment for PPE and PPS (please refer to definitions in TG1 and TG2) are in many cases time consuming, expensive and destructive, which makes them not suitable for routine testing during the life cycle of the products. To assess the 'fitness for use' simple, quick, effective and non-destructive test methods that can be performed by the user need to be developed
4. In the development of test methods, very little consideration is given to the environmental impact of those tests and/or pre-treatments. For instance in many cases tests for protective garments have to be carried out after the maximum number of washing cycles foreseen by the manufacturer. It is not always clear if this is a real added value for the result as washing is only one aspect determining the ageing and life span of a product (Annex 8). On the other hand, the washing requires a lot of energy, water and detergent consumption.

4 Proposals

4.1 Proposals for standardisation projects

In the following an overview over the different proposals for standardisation projects coming from CEN-CLC BTWG8 is given in Table 1 below. Included is the urgency for each proposal to be processed. Please refer to Annex 3 for the detailed proposals.

To establish the priority the factors economic impact (will this project lead to economic benefits for stakeholders, will the document lead to improve bringing to the market of innovations or new products, if the document doesn't exist will that lead to a standstill in the market, reduced value of standards...), technological (will this document allow developments and innovations, will this document create a technological step forward, will the lack of existence of this document hinder innovation, ...) and legal (does this document allow stakeholders to comply with legislation, does the non-existence of the document create difficulties for stakeholders to comply with relevant legislation, ... impact were taken into account. The priorities were set based on the combination of these three factors.

Apart from the **priority** (high, medium or low) also an estimate of the **foreseen cost** (low, medium high) to develop the project, including validation of methods) and **time-frame** (short, medium, long), the time needed from start to publication/completion is given, with the following evaluation:

Cost:

- low: it is possible to start the project but funding is desirable for delivering results in short time.
- medium: funding is needed as (1) results may not be obtained without funding and/or will take substantially longer (e.g. arranging inter-laboratory testing) and (2) the number of available experts will be limited.
- high: Funding is essential as without funding the project will not go through because results cannot be obtained (e.g. financing of inter-laboratory testing) or number of available experts will be too limited.

Time frame:

- short: maximum 3 years
- medium: 3 to 5 years
- long: 5 to 10 years

The proposals listed in the table are linked to the three main topics of the programming mandate (Annex 1), and have been labelled accordingly:

- INT: Integration
- COM: Ergonomics and comfort
- SUS: Sustainability, total cost of ownership

The numbering is following the priority given to the proposal and is reflected in the order of appearance of the proposals listed in Annex 3.

Table 1: Overview over the different proposals for standardization documents from CEN-CLC BTWG8

Priority	Cost	Time-frame	Proposed title	Proposed scope	More details in form
High	Low	Short	Personal Protective Systems – Definitions, categorisations and standardisation needs	Provide definitions in the field of personal protective systems as well as categorisations of different types of personal protective systems, which included different elements of current personal protective equipment as well as other items that are essential to the functioning of the complete system. Examples are (1) the integration of (smart) functionalities, including electronics and ICT and (2) elements that are currently not taken into account but are like underwear and gear used for attaching the wearer to e.g. a rope, a wall, etc. The focus will be on the functioning of the ensemble instead of the individual parts.	Proposal INT- 1
High	Low	Short	Roadmap for standardisation of Smart Personal Protective Systems with integrated technology	Definition of terms, categorisation & guidelines for standardisation of Smart Personal Protective Systems (as will be defined in Proposal INT- 1)	Proposal INT- 2
High	Low	Short	Overview of existing test methods for ergonomics and comfort testing	Technical report with an overview of test methods as described in the present PPE standards.	Proposal COM- 1
High	Low	Short	Extend the scope of BS 8469 towards PPE ensembles including clothing and respiratory protective equipment (RPE) for any kind of PPE application	The present BS 8469 is specific for firefighters' PPE. This national standard can serve as a base for a new work item to develop a general standard with guidelines towards ergonomics and comfort for PPE.	Proposal COM- 2

Priority	Cost	Time-frame	Proposed title	Proposed scope	More details in form
High	Medium/Low	Short	General principles for Selection, Care, Use and Maintenance of PPE and PPS	Harmonised structure for all SUCAM documents + general principles – to be completed with specific documents based on the user needs at the second stage	Proposal SUS- 1
High	Medium/Low	Medium/Long	Selection, Care, Use and Maintenance of PPE and PPS for specific sectors and/or hazards	Series of documents for all types of PPE / PPS from the users point of view - Including guidance on compatibility (e.g. fit of equipment – more comfort versus more safety)	Proposal SUS- 2
High	Medium	Short	Standard for Maintenance, Repair and Disposal of PPE	Ensure that the functionality and protection is maintained over the “useful life” of the PPE. Develop test methods and procedures to simulate wear and tear to ensure PPE remains compliant with Directive during its indicated useful life..	Proposal SUS- 3
High	Medium	Medium	Standard method for calculating the total cost of ownership	Develop a standard method for calculating the total cost of ownership of PPE, for the life time of the PPE from purchase to disposal. .	Proposal SUS- 4
High	Medium	Medium	Model to determine cost of accidents/incidents	Development of a standard model for determining the cost of accidents/incidents during the lifetime of PPE, as input parameter for assessment of the total cost of ownership.	Proposal SUS- 5
high	Medium	Medium	Tests to predict in-use performance and service life	Test methods for multitude risks of ensembles (including of heat, chemicals, soiling, UV radiation, abrasion, washing/ disinfection, compression and saturation with sweat and water on the effect on thermal, chemical/biological resistance and comfort).	Proposal SUS- 6

Priority	Cost	Time-frame	Proposed title	Proposed scope	More details in form
High	Medium/High	Medium	Test methods and performance criteria for personal protective ensembles	Development of test methods for compatibility for full ensemble testing for evaluating functional performance and comfort under different hazards, taking into account functional requirements, design and sizing	Proposal INT- 3
High	High	Medium	Fit for use testing of PPE/PPS during their lifecycle through non-destructive tests (series of documents)	Test methods that can be used during the life of the PPE/PPS to evaluate the fitness for use. The methods need to be quick, easy, non-destructive and possible to perform by trained users and not in specialised laboratories	Proposal SUS- 7
High	High	Medium	Tests for ergonomic function and comfort.	Develop laboratory test methods for sensorial comfort, dexterity, mobility, sweat absorption, material stiffness and friction. Develop guidelines for ergonomic/comfort testing, as well as objective pass/fail criteria for the above mentioned methods.	Proposal COM- 3
High	High	Medium	Computer based predictive models for ergonomics and comfort.	Development of standard analytical models that can serve as tools to assist the development of new materials and equipment.	Proposal COM- 4
High	High	Long/Medium	Models for predicting comfort and ergonomic performance	Development of validated (open source) models to predict the performance and ergonomic and comfort aspects of PPE, PPS and ensembles	Proposal COM- 5
Medium	Low	Medium	Minimum requirements for the knowledge of experts on PPE/PPS	Setting a European standard for the minimum knowledge of the different stakeholders will increase the level of professionalism and harmonisation throughout Europe.	Proposal INT- 4

Priority	Cost	Time-frame	Proposed title	Proposed scope	More details in form
Medium	High	Medium	General standard with test methods for ergonomics and comfort	Standard covering all aspects of ergonomics and comfort that can be referred to in present PPE standards	Proposal COM- 6
Medium	High	Medium	Tests for thermal protection in sub-flashover environments and prolonged duration	Suitable standardised test methods for determining heat protection, thermal load and the rate of protection and discomfort during prolonged exposure to low(er) levels of (radiant) heat.	Proposal COM- 7
Medium	High	Medium	Tests for robustness and durability of PPS (ensembles) for long lasting operations, including rough terrain (e.g. USAR).	Standard with minimal requirements for robustness and durability of all separate items of a PPS (PPE/ensembles/systems) for long lasting operations. Evaluation of how deterioration of protective ensembles during long-term use in long lasting operations in rough terrain affects ergonomic and comfort. Performance requirements for physical protection and durability need to be addressed with focussed research efforts.	Proposal INT- 5
Medium	High	Long	Methods to translate material tests into PPE/PPS performance levels	Develop methods and models showing the relationship between materials test and PPE/PPS performance level towards protection and including ergonomics and comfort.	Proposal INT- 6
Medium	High	Long	Virtual test methods of comfort and ergonomics of PPS/PPE.	Development of standards for virtual testing methods of comfort and ergonomics of PPS/PPE that are validated on humans and can predict the impact of poor ergonomics and comfort on personal protective systems without using human test subjects.	Proposal COM- 8

Priority	Cost	Time-frame	Proposed title	Proposed scope	More details in form
Medium	High	Long	Modification of ISO 20471 for High-vis clothing to allow for the use of LED lamps	Requirements of the standard need to be revised to be applicable to other materials including active lighting	Proposal INT- 7
Medium	Medium/High	Long/Medium	Tests for performance evaluation of smart materials and solutions	Re-evaluation of test methods and necessary adaptations when using smart materials in place of standard materials.	Proposal INT- 8
Low	Low/Medium	Short/Medium	Test methods & virtual testing for the development of 'Apps' for estimating ergonomics and comfort of PPE	Development of test methods and virtual testing which can be used for developing smartphone applications (apps) for quickly evaluating the performance of PPE.	Proposal COM- 9
Low	High	Long	Use of Auto-ID-Systems for Life Cycle Data Management of PPE	Use of existing auto-ID technologies for recording life-cycle data from various PPE regarding time-dependent features.	Proposal INT- 9

4.2 Proposals related to standardisation work structure

The following proposals are related to the organisation and management of standardisation projects in the PPE field. They are intended to make the proposals formulated in 4.1 possible or easier to realise.

1. The creation of a new additional drafting body in the PPE field is proposed. Ideally this would be a joint TC combining the expertise of CEN, CENELEC and ETSI. The function of this drafting body is the following :
    a. Develop standards for ensembles of PPE and PPS, taking into account also the integration of novel technology, including electronics and ICT. This includes test method standards for PPS and ensembles – working from skin to outer layer and from head to toes.
    b. Several of the proposals made in 4.1 that cannot be dealt with in the current standardisation structure can be developed by this TC.
    c. Develop TRs describing user needs that can be used as basis for performance standards for specific types of PPE or PPS (sector related). For this purpose user working groups (e.g. chemical industry, construction sector, sports practitioners, etc.) should be set up with the relevant sector representatives in order to develop TR's describing their needs. These TRs will then be the basis for the specific product TC's for the development of the requirement standards. This way a matrix structure is set up where all stakeholders (including users) contribute with their specific expertise.
    d. Develop SUCAM documents with user focus (organised per sector and/or type of risks to be covered) and this including all elements of the PPE needed for this user
    e. Develop service standards, including training requirements
    f. Be aware of the international standardisation work and link this with the European activities in the standardisation of PPE/PPS/Ensembles in order to make sure that the European standards keep up with the global market developments and do not create unnecessary trade barriers to and from the EU.

    This new drafting body is not meant to replace the existing ones, but would strengthen the cooperation among the existing TC's and WG's to better cover gaps and avoid overlaps.

    Within the current structure of the standardisation bodies on European level only the individual components of the PPE are taken into account. These components fall under different technical committees at CEN or CENELEC. In order to facilitate exchange among these different TC's and WG's the PPE sector forum was established. This sector forum thus tries to harmonise the standards development of the components however does not have the executive power to develop standards, e.g. for the complete ensemble or personal protective system (PPS). BTWG 8 sees the need for a horizontal standardisation group at this stage of the developments in the PPE field in order to be able to keep up with the state of the art of technology and facilitate the market introduction of innovative products and services.
    At the same time, CEN-CLC BT WG 8 concludes that the stakeholder involvement in standardisation is too low. The reason for this is the difficulty for especially users or their representatives as well as SMEs to allocate resources for active participation in several TC's

and WG's dealing with PPE that can be used in their industry. This was experienced again when inviting experts to join the working group.
Continued efforts need to be made to include all relevant stakeholders in the standardisation process. Efforts to include SME's are being made by CEN/CENELEC but also efforts to include user representation are necessary.

Without the appropriate standards, the EU suppliers risk to be hindered in their developments while in other parts of the world innovation is supported to the fullest.

2. The PPE sector forum should create a coordinated ad-hoc group having different fields of expertise and competence such as toxicologist, chemical risk assessors, PPE producers and end users but also including regulators such as DG Enterprise, DG Environment, DG employment and DG Health and Consumer Protection or the respective agencies ECHA and the European Agency for Safety and Health at Work from a REACH and OEL perspective to validate such an approach. This group should look into an approach that correlates the level of toxicity of chemical agents and the permissible exposure through the PPE, ensemble or PPS by determining the level of cumulative permeation that is allowed to ensure safety of workers. There would of course be a requirement to collaborate with the other existing TC's and WGs where appropriate and to ensure that there is no duplication of effort, which would be an undue expense for Industry, SME's, Notified Bodies and Manufacturer's.
   A major issue was identified by both CEN TC 162 WG 3 and the French Authorities on PPE for the operators applying liquid pesticides. It is necessary that chemical permeation tests better reflect reality. There should be a correlation between levels of toxicity of chemicals and the permissible exposure through the PPE/PPS/ensemble by determining different levels of cumulative permeation. (See also Annex 5 proposal for more detail)
   Without such a coordinated approach and an agreement on correlating the permitted permeation with the hazard of the chemicals the protection of the workers cannot be ascertained as the tests do not sufficiently reflect reality

3. The cooperation between CEN, CENELEC and ETSI is being encouraged, but in practice establishing cooperation between WG's and TC's among these three ESO's is not straightforward. This type of cooperation is essential though especially for WG's active in strongly cross sectorial topics, e.g. CEN TC 248 WG 31 Smart Textiles, which include electronics and ICT. Apart from the need to establish new joint working groups for e.g. flexible and stretchable electronics, liaisons with existing TC's or WG's are of interest, e.g. with the ETSI TC SmartBAN (smart body area networks). Also on the level of national mirror groups set up by the NSBs this cooperation needs to be encouraged.
   The CEN PPE sector has to monitor this cooperation and where necessary encourage the relevant bodies to take action.

