TECHNICAL REPORT

D4.1: Report on accumulated evidence and final guidelines to mitigate heat stress of workers from the addressed key industries (agriculture, construction, manufacturing, transport and tourism)

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SUMMARY (overview of identified issues and screened solutions)

The present report shall provide the reader with an integrated overview including up-to-date, evidence-based and best-practise guidelines on how to maintain worker health and productivity during periods with increased heat stress. In the appendices we provide concrete examples of information material targeting specific stakeholders and recipients (ranging from policy makers to managers and individual workers) presenting the solutions and guidelines that we developed in parallel with, and following completion of, the previous work package (WP3, which included five reports on issues and identified solutions for each of the five Heat-Shield key industries; see https://www.heat-shield.eu/technical-reports for reports on construction, manufacturing, agriculture, tourism and transport). During WP4, the general and industry-specific guidelines were distilled into presentations that we delivered to key stakeholders within the specific industries who represented a wide variety of relevant occupations within the target industries, such as: workers (farmers, drivers, builders, etc), worker and union representatives, safety officers, company doctors, occupational hygienists, insurance providers, policy makers and politicians. We collected feedback from these stakeholders at each meeting regarding the feasibility, implementability and cost-effectiveness of our proposed heat stress solutions. The feedback was then conglomerated and organised to be able to extract common areas where the stakeholders felt information was lacking or further details were needed to describe and exemplify the recommended interventions. Following the feedback from the stakeholders, our guidelines were both expanded upon and revised to create updated advice based on the best available evidence and refined to meet the demands of those who will actually use these recommendations in real-life scenarios on a daily basis.

The primary points and main considerations are in summary:

1. A proper understanding of the negative effects of heat stress on worker health and performance is still largely lacking and novel and effective methods are required for disseminating critical information to the affected industries.
2. Even for those who believe that heat stress does negatively affect workers, solid step-by-step plans for what should be done to protect workers from heat stress are lacking and there is a need for readily accessible heat mitigation plans in the workplace.
3. Early-warning systems are becoming more prevalent and specifically tailored to individuals and these systems can be a simple and effective way to ensure workers and companies are prepared for when hot weather strikes; however, many people still are unaware of these warning systems and need to be informed about their use and existence.
4. Adding pre-planned breaks to the work day during periods of hot weather is a method that most stakeholders agree would be an effective and easy intervention to implement; however, delivery of clear and accurate information is needed to illustrate that these breaks will not reduce worker productivity, as many employers are initially sceptical of having their workers take more breaks, is critical.
5. Ensuring workers are adequately hydrated is extremely important. While many agree that this is an incredibly important point for workers' health, dehydration at the workplace is still rampant. Preliminary findings suggest as many as 70% of European workers arrive to work dehydrated and this will undoubtable affect their work performance. Meanwhile, employers in some sectors continue to encourage their workers not to drink during periods of hot weather for fear their workers will lose productivity with more frequent bathroom breaks. Hydration at work sites can be improved by establishing drinking stations indoors or giving workers water backpacks and other water carrying devices outdoors.

Alternatively, in outdoor settings, establishing “water caches” – areas known to workers where clean cool drinking water is stored – can be effective.

6. The establishment of rest areas, either air-conditioned rooms or areas with access to electrical fans and cool drinking water indoors or shaded, well-ventilated (and portable if necessary) rest areas for outdoor work was recognised by both researchers and stakeholders as an important method for combatting heat stress.
7. In some scenarios, heat stress may be effectively reduced by optimizing the clothing worn by the workers. Outdoors, this should include light-weight, light-coloured, loose-fitting, long-sleeved clothing made with materials that “breathe well”, as well as a hat in order to minimize the amount of skin exposed to solar radiation while maximizing heat lost to the environment. Indoors, loose, light clothing should also be worn, but – if the work environment allows – these clothes should expose as much skin to the open air as possible. If more sturdy protective clothing such as coveralls are required, mesh patches should be incorporated into the more protected areas of the clothing such as the armpits, behind the knees and elbows, and by the groin area to facilitate heat loss.
8. The knowhow, confidence, willingness to embrace, and resources to execute cooling interventions for workers varies greatly from company to company. Therefore, while it is important to provide information on more effective, yet more costly, cooling interventions for those who are interested, the primary focus for disseminating advice on cooling strategies should be on the interventions that have the best balance of effectiveness, economic cost, and feasibility.

With the above findings from stakeholder feedback in mind, simple dissemination materials were made which condensed our best-practise recommendations to the most important, cost-effective and feasible interventions and combined this information with the most important points about the effects of heat on worker health and productivity. Several versions were created to target specific industries, as well as different positions held within these industries from workers to owners. Additionally, a brief heat-defence plan was created that focuses primarily on the basics of what should be done to protect workers from heat stress and could be employed by any occupational firm, regardless of size and resources. These materials will be graphically optimized in subsequent work packages of the Heat-Shield project.

Section 1: Integrating and translating the industry specific guidelines

During WP3 of the Heat-Shield project, which extended from months 13 to 34, multiple solutions to combat heat stress were screened for the five target industries of interest to the Heat-Shield project: construction, manufacturing, tourism, transportation, and agriculture. These solutions were industry-specific and accounted for the unique challenges characteristic of each domain. For example, in agriculture, workers are often exposed to high ambient temperatures and humidity levels, with additional solar radiation when working in the fields during the middle of the day. Whereas in manufacturing, workers often need to wear protective equipment limiting the body's natural abilities to lose heat to the environment and have to work in close proximity to mechanical equipment that radiates large amounts of heat to the surrounding environment, thereby making heat stress a year-round issue as opposed to solely during the summer.

At the conclusion of WP3, the accumulated information on the five sectors were conglomerated into five industry specific reports that can be found on the Heat-Shield project website (https://www.heat-shield.eu/technical-reports). Subsequently, the information from these reports were transferred into a PowerPoint presentation (included in Appendix 1) and were presented during workshops to stakeholders from the five target industries. The workshop attendees represented a wide range of roles within their respective industries, including: workers, shop stewards, union representatives, company doctors, occupational hygienists, policy makers and legislators.

In order to standardize and quantify the feedback from these meetings, preliminary feedback documents were made, with sections presented before and after the meeting (see Appendix 2 for feedback documents). The first part of the feedback document was administered to the workshop attendees before the workshop in order to get an indication of: who was attending the meetings, how much experience they had in their given industry, how much of an issue they believed heat stress to be within their industry, and finally what plans procedures they were currently aware of prior to the information we presented in the workshops. Subsequently, the second part of the feedback document was administered to the attendees after the presentation of the workshop, in order to receive feedback on whether the quality of the interventions proposed by the Heat-Shield team was acceptable, whether the industry representatives believed the presented solutions were feasible from an economic and implementation perspective, whether the interventions were likely to be adopted, and finally, whether the industry representatives believed the interventions would be adopted by employers and if not, why not. The feedback document also allowed for the industry representatives to state whether they disagreed with the solutions presented or if they believed important interventions were missing and should be added to the material.

Following this initial round of "local" meetings, the presentations were updated to take into account the feedback received. The updated presentations were then delivered to individuals/organizations with national or international involvement/impact capacity, either through being legislators, policy producers, or part of large information dissemination networks.