4. CEN-CLC BT WG 8 proposes to CEN to investigate a possible alignment with CENELEC and ETSI rules on IPR.
   For the development of standards, the current CEN clauses on IPR cause problems for standardization experts and/or companies used to working in the electronics and ICT area. Companies developing products where classified information has to be provided to develop a standard are not willing to forfeit all their IPR rights. This is strongly the case for electronics and ICT, which is why CENELEC and ETSI do not have the according clauses on IPR rights.

If this issue is not dealt with in some way, BT WG 8 fears that some necessary parts of standards will not be developed, which on its turn can cause problems for the market as no standardised methods for conformity assessment for manufacturers which leads to customers not trusting the offered innovative solutions.

5. A continued system of linking R&D and innovation projects (both European and national/regional) with standardisers in order to establish early information exchange would be beneficial.
   BT WG 8 suggests the EC (and national/regional funding authorities) to establish and implement a system for supporting (also financially) the standardisation efforts of an R&D or innovation project beyond its lifetime. This as In most cases only towards the end of the project practical proposals for standardisation can be made and thus only at that moment the standardisation work can start, which then will have to be carried out for several years before the standard deliverable is finalised. This also includes preparing guidelines for researchers on how to feed their results into the standardisation system (see e.g. the current EU FP7 project Susta-Smart, Bridgit).
   At the same time, CEN-CLC BT WG 8 suggests that NSBs maintain (and make publically available) a list of relevant national R&D projects and encourage their national authorities to include standardisation issues in all supported projects.
   Without the above actions, important relevant information for standardisers will continue to get lost, which means that the standards cannot keep up with the state of the art of the technology as efficient as it could be.

6. A permanent system should be installed to allow testing laboratories to develop test methods including their validation based on standardised samples (using round robin testing). Additionally a round robin test should be integrated already during the work on a new or revised standard and the standard shall only be published if the RRT results show that the proposed testing method is reproducible and validated. BT WG 8 proposes that the Commission in close collaboration with the ESO's establish this system.
   Currently the test methods are revised or new ones are developed by the various standardisation committees (be it European or international), and their validation through round robin testing among different laboratories is based on voluntary cooperation between labs/testing houses, certification bodies and manufacturers. As a result these activities are usually considered low priority as there is rarely financial compensation of these efforts. There is a clear need, though for:
   (1) confirming robust test method standards
   (2) reducing the time needed to develop or revise test methods and standards
   (3) there may be a need for additional test methods and standards for Ensembles/ PPS.
   For examples please refer to Annex 5.

   The lack of reproducibility puts into question a number of test methods/standards, reduces the protection of workers, could lead to an effect of shopping for the 'most appropriate' right test house to obtain the most convenient results for a specific test. All this is leading to a reduced level playing field on the EU market.

7. CEN-CLC BT WG 8 requests the PPE sector forum to introduce the concept of 'smart standardisation' into their guidelines on the drafting and revising of PPE standards and recommends CENELEC and ETSI to take into consideration these guidelines.
   Currently standards for test methods and requirements are frequently based on technical and materials requirements. These standards are not open to adapting/improving the test method to take into account innovations in materials and technical developments concerning the samples to be tested as well as the testing equipment itself.

   The use of the principle of 'smart standardisation'(use only functional requirements instead of specific technical or materials requirements) is the way forward. This smart standardisation opens the way for innovations in PPE and PPS including the use of smart textiles and intelligent equipment. An example is the adaptation of the HIGH-VIS requirements standard (please refer to Annex 3 and Annex 4).

8. CEN-CLC BT WG 8 requests the PPE sector forum to establish a database and procedure for updating references in existing standards in close collaboration with CCMC and the relevant TC's.
   When a given (test method) standard is revised there are often consequences for standards referencing this standard, as well as for SUCAM documents. The user of the referencing standard is not always aware of these changes and the resulting consequences.
   A user-friendly and easily available database for all standardisers with an overview of the cross references of standards together with a simplified procedure to update references in existing standards will allow all concerned standardisers to align all relevant standards at the same time. This will avoid discussions among users of standards. A good first initiative has been taken by DIN (see Annex 12), which should be brought to a European and international level.
   The existing rules to avoid dated references in standards need to be enforced at ESO level as dated references often cause problems for stakeholders. Only exceptionally a dated reference may be acceptable. The NSB's acting as secretariat for TC's should give specific attention to this point during the final editorial check.

9. CEN-CLC BT WG 8 requests the PPE sector forum in collaboration with the CEN consultants for PPE to establish an education programme for standardisers.
   Standards should be comprehensible, simple and easy to use so that they can be implemented more effectively by manufacturers, test houses, notified bodies and other relevant stakeholders. Only the essential requirements should be tested or specified, otherwise innovations can be blocked from being implemented. This is of high importance for innovative companies and especially SME's.
   Too often a revision only brings extra testing without questioning the added value for the user of the products. An impact assessment (looking at all consequences for all concerned stakeholders, including the environment) would be helpful in the process of revision of standards.

4.3 Challenges for the PPE sector

During the preparation of this report it was clear that there are a number of challenges faced by the PPE sector that are not directly linked to standardisation but still have an influence on future standardisation work.
If the following points don't get the necessary attention, the PPE sector will encounter problems for conformity assessment of products and solutions which might lead to a technological stand still in the EU while new developments will be marketed in other markets. This could not only jeopardise the EU PPE sector but also the further improvement of the safety of the EU citizen.

1. Harmonisation of different sector Directives (e.g. among PPE, ATEX, Medical Devices, EMC, WEEE, REACH, etc.).
   As PPE and PPS need to comply more and more with several Directives, efforts are needed at legislative level to harmonise the legislation as much as possible. At this moment, different requirements concerning for instance conformity assessment procedures, marking and user instructions make it unnecessary complex for manufacturers to comply with all the applicable legislation. Harmonisation of the legislation also makes it easier to prepare standards to assist in the application of the legislation.
   CEN-CLC BT WG 8 encourages the European Commission to take action to establish harmonisation among different sector directives taking into consideration the recommendations of this report.

2. Guidelines for manufacturers and Notified Bodies for the conformity assessment procedures for products falling under several Directives (e.g. PPS containing electronics and ICT) should be developed to assist with:
   - Identifying which Directives apply
   - How to interact with a notified body working under a different directive

   Additionally manufactures and to a less extent Notified Bodies need to learn to distinguish certification based on the directives from performing testing using standards (important is the conformity assessment with the EC legislation).
   These guidelines should be developed by the Horizontal Committee of Notified Bodies in cooperation with the relevant EC services and stakeholders as soon as possible, as this is an acute problem: companies developing innovative (smart) PPE/PPS encounter reluctance among Notified bodies for assessing their conformity.
   These guidelines could be completed with training sessions or e-learning tools for manufacturers and Notified Bodies.

3. A harmonised conformity assessment system for products that need the involvement of different Notified Bodies (NB) should be established, for instance based on a 'lead' NB using the expertise of 'subcontracted' NB's. In this case the lead NB is the first point of contact for the manufacturer for the conformity assessment procedure of his product. This lead NB has a complete overview of the product and the procedures which is important for instance when checking markings, user instructions and declarations of conformity.
   CEN-CLC BT WG8 encourages the Horizontal Committee of Notified Bodies to investigate on the implementation of such a system

4. The suggestions of this report should be implemented in the revision of the guidelines for the (revised) PPE Directive and or other relevant Directives
   CEN-CLC BT WG 8 encourages the Commission to take action to implement the recommendations of this report in their relevant guidelines.

5. CEN-CLC BT WG 8 will initiate the necessary work to define the new terminology (PPS).
   The term PPS should then be introduced into the legislation, complementing the current term PPE (Personal Protective Equipment) as it is more suitable to describe systems including e.g. electronics and ICT. This concept is also of importance for other cross disciplinary items/ systems/ products.

6. Harmonisation between legislation from different DG's.
   At this moment, two Directives dealing with PPE exist (89/686/EEC and 89/656/EEC). Even if the purpose of the two Directives is very different (one for the market and one for the users of PPE) overlapping content should be identical. An example is the small but significant deviation in the definition of PPE in both Directives. As SUCAM documents are intended to bridge between products on the one hand and users on the other, harmonisation of all relevant legislation is the key for clear and simple guidance.
   CEN-CLC BT WG 8 encourages the EC to take action to harmonise the legislation between different DGs.

4.4 Other proposals

1. Directive 89/656/EEC on the use of PPE, sets on the employers, the obligation to create a safe working environment for their employees, by completing a risk analysis and risk assessment to determine the required PPE and the supply and maintenance of the PPE, as well as provide the appropriate training (all this, free of charge for the employees). To perform this risk analysis and assessment it is currently necessary to consult a variety of different documents including the EU legislation (such as REACH, CLP, Chemical agents ant work Directive, etc.), standards, SUCAM and the manufacturer's "instruction for use". For employers it is important to bring all this information together in a single document.
   CEN-CLC BT WG 8 suggests to the European Agency for Occupational Health and Safety to further develop and maintain 'best practice' cases taking into account the complexity of legislation and workplaces.

2. In the PPE field several SUCAM documents exist, either in the form of a separate TR or even standard or in some cases in the form of an annex in the product standard. In order to encourage all stakeholders, especially SME employers and consumers to use the SUCAM documents, these should be made easier comprehensible by (1) writing them in more understandable language, (2) providing a user friendly structure to avoid the need to use different documents for one situation and (3) providing translations into national languages. Currently SUCAM documents are translated into a very limited number of national languages.
   It should be investigated by the PPE sector forum in collaboration with CCMC what options are available to promote the SUCAM documents to industry (especially SMEs) and consumers and to provide a low threshold to obtain the documents.

It is a legal obligation for the manufacturer to provide Instructions for the User with each PPE product and this in printed form. The minimum content is part of the requirements of the PPE Directive (89/686/EEC). However in standards often information beyond the minimum is required to be added to the instructions. This information is often of importance for the selection of the PPE or for the specialised care and maintenance. In those cases, guidance should be given to standardisers and stakeholders to make this information available but not necessarily in printed form with each product, but made available to the person(s) responsible for the PPE management in any form suitable. In the case of PPE destined for consumers this information should be available at the point of sale so that the consumer can make an educated selection. The relevant SUCAM documents can be the basis for this additional information. By reducing the volume of the instructions for the user delivered with the PPE, the readability for the user will increase and thus will contribute to the correct use of the PPE, which is the intention of the legislator. The PPE sector forum should investigate the legal options and take this into account in future guidance documents. The new horizontal TC should take this into account when creating the structure for SUCAM documents.

The risk is that the current SUCAM documents become irrelevant and similar documents will be created outside the standardisation activities by other stakeholders (e.g. sport associations or industry groups (e.g. petroleum industry, industrial fire fighters, etc.).

5 Conclusions

Given the active participation in CEN-CLC BT WG 8 of many experts from the PPE sector the programming mandate fulfilled a need from the industry. The work of CEN-CLC BT WG 8 can therefore be recognized as the start of a possible new approach for the standardization of PPE and perhaps even be an example for other sectors.

Whilst the list of proposals for standardization documents is certainly not as comprehensive as it may need to be they do nevertheless cover all aspects of the programming mandate.

Integration is clearly a trend for the shorter term but standardization needs to follow such a trend and allow developments and innovations whilst at the same time avoiding barriers to manufacturers and other stakeholders bringing innovative solutions to the market.

Comfort and ergonomics have historically been important for PPE but there still remains a significant gap in standardization efforts making those 'subjective' characteristics measurable and comparable.

Sustainability and environmental aspects have found their way into the PPE industry more recently but tackled properly, e.g. by addressing non-destructive testing, or total cost of ownership, they can become an added value for all parties involved.

Starting with a clear set of definitions for the future work is key to good progress. Standards looking at PPE also from the point of view of the user as well as from the point of view of product certification are a challenge for all stakeholders but one which if addressed successfully would bring significant benefits.

If the standardization in the PPE field has been focusing on product groups, it is clear that an approach with the user in the centre is also necessary and appropriate. As the current standardization structure is based on product groups it is proposed to set up a complimentary horizontal Technical Committee (TC) to deal with issues looking from a user perspective. Simultaneously the TC could be tasked to establish 'user groups' that have the task to clearly define the user needs as an input for the work of the product TC's.

Helping the user (professional and consumer) in the correct selection, use, care and maintenance of PPE is an area where a more efficient structure would also be very much welcomed by the stakeholders. At the same time proposals are formulated to make this important information easily available to SME's as well as consumers. 'Fit for use' testing is in many cases a missing link for users of PPE, where, after setting the general framework, the existing TC's should work on effective but fast and relatively inexpensive methods for evaluation of PPE in use.

Whilst the focus of the work of CEN-CLC BT WG 8 has been to develop a proposal for a working program for standardization for the short to medium term future it is essential that this is done in conjunction with examining the structures and legal framework around which PPE operates. As in every sector, products become more and more complex and need to fulfil requirements of a variety of legislation and regulation. A harmonized approach on how to do this in a simple and effective way would assist the sector in its development. Whilst it is recognized that it is not to the responsibility of the ESOs to resolve these issues a clear formulation will have an impact on standardization work and consequently proposals are identified in this field.

Clearly the more complex the test methods that need to be developed, the more crucial validation of those test methods becomes. Identifying the necessary resources for the development and validation of such test methods will be an important challenge in the forthcoming years in order to continue to guarantee the best possible 'state of the art'

protection for the European citizens and as a consequence enhance the reputation of the European PPE industry worldwide.

In all the proposals cooperation with all involved stakeholders is a key issue. Cooperation between the experts from the different ESO's; between manufacturers, users, notified bodies, test houses, the R&D community and authorities; and so on. Efforts to intensify these co-operations are essential. Proposals on how to include users and the R&D community in the standardization work are included, but attention to IPR issues is also addressed.

In order to ensure positive outcomes and realize the objectives from the report, the content will be disseminated to as broad an audience as possible. This will in part be the responsibility of the PPE Sector Forum in collaboration with CCMC. Within the EU Commission several units have already expressed an interest (e.g. in DG ENTR the unit dealing with Textiles, with PPE and with standardization, DG RTD, DG EMPL). Additionally the Notified Bodies in the PPE field will be informed as will the R&D community more generally. Similarly, the relevant TC's will be informed both on the specific proposals that fall under their responsibility as well as on the general content of the report. Some specialized press in the PPE field have also requested further information on the results and will receive this based on the management summary of this report.

Finally; it is apparent that the programming mandate has created a momentum in the PPE sector that warrant maintaining in the short and medium time frame. The PPE Sector Forum together with CCMC and others are committed to ensure that this will be the case with the support of the other stakeholders. In this way the PPE industry in Europe can both maintain and enhance its status as a leading player in the PPE field globally and ensure the millions of PPE users receive the best possible level of protection.

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6 Annexes

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Annex 1: Mandate M/509 EN

EUROPEAN COMMISSION
DIRECTORATE-GENERAL ENTERPRISE AND INDUSTRY

Tourism, CSR, Consumer Goods and International Regulatory Agreements
Textiles, Fashion, and Forest-based Industries

Brussels, 18th September 2012
M/509 EN

PROGRAMMING MANDATE TO CEN, CENELEC AND ETSI ON PROTECTIVE TEXTILES AND PERSONAL PROTECTIVE CLOTHING AND EQUIPMENT

1. SCOPE

This mandate concerns the development of a programme for standardisation deliverables in the area of protective textiles and personal protective clothing and equipment, including revision of existing European standards and other standardisation deliverables as appropriate.

2. JUSTIFICATION

2.1. Political context

As a response to the Competitiveness Council, the European Commission launched the Communication on a lead market initiative (LMI)[1] at the end of 2007. This Communication identified a first set of markets with potential to become lead markets and proposed action plans for urgent and coordinated action in each area. Protective textiles - technical textiles for intelligent personal protective clothing and personal protective equipment (PPE[2]) - were one of the lead markets areas identified in the Communication.

As described in the task force report "Accelerating the development of the protective textiles market in Europe", the concept of protective textiles is closely linked to PPE, as defined in Directive 89/686/EEC. However, protective textiles encompass a wider range of products and uses than the legal definition. In the LMI context, protective textiles cover technical textiles for intelligent[3] personal protective clothing and equipment, comprising clothing and other often textile-based systems and accessories whose main function is to protect the user. These products are used for professional workers,

[1] COM (2007) 860 final, Brussels 21.12.2007

[2] All references to PPE in this document are not restricted to the legal definition given in Article 1 of Directive 89/686/EEC but refer to a broader concept, encompassing a wide range of products and uses.

[3] CEN/TR 16298:2011 may provide a definition of intelligent textiles

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emergency services, defence personnel or healthcare professionals exposed to hazardous environments, extreme climatic conditions or chemical and bacterial contamination.[4]

The action plan for protective textiles, which envisaged coordinated action in the areas of legislation, standardisation, public procurement and complementary activities, has been implemented since 2008 delivering positive results. A recent independent evaluation[5] highlighted especially stakeholder engagement, mobilisation of resources and first promising steps in public procurement.

A number of R&D projects in this area as well as the ENPROTEX public procurement network have identified standardisation as a key instrument for further uptake of innovative advances in public and private markets. Thus, it is now necessary to further strengthen the innovation potential of this market, ensuring continuity and lasting impact of the lead market initiative beyond the initial action plan. Building upon the results of the LMI action plan, the present mandate, which covers a wide variety of technical textile-based goods, shall take into account standardisation work of relevance to EU legislation, in particular related to PPE.

2.2. Rationale

For over 20 years, European standards have played a crucial role supporting the implementation of EU legislation on PPE; namely as regards Directive 89/686/EEC on PPE. In addition, standards play a crucial role to facilitate the development and market deployment of new technologies applicable in this field.

On the other hand, funding for R&D in the area of smart protection systems has lead to substantial technological progress, including in the area of pre-normative research, which still needs to be fully exploited commercially.

Thus, in order to fill in those gaps, standardisation needs to build upon recent technological developments in this field and integrate user-driven design into innovative solutions in the area of protective textiles, clothing and equipment. Furthermore, sustainability and lifecycle cost of products are increasing concerns that need to be integrated into technical standards.

The main topics to be addressed are:

- **Compatibility of different elements** is crucial to ensure effectiveness of advanced, smart integrated protection systems. This includes compatibility of different system components and especially when ICT, other electronics and other advanced technologies are integrated in advanced PPE.

- **Ergonomics and comfort** are essential requirements for PPE to deliver the targeted level of safety and well-being in intended operating conditions. However, the assessment of such requirements relays on costly and frequently subjective testing methodologies; therefore, there is a need to explore and develop testing methods which are simple, objective and cost-effective. Virtual testing and simulation offer a potential yet under exploited in this area.

[4] The task force report contains further details and is available at the website of the Commission: http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/files/pt_taskforce_report_en.pdf

[5] http://ec.europa.eu/enterprise/policies/innovation/policy/lead-market-initiative/files/final-eval-lmi_en.pdf

- **Environmental sustainability and the total cost of ownership** (lifecycle cost approach) are increasingly drivers of innovation in private and public PPE markets. In this context, it is necessary to develop methodologies to assess the total cost of ownership (or lifecycle cost) as well as the environmental impact throughout the lifecycle of products, including recycling and end-of-life disposal. The total cost of ownership should take into account not only the costs and impacts linked to the product supply chain but also those related to services (care and maintenance) that are critical for preserving the functionalities and ensuring optimal performance.

Consequently and on the basis of Directive 98/34/EC laying down a procedure for the provision of information in the field of technical standards and regulations and of rules on Information Society services, the Commission is launching this mandate: to explore emerging standardisation needs in the field of protective textiles, clothing and equipment[6]; and to revise existing European standards and other standardisation deliverables as appropriate.

3. DESCRIPTION OF THE MANDATE

CEN, CENELEC and ETSI are invited to execute the following tasks, building on the activities of the CEN Personal Protective Equipment Sector Forum and on the results of LMI action plan (see footnotes 1 and 4) for the area of protective textiles, which was implemented between 2008 and 2011 with positive results.

This mandate complements other mandates related to relevant EU legislation on PPE (Directive 89/686/EEC). Where progress in this field should involve development of new harmonised standards or revision of existing harmonised standards under the Directive 89/686/EEC, such work should proceed according to existing mandates under the Directive 89/686/EEC.

3.1. Tasks

The tasks to be carried out are:

- Further explore and identify key recent technological developments for the deployment of smart integrated protection systems which integrate ICT, other electronics and other technologies in protective textiles, clothing and equipment.

- Identify cross-cutting barriers and drivers for the integration of technological developments resulting from R&D projects into new standards (or other standardisation deliverables). Among others, such barriers may include differing intellectual property right (IPR) management or protection of personal data.

- Explore existing standards in the field of ergonomics and comfort in order to identify whether recent technological developments and smart integrated protection systems would require further standardisation in this field.

- Explore existing methodologies to assess the overall lifecycle cost of protective textiles, clothing and equipment as well as the overall environmental impact in order to identify further standardisation needs.

[6] The scope of the present mandate should be understood in a broad sense, covering uses that are excluded from the PPE Directive and covering not only protective clothing but also other types of PPE (see footnotes 2 and 3).

- Establish a programme of standardisation deliverables, including Technical Reports and Technical Specifications that could eventually lead to European Standards for the three areas:

  1 - Advanced integrated smart protection systems

  2 - User-driven ergonomics and comfort

  3 - Assessment of lifecycle cost and environmental impact

The programme should clearly identify the work items that are likely to involve the development or revision of harmonised standards supporting essential requirements of the Directive 89/686/EEC.

The programme should also identify and indicate any needs to develop new test methods, including needs for inter-laboratory trials.

3.2. Synergies and cooperation

CEN, CENELEC and ETSI are invited to take into account in particular ongoing pre- and co-normative research and development activities undertaken by relevant stakeholders, including EU funded projects (i.e. EU's Framework Programmes for Research Technological Development and Competitiveness and Innovation Framework Programme (CIP)).

The ongoing activities of the CEN Personal Protective Equipment Sector Forum should be considered as a starting point. Furthermore, multidisciplinary and cross-sectoral technological developments require increase coordination efforts beyond the traditional sectorial boundaries. CEN, CENELEC and ETSI are therefore requested to pay particular attention to co-ordinate activities and involve all relevant technical committees of CEN, CENELEC and ETSI.

Moreover, they should also establish and/or build upon existing appropriate links for the above described tasks with PPE users and public procurers as well as relevant European Technology Platforms, especially with Future of Textile and Clothing (FTC) and Industrial Safety (IS) to ensure coordinated and fast progress of their tasks.

European standardisation efforts should also be elaborated wherever possible in cooperation with the international standards bodies and take into account the ongoing activities in other parts of the world.

4. EXECUTION OF THE MANDATE

The Commission hereby asks CEN, CENELEC and ETSI to fulfil the tasks as described above, while taking into account the rationale of this mandate stated in the justification.

- The Commission invites CEN, CENELEC and ETSI to confirm whether they intend to accept the present mandate within 2 months after receiving this mandate.

- CEN, CENELEC and ETSI are asked to submit a work programme for deliverables in the area of protective textiles, clothing and equipment within 12 months after the acceptance of this mandate. A progress report is expected within 6 months after the acceptance of this mandate.

CEN, CENELEC and ETSI are required to keep close contacts with the Commission and to ensure that their activities are co-ordinated in a way to create a consistent and coherent framework at the international level, notably with regard to OECD activities.

5. BODIES TO BE ASSOCIATED

The execution of the mandate should be undertaken in cooperation with the widest possible range of interested groups: European Technology Platforms (see section 3), the European Agency for Safety and Health at Work (OSHA), research organisations and other stakeholders.

As appropriate, CEN will invite the standardisation stakeholders representing consumers' interests (ANEC), environmental protection (ECOS), workers (ETUI), SMEs (NormaPME), the European Federation of Textile and Clothing industry (Euratex), the European Safety Federation (ESF), the European Textile Service Association (ETSA) and others to take part in the development of the programme.

Annex 2: List of Abbreviations

Abbrev.	Long Name
(e)SDS	(electronic) Safety Data Sheet
ATEX	Explosive Atmospheres
BT	Technical Board
CCMC	CEN – CENELEC Management Centre
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
EC	European Commission
EMC	Electromagnetic Compatibilities
ESO	European standardisation organisation
ETSI	European Telecommunications Standards Institute
EU FP7	the European Union seventh Framework Program for research
HCNB	Horizontal Committee of the Notified Bodies
ICT	Information and Communication Technology
IPR	Intellectual Property Rights
LCA	Life Cycle Assessment
NB	Notified Body
NSB	National Standards Body
OSH	Occupational Safety and Health
PPE	Personal Protective Equipment
PPS	Personal Protective System
R&D	Research & Development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RFID	Radio Frequency Identification
SUCAM	Selection, Use, Care And Maintenance
TC	Technical Committee
TCO	Total Cost of Ownership
TG	Task Group
TR	Technical Report
WEEE	Waste Electrical and Electronic Equipment
WG	Working Group
WLC	Whole Life Cost

Annex 3: CEN-CLC BT WG 8 proposals

Reference document

Proposal XX-N					
Title: **Scope:** **Keywords** (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)					
Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☐	- Requirements	☐	- standard	☐
- System	☐	- Characteristics	☐	- technical specification	☐
- Service	☐	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		
Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard)					
Market relevance (for which type of stakeholder is this important):					
Priority ☐ high ☐ medium ☐ low			**Need for harmonization** ☐ yes ☐ no ☐ not clear for moment		
Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...):					
Required participation in the work (type of expertise needed):					
Additional comments / information:					

The individual proposals are linked to the three main topics of the programming mandate (Annex 1) and have been labelled accordingly:

- INT: Integration
- COM: Ergonomics and comfort
- SUS: Sustainability, total cost of ownership

The numbering is following the priority given to the proposal which is reflected in the order of appearance in this annex.