With all of the feedback from the meetings undertaken throughout the duration of WP4, areas from WP3 that needed to be strengthened or altered were identified and outlined in this report. Additionally, dissemination materials that reflect the needs of the target industries, as identified by the stakeholders throughout the WP4 meetings, are included in the appendices of this report, with some directions for their use.

Section 2: Summary of 1st level local meetings

As discussed in section 1, the first meetings were carried out in accordance with the stated purpose of WP4 and are discussed below. In order to organize the workers' current knowledge of occupational heat stress and methods by which to manage the heat stress, questionnaires were created (Appendix 2). Descriptions of these meetings and the formalized feedback from the questionnaires are presented below, followed by a general summary of the types of feedback received from the meetings.

Florence, Italy 2018

This meeting was undertaken in Florence, Italy on May 30th, 2018. Feedback from the workshop was collected from 11 people, who were responsible for health of occupational workers from both construction and agricultural industries. Types of positions held by these individuals included chief operative officer, occupational technician of the local health unit, occupational physician, manager and safety representative. On average the employees were very experienced working in their respective fields, as the mean on the job experience was 21 years, ranging from 7 to 30 years of experience.

These representatives reported a variety of methods currently recommended or under taken by the companies which they represented or countries they hailed from. These included changing the work hours in order for work to be carried out at cooler times of the day, coming up with a risk stratification method based upon the location and type of work being carried out, following guidelines provided by local governments, providing areas at outdoor work sites (in construction) where workers can rest in the shade and have access to drinking water, installation of air conditioning or air treatment, additional supplementation of electrolytes (salts) for employees working outdoors who have very high sweat rates, modification of clothing, checking government and weather websites for heat wave warnings, having safety meetings at the start of summer to advise workers on health precautions to be taken during periods of high heat stress and initiating pre-planned breaks or "work-rest" cycles once the ambient temperature and humidity reach a given threshold (e.g. NIOSH work-rest cycles based on wet-bulb globe thermometer measurements).

When asked about the effectiveness of the actions currently being taken by their companies, five of the representatives thought the current measures were effective, while another thought that the measures were partially effective. Additionally, some representatives reported the importance of approaching heat stress on a case-by-case basis and that not all occupational work and hot environments should be treated the same. Additionally, the importance of making sure the workers and safety representatives are aware of the signs of heat illness were raised. Finally, the issue of how difficult supplying fresh water to outdoor workers (agricultural workers in particular) was raised and that greater efforts may be needed to supply these workers with safe/clean drinking water while out in the fields, far away from any sources of drinking water.

On average, the representatives reported that heat stress was an issue 3 months of the year, and individual replies given ranged from 2 to 4 months. The representatives estimated that on average there were 20 days per year where the workers' health or productivity was affected by heat stress. When the representatives were asked on a four-point scale how much of an issue heat stress was on their workers' productivity, 1 being no/minimal effect and 3 being a high impact, the mean reported score was 1.9 and ranged from 1 to 3. Similarly, when asked on a four-point scale how

much the worker's health was affected, 1 being no/ minimal effect and 4 being affects performance greatly, the mean reported score was 2.8 and the scores ranged from 1 to 4.

The following table contains the mean and range of scores provided by the workers in terms of the importance of a given list of factors in relation to implementing heat-prevention- procedures

Q13 Please rank (score from 1 [low] to 10 [high]) the importance of the listed factors in relation to implementing heat-prevention-procedures.	Mean	Minimum	Maximum
13.1 Prevent loss of productivity (individual or company capacity):	6.1	5	9
13.2 Prevent/minimize risk of heat-health hazards:	9.6	9	10
13.3 Comply with company or national regulations:	6.3	1	10
13.4 For safety reasons:	8.0	3	10
13.5 Minimize impact on well-being i.e. reduce heat-related symptoms (such as thirst, thermal discomfort etc.):	8.6	4	10
136 Benefit income (my individual piecework rate):	5.7	2	8
13.7 Benefit income (company economy):	5.3	1	8

In the post-workshop questionnaire, only two of the representatives commented that they had doubts about the effectiveness of our proposed heat defence plan but elected not to elaborate on what aspects they did not disagree with. Another representative stated that, while they agreed with the proposed solutions, there may be some conflicts with the worker contracts. The procedures for protecting against heat stress within this cohort included: creating informed plans for the workers, changing the work hours of the day to cooler hours, using pre-planned rest breaks during hot weather, using weather alert systems, providing sufficient drinking water, improving the workers' protective clothing, using risk assessment documents, providing shading for the workers outdoors and minimizing performing physically intense activities at the hottest points of the day.

Of the heat defence procedures presented during the workshop, the attendees reported having not heard of using pre planned breaks or early alert weather notifications before (specifically, alert systems which take into account the work intensity and clothing of the workers, in addition to hot weather warnings). Potential barriers to the adoption of the proposed heat defence procedures included: unsustainable costs for large operations, inability to alter the work schedule (especially for contracted workers), workers being unaware of the solutions available to them, personal and cultural habits as well as external pressures from managers and peers, inflexible work hours. It was further suggested that greater discussion about the negative health effects of heat stress be added to our presentation as many are unaware of the seriousness of the health risks, for us to consider planning an educational program that could be taught to children in schools so they could

learn the dangers of heat stress at a young age and for us to extend our outreach to other manual labour sectors which were not included in our five primary industries.

Tønder, Denmark

This meeting was undertaken on the 4th of June 2018 at Hydro Aluminium Rolled Products in Tønder, Denmark, a company specializing in aluminium extrusion, and was one of our stakeholders representing the manufacturing industry. From the workshop eight employees representing multiple different roles within the company, responded to the feedback questionnaire, including: aluminium pressing, production, team leader, packers, machine operators human resource manager, safety representative, shop steward as well as management. On average the employees had been working for the company for 10.25 years, ranging from 1 to 33 years.

Half the workers reported that they did not know of any specific procedures, either within their company or at a national level, were in place in order to protect workers from occupational heat stress. Of the workers who did report previous knowledge of heat defence policies, methods for remaining cool listed were wearing appropriate clothing, using electric fans to increase air movement over the skin when possible, drinking frequently, putting up barriers around very hot machinery, drinking cold water with ice in it if possible, and taking more breaks. Additionally, approximately half the workers reported that during periods of hot weather, the company held additional meetings to address the issues surrounding occupational heat stress and encouraged the workers to take more breaks, drink more fluids and try to spend time in front of a fan/ventilator.

Furthermore, in addition to the heat prevention guidelines provided to the employees either by the company or by the federal government, the workers reported that additional action that should be taken was to further isolate the hot machinery from areas of the manufacturing factory where the employees were working in order to minimize the environmental heat load. Alternatively, the workers expressed interest in the possibility of building upgrades to facilitate the removal of heat from within the manufacturing location to the external environment. Finally, the workers expressed interest in to whether further improvements to the mandatory protective equipment could be made to further support heat loss. Specifically, multiple workers reported that the mandatory helmets caused them great discomfort when they worked.

On average the workers reported that heat stress was an issue at their job site approximately 5 months of the year, with answers ranging from heat stress never being a problem to heat stress being a problem all year round. This wide range of self-reported frequency of heat stress likely stemmed from differences in job requirements within the company, as some workers were in close proximity to extremely hot machinery, causing heat stress to be an issue, even in the middle of the winter. When asked on a four-point scale how much of an issue the workers found heat stress to be during the hot periods, ranging from 1 “does not or minimally affects my health and performance” to 4 “greatly affects my health and performance”, the average score was 2.8, or approximately “the heat moderately affects my health and performance”, with scores ranging from 1 to 4.

The following table contains the mean and range of scores provided by the workers in terms of the importance of a given list of factors in relation to implementing heat-prevention- procedures

Q13 Please rank (score from 1 [low] to 10 [high]) the importance of the listed factors in relation to implementing heat-prevention-procedures.	Mean	Minimum	Maximum
13.1 Prevent loss of productivity (individual or company capacity):	7.3	6	9
13.2 Prevent/minimize risk of heat-health hazards:	7.8	5	10
13.3 Comply with company or national regulations:	6.0	6	6
13.4 For safety reasons:	8.0	5	10
13.5 Minimize impact on well-being i.e. reduce heat-related symptoms (such as thirst, thermal discomfort etc.):	8.7	8	10
136 Benefit income (my individual piecework rate):	3.5	3	4
13.7 Benefit income (company economy):	3.3	3	4

Subsequently, in the post-meeting follow-up questionnaire, the workers reported that the most effective solutions from their perspective was to create “cooling oases” (that is, areas within the factory purposefully created to give the workers a respite from the heat stress, including: cooled air [if possible], ventilation, and fluids [cooled if possible]), ventilation, clothing with less thermal insulation (via inclusion of air vents, more breathable fibres, etc.) and having fluid stations throughout the factory. In general, both the manual workers as well as those in managerial positions believed that the proposed cooling solutions were feasible, both from an employability as well as an economic point of view. Finally, from this meeting an additional comment/ observation was to lower the level of technicality of which the data was presented to the workers to a level that was more accessible to them.

Rome, Italy

The workshop was attended by 14 persons who consisted of a wide range of professionals from the agricultural and construction industries. These occupations included: company managers, medical directors, small business owners, health and safety officer, occupational physician for agricultural company, occupational technician, and agronomist. On average, the attendees had been working for their respective companies for 13.6 years and ranged from 1 to 25 years of employment at their respective companies.

Of the attendees, eight of the 14 reported having no previous information on heat stress policies either within their company or from the local government. Of those who were aware of existing policies, examples cited were: taking longer rest breaks, drinking more water, wearing suitable clothing, monitoring environmental conditions and adjusting the work-rest cycles accordingly, local company and regional union heat health pamphlet distribution, avoiding exposure to the hottest temperatures of the day, avoiding rapid changes in environmental conditions (e.g. going from an air conditioned home to hot outdoors and vice-versa) and eating a healthy diet.

Additionally, other interventions that their companies employed were: providing water bottles during periods of hot weather, measuring health markers in order to assess how the workers were coping, rescheduling difficult tasks to cooler times of the day, providing saline infusions for workers who became ill, adjusting protocols for food preparation within the company canteens in order to prevent food spoilage, turn on air conditioners, open doors and windows to promote air flow, extra inspections of personal protective equipment and add shading to windows.

The attendees reported heat stress being an issue for their workers 1.9 months of the year with a range from 0 to 3.5 months. During these hot months, it was reported that on average 30 of these days reached severe enough heat levels to affect the workers' health and performance, with the answers given ranging from 3 to 90 days. When asked "how often does heat stress affect worker productivity, rated on a scale from 1 to 3, where 1 was "little to no impact" and 3 was high impact, the average score was 2.1 with a range from 1 to 3. Similarly, when asked how much the workers' health was affected, from 1 being little or no impact to 4 being high impact, the average score was 2.8 with a range from 2 to 4.

The following table contains the mean and range of scores provided by the workers in terms of the importance of a given list of factors in relation to implementing heat-prevention- procedures

Q13 Please rank (score from 1 [low] to 10 [high]) the importance of the listed factors in relation to implementing heat-prevention-procedures.	Mean	Minimum	Maximum
13.1 Prevent loss of productivity (individual or company capacity):	7.5	5	10
13.2 Prevent/minimize risk of heat-health hazards:	9.5	8	10
13.3 Comply with company or national regulations:	8.2	5	10
13.4 For safety reasons:	9.2	7	10
13.5 Minimize impact on well-being i.e. reduce heat-related symptoms (such as thirst, thermal discomfort etc.):	8.7	7	10
136 Benefit income (my individual piecework rate):	6.4	1	9
13.7 Benefit income (company economy):	6.6	4	9

Subsequently, all of the 14 attendees agreed with the interventions presented to them in the presentation. Of the interventions presented, those that were ranked most favourably were: using a personalized advanced warning system to notify workers or health safety representatives of incoming hot weather and what actions should be carries out, using ventilated protective equipment, improving the protective clothing worn to allow for greater heat loss, supply workers with fresh drinking water, using work-rest cycles, creating rest areas with shade outdoors, reorganization of work throughout the work day and incorporating cooling packs into the protective equipment of very thermally stressful jobs (e.g. when spraying pesticides in a greenhouse). According to the attendees, the interventions that they had not heard of prior to the presentation

were: the customized weather warning platform, the ventilated personal protective equipment and work rest-cycles based upon given temperature limits. Nine of the 14 attendees reported that they believed the proposed solutions were both feasible and reasonable in terms of cost, whereas five attendees raised concerns of the interventions being too costly or the ratio between the cost of the interventions relative to the increase in productivity were not sufficient for employers to be encouraged to adopt the interventions. Additionally, two attendees stated that not all interventions could work under all scenarios that may arise at a given job site.

The attendees reported that aspects that should have been included in the presentation was more specific information for what local health unit supervisors should do during periods of high heat stress, more specific information about the physiological responses to heat stress, and particularly if there were signs/symptoms or biomarkers that could be identified which could give an indication of whether a worker would become ill or was at greater risk for heat illness. More information on sectors outside of the five sectors of primary focus was requested with more specific conditions such has the heat stressed experienced by those working underground/in tunnels, in quarries. Finally attendees stated that they wished more information on how heat stress affects workers' cognition and how this leads to increase on site accidents, more information about the individualized advanced warning platforms and how companies could use this platform to protect their workers, a more detailed/ step-by-step description/plan for exactly what employers should do during heat stress, more information about what factors may put a worker at greater risk for heat illness and what factors may exacerbate heat stress which should be avoided during periods of heat stress (e.g. smoking, drinking, medications, nutritional aspects), as well as the effect of gender differences on workers' response to heat stress.

Nicosia, Cyprus

This meeting was undertaken in Nicosia, Cyprus in June 2018. The workshop was attended by 8 people who worked in the agricultural industry as occupational health policy creators, labour unions, health and safety research officer, agricultural researchers, managers, labour inspector, and health and safety officer. On average, the attendees had been in their current role or working for their current employer for 16.8 years, with a range from 5 to 29 years.