Proposal INT- 1

Title: Personal Protective Systems – Definitions, categorisations and standardisation needs
Scope: Provide definitions in the field of personal protective systems as well as categorisations of different types of personal protective systems, which included different elements of current personal protective equipment as well as other items that are essential to the functioning of the complete system. Examples are (1) the integration of (smart) functionalities, including electronics and ICT and (2) elements that are currently not taken into account but are like underwear and gear used for attaching the wearer to e.g. a rope, a wall, etc. The focus will be on the functioning of the ensemble instead of the individual parts.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☐	- Guidance	☒	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide,	☐
		- Terminology etc.	☒	CWA)	

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :
This technical report will set the basic terminology for Personal Protective Systems and point out the needs for standardisation, giving a prioritisation.

Market relevance (for which type of stakeholder is this important) :
Definition of terms is of high market relevance, It forms the basis for clear communication between all stakeholders.

Priority	Need for harmonization
☒ high ☐ medium ☐ low	☒ yes ☐ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:**
CEN TR 16298, CEN ISO TR 11610:2004

Required participation in the work (type of expertise needed) :
- Personal protective equipment & components,
- Textiles, shoes, pressure equipment, helmets, masks, …
- Electronics (CENELEC), ICT (CENELEC, ETSI), Materials
- Users, Manufacturers

Additional comments / information :
Writing this technical report will require a cross disciplinary approach and must focus on the system not the individual components. Currently there is no TC or WG which could perform this work.
Both TG1 and TG2 have developed some **preliminary definitions**:
TG1 :
- *Personal Protective Equipment*: see Directive 89/686
- *Personal protective system*: One or more parts of PPE that are working together with

an additional component: e.g. a piece of clothing with an electronic device: only the complete system ensures safety, the individual parts do not.The additional component(s) provide additional safety allowing modified use of the PPE
- *Ensemble*: complete assembly worn during intervention

TG2 :

Personal protective System (PPS)- Definition:

The combination of single items of Personal Protective Equipment that protect against all possible risks and that can be certified individually or as ensembles which provide protection from head to toe, from skin to outer layer, and which can comprise all other auxiliary elements which are worn by an individual to enable him/her to carry out his/her task protect. Examples for all other auxiliary equipment or elements are ICT hardware and software, data logging, monitoring and warning systems (both the individual and the safety management), localization equipment, communication systems. Parts of the PPS include PPE such as:

- Head protection (helmet)
- Hearing protection
- Eye and face protection
- Respiratory protection
- Protection against fall from a height
- Foot protection (safety shoes, boots)
- Hand protection (gloves, arm protection)
- Body protection/protective garments (incl. e.g. ballistic impact protection)

The following are explanations of various elements of any PPS, linking all elements their compliance to standards and their compatibility as a protective system

1. Base layer (Underwear)

Clothing worn next to the skin, for women Bra, slip and Pants and for men e.g. t-shirt and briefs. Other items such as socks, gloves fire-hood/balaclava may be included.

2. Mid Layer (Undergarments)

Garments that are not necessarily intended as PPE, but may or may not be worn as underclothing under PPE as determined by the Employer/End User.

3. Outer Garment

This refers to work wear that can be worn over 1 & 2.

4. Other Equipment

Any additional equipment worn, i.e. Safety Harness, Respiratory Devices, Helmet, Hearing Protection, Face Protection, Footwear.

5. PPS/PPE

PPS/PPE can comprise of a single or multiple components of the above. It will be necessary to state if Underwear and or Undergarments are to form part of the PPE and if yes, to which standard and test methods they shall be subjected to.

Reliability:

An important issue will also be the level of reliability needed and how to evaluate this.

Longer Term follow up:

On longer term a standard could be developed for guiding standards writers on how to deal with PPS & integrated technology (see also CEN/TR 16298).

Proposal INT- 2

Title: Roadmap for standardisation of Smart Personal Protective Systems with integrated technology

Scope: Definition of terms, categorisation & guidelines for standardisation of Smart Personal Protective Systems (as will be defined in Proposal INT- 1)

Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☐	- standard	☐
- System	☒	- Characteristics	☐	- technical specification	☐
- Service	☒	- Guidance	☒	- technical report	☐
- Interface	☒	- Test method	☐	- other (e.g. CEN Guide, CWA)	☒
		- Terminology etc.	☒		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :

This technical report is intended to be an important roadmap and guidance for current and future standardisation needs. Important issues will be:

- Degree of integration (e.g. separate parts or complete integration)
- Categorisation (matrix): including integrated safety/additional safety, power supply, communication…
- Reliability & failure
- Testing (e.g. of components, integrated parts, representative systems - live electronics or not)
- - Safety during testing

Market relevance (for which type of stakeholder is this important) :

This roadmap is op importance to all stakeholders as it will be the basis for further standardisation work.

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:**

CEN/TR 16298 “Textiles and Textile Products – Smart Textiles – Definitions, categorizations, applications and standardization needs”

Required participation in the work (type of expertise needed) :

Textiles and other domains (electronics, ICT, medical, equipment, ..) to cover all possible technologies that are envisioned to be integrated into Smart PP systems.

Additional comments / information :

Proposal COM- 1

Title: Overview of existing test methods for ergonomics and comfort testing
Scope: Technical report with an overview of test methods as described in the present PPE standards.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☐	- standard	☐
- System	☒	- Characteristics	☐	- technical specification	☐
- Service	☐	- Guidance	☒	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide, CWA)	☒
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :
There is a variety of test methods available, but they are frequently not separate test methods but part of PPE test methods. It is therefore important to create a reference document giving an overview over all available methods.

Market relevance (for which type of stakeholder is this important) :
This reference document will be of high interest to users, manufacturers, procurers and test houses.

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:An overview over the relevant documents can be found in** Annex 7**.**

Required participation in the work (type of expertise needed) :
Experts on ergonomics and comfort, PPE

Additional comments / information :

Proposal COM- 2

Title: Extend the scope of BS 8469 towards PPE ensembles including clothing and respiratory protective equipment (RPE) for any kind of PPE application

Scope: The present BS 8469 is specific for firefighters' PPE. This national standard can serve as a base for a new work item to develop a general standard with guidelines towards ergonomics and comfort for PPE.

Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☐	- Requirements	☐	- standard	☒
- System	☒	- Characteristics	☐	- technical specification	☐
- Service	☐	- Guidance	☒	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :
This standard can be a way forward to describe specific products functional instead of technical in terms of ergonomics and comfort.

Market relevance (for which type of stakeholder is this important) :
End-users and manufacturers

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☒ yes ☐ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, ...)**:**

Required participation in the work (type of expertise needed) :
Ergonomics, human factors, physiology, materials

Additional comments / information :

Proposal SUS- 1

Title: General principles for Selection, Care, Use and Maintenance of PPE and PPS
Scope: Harmonised structure for all SUCAM documents + general principles – to be completed with specific documents based on the user needs at the second stage
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☐	- Requirements	☐	- standard	☒
- System	☐	- Characteristics	☐	- technical specification	☐
- Service	☐	- Guidance	☒	- technical report	☐
- Interface	☒	- Test method	☐	- other (e.g. CEN Guide,	☐
		- Terminology etc.	☐	CWA)	

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :

1. The aim of the SUCAM is to provide in an understanding of how to select (based on the risk analysis & assessment) the PPE based on its strengths and weaknesses. The strength and weakness of PPE can be better explained in the Selection part of the SUCAM by providing the adequate questions a user should be asking including the risk that may be there during the lifetime of the PPE (use, care and maintenance). The SUCAM could provide a step by step approach on doing the risk analysis and assessment by explaining the role of PPE in overall risk management. Explain the value (strength, weakeness, purpose) of the various test performed with respect to protection. Integration of the various tools that already exist in providing information or where to get additional information, for example though the eSDS under REACH, a form manufacturers of substances and mixtures.
2. The SUCAM could provide information on how to train the users of PPE on putting (donning) and taking off (doffing) PPE, how to use PPE, and how to clean (hygiene) or decontaminate PPE (contamination) and the risk associated with this cleaning operation.
3. The SUCAM could provide information on needs for storage; inspections, including how to inspect (internally, externally); test PPE; repair (spare parts, garment repair, etc.); to ensure adequacy of PPE and optimum longevity in use
4. Today the manufacturers of PPE and the participants in the national standards bodies, due to the little use of the SUCAM and probably many other reasons, have not had much energy for the SUCAM. This could change under a number of conditions:
   - Making the SUCAM part of the standard writing.
   - Making SUCAM user based, meaning that the documents need to be written from the point of view of the user, and not from the point of view of the product. This means starting from the Risk Assessment. A common base document can be developed completed with specific documents for sectors or types of activities. In this case, not only occupational use of PPE can be covered by SUCAM documents, but also private use.
   - Providing guidance on compatibility (fit, comfort, safety)

Market relevance (for which type of stakeholder is this important):
Users of PPE as professionals or consumers

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Protective textiles and personal protective clothing and equipment

Priority ☒ high ☐ medium ☐ low	**Need for harmonization** ☐ yes ☒ no ☐ not clear for moment
Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...)**:**	
Required participation in the work (type of expertise needed) : Experts on SUCAM documents and users representatives.	
Additional comments / information :	

Proposal SUS- 2

Title: Selection, Care, Use and Maintenance of PPE and PPS for specific sectors and/ or hazards

Scope: Series of documents for all types of PPE / PPS from the users point of view - Including guidance on compatibility (e.g. fit of equipment – more comfort versus more safety)

Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☐	- Requirements	☐	- standard	☒
- System	☐	- Characteristics	☐	- technical specification	☐
- Service	☒	- Guidance	☒	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :
Important follow up of Proposal SUS- 1.

Market relevance (for which type of stakeholder is this important) :
Users of PPE as professionals or consumers

Priority	Need for harmonization
☒ high ☐ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...)**:**

Required participation in the work (type of expertise needed) :
Experts on SUCAM documents and users representatives.

Additional comments / information :

Proposal SUS- 3

Title: Standard for Maintenance, Repair and Disposal of PPE
Scope: Ensure that the functionality and protection is maintained over the "useful life" of the PPE. Develop test methods and procedures to simulate wear and tear to ensure PPE remains compliant with Directive during its indicated useful life.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☐	- Requirements	☒	- standard	☒
- System	☐	- Characteristics	☐	- technical specification	☐
- Service	☒	- Guidance	☒	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard): It is essential that PPE is correctly selected for functionality and protection over its "useful life".

- Understand the effects of contamination on the use of the PPE, how to ensure that the contamination does not affect the overall performance after cleaning (e.g. chemical contamination, fire residue on fire fighting clothing).
- Develop test methods and procedures to simulate wear and tear of life of PPE to ensure PPE remains compliant with legislation. For example, test methods and performance criteria are needed to evaluate the influence of heat, chemicals, soiling, UV radiation, abrasion, washing/disinfection, saturation with sweat and water on the effect on thermal, chemical/biological resistance and comfort.
- These tests and procedures would have as purpose to determine the "useful life" of the PPE. They also need to indicate what type of maintenance and repairs that may be needed to maintain its functionality over time.

The result should be to optimise the use and maintenance of PPE. This will consequently effect sustainability, especially on products where removal of soiling and maintaining functionality(e.g. high visibility and heat and flame protection) need to be balanced

Market relevance (for which type of stakeholder is this important) :
Potentially better design, use, longevity of PPE as reduced cost for users. Advantage for producer and end users.

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☐ yes ☐ no ☒ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...)**:**
Emerging EN ISO standards start to consider ageing but no tests to assess impact of soiling, wear and tear on garment protective qualities: CEN /TR 15321 in part raises the issue but NFPA 2113 is a more prescriptive and educational example.

Required participation in the work (type of expertise needed) :
Laundry and garment experts, including outerwear(often first layer seeing hazard): FR experts, stakeholder representatives

Additional comments / information:

Proposal SUS- 4

Title: Standard method for calculating the total cost of ownership

Scope: Develop a standard method for calculating the total cost of ownership of PPE, for the life time of the PPE from purchase to disposal.

Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☐	- Requirements	☒	- standard	☒
- System	☐	- Characteristics	☐	- technical specification	☐
- Service	☒	- Guidance	☒	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :

For determining costs of the complete life cycle one needs to take into account the initial costs of the PPE, maintenance costs in a year including repair and/or early replacement, and the protection levels of PPE as well as the expected life obtained by life cycle analysis. This analysis will also need to be extended to integrated smart systems.

Essential that PPE is considered to be correctly selected for functionality (protection, safety, durability and comfort) over “useful life”, that is from the moment of purchase to the moment that the PPE is considered to no longer meeting specification or is being discarded because it is unclear whether it is still fit-for-purpose.

The whole of life cost of PPE also ensure that continued research is invested in innovation to protect workers by providing better, lighter, more effective PPE for workers that may risk their lives if not adequately protected.

- Determination of the factors that need to be taken into account to determine the cost and to define performance factors that are required to determine the lifespan of the PPE. The intent is to be able to compare a PPE on a cost/year basis.
- Determination tests or procedures to be retained or possibly developed, to determine the life of PPE to ensure it remains compliant to the relevant standards and with the Directive (e.g. strength, dimensional change, abrasion, ageing, resistance to chemicals and/or to heat and flame). These tests shall provide an indication of the durability and damage in the usual wear and tear that the PPE endures in the field. Although theoretical performance, the intention is to be as close as possible to reality as the performance can vary significantly already depending on the storage, cleaning and maintenance.