When asked if they were aware of any current heat prevention plans in their company or local government, most of the respondents specified that guidelines and procedures to follow during heat stress were set forth by the ministry of labour with one respondent commenting "Yes, I am the one who wrote the heat stress safety code in Cyprus". This "Heat Stress Safety Code" primarily consists of implementing work-rest cycles based upon the prevailing weather conditions. It is worth noting here, that approximately half the attendees worked for the Cypriot government in the agricultural ministry and about half the attendees represent worker unions. Despite the ministry employees confidently asserting that Cyprus had a solid heat stress policy in place, the union representatives countered that many of the employers in Cypriot agricultural industry were either unaware or neglected these policies and that workers often had to work continuously without a break or any provided cooling interventions, despite environmental conditions warranting extended breaks according to the government policy. These discussions illustrated that heat stress policies only work if they are properly enforced and that to convince employers to enact heat stress policies, particularly in countries where governmental enforcement of these policies may not be strong, other methods may need to be relied upon, such as highlighting the employers will save money by improving worker productivity.

On average, the attendees reported heat stress being an issue for agricultural workers for months of the year, with answers ranging from 0 to 6 months. During these four months, the attendees estimated that that on average 71 days were hot enough to cause reductions in worker productivity, with answers ranging from 0 to 180 days. In terms of how severe the heat stress was on average during these 71 days, on a scale from 1 to 4, with one being no to little impact and 4 being very high impact, the average response was 2.7, with answers ranging from 1 to 4.

When asked about cooling interventions that were in place in their companies, answers given by the respondents included: using specialized personal protective equipment when working outside, working in air-conditioned environments when working inside, drinking cold water, working in the shade, changing work hours to work at a cooler time of day and taking additional breaks. When asked whether these procedures were effective, the respondents generally stated that the procedures were effective or very effective and that the primary issue of concern was that often the procedures were not appropriately implemented.

The following table contains the mean and range of scores provided by the workers in terms of the importance of a given list of factors in relation to implementing heat-prevention- procedures

Q13 Please rank (score from 1 [low] to 10 [high]) the importance of the listed factors in relation to implementing heat-prevention-procedures.	Mean	Minimum	Maximum
13.1 Prevent loss of productivity (individual or company capacity):	7.1	1	10
13.2 Prevent/minimize risk of heat-health hazards:	8.8	1	10
13.3 Comply with company or national regulations:	7.4	5	10
13.4 For safety reasons:	6.0	1	10
13.5 Minimize impact on well-being i.e. reduce heat-related symptoms (such as thirst, thermal discomfort etc.):	8.0	2	10
136 Benefit income (my individual piecework rate):	7.5	6	10
13.7 Benefit income (company economy):	7.9	5	10

Following the workshop, none of the attendees reported disagreeing with any of the procedures presented. Of the heat defence procedures, the attendees were aware before or learnt about during the workshop, those that were considered to be most important/effective included: better scheduling of work hours, easy access to cold water, wearing proper personal protective equipment, adding extra breaks, hot weather-specific training for the individuals and providing relevant information to the workers. Of the procedures presented, the only one that the attendees reported they had not been previously aware of was the garments which incorporated personal ventilation systems. When asked if there were any concerns about the feasibility of these methods, the only concern raised was whether the employers would be convinced to implement these procedures. In regard to whether the attendees felt as though there was any information

missing from the presentation, only one attendee responded, asking whether the researchers had any previous personal experience working in the agricultural industry. Finally, when asked if there was any information missing, the attendees stated that they wish to know more about the results from the Heat-Shield field experiments, and whether the sex of the workers affected how heat stressed threatened their health and productivity.

Ljubiana, Slovenia

This meeting took place at the EU house in Ljubljana, Slovenia on the 8th of June 2018. The meeting was attended by 31 people who came from a wide variety of backgrounds including: the Clinical Institute for Occupational, traffic and sport medicine, the Slovenian Environment Agency, the Slovene Chamber of Agriculture and Forestry – Institute of Agriculture and Forestry Maribor, the association of trade unions of Slovenia, the Chamber of Safety and Health at Work, media journalists, Faculty of Law, Legal-Information Centre for NGOs, the Chamber of Tourism and Catering, Youth Union No Excuse – Youth Association for Sustainable Development, Greenpeace CEE Slovenia, as well as students, medical doctors, and journalists. At this meeting, all five of the heat shield primary industries of interest – agriculture, manufacturing, construction, tourism and transport – were represented. The format of the meeting included several round table discussions, regarding the current state of occupational heat stress in Slovenia.

The first roundtable focused on the effects of global warming on the five primary industries of the Heat-Shield project in Slovenia. During this roundtable, the possibilities of disseminating and implementing the results of the project were discussed. One of the key points raised was that, due to the nature of agricultural work, it is difficult for workers to postpone work. Therefore, it is of critical importance for companies to be motivated to help facilitate the enactment of cooling procedures to benefit their employees. Unfortunately, awareness towards the negative effects environmental heat stress has on both worker health and productivity is currently very limited. Additionally, employers are often unaware that the poor working conditions stemming from occupational heat stress will decrease the level of performance of their employees and will therefore actually negatively affect the company's productivity and profits. Therefore, making sure employers are aware that reducing heat stress will help maintain productivity is critically important. On the positive side, awareness appears to be increasing. For example, using protective hats and glasses is becoming more common (however, primarily to protect against UV radiation, not heat, although some employees did not know the difference). New distribution avenues, such as large display screens in highly trafficked areas, are becoming available to deliver heat health information, including weather warnings and encouragement to drink water, avoid direct sunlight, etc. As a potential future step, ARSO (Slovenian Environment Agency) could make its forecasts more accessible and friendlier to people, especially on radio (which would be of particular use for reaching older people, drivers, etc.). However, it was highlighted that the media needs to find a new way to provide information about the severity of heatwaves, e. g. reports with positive impacts (increased productivity due to the use of various mitigation measures, fewer visits to the emergency department, etc.).

The second roundtable focused on improving the attitude of workers and management regarding heatwaves, during which the role of the media, policymakers, stakeholders, academia, and researchers play in initiating actions to improve the knowledge, perceptions, and attitudes of workers and management towards the problems caused by heat waves was discussed. A major theme that emerged from this roundtable was that there is still an overwhelming lack of awareness about the impact heat stress can have on the body and how this can be properly managed. For

example, in construction, exposure to the sun is still commonly not recognized as a serious problem that should be addressed. Similarly, there are still jobs where managers encourage workers to not drink water during work because the managers were afraid the company would be less productive if the workers took toilet breaks. Further, some workers were under the impression that sweating was not good for their health (despite it being the primary way humans liberate heat from their bodies during heat stress) and because of this consciously limited the amount of fluids they consumed in a day. Therefore, in order to combat this issue of lack of education, ideas were put forth to include warnings for heat waves in the media, companies, trade unions, etc. Further, awareness of the negative effects of heat waves should be transferred to the educational system, in order for the general public (but especially those working jobs involving manual labour) to start protecting and taking care of themselves during periods of hot weather.

The third roundtable focused on mitigating the effect of heat waves on workers' well-being and productivity, during which previous experiences with the impact of heat stress, available solutions, and possibilities for use in various sectors, were discussed. It was highlighted that the forecasting of heat waves in Slovenia is as good as in other European countries, but awareness is not. For example, drinking water is important to increase sweating and reduce heat, but as discussed in the previous paragraph, is often ignored. In some industrial environments, the cooling of large production halls is not possible or is too costly, and therefore, there is a need to present strategies for personal (individualized) cooling. For example, using cooling vests as a possibility to reduce heat stress at work. However, current legislation prevents the introduction of certain solutions that would make sense (e.g. trees around factories in the industrial zone which would provide shading and lower that radiative thermal load placed upon the building). Therefore, legislation needs further support from researchers to be able to make evidence-based decisions. Indeed, in the Occupational Safety and Health Agency, new risk assessments related to heat loads are presently being prepared. The role of governments is so strong that implementation of measures to reduce heat stress is feasible only through new legislation. Accordingly, it will be very difficult to protect outdoor workplaces.

Summary

From the five workshops described above, the following generalizations and major findings in regard to the industry representatives' assessment of the prevalence and severity of heat stress within their given industries, their existing level of knowledge in regard to heat stress, their evaluation of our presented procedures and any additional information they requested are outlined below.

Better dissemination of information concerning occupational heat stress is needed - Individuals vary widely in regard to how informed they are about heat stress, how dangerous it is, how much it affects worker productivity and what to do about it. A common theme from all five meetings was that, while some attendees stated that they believed that heat stress is a major issue in their industry, other attendees (despite holding similar positions and having worked within the industry for similar amounts of time) stated that heat stress was not a major issue, that heat stress is just part of the job, or that heat stress can not affect the body in any major way. Alternatively, some workers stated that heat stress was an issue but reported not knowing what should be done to prevent it. Also, some of the attendees responsible for others safety (e.g. safety officers, occupational hygienists, etc.) requested more information on which workers were at the most risk, the signs and symptoms of heat illness and what should be done with a sick worker. These findings demonstrate the need for greater dissemination of information in regard to heat

stress. The ramifications of this lack of knowledge was best characterized by examples of employers who discouraged their workers from drinking water in order to avoid breaks to urinate; ignorant that by not allowing their workers to drink, the workers would dehydrate faster, thereby reducing their work productivity. Additionally, sometimes the information presented in the workshops were misunderstood, particularly by the less educated workers, highlighting the need to simplify the information presented. Accordingly, the following steps were taken:

- Creation of infographics illustrating the loss of productivity experienced by the employers if their workers overheat
- Creation of infographics which inform workers of the negative effects heat stress will have on their health and work productivity
- Special attention paid to creating infographics of different comprehension levels targeted for the employees and the employers
- Infographic on signs and symptoms of heat illness

A ready-made heat stress plan would be beneficial. Related to the last point several attendees stated that if a premade document could be made which could then be presented to employers, policy makers, and any others whose job involves protecting the workers' health and productivity from heat stress. Accordingly, as the WP3 documents largely served this role, the information from these documents were distilled into a more easily to read format which could serve as the requested "pre-prepared heat defence plan".

Cooling oases – One of the recommended interventions/procedures which workshop-attendees responded most positively to, was the creation of cooling oases/ cooling rest-areas. This concept was most liked by those working in the agriculture, construction and manufacturing industries. Indoors, these areas can be created through either air-conditioned rooms or having areas with higher air speeds via ventilator/ electric fans. Outdoors, similar cooling areas can be created by having areas with shading. Both indoors and outdoors, these areas should be supplied with ample drinking water and cooled drinking water can be provided if preferred. Accordingly, the following steps have been taken:

- Highlighting section on cooling oases in the Heat-Shield heat defence plan/document

Pre-planned breaks – Pre-planned were well received, however, some respondents raised concerns that employers may be hesitant to adopt these measures since they were calling for the cessation of work. For this reason, it is of critical importance to make it clear to the employers that they will not lose productivity by implementing these procedures and may in fact gain productivity when combined with other procedures. Accordingly, infographics were created to disseminate this information and adding pre-planned breaks was included as part of the heat defence plan.

Hydration is critical but difficult – Essentially all responders agreed that hydration was important and generally easy to implement intervention. A major exception to this was in the agricultural industry where delivering water to workers out in the fields can be very difficult. Methods of bypassing this issue was stocking water caches around the field and at cooling oases sites, as well as getting water carrier belts and devices for the workers. Accordingly, infographics were made in order to promote water consumption and inform on how to deliver water to workers.

Clothing – one of the most commonly well-reviewed recommendations was wearing appropriate clothing, what constituted appropriate clothing for the job, and how clothing could be optimized for the job. Further, much attention and positive feedback was given to the novel clothing which

incorporated a personal ventilator, developed as part of the Heat-Shield project. Accordingly, industry-specific infographics were made in order to give an example of what the best available clothing option for their given industry was.

Large discrepancy in resources – A notable finding was the large discrepancy between feasible interventions and philosophies towards heat stress, often based on income. Some large Italian firms were able to employ occupational hygienists/medical doctors in order to give saline injections to sick workers, whereas in poorer areas, employers were unwilling to even supply water. While this is partially an educational issue outlined above, it also highlights the need to be resource-conscious with the recommendations. Accordingly, infographics were made with the main effective and low-cost interventions including:

- Provide the workers with plenty of hydration
- Optimize clothing
- Provide pre-planned rest breaks in cooled areas
- Adjust the time of working hours to cooler parts of the day if possible.

Weather notification platforms – Attendees regularly reported their approval of advanced warning platforms, in particular those which can deliver individualized recommendations to employers and employees. In particular, incorporating weather systems to activate established heat defence plans were highlighted. As such, the use of the advanced weather warning systems was highlighted in both the pre-planned heat defence plan and an infographic.

Requests for information on other industries – Another common bit of feedback was a request for information on other sectors not included in the present horizon 2020 project (e.g. miners, garbage collectors, railway workers etc.). While this request falls outside the scope of the Heat-Shield project, it is worth noting, and similar industries may be contacted and made aware of the Heat-Shield findings.

Optimize building design – Some attendees requested for specifics in regard to what can be done to optimize buildings to minimize heat stress (apart from using air condition), which was not an aspect presently included in the Heat-Shield project.

Section 2.5: Meetings separate from, but relating to, WP4

In addition to the level 1 meetings described in the previous section, two additional meetings were carried-out that followed a similar format and purpose as the level 1 meetings but were not a part of the level 1 meetings. The first of which was a series of meetings with health clinicians in order to get their opinions on the Heat-Shield recommendations. The second meeting, undertaken in February 2019 in Florence, was conducted with a very similar group as the initial meeting in Florence but contained the updated guidelines as well as the prototypical dissemination materials described in Section 4 and presented in Appendices 3 and 4. As such, many of the feedback given is unactionable for WP4, which concludes February 2019, but will be taken into account during the work packages that primarily focus on information dissemination, namely WP5 and 7.