Such work will lead to realisation of life cost (rather than discard) and consequent effect on sustainability especially on products where removal of soiling contributes to continued functionality :e.g. high visibility and heat and flame protection

Market relevance (for which type of stakeholder is this important) :

Stimulate innovation and durability of PPE, while creating an improved decision making process by the purchasers and end-users

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:** Emerging EN ISO standards start to consider ageing but no tests to assess impact of soiling, wear and tear on garment protective qualities : CEN /TR 15321 in part raises the issue but better reference is NFPA 2113 a more prescriptive and educational example For a detailed literature study on life cycle cost please refer to Annex 6.
Required participation in the work (type of expertise needed) : PPE experts, public procurement experts, user representatives Laundry and garment experts, including outerwear(often first layer seeing hazard): FR experts, stakeholder representatives
Additional comments / information : The intent is not to perform a Life cycle assessment (LCA) of a product as this would be too complex and standards already exit to perform LCAs. The intent is to look at the performance of the textile, PPE article, clothing, garment or whole ensemble for the protection of workers (private or public) over the life span of the whole or parts of the PPE. To determine a standardised method to calculate the life span. Understanding the reality about the life span of PPEs are dependent on the type and amount of field use that each separate garment has been exposed to. Additional effective factors are frequency of maintenance, storage conditions, exposures and other issues that out of the control of manufacturer, supplier or user.

Proposal SUS- 5

Title: Model to determine cost of accidents/incidents
Scope: Development of a standard model for determining the cost of accidents/incidents during the lifetime of PPE, as input parameter for assessment of the total cost of ownership.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☐	- Requirements	☒	- standard	☒
- System	☐	- Characteristics	☒	- technical specification	☐
- Service	☒	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :
The cost of accidents/incidents may also be taken into account for the calculation of total life cycle costing for PPE/PPS. This increase the personal cost for an employee at different rates. Because the injured person may need prolonged treatment and rehabilitation and may not be able to return to work, may lost his/her quality of life or may become depressed and his or her personal and family relationships may be negatively impacted. In a study, the thermal hazards in electric arc injuries were investigated and regarding medical, indemnity and vocational costs, total costs changed between 45,000$ - 1,597,000$ between 1993-1995. They also classified the costs of injuries, according to the intensity of exposure conditions describing the injury [Doan et al, 2003].

Market relevance (for which type of stakeholder is this important) :
Authorities, employers, users, suppliers and service providers.

Priority	Need for harmonization
☒ high ☐ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, ...) **:**

Required participation in the work (type of expertise needed) :
OSH managers, labour insurance, employee and employer representatives, authorities

Additional comments / information :

Proposal SUS- 6

Title : Tests to predict in-use performance and service life
Scope : Test methods for multitude risks of ensembles (including of heat, chemicals, soiling, UV radiation, abrasion, washing/disinfection, compression and saturation with sweat and water on the effect on thermal, chemical/biological resistance and comfort).
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☐	- standard	☒
- System	☐	- Characteristics	☐	- technical specification	☐
- Service	☒	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):
Test methods for multitude risks of ensembles are lacking. Test methods and performance criteria are needed to evaluate the influence of heat, chemicals, soiling, UV radiation, abrasion, washing/disinfection, compression and saturation with sweat and water on the effect on thermal, chemical/biological resistance and comfort.

Market relevance (for which type of stakeholder is this important):
Service providers, users, employers, suppliers, market surveillance authorities.

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, ...)**:**

Required participation in the work (type of expertise needed) :
Experts on various risks for PPE.

Additional comments / information :

Proposal INT- 3

Title: Test methods and performance criteria for personal protective ensembles
Scope: Development of test methods for compatibility for full ensemble testing for evaluating functional performance and comfort under different hazards, taking into account functional requirements, design and sizing
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☒
- Service	☐	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :
Test methods for full ensemble testing are few and not well verified including compatibility.

Market relevance (for which type of stakeholder is this important) :
Notified bodies, manufacturers, suppliers, users

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☐ yes ☐ no ☒ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:**

Required participation in the work (type of expertise needed):
Experts on different parts of PPE, ergonomics & comfort testing.

Additional comments / information:
Proposed are advanced instrumented manikin test on full ensembles, which can be combined with controlled human physiological stress and ergonomic (comfort) to validate the manikin measurements and provide improvements for design and materials. Producing the “design coefficients” that can be used to evaluate performance e.g. based on garment length, stiffness, position of openings, size (in relation to body form)

Proposal SUS- 7

Title: Fit for use testing of PPE/PPS during their lifecycle through non-destructive tests (series of documents)

Scope: Test methods that can be used during the life of the PPE/PPS to evaluate the fitness for use. The methods need to be quick, easy, non-destructive and possible to perform by trained users and not in specialised laboratories

Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☐	- Characteristics	☐	- technical specification	☐
- Service	☒	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):
Currently most of the tests to ensure fitness of use of PPE are destructive. There is a need to develop simple and cost effective testing for end users that are not destructive, but better that just visual inspection.

Market relevance (for which type of stakeholder is this important) :
Focus on end users to ensure only use of PPE that are “fit for use”

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:**
See current product standards.

Required participation in the work (type of expertise needed) :
Usual TCs and WGs in respective areas

Additional comments / information :

CEN-CLC BT WG 8

Protective textiles and personal protective clothing and equipment

Proposal COM- 3

Title: Tests for ergonomic function and comfort of PPS

Scope: Develop laboratory test methods for sensorial comfort, dexterity, sweat absorption, material stiffness and friction. Develop guidelines for ergonomic/comfort testing, as well as objective pass/fail criteria for the above mentioned methods.

Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☐	- Guidance	☒	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :

Protection encumbers dexterity and effective functioning. Reliable laboratory test methods are needed for sensorial comfort, dexterity, sweat absorption, material stiffness and friction. Guidelines for ergonomic/comfort testing need to be developed, as well as objective pass/fail criteria for the above mentioned methods

Market relevance (for which type of stakeholder is this important) :

These tests are of importance to all stakeholders: users, manufacturers, procurers and test laboratories

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☒ yes ☐ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:**

Required participation in the work (type of expertise needed) :

Experts on comfort and ergonomics testing, PPE.

Additional comments / information :

Proposal COM- 4

Title: Computer based predictive models for ergonomics and comfort
Scope: Development of standard analytical models that can serve as tools to assist the development of new materials and equipment.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☒	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard) :
Analytical models that can serve as tools to assist the development of new materials and equipment. They could forecast the effects of design options on the resulting protection and comfort on ensembles for emergency response. These models would increase our understanding of heat and mass transfer and the influence on protective properties. There is a need for validated open-source models that can be used in standardisation.

Market relevance (for which type of stakeholder is this important) :
Of major importance to manufacturers of PPE. These models could significantly reduce the cost of product development and time-to-market.

Priority	**Need for harmonization**
☒ high ☐ medium ☐ low	☐ yes ☐ no ☒ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, ...) **:**

Required participation in the work (type of expertise needed) :
Experts on modelling of materials and PPE.

Additional comments / information :

Proposal COM- 5

Title: Models for predicting comfort and ergonomic performance
Scope: Development of validated (open source) models to predict the performance and ergonomic and comfort aspects of PPE, PPS and ensembles
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☐	- Guidance	☒	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):
The development of a validated virtual engineering model will permit to predict how thermo-physiological comfort of protective garments will change under the influence of design issues and fabric selection. This model will be a useful tool for fast and cost effective product development avoiding the production of too many needless physical prototypes

Market relevance (for which type of stakeholder is this important):
Of major importance to manufacturers of PPE. These models could significantly reduce the cost of product development and time-to-market.

Priority	Need for harmonization
☒ high ☐ medium ☐ low	☐ yes ☐ no ☒ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, ...)**:**

Required participation in the work (type of expertise needed):
Experts on modelling of materials and PPE

Additional comments / information:

CEN-CLC BT WG 8

Protective textiles and personal protective clothing and equipment

Proposal INT- 4

Title: Minimum requirements for the knowledge of experts on PPE/PPS Training

Scope: Setting a European standard for the minimum knowledge of the different stakeholders will increase the level of professionalism and harmonisation throughout Europe.

Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☐	- Requirements	☒	- standard	☒
- System	☐	- Characteristics	☐	- technical specification	☐
- Service	☐	- Guidance	☒	- technical report	☐
- Interface	☒	- Test method	☐	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):

Setting a European standard/TR/TS for the minimum knowledge of the different stakeholders will increase the level of professionalism and harmonisation throughout Europe.

Market relevance (for which type of stakeholder is this important):

End users, safety managers, suppliers, service providers, authorities

Priority	Need for harmonization
☐ high ☒ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, ...)**:**

- Current and future SUCAM and relevant standards
- User information
- Directives and requirements

Required participation in the work (type of expertise needed):

SMEs, end users and manufacturers

Additional comments / information :

Proposal COM- 6

Title: General standard with test methods for ergonomics and comfort
Scope: Standard covering all aspects of ergonomics and comfort that can be referred to in present PPE standards.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☐	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):
This standard will be a relevant reference document for testing ergonomics and comfort in PPE.

Market relevance (for which type of stakeholder is this important):
This standard is of importance to users, manufacturers, procurers and test laboratories

Priority	**Need for harmonization**
☐ high ☒ medium ☐ low	☐ yes ☐ no ☒ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...)**:**

Required participation in the work (type of expertise needed):
Experts on ergonomics and comfort, PPE

Additional comments / information:

Proposal COM- 7

Title Tests for thermal protection in sub-flashover environments and prolonged duration.
Scope: Suitable standardised test methods for determining heat protection, thermal load and the rate of protection and discomfort during prolonged exposure to low(er) levels of (radiant) heat.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☐	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):
There are at the moment no suitable standardised test methods for determining heat protection, thermal load and the rate of discomfort during prolonged exposure to low(er) levels of (radiant) heat.

Market relevance (for which type of stakeholder is this important):
Test laboratories and manufacturers

Priority	**Need for harmonization**
☐ high ☒ medium ☐ low	☐ yes ☐ no ☒ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...)**:**

Required participation in the work (type of expertise needed):
Experts on thermal protection, thermal load, comfort, PPE.

Additional comments / information:

Proposal INT- 5					
Title: Tests for robustness and durability of PPS (ensembles) for long lasting operations, including rough terrain (e.g. USAR) **Scope:** Standard with minimal requirements for robustness and durability of all separate items of a PPS (PPE/ensembles/systems) for long lasting operations. Evaluation of how deterioration of protective ensembles during long-term use in long lasting operations in rough terrain affects ergonomic and comfort. Performance requirements for physical protection and durability need to be addressed with focussed research efforts **Keywords** (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)					
Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☐	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		
Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard): This standard does not exist and is important for evaluating the “fitness for use” of the PPE**.**					
Market relevance (for which type of stakeholder is this important): Manufacturers, suppliers, users					
Priority ☐ high ☒ medium ☐ low		**Need for harmonization** ☐ yes ☒ no ☐ not clear for moment			
Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:**					
Required participation in the work (type of expertise needed) : Manufacturers, suppliers, users					
Additional comments / information :					

Proposal INT- 6

Title: Methods to translate material tests into PPS performance levels
Scope: Develop methods and models showing the relationship between materials test and PPE/PPS performance level towards protection and including ergonomics and comfort.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☐
- System	☒	- Characteristics	☒	- technical specification	☒
- Service	☐	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):
Currently there is no systematic way to correlate materials performance testing with the real life performance of PPE, including protection as well as ergonomics and comfort.

Market relevance (for which type of stakeholder is this important):
Test laboratories, standardisers, manufacturers

Priority	**Need for harmonization**
☐ high ☒ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:**

Required participation in the work (type of expertise needed) :
Experts on materials testing, PPE, modelling.

Additional comments / information :

Proposal COM- 8

Title: Virtual test methods of comfort and ergonomics of PPE/PPS
Scope: Development of standards for virtual testing methods of comfort and ergonomics of PPS that are validated on humans and can predict ergonomics and comfort on personal protective systems without using human test subjects.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☒	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):
Virtual testing using tools that are validated on humans and can predict ergonomics and comfort on personal protective systems without using human test subjects have the advantage of being more cost efficient than actual trials on human subjects.

Market relevance (for which type of stakeholder is this important):
Relevant to all stakeholders, in particular manufacturers. Reducing costs of product development.

Priority	**Need for harmonization**
☐ high ☒ medium ☐ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, ...) **:**

Required participation in the work (type of expertise needed) :
Modelling, PPE, ergonomics and comfort.

Additional comments / information :

Proposal INT- 7

Title: Modification of ISO 20471 for High-VIS clothing to allow for the use of LED lamps
Scope: Requirements of the standard need to be revised to be applicable to other materials including active lighting.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☐	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):
The current standard does not allow for the evaluation of High VIS clothing using active lighting.

Market relevance (for which type of stakeholder is this important):
A modified standard would simplify assessing the conformity of novel developments in the field of smart PPE/PPS using e.g. active lighting. Currently this has to be done without having a suitable test standard, as a result costs are higher.

Priority	**Need for harmonization**
☐ high ☒ medium ☐ low	☐ yes ☐ no ☒ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...)**:**

Required participation in the work (type of expertise needed):
Experts in High-VIS clothing, evaluation of visibility of active lighting (lamps e.g. for bikes, cars)

Additional comments / information:
This proposal is linked to example 4 of Annex 4**.**

CEN-CLC BT WG 8

Protective textiles and personal protective clothing and equipment

Proposal INT- 8

Title: Tests for performance evaluation of smart materials and solutions

Scope: Re-evaluation of test methods and necessary adaptations when using smart materials in place of standard materials.

Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☐	- Characteristics	☒	- technical specification	☐
- Service	☐	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):

The use of smart materials can give the PPE novel properties, which not necessarily are covered by current test methods. In these cases existing standards may require adaptations or new standards must be written.

Market relevance (for which type of stakeholder is this important):

Having more general test methods which allow for testing new types of materials will simplify the conformity assessment process, reducing costs.

Priority	**Need for harmonization**
☐ high ☒ medium ☐ low	☐ yes ☐ no ☒ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...)**:**

CEN/TR 16298 “Textiles and Textile Products – Smart Textiles – Definitions, categorizations, applications and standardization needs”.

Required participation in the work (type of expertise needed):

This type of work items belong to the scope for CEN TC 148 WG31 Smart Textiles.

Additional comments / information :

CEN-CLC BT WG 8

Protective textiles and personal protective clothing and equipment

Proposal COM- 9

Title: Test methods & virtual testing for the development of 'Apps' for estimating ergonomics and comfort of PPE

Scope: Development of test methods and virtual testing which can be used for developing smartphone applications (apps) for quickly evaluating the performance of PPE.

Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☐	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☒	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):

Give the users simple tools to screen different PPE equipment and quickly identify the PPE more interesting for further evaluation**.**

Market relevance (for which type of stakeholder is this important):

Pre-screening before in depth evaluation will allow saving costs when searching for new PPE.

Priority	**Need for harmonization**
☐ high ☐ medium ☒ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...)**:**

Required participation in the work (type of expertise needed):

Experts on comfort and ergonomics, developing test methods and developing apps.

Additional comments / information :

Proposal INT- 9

Title: Use of Auto-ID-Systems for Life Cycle Data Management of PPE
Scope: Use of existing auto-ID technologies for recording life-cycle data from various PPE regarding time-dependent features.
Keywords (Descriptors) characterising the scope (multiple ticks are possible and/or necessary)

Proposal concerns :		Proposal sets :		Proposed format :	
- Product	☒	- Requirements	☒	- standard	☒
- System	☒	- Characteristics	☒	- technical specification	☐
- Service	☒	- Guidance	☐	- technical report	☐
- Interface	☐	- Test method	☐	- other (e.g. CEN Guide, CWA)	☐
		- Terminology etc.	☐		

Justification and impact on smart PPE (problems or difficulties to be solved by the standard, impacts and benefits to be expected from the standard):

Market relevance (for which type of stakeholder is this important) :
Users, authorities, suppliers, manufacturers

Priority	**Need for harmonization**
☐ high ☐ medium ☒ low	☐ yes ☒ no ☐ not clear for moment

Listing of relevant existing documents supporting the proposal (scientific reports, existing national standardisation documents, studies, ...) **:**

Required participation in the work (type of expertise needed):
Experts on RFID technology, users, manufacturers, authorities

Additional comments / information:
Prof. Helmus from the Bergische Universität Wuppertal has conducted a project between 2010 and 2011 titled “Using Auto-ID-Systems for Life Cycle Data Management of Personal Protective Equipment”. The standardization workgroup “RFID in PPE” that is listed in DIN Standardization Committee found that auto-ID technologies could be the optimal solution for recording life-cycle data from various PPE regarding time-dependent features. The work packages of the project are “identification of time-dependent PPE features”, “identification of useful auto-ID-system”, “identification of suitable auto-ID-system components” and “evaluating commercialization possibilities and documentation of the results” [Helmus, 2011]. It is recommended to introduce this work at DIN level to CEN/CENELEC for further development on European level.

Annex 4: Examples of integrated technology

As discussed under 3.1 it is beyond the capabilities of BTWG8 to identify all current and future and possible future needs for Personal Protective Equipment and systems with integrated (novel) technology.

In order to assist stakeholders with how to address these needs, examples of current developments (mostly on research level) are given, demonstrating the existing and lacking standardisation related framework.

Example 1: Personal protective garment connected via an interactive unit to the machinery the user is protected from and which will cut off the machinery when danger arises.

This personal protective garment contains an interactive unit comprised of an integrated sensor, a signal processing device and a signal transmitting unit. This garment is protecting the user from a piece of equipment, which is in communication with the garment via a wireless signal. If danger from the equipment arises (e.g. by coming too close to the garment) the equipment is cut off immediately.
As a result, the garment as such (without the interactive unit) will not need to provide the protection on its own. This means that if the interactive unit is 100% reliable the garment itself can be designed less protective.

Modifications in testing protocol:
This garment can be classified as PPS of the type where only the complete system will ensure the safety of the user, the individual parts will not. Consequently it is necessary to test the complete system (garment with integrated interactive unit + equipment) to correctly assess its capability of protecting the user.

Conformity assessment – applicable Directives:
Next to the Directive 89/686/EEC Personal protective equipment other directives apply, including Directive 2006/42/EC Machinery and Directive 2004/108/EC Electromagnetic compatibility (EMC), with additional Directives applying depending on the technology used and the specific application settings.

Examples for demonstrators with a high potential for being developed into product prototypes:
1) Chain saw protective trousers – Interact with chain saw.
2) Laser protective gloves/clothing (drilling, cutting) – interact with the laser.
The respective references can be found in Annex 11.

Example 2: Man down unit in chemical laboratory, built into the lab coat and wireless emergency notification

This personal protective system consists of a ‘man down unit’ for use in a chemical laboratory (controlled environment), which is built into lab coat. It detects that the user has fallen/ no longer moves and has the capability to transmit this information to a remote location, e.g. a central switch board. This system is envisioned as a combination of lab-coat and a currently available man-down unit.

Modifications in testing protocol:
The electronics hardware needs to be tested towards water/chemical resistance and washability.

Conformity assessment – applicable Directives:
As applicable for the man-down unit (Directive 94/9/EC Equipment and protective systems intended for use in potentially explosive atmospheres - ATEX), wireless data communication (e.g. Directive 2004/108/EC Electromagnetic compatibility (EMC) and Directive 2002/58 EC Privacy and Electronic Communications.

Example 3: Garment with a monitoring unit to measure physiological data of fire fighters and transmit these wirelessly

This garment is a modified firefighters garment with an integrated monitoring unit consisting of a sensor, signal processing device and signal transmitting unit. It measures the physiological data of firefighters (e.g. skin temperature, respiration, heart beat) and transmits these to 1) a remote control unit where a controller monitors the fire fighter and 2) to a display visible to the firefighter. The purpose of this monitoring unit is to assess whether the firefighter can stay on site or needs to leave.
This system is rather complex and before determining the standardisation needs and the necessary conformity assessment the following important issues will need to be considered:

- The threshold for leaving will be strongly dependent on the individual fire fighter and therefore needs to be calibrated per individual
- Reliability is extremely important (life threatening)
- Measuring physiological data and relying on them to assess the health of a person falls under the medical Directive, which requires specialized testing
- Concerning the processing and the interpretation of the data the available resources and capabilities (power, processor, transmitter, human observer) need to be considered
- Data has to be presented so that it can be visualised quickly as well as easily interpreted and followed. Possibly acoustic warning signal should be included.
- Data protection should be insured (block accessibility to third parties, personal data protection)

Conformity assessment – applicable Directives:
In the above example a variety of Directives next to the Directive 89/686/EEC Personal protective equipment apply, including Directive 2004/108/EC Electromagnetic compatibility (EMC), Directive 94/9/EC Equipment and protective systems intended for use in potentially explosive atmospheres (ATEX), 93/42/EEC Medical Devices, Directive 2002/58 EC Privacy and Electronic Communications,

Example 4: High VIS clothing using integrated LED's to replace the reflective stripes

The current test method (EN 471:2007, as of October 1, 2013 replaced by ISO 20471:2013) is based on measuring (1) the retro-reflection of the reflective tapes under different angles (night use) and (2) the fluorescence of back ground material (day use). One uses a specified light source in a specified apparatus and the retro-reflected light is measured by a specified detector. The

fluorescence of the background material is evaluated by measuring the colour coordinates (chromaticity coordinates) and luminance factor.
Testing is performed on samples before and after simulated wear (including abrasion, flexing, folding at cold temperatures, temperature variation, rainfall, washing and dry cleaning).
Additionally it is required that there is a defined ratio between retro-reflective material and the background material (3 different classes). There is an option to have a combined retro-reflective and fluorescent material, as long as the surface area ratio condition is met.
Current developments of novel High-VIS clothing are using LED's to provide active lighting and enhance extra safety at night (no longer dependent on reflecting an external light source).
This type of High-VIS clothing will not fulfil the current standard as it does not need to contain retro-reflective material (given the lights are strong enough).

Modifications needed for the testing protocol:

- The test method in ISO 20471:2013 needs to be modified as to assess the **visibility of the wearer**, where the visibility is related to the amount of light being emitted from the clothing no matter if produced by active lighting or retro-reflected.
- The lights need to fulfil requirements for lights on the road (white/yellow in front, red in back)

Annex 5: Examples of test methods that need to be revised due to a lack of validation

Due to a lack of funding several quite important test methods cannot not be properly validated for accuracy or reproducibility. As a result performing the tests and results among and inside laboratories can have a strong variation and the classifications based on these test methods are unreliable (see also Section 3.2).

A major issue identified by the CEN PPE Consultants and several CEN TC's & WG's is the present lack of confidence in certain test methods. This is the case for both individual tests and also for more complex testing, for instance on complete garments or ensembles or material assemblies. A comprehensive evaluation and scoping study needs to be conducted to identify those existing test methods that require revision and/or replacement by far more reproducible test methods that will ensure the confidence of manufacturer's, notified bodies, end users and National Standards Bodies and will also better reflect the use of the PPE.

Neither the current test methods nor virtual simulations of intervention situations are accurate enough to simulate realistic situations and do not show well agreement between each other. Limitations in the known tests for thermal protective performance are:

- adequate thermal sensors and a variety of skin burn translation models,
- test methods and performance criteria for evaluating the potential for stored thermal energy and moisture absorption in materials (risk on skin burns),
- effect of moisture in the different layers of the assembly and the impact on thermal protection (particularly sub flashover conditions),
- ability to retain strength in exposure to flash fire conditions, instrumented manikin for evaluating protection in a wide range of different thermal conditions and postures.

Some examples are:

- Test method EN ISO 6530 on resistance to penetration of liquids & EN ISO 9185 on molten metal splash. Here the issues of consistency need to be resolved by conducting round robin trials and developing an improved test set-up (including new thermal sensors.
- The test method EN 388 has had issues from both a reproducibility and comparability for the higher cut performance levels for gloves. Problem is that the knife can become more or less easily blunted, depending on the material tested, so that the reproducibility & consistent interpretation of the test results are compromised. Also the abrasion test method is being hindered by laboratories not being required to buy the same abrasive test material which results in differences in test results among laboratories.
- Currently EN 14325 is used for testing the chemical permeation of PPE used for applying liquid pesticide, but it is not sufficiently clear on how to test highly toxic chemicals: "Where testing is performed against chemicals known to have high levels of skin toxicity, a lower cumulative permeation mass shall be specified and the time to reach that cumulative permeation mass shall be reported with the notation that a different cumulative permeation mass is used for the reporting of chemical permeation resistance." Clearly the test method aims at reducing the risk for the laboratory technician performing the testing by recommending using lower amounts

of toxic chemicals. No guidance is given though on how to correlate the test results to the higher exposures that can be encountered during use of this type of PPE. In order to correctly asses the permeation behaviour of this PPE under conditions of use the following is needed

- The correlation between levels of toxicity of chemicals and the permissible exposure through the PPE needs to be established.
- Establish this correlation for gaseous, liquid and/or particulate exposure.
- Ensure that all parts of the PPE ensemble (clothing, footwear, gloves, etc.) meet similar, if not identical, minimum requirements for the same hazard.

Additional problems due unreliable or non-existing (ensemble) testing

- ISO 13506 for "Protective clothing against heat and flame" (mannequin test on complete set of garments) needs significant improvement to be more reproducible and to meet the essential requirements of the directive from a burn prediction perspective. To achieve this initial steps in the ISO TC 94 SC13 has been taken by splitting the standard in two parts "Part 1: Test method for complete garments – Measurement of total transferred energy using an instrumented manikin" and "Part 2: Skin burn injury prediction – Calculation requirements and test cases". This Thermal Manikin Test for clothing requires further work during its revision, before it can be introduced into the EU as a possible CEN Standard. In addition, this test equipment could be more broadly used to test not only single layer garments, but also multilayer and full ensembles (including gloves, footwear, head protection, ...). This would require revision of the manikin, the sensors and their placement.
- The new ISO 18640 Sweating Torso test method "Protective clothing for fire fighters – physiological heat load – Part 1 Measurement of coupled heat and mass transfer with the sweating torso", and "– Part 2 Determination of physiological heat load caused by protective clothing worn by fire fighters" has a high potential for testing and ranking garments and ensembles. This is an essential requirement under the directive that has never been fully addressed. As of today this type of testing is limited by ethical issues and conclusions that can be drawn from human wear testing towards comparing different garments and ensembles. This standard also has potential for applying it to other types of PPE such as for chemical protection, emergency response or particulate protection.
- Currently a standard is being developed for evaluating the inward leakage of hazardous substances for PPE. The aim is to also include nano-sized particles. A test method exists, but the validation hereof is hindered by the necessary investment into new equipment: before the test method is validated laboratories are not willing to invest, which in turn makes validation by inter-laboratory testing impossible.