Meeting with Clinicians - West Midlands, UK

Six different meetings took place during 2018 and start of 2019 in different Hospitals and NHS Trusts in the West Midlands area, engaging more than 20 non-communicable disease managing Consultants and Registrars, from different specialties, including cardiology, oncology, trauma, rheumatic and musculoskeletal diseases. The meetings took place in the following Hospitals: 1) Russell's Hall Hospital, 2) Guest Hospital, 3) Corbett Hospital, 4) Heartlands Hospital, 5) Burton Hospital, 6) Cannock Chase Hospital). The discussions of these meetings, that took place during department research meetings and/or meetings with a specific focus on the effects of climate change on the health of working vulnerable groups (ageing population, patients with non-communicable diseases, pre- and post-operatively procedures), addressed the knowledge on prevention strategies as well as effective interventions that can be used to minimize the impact of climate change on symptoms and management of NCDs as well as for hospital inpatients (i.e. patients visiting accident and emergency departments as well as patients pre- and post-surgery). The use of existing strategies and the current state-of-the-art and how this is applied in current clinical practice by the attended healthcare professionals was also explored. The meetings had the approach of a focus group with an exploratory purpose i.e. to help develop implementation intelligence that will be used for future dissemination and strategies. The primary focus was on gathering implementation intelligence from Consultants and Registrars, as these are the frontline healthcare practitioners primarily treating NCD patients (and workers) in their everyday clinical practice. The discussions utilized the following questions:

Questions explored in the focus group / departmental research meetings between WLV and regional / local Hospitals

Questions:
What is your understanding about the current situation with regards to climate change?
Do you experience situations during your clinical practice where you have to treat patients with NCDs exposed to increased heat / NCD patients working outdoors?
Are you aware of relevant guidelines on specific strategies that aim to minimize heat-related injuries (stroke, fatigue) in NCD workers?
How do you apply evidence-based medicine in your everyday clinical practice?
Where in the application of current clinical practice do you believe that strategies are necessary to mitigate the heat-related injuries in NCD workers?
Have you come across any evidence on climate change and NCDs?
What would help you to implement in your current clinical practice, strategies to mitigate heat-related injuries in your NCD patients?

Collectively, the results revealed that frontline healthcare practitioners as well as policy makers in the UK, are in need of relevant legislation aiming to mitigate the detrimental effects of climate change and heat on health and are positive in welcoming strategies for preventing heat-related injuries in industrial workers with NCDs. However, it was unanimously identified in all meetings that the material and/or guidelines to implement such strategies, are currently not available or, if they are, the frontline healthcare practitioners that attended these meetings were unaware of them.

The primary conclusions and take-away recommendations from the meetings were as follows:

1. For vulnerable groups, particularly the elderly and children, healthcare practitioners collectively mentioned that they were only aware of general guidance on how to minimize the risks of heat-related illnesses (e.g. heat stroke). The general guidance they provide during their clinical practice is to avoid going out during periods of high temperatures, to stay indoors and hydrated.
2. Frontline health practitioners are unaware of preventative strategies to reduce heat-related injuries in industrial workers with NCDs. All the attendants agreed that this is becoming increasingly important as the temperatures in the UK have started increasing.
3. Trauma Consultants revealed that increased heat within the hospital during the warm months pre- and post-operatively was a major concern and relevant strategies should be put in place to mitigate the adverse effects of heat-related fatigued and discomfort.
4. In the absence of legislation and official guidelines, efforts to prevent and manage industrial workers with NCDs are left to the managing healthcare practitioner; unfortunately, such individual efforts are inconsistent in the way there are applied in clinical practice and thus, effectiveness is compromised.
5. For the application of any relevant managing guidelines, frontline healthcare practitioners are applying evidence-based medicine. As such, research outputs that have strong

methodological designs and are published mainly in peer-reviewed journals targeting healthcare professional audiences, are currently required to help them be more knowledgeable and apply them in their everyday practice.

6. None of the healthcare practitioners engaged in the discussions, has come across preventative strategies for heat-related illness in workers with NCDs and none of them also is informed by peer-reviewed journals outside the scope of their clinical practice. Therefore, relevant strategies are currently required to maximize the education of frontline healthcare practitioners, with regards to relevant strategies to mitigate heat-related illnesses.
7. The preferred method of providing information during clinical practice is in the form of a quick guide, such as a leaflet, handout and/or infographic. This is because visits in the UK NHS are rather quick, ranging between 8-12 minutes per patient consultancy. As such, given that the majority of the 8-12 min focuses on medication dosage/prescription and overall patient management, the information – about how to minimize risks on heat-related injuries – has to be quick but impactful.
8. NCD prevalence is rapidly increasing and temperatures worldwide are also rising. As a result of the above, more workers with NCDs will be working in hotter environments, therefore, increasing the prevalence of heat-related injuries worldwide as well as productivity loss. As a result of the above, mortality and healthcare cost will significantly increase worldwide while productivity will be reduced.
9. For engaging frontline healthcare practitioners, good quality outputs are currently necessary. Adopting the Equator Network guidelines in the reporting future research papers is recommended, such as by pre-registring trials and systematic reviews to minimize research biases. Additionally, medical journals should be more often targeted with the scientific output of the Heat-Shield project in order to inform the medical community.
10. It was suggested that future relevant calls for proposals should be identified that may be relevant to the abovementioned issues.
11. It was suggested that the HEAT-Shield online site could incorporate a section specifically devoted to address the abovementioned challenges (NCD and climate change challenges).

Comments on main conclusions of meetings with clinicians

The comments raised by the clinicians largely fell in line with the previous meetings held with level 1 stakeholders. In general, these comments could be separated into three categories: 1) There is presently a lack of quality and quantity of information regarding what should be done to protect those with NCDs from the effects of heat stress at work and at home as well as a good medium to disseminate this information, 2) the issue of people with NCDs in the workplace is a growing concern as the number of people with NCDs and the number of days where heat stress may be of particular concern for those with NCD are both on the rise. Accordingly, information specific to protecting these individuals is greatly needed, and 3) The types and quality of information needed by clinical practitioners to make recommendations is currently lack.

For the first and second category of comments raised, information specific to people with NCDs will be included in the Heat-Shield dissemination materials in the following ways: First, identifying individuals with NCDs, highlighting how these individuals are at an elevated risk for occupational heat stress and what should be done for them has already been added to the WP3 reports as

well as the ready-made heat-defence plan included in Appendix 4. Additionally, to help disseminate this information to clinicians, an infographic specifically tailored for them has been included with this report as Appendix 3.10.

The third category of concerns raised was similar to previous stakeholder meetings that called for the expansion of our guidelines to include other industries such as garbage men, miners, etc. Although we would like to run clinical trials on people with NCDs, this type of commitment is currently outside the scope of the Heat-Shield project. We will, however, keep this information in mind for future funding calls.

Meeting providing feedback on WP4 summary documents - Florence, Italy 2019

A second, follow-up meeting was undertaken in Florence, Italy in February of 2019; shortly before the submission of this WP4 report. At this meeting the prototype dissemination materials were presented to a collection of representatives, similar to the first meeting in Florence, who were responsible for health of occupational workers from both construction and agricultural industries. From this meeting, the following feedback was given in regard to our prototypical dissemination materials and this advice will be taken into account during the further preparation of the dissemination materials in later work packages (specifically WP5 and 7):

1. In the preparation of risk assessment documents and safety plans, among the procedures necessary for the implementation of prevention and protection measures to be carried out in the workplace also those to mitigate heat stress and UV risk should be included.