Annex 6: Literature study on life cycle cost

INTRODUCTION

Different parts of personal protective equipment (PPE) provide a large contribution to protect the user being damaged. **However, time- and usage-dependent characteristics of PPE are of great importance for their useful life span.** For PPEs, the cheap one when procuring does not mean the cheap one when using. Workers who are the user of PPEs in their works are risking their lives. Regarding to this, the importance of fit for purpose of PPE is understood. The important one is not having the lowest price, but having the longest useful life span. The expensive PPEs on the time of procurement will most probably last longer and perform better. However, it has to be noted that this is very dependent on the maintenance and usage conditions of PPEs.

WHOLE LIFE COST OF PPE

Determining the whole life cost (WLC) involves determining the life cycle assessment (LCA) of a product. LCA is considered to be the suitable scientific base for an environmental product declaration and labelling to be applied to communicate towards consumer. However, LCA study is a very **complex** study. To carry out a LCA study, *firstly product specifications i.e. quality aspects of that products should be defined*. If LCA study is performed by a researcher without knowledge of the product (in this case personal protective equipment), the definitions are generally missed. For instance, results show inappropriate functional unit like kg for textiles [Nieminen et al., 2007]. Due to complexity of LCA results, inventories (LCI or indicators) or simplified LCA may be applied in practice. In the scope of COST 628, LCI database was developed in Finland and repeated for UK in Bolton Institute for conventional textiles and their processes, for example, cotton growing, weaving and finishing, laundering and integrated life cycles. Another **complexity** in LCA studies of textiles, *the results from individual LCA studies have only limited significance for a life cycle assembly of textiles.* Particularly quality aspects show too many diverging parameters. Even the same fabric produced with different processes technology with their different formulas and so different impacts to environment. Research showed that regarding a fabric's life cycle, the environmental impacts in the use phase are much higher than in finishing [Nieminen et al, 2007]. When trying to find PPEs useful life span, complexity is increased. Because they are end products, in addition to production conditions, using conditions has also effect on life of PPEs. For example, exposure conditions are important factor for their life. Cost of

Prof. Helmus from the Bergische Universität Wuppertal had conducted a project between 2010 and 2011 titled "Using Auto-ID-Systems for Life Cycle Data Management of Personal Protective Equipment". The standardization workgroup "RFID in PPE" that is listed in DIN Standardization Committee found that auto-ID technologies could be the optimal solution for recording life-cycle data from various PPE regarding time-dependent features. The work packages of the project are "identification of time-dependent PPE features", "identification of useful auto-ID-system", "identification of suitable auto-ID-system components" and "evaluating commercialization possibilities and documentation of the results" [Helmus, 2011].

Determining whole of life cost, one take into account the initial costs of the PPE, maintenance costs in a year including repair and/or early replacement, protection levels of PPE and then divided by the expected life obtained by life cycle analysis. These calculations give an idea about whole life cost of PPE [Annex 8]. In addition, when smart systems are used in PPEs, their life in PPEs extreme conditions should be taken into account, too.

Besides, cost of burn injury may be also taken into account for the calculation of whole of life costs of PPEs. This increases the personal cost for an employee at different rates. Because the injured person may need prolonged treatment and rehabilitation and may not be able to return to work, may lost his/her quality of life or may become depressed and his or her personal and family relationships may be negatively impacted. In a study, the thermal hazards in electric arc injuries were investigated and regarding medical, indemnity and vocational costs, total costs changed between 45,000$ - 1,597,000$ between 1993-1995. They also classified the costs of injuries, according to the intensity of exposure conditions describing the injury [Doan et al, 2003].

STANDARDS and USEFUL LIFE SPAN OF PPEs

National and international standards that giving performance characteristics like ISO, EN, NFPA, BS, AS/NZS, DIN etc. include test methods for properties of protective clothing like mechanical properties (tear strength, breaking strength etc.) and thermal properties (flame spread, radiant heat protection, convective heat protection, etc.), together with dimensional stability. They are applied to products for procurements. These test can show indication about the performance of protective clothing in the use. In addition to this, abrasion resistance may be applied to determine the wear properties. However, it should not be forgotten that these results only give opinion about theoretical performance. Use performance of the fabrics can be change by using, cleaning, storing and maintaining conditions. According to performance in the for example AS/NZS 4824-Protective Clothing for Firefighters- Requirements and test methods for protective clothing used for wild land fighting (ISO 15384:2003), the fabrics can be divided into three categories as the fabrics would last approx. 2-3 years, the fabrics would last 3-4 years and the fabrics would last 4-5 years [Annex 8]].

According to NFPA 1851, the life span of parts of personal protective equipment is 5-10 years. However, as the most wear off part of firefighters clothing, turnout gear and gloves is needed to be changed shorter than 10 years. Most of the PPEs are degraded from UV light, chemical exposure and washing. Gloves may have more contaminant chemicals and products of combustion than the rest of PPE. Helmets need to be changed because of the continued heat damage. The protection property from falling objects and tools are damaged, therefore hood can be changed also in shorter time than 10. Hoods soak up a lot of smoke and soot and so they may be changed shorter than 2 years. There is also another point of view that the users, if they do not know how to properly use the PPEs, they may affect also the useful life span of the parts of PPEs. Due to this, users must be trained to use properly their PPEs, to fit and wear them correctly and to know what its limitations are. For some parts of PPEs like helmets, some basic information may be sufficient for users. On the other hand, for example for laser eye protection or anti-static footwear, they need adequate understanding of the principles behind them to use safely these products [myfirefihgternation, 2013; NFPA1851, 2008; PPE at work, 2005].

The realistic life span of PPE’s is dependent on the type and amount of field use that each separate garment has been exposed to. Additional effective factors are frequency of maintenance, storage conditions, exposures and other issues that out of the control of manufacturer, supplier or user. Repeated heat exposure when intervening in fires as well as decontamination procedures after usage both cause changes in the properties of the cloth. Due to care and maintenance conditions, some PPEs seem to be older but they may be still useful in fact, although the others may be destroyed because of the intense exposures after the first usage. There is almost no information about life of protective equipment and determination of useful life of a protective garment is under the responsibility of end-user. **For example, the firefighter's clothing is a layered structure. Therefore, all of the layers should be investigated in**

its exposure conditions. Discoloration is one of the indicators of damage. If any part of PPEs has changed color, this shows that, that part of PPE will not protect at the same level as before [www.globalturnourgear.com, 2013; Rossi et al., 2008]. Regardless of production time, all ensembles of the protective equipment should be inspected in details and routinely by a safety officer or authority having jurisdiction. Since the wearer cannot see the difference between an effective and ineffective PPE. **In addition to this,** normally it is almost impossible to understand the level of hazard in the PPEs without performing destructive testing like vertical flammability or convective heat transmission and this is dangerous [DuPont Technical Bulletin, 2013; Kutlu & Akşit, 2013; Mansdorf, 2013]

Besides being complex, in the standards there may be life span information with a given type of exposure at a given time and flux, giving details of hazard level of the parts of PPE.

CONCLUSIONS

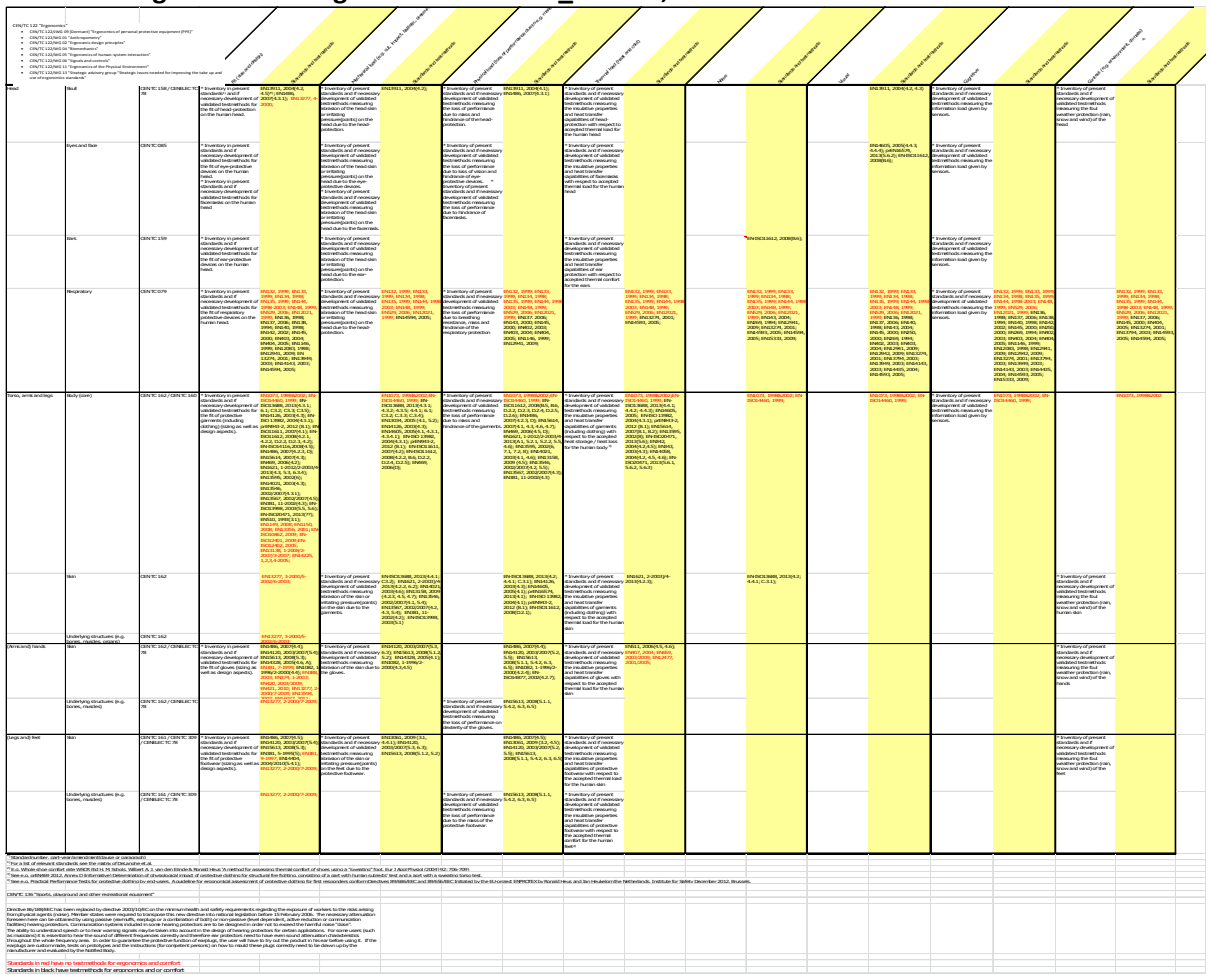
Budgets are very limited for procurements and producers are under pressure to find cost saving products wherever possible. However, if cost at the outset is to be the determining factor, there may be a probability that manufacturers believe the end users prefer to choose the cheapest products and this may lead them to produce products meeting the minimum performance requirements in the Standards for their profits. However, it should not be forgotten by the all stakeholders (producers, end-users, buyers etc.) that class leading products allied to protection, innovation, quality control, durability, comfort and breathability, and customer care, all have importance for protection. For this manufacturers should maintain their high standards [Annex 8, Hainsworth, 2013].