2. Recommendations must be translated into the main languages spoken by foreign workers.

3. With regard to personal protective equipment (PPE):
   a. It should have the dual purpose of protecting the worker from the contact with harmful chemicals and at the same time of offering protection against heat stress and ultraviolet radiation;
   b. If the worker wears a PPE that causes an increase in the risk of incurring heat stress (e.g. a helmet) he/she should avoid wearing it when it is not useful: there are some tasks for which the use of certain PPE is only counterproductive
   c. In the case of safety footwear, in the summer these should be of breathable materials

4. Ventilated jackets and apparel solutions proposed in the Heat-Shield WP3 technical reports must also meet the requirements set out in the PPE EU regulation. If they are only prototypes, their use <u>cannot</u> be recommended.

5. The worker should be strongly encouraged to pay attention to his/her own health.

6. For what concerns the environmental manipulation: the microclimatic conditions of the barracks (temporary huts where workers might have breaks, and where often they eat lunch) must also be monitored. Recommendations should specify that the lunch breaks must necessarily be spent in an air-conditioned or at least shaded and ventilated environment.

7. WBGT is an index calibrated on healthy subjects. Particular attention should therefore be paid to the most vulnerable subjects, e.g. those with chronic diseases, who suffer the most and earlier from the effects of heat stress.

Recommendations concerning the dissemination of the Heat-Shield materials

Further the following suggestions were given towards what strategy should be undertaken to best deliver the heat defence recommendations to the public:

1. Information campaigns at the regional level.
2. Involvement of social partners.
3. Training of occupational physicians, GPs and workers' safety representatives (WSR) on these issues is crucial. These professional figures, in turn, will have to make companies, employers and workers aware of the problem of heat stress and of the measures to be implemented before and during the summer season to prevent damage to health and loss of productivity due to heat stress. Therefore, colleges of physicians, employers' and trade union organizations, the national authorities for training in the different occupational sectors, training agencies (also private ones), and employment centres should be involved in such training.
4. It is preferable to reach the workers by SMS than by e-mail (in fact in some sectors the e-mail is not used at all), in order to avoid the risk of not reaching those targeted by the recommendations.
5. Disseminate the recommendations through the websites of the producers (as it was done by the Vernaccia wine consortium, for example), the websites of the Municipalities, dedicated Facebook pages, in Italy a specific section on the Physical Agents Portal (PAF; https://www.portaleagentifisici.it/?lg=EN) will be created.
6. Development of specific Apps. For Italy the PAF app which is about to be available, might be integrated with recommendations for outdoor workers for the prevention of health issues due to the heat stress and UV radiation and combined with the personalized alert system developed within the HEAT-SHIELD PROJECT.
7. Newsletters to trade associations, workers, employers, WSR.
8. Dissemination of information to national congresses (e.g.: for Italy the National Congress of Industrial and Environmental Hygiene in Matera from 26 to 28 June 2019, and the National Congress of Occupational Medicine in Trieste from 25 to 27 September 2019).

Section 3: Summary of 2nd level meetings

Following the adjustments made to the presentation of our guidelines following meetings with the first level stakeholders, our occupational heat guidelines were updated into a new presentation format and presented to higher level stakeholders to whom the information may not be directly applicable, but who were typically policy makers and legislators. The following are brief summaries of these meetings.

Sankt Augustin, Germany

This meeting took place in Sankt Augustin, Germany on October 30th, 2018 at the Institute for Occupational Safety and Health of the German Social Accident Insurance (DGUV). The DGUV's mandate is to prevent occupational accidents, accidents on the way to and from work, occupational diseases and work-related hazards as well as to ensure effective first aid. The organization is comprised of multiple expert committees, from different occupational-related sectors, which include the construction industry, health in the workplace, wood and metal working, foodstuffs industry traffic and the environment, among others. These expert committees serve to create uniform, substantiated expert opinions on prevention of issues under the jurisdiction of all the DGUV institutions. Further, these committees inform government departments, manufacturers, and other parties interested in occupational safety issues. The DGUV often serves as the first point of contact for many companies, facility operators and individual workers who require expert advice.

This expert group meeting was primarily concerned on health and safety topics in regard to indoor environments, including the inside of transport and other professional vehicles, as well as the interior environments of manufacturing and construction buildings and factories. The hour-long presentation was well received, with much interest in the Heat-Shield project and discussions of potential future collaborations. Some information that was highlighted as particularly useful was the cooling solutions offered. As well, it was mentioned the physiological evidence supporting these interventions was particularly appreciated, as the DGUV had previously, in some instances, provided information to interested parties, which differed from the Heat-Shield guidelines. For example, one member had stated that they previously discouraged the ingestion of cold fluids based on the assumption that the body "would have to expend additional energy to warm the fluid, thereby causing the person to tire faster". Indeed, these types of anecdotal or assumed knowledge have been encountered at the meetings at all levels of employment (i.e. from the workers to the policy administrators).

Items of concern raised by the committee primarily cantered around cooling options available to those in the transport industry. From their studies, the only reliably effective cooling method for inside vehicles which they had found to make a reliable difference was the use of air-conditioning. This issue raises two primary concerns: 1) the use of air-conditioning uses a considerable amount of energy, therefore creating more exhaust, releasing more CO2, thereby worsening the overall problem of climate change and 2) because of this higher energy consumption, many companies had begun removing the air conditioning systems from their vehicles in order to improve their "bottom line" by saving on fuel costs. This was a particular issue for garbage trucks, where the doors had either been removed or were being opened on a regular basis to let the workers out. Because of this, cooling the truck cabins with air conditioning was very difficult, ineffective and costly. In terms of our suggestion of ensuring vehicles use window tinting, which can reduce solar radiation by 30%, the committee was sceptical, stating that they had found this method to be largely ineffective at lowering the actual temperature within their vehicles. Another option discussed was incorporating electrical fans in the seats of the vehicles, which the committee said was occasionally done but not very often.

Additionally, the committee challenged our recommendation to modify the work hours to cooler times of the day, as much of the transport industry and other driving-related industries (such as garbage collection) relies upon very tight, inflexible schedules.

Other concerns raised by the committee were that we had not touched upon the importance of the housing of the trucks. From their work, they had found that transport trucks would often be stored overnight in concrete bays or on the side of highways which had spent the day being exposed to high levels of heat, particularly when in the sun, so at night the concrete surfaces would radiate out heat to the trucks. Because of this, by the time the drivers came to work the next day, the temperature in the trucks were already above 30°C.

Another concern raised was that, from our materials, there was no mention of how the buildings and factories that house manufacturing and construction firms could be better improved to facilitate heat loss. Specifically, the committee asked for recommendations in regard to what the internal environmental conditions should be, as well as what physical parameters of the building could be modified to improve the thermal qualities of the building and make cooling more effective and energy efficient. The committee also noted this lack of guidelines is a general problem, and that there were no current recommendations on this topic from the International Organization for Standardization (ISO). Further, various standards that can be found typically have a tendency to be in regard to office buildings, not construction and/or manufacturing companies. One recommendation put forth by the committee on this topic was for (cool) clean air to be pumped in near the floor so it would rise, thereby cooling the workers and pulling air pollutants upwards and away from the workers.

Finally, several societies and organizations that work in similar fields and would be interested in working with the Heat-Shield project were recommended as potential future collaborators.