The responsible for the procurements of PPEs in use sectors should be trained for the right point of view, to have an understanding of risk assessment and so he/she can make the right call. Determining the real cost, i.e. value of PPEs, the motto should be “to ensure users will be protected by PPEs with the best possible standards of protection and with the best durability and will able to turn back to their home safely.” [Hainswoth, 2013]

CEN-CLC BT WG 8

Protective textiles and personal protective clothing and equipment

Annex 7: N70 ergonomic testing in PPE-standards_revised, 2013



Annex 8: N65 table garment costing

Fabric description	Jacket Size 102R MF Cost ($)	Trouser Size 92R MF Cost($)	Total Garment MF Cost ($)	Maximum life expectancy (years)	Average Cost spread over whole of life ($)
1	124.80	88.50	213.30	2-3	71.10
2	120	85	205	2-3	68.33
3	115.56	81.76	197.52	2-3	65.84
4	109.44	77.30	186.74	2-3	62.24
5	130.08	92.35	222.43	2-3	74.14
6	181.08	129.54	310.62	4-5	62.12
7	209.88	154.54	360.42	4-5	72.08
8	227.76	163.58	391.34	4-5	78.26
9	129.12	91.65	220.77	3-4	55.19
10	177.60	127.00	304.60	4-5	60.92
11	145.20	103.38	248.58	4-5	49.71
12	159.12	113.38	272.65	3-4	62.14

Annex 9: List of participants in BT WG 8 and the different Task Groups

Function	Name	NSB	Task group
Secretary	Karin Eufinger	NBN.Experts	Chair TG 1, 2
Chair	Henk Vanhoutte	ESF	Chair TG 4, 3
CCMC	Marie Poidevin	CCMC	-
	Vicente CAMBRA	AENOR.Experts	1, 2, 3
	Laurent Houillon	AFNOR	-
	Mohamed Trabelsi	AFNOR	-
	Christophe Didelot	AFNOR.Experts	1, 2, 3, 4
	Christine Sohier	AFNOR.Experts	1, 2, 3
	Jean-Claude Cannot	AFNOR.Experts	3, 4
	Eddie Levio	BSI	-
	James Berry	BSI	-
	Maxi Brown	BSI	2, 3
	Brian Hansford	BSI.Experts	1, 2, 3
	David Frodsham	BSI.Experts	3
	Jim Findlay	BSI.Experts	4
	Richard Graveling	BSI.Experts	3
	David Matthews	BSI.Experts	Chair TG 2, 1, 4
	Andreaa Gulacsi	CCMC	-
	Karolina Krzystek	CCMC	-
	Fred Foubert	CEN Consultant PPE	-
	Damir Zorcec	DIN	-
	Gerhard Imgrund	DIN	1
	Guido Höppner	DIN	-
	Sebastian Lentz	DIN	3
	Barbara Schrobsdorff	DIN.Experts	2
	Dirk Wenzel	DIN.Experts	1
	Edith Claßen	DIN.Experts	3
	Jan Beringer	DIN.Experts	1
	Petra Klein	DIN.Experts	4
	Peter Heffels	DIN.Experts	1
	Sigfried Assmann	DIN.Experts	1
	Wolfgang Drews	DIN.Experts	3
	Helle Stålung	DS	-
	Henning Hansen	DS.Experts	2, 4
	Tina Sønderup Heinze	DS.Experts	2, 4
	Julio Cardoso	EC	-
	John Heppleston	EC	-
	Michael Thierbach	EC	-
	Robert Long	ETSA	4
	Mauro Scalia	EURATEX	-
	Alberto Bichi	FESI	1
	Dana Kremenakova	FESI	-
	Gilda Santos	IPQ.Experts	1, 2, 3, 4
	Pál Pataki	MSZT.Experts	3

Function	Name	NSB	Task group
	Pierfrancesco Valente	NATO NSA	-
	Alexandra De Raeve	NBN.Experts	3
	Andrew Proudlove	NBN.Experts	2
	Carine Luca	NBN.Experts	-
	Carla Hertleer	NBN.Experts	1, 2
	Christophe Veys	NBN.Experts	-
	Filip Jambon	NBN.Experts	4
	JimmyWuyts	NBN.Experts	1
	Jean Léonard	NBN.Experts	3
	Johanna Louwagie	NBN.Experts	1
	Joris Cools	NBN.Experts	3
	Rebecca Delanghe	NBN.Experts	3
	Tommy Verminck	NBN.Experts	3
	Vera De Glas	NBN.Experts	3
	Anneke Wentzel	NEN	-
	Anton Luiken	NEN	4
	Reinier Hoftijzer	NEN	3
	Ronald van Kampen	NEN	1, 2
	Stephanie Jansen	NEN	-
	Jan Heukelom	NEN.Experts	2
	Maurice Kemmeren	NEN.Experts	2
	Ronald Heus	NEN.Experts	Chair TG 3
	Joanna Mandziuk	PKN	-
	Grazyna Bartkowiak	PKN.Experts	3
	Saana Seppänen	SFS	-
	Carita Aschan	SFS.Experts	1
	Helena Mäkinen	SFS.Experts	1
	Björn Ericsson	SIS.Experts	3
	Ingvar Holmér	SIS.Experts	3
	Kalev Kuklane	SIS.Experts	3
	Ouri Nicolet	SNV	-
	Alfred Furrer	SNV.Experts	-
	Eric van Wely	SNV.Experts	2, 3, 4
	Helmut Eichinger	SNV.Experts	2, 3, 4
	Lukas Scherer	SNV.Experts	1
	Martin Camenzind	SNV.Experts	3
	Bengi Kutlu	TSE	4
	Massimo Bartolucci	UNI.Experts	3

Annex 10: List of relevant standardization committees (PPE and other)

The list below is not exclusive and reflects the current state of knowledge of CEN-CLC BTWG8 members and includes not only standardization committees working on PPE related items but also those which could address some of the standardisation proposals made in this report that cannot be related to the committees currently active in PPE related issues.

ISO

ISO TC 94 Personal safety -- Protective clothing and equipment

CEN

CEN TC 79 Respiratory Protective Devices*

CEN TC 85 Eye Protective Equipment*

CEN TC 158 Head Protection*

CEN TC 159 Hearing Protectors*

CEN TC 160 Protection against falls from height including working belts*

CEN TC 161 Foot and Leg protectors*

CEN TC 162 Protective clothing including hand and arm protection and lifejackets*

CEN TC 136 Sports, playground and other recreational equipment*

*Member of the PPE Sector Forum

CENELEC

CENELEC TC 78, Equipment and tools for live working*

Related

ISO TC 38 Textiles

ISO TC 94 Fire safety

CEN TC 205 WG 14 Surgical clothing and drapes, and medical face masks

CEN TC 248 Textiles and Textile products

- CEN TC 248 WG 9 Prioritisation of Research Topics
- CEN TC 248 WG 31 Smart Textiles

CEN TC 122 WG 5 Ergonomics of human-system interaction

CEN-CLC JWG PPE against electrostatic risks

CENELEC TC 210 Prioritization of research topics

CENELEC TC 106X Electromagnetic compatibility

ETSI TC SmartBAN

ETSI TC eHealth

Annex 11: Recent R&D and innovation projects with a potential link to standardization of PPE/PPS

EU FP7 projects:

1. SustaSmart - Supporting Standardisation for Smart Textiles.

Standardisation is crucial to exploit and commercialize smart PPE, construction materials and consumer goods, for all of these products have to comply with legal regulations. SUSTA-SMART will map, synthesise and prioritise the standardisation needs, work out a standardisation roadmap and present the input documents to the relevant European and international standardisation committees. More information is available at http://www.susta-smart.eu/

2. smart@fire - Integrated ICT Solutions for Smart Personal Protective Equipment for Fire Fighters and First Responders "

Continuously operating in perilous situations, firefighters need a solution to monitor, measure, interpret and act on the environment (persons, equipment & external conditions). The solution must combine safety and comfort, in all situations (buildings, forests, highways,...).

Based on an in-depth needs assessment, Smart@fire envisions the next generation Smart Personal Protective Systems for firefighters. Those integrated systems cover:

- Localization systems: determine position in relation to colleagues and hazards, in buildings, forests, …
- Data transfer and visualization: provide an intuitive dashboard to the remote coordinating officer
- Sensing: measure environmental parameters and firefighter's vital functions

More information is available at http://www.smartatfire.eu

3. IFREACT - Improved First Responder Ensembles Against CBRN Terrorism

European major cities continue to face the threat of terrorism and, in the near future, may be subject to a serious chemical, biological or radiological terrorist attack.

To adequately prepare for such an attack, IFREACT considers the development of state-of-the-art, protective clothing for European first-responders to be vital. Although the threat of terrorist attacks involving CBRE agents was the primary driving force for this project, it is not only man made threats that are an issue. Pandemic outbreaks, accidents and other incidents involving dangerous substances, also pose a significant threat to European society and present major challenges to first responders. IFREACT takes both kinds of threat into account in order to achieve its goal of developing pioneering personal protective equipment (PPE) systems. More information is available at http://www.ifreact.eu/

4. i-Protect - Intelligent PPE system for personnel in high-risk and complex environments

The main objective of the project is to develop advanced personal protective equipment (PPE) system that will ensure active protection and information support for personnel operating in high risk and complex environments in fire fighting, chemical and mining rescue operations.

At the same time the new PPE system will be ergonomically designed and fully adapted to end-users' needs as well as to working conditions. More information is available at http://www.ciop.pl/21160.html

5. PROSYS-Laser - Intelligent personal protective clothing for the use with high-power hand-held laser processing devices

PROSYS-Laser is dedicated to developing highly innovative "passive" and "active" laser protective clothing for use with hand-held laser processing devices (HLD) and curtains for use with automated laser machines, which are not available on the market today.

The major project objectives are: a) to open new markets for high performance PPE and its testing, especially encouraging participating SMEs to widen their product range and directly benefit from project developments and prototypes, b) to sustain the growth of laser technology by providing means for the safe use of innovative developments such as hand-held laser devices for material processing and high power lasers with high brightness, c) to minimize health risks for the operators of HLD and automated laser machines, and consequently to reduce the number of related accidents, d) to contribute to the standardization process regarding laser PPE and PPE testing procedures. More information is available at http://www.prosyslaser.eu/

6. SAF€RA: Coordination of European Research on Industrial Safety towards Smart and Sustainable Growth

This ERA-NET project aims at improving cooperation and coordination of national and regional research programmes addressing industrial safety and funded under the FP7 within the ERA-NET scheme (1.5 M€). More information is available at http://www.safera.industrialsafety-tp.org/ and http://call.safera.eu.

Other European funded projects

1. BRIDGIT

The aim of the BRIDGIT project is to bridge the gap between research and standardisation. To this end, 9 national standardisation institutes and the CEN-CENELEC Management Centre are working together to identify good practices in Europe, and to develop tools and methodologies to facilitate interaction between the research and innovation community and standardisation institutes.

This project is co-funded by the European Commission, DG ENTR and has a duration from Jan 2013 - Dec 2014. Further information can be found under

http://www.cencenelec.eu/research/BRIDGIT/Pages/default.aspx

National projects :

1. COVER - Clothing Comfort Virtual Engineering (Belgium)

The project aims at the development of a validated virtual engineering model that will permit to predict how thermo-physiological comfort of protective garments will change under the influence of design issues and fabric selection. This model will be a useful tool for fast and cost effective product development avoiding the production of too many needless physical prototypes. The project is supported by the research fund of University College Ghent.

2. ProCOM -Study on the impact of care and maintenance on thermo-physiological comfort of protective garments and workwear (Belgium)

Project supported by the Agency for Innovation by Science and Technology (IWT) Flanders

3. “HORST” - Chain saw protective trousers (Germany)

“Sensor based PPE for forestry work with dangerous machines and equipment at the example of a gasoline powered chain saw (Sensorbasierte persönliche Schutzausrüstung bei der Forstarbeit mit gefährlichen Maschinen und Geräten [Motorsägen]), financed by the German Ministry of Economics (AiF), AiF-Nr.: 16119N. More information available at

http://www.hohenstein.de/media/pdf/270-EN_16_14_Schnittschutzsystem_HORST_2011_3840.pdf

4. Firefighter Suits (Germany):

“Development of a physiological functional and industrial reprocessable Firefighter PPE under maintainance of the protective function and usability (Entwicklung einer physiologisch funktionellen und

industriell wiederaufbereitbaren Feuerwehrschutzkleidung unter Erhalt der Schutzfunktion und Gebrauchstauglichkeit)", financed by the German Ministry of Economics (AiF), AiF-Nr.: 16676N. More information available at

http://www.hohenstein.de/en/inline/pressrelease_26113.xhtml

5. PPE for Workplaces in Hot Environments (Germany):

"Requirement profiles, limit values and construction principles for PPE for hot environments in industry (Anforderungsprofile, Grenzwerte und Konstruktionsprinzipien für Schutzkleidungssysteme an wärmebelasteten Arbeitsplätzen der Industrie), financed by the German Ministry of Economics (AiF), AiF-Nr.: 16782N. More information available at

http://www.hohenstein.de/en/inline/pressrelease_8642.xhtml

6. Reprocessing of Flame Retardant PPE (Germany):

"Optimisation of care and durability of flame retardant PPE (Optimierung der Pflegbarkeit und Langlebigkeit Flammhemmender Textilien)", financed by the German Ministry of Economics (AiF), AiF, AiF-Nr.: 14311N.

Related mandates

1. Mandate M/487 EN Security

Thise Programming Mandate to establish security standards was performed in order to analyse the existing security standardization landscape, select priority sectors and develop standardization roadmaps for three selected security sectors to support EU policy on security:

- Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE);
- Border Security – automated border control systems (ABC), as well as biometric identifiers;
- Crisis Management/Civil Protection –communication interoperability and interoperability of command and control, including organizational interoperability, as well as mass notification of the population.

The work on Mandate M/487 EN was led by CEN/TC 391 'Societal and Citizen Security' of which secretariat is ensured by NEN (Netherlands Standardization Institute).

The project is co-funded by European Commission, DG ENTR.

The project finalized its final report (phase 2) on July 2013.

More information and the report can be found under http://www.cen.eu/cen/Sectors/Sectors/Security/citizens/Pages/default.aspx

Annex 12: Bibliography

Standards & related publications

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5. NFPA1851 – Standard on selection, care, and maintenance of protective ensembles for structural fire fighting and proximity fire fighting, 2008.
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12. ISO/TR 2801:2007 : Clothing for protection against heat and flame - General recommendations for selection, care and use of protective clothing
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14. CEN-ISO/TR 18690:2012 : Guidance for the selection, use and maintenance of safety and occupational footwear and other personal protective equipment offering foot and leg protection
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16. NFPA 1851 : PPE for FF for structural fires
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20. ISO 13506:2008 Protective clothing against heat and flame -- Test method for complete garments -- Prediction of burn injury using an instrumented manikin
21. IEC 61482-2:2009 Live working - Protective clothing against the thermal hazards of an electric arc - Part 2: Requirements
22. ISO/IEC 17043:2010 Conformity assessment -- General requirements for proficiency testing: Specifies general requirements for the competence of providers of proficiency testing schemes and for the development and operation of proficiency testing schemes. These requirements are intended to be general for all types of proficiency testing schemes, and they can be used as a basis for specific technical requirements for particular fields of application.

EC publications

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