Ministry of Labour, Greece

This meeting took place in Athens, Greece, on September 21st, 2018. UTH co-organized a consultation meeting with CETRI in Greek Ministry of Labour in Athens with the participation of the National Meteorological Service, the Ministry of Health, the General Confederation of Greek Workers, the Public Power Corporation, the Association of Greek Industrialists and the Technical Chamber of Greece. Professor Andreas Flouris (UTH) and Professor Tord Kjellstrom (CETRI) gave two presentations regarding the effects of heat stress on health and productivity of workers and measures to address these effects.

This expert group meeting was primarily concerned on health and safety topics in regard to occupational environments, including tourism and agriculture industries. The presentations were well received, with much interest in the Heat-Shield project and discussions of potential future collaborations. Specifically, certain approaches were discussed that could be used to downscale the weather forecast of the Greek National Meteorological Service to the workplace level.

An important concern raised during the meeting, was the use of thermal indices to provide guidelines on protecting workers against heat-related diseases. The ISO standard 7243:2016 recommends the Wet Bulb Globe Temperature (WBGT) for assessing the heat stress in occupational settings. However, directly measuring WBGT involves specialized instruments requiring equipment which is not used at weather stations and knowledge about other factors such as the clothing and metabolic rate of employees. Importantly, it was repeatedly mentioned that a WBGT station is very expensive for a small company to afford. Therefore, it has been requested to conduct a systematic review aiming to provide statistical formulas to calculate

WBGT in indoor (tourism) and outdoor (agriculture) environments, without the need of specialized equipment. The University of Thessaly (Heat-Shield partner) agreed to assist the Greek Meteorological Service (GMS) for validating their models so that they can provide predictions for WBGT. To do so, the University of Thessaly will make available to the GMS four of its portable weather stations that allow calculation of WBGT for the entire duration of the spring and the summer of 2019. The data will be used to validate the models that GMS will use to predict WBGT.

Finally, future meetings have been planned to further develop and refine these and other aspects of a potential law aiming to protect workers' health and productivity under occupational heat strain. The University of Thessaly (Heat-Shield partner) is playing a leading role in this work.

Met office UK

This meeting was with the Met Office, December 2018. The Met Office is the primary governmental weather and climate forecasting organisation in the UK. Nominally part of BEIS (Business, Energy and Industrial Strategy) it is a Trading Arm of the UK Government and operates essentially as a private business. Its Hadleigh Centre is the world's leading authority on climate change. It has a Health Division. Age UK has had partnerships with the Met Office for the last 10 years. Members from AgeUK and Loughborough attended a meeting at the Met-Office in Exeter, UK. Present from the Met Office were the new Principal Scientific Consultant and Strategic Head of Health Science Integration, the Head of Business Contracts and a senior scientist. Age UK presented the strategic background and the structure of the Heat Shield project. Loughborough University presented the new data from WP3. Unfortunately, we were not able to agree on terms for the Met-Office involvement in WP4, despite genuine interest in the project. Though not willing to engage for what appeared to be economic grounds, the Met Office asked if we would share our data and empirical outcomes.

Communication with British Occupational Hygiene Society

In December 2018 Age UK and Loughborough University began a public engagement activity with the British Occupational Hygiene Society (BSOH) with whom Loughborough have a long-standing strategic relationship. A substantial proportion of their work force is over 50 years of age and the Society is the UK leader in its field. Key individuals from BSOH have agreed to meet at Loughborough University on 4th March next, as follows: Simon Festing, CEO (formerly of Help the Aged) and two members: one, the Director of Industrial Hygiene in BP and the other, a Shell industrial hygiene consultant. The purpose of the initial meeting is to share a draft public guidance document, for their comments and responses. Via this engagement, we are generating a relationship which will change awareness, understanding and behaviour in the BSOH to the benefit of their membership. In addition, there is the potential for considerable leverage for impact in the many industrial companies whom their membership represents.

Geneva, Switzerland

This meeting was undertaken in October 29, 2018 in Geneva Switzerland at the WHO Headquarters and focused on issues additional to the heat that should be considered, such as air pollution. During this meeting, we presented the findings from our field studies and the systematic reviews.

Bonn, Germany

This meeting was undertaken in November 2018 in Bonn Germany with the WHO-European Working Group on Health in Climate Change. During this meeting, we presented the findings from our field studies and the systematic reviews.

Hong Kong, China

This meeting took place in December 2018 with the WHO-WMO spearheaded GHHIN network (Global Heat-Health-Information-Network). At this meeting, findings from our intervention (field) studies and the systematic reviews were presented.

Skopje, Macedonia

Additionally, we were at the local South East-Europe WHO-Europe working group meeting. Here, the overall project was presented and future collaboration on dissemination discussed with representative from OSHA (occupational safety and health association – European office).

Summary

In summary, the second grouping of meetings were successful at accomplishing the task outlined in the grant agreement concerning meeting with higher level health entities across Europe and internationally. In general, these meetings primarily served to present our findings and commence to establish a dissemination network for our proposed recommendations. Typically, the main takeaways from these meetings were not further adjustments to the guidelines for the industries but rather the types of dissemination materials needed in order to effectively circulate our guidelines to stakeholders at multiple levels in our target industries. As such, the following section will highlight the adjustments made in response to the preliminary meetings summarized in section two of the present report as well as the dissemination materials created in response to the meeting with the higher-level health authorities summarized in section 3.

Section 4: Description of the accumulated evidence and out best practice recommendations

As established in preceding sections, the first level of meetings (described in section 2) primarily served to obtain direct feedback from various stakeholders working within the five target industries regarding the recommendations generated in WP3, whereas the second round of meetings (described in section 3) primarily served to form the basis of our dissemination strategy and establish a network to deliver our recommendations. Considering, that WP4 was in part conducted in parallel with the process of creating the final versions of the industry specific (WP3) reports, those reports did, to some extent, already account for the feedback (e.g. on feasibility) provided during the stakeholder meetings; therefore, very few changes are required regarding the actual cooling recommendations made in WP3. However, as highlighted by both rounds of the WP4 meetings as well as results from Heat-Shield conducted field studies and verified by our systematic evaluations/publications on current practice (e.g. on hydration – see Piil et al 2018) vs knowhow (on e.g. importance of hydration – see e.g. Pogacar et al 2017), there remains a large need to educate workers and employers on the dangers of occupational heat stress. Therefore, in order to further address the concerns and facilitate how recommendations and solutions are translated into practice, we have produced a variety of different dissemination materials (exemplified in appendix 3) that can be used (in different versions – e.g. translated into relevant languages for workers) to contact and inform relevant parties occupying multiple different types of positions within the five target industries. The following section revisits the concerns raised in section 2 and pairs them with the dissemination materials requested from section 3.

Addressing the stakeholder concerns from the first round of meetings

To reiterate the main points highlighted by the preliminary meetings, the critical areas requiring attention and the actions taken by the Heat-Shield team to address these concerns are as follows:

1. Better dissemination of information concerning occupational heat stress is needed
    a. A common point raised was the lack of awareness of the seriousness of occupational heat stress, how heat stress affects workers and the link between worker health, productivity and safety.
    b. In order to address this issue, the following actions were taken:
        i. Creation of infographics warning of the loss of productivity experienced by the employers if their workers overheat
        ii. Creation of infographics which inform workers of the negative effects heat stress will have on their health and work productivity
        iii. Special attention paid to creating infographics of different comprehension levels targeted for the employees and the employers
        iv. Infographic on signs and symptoms of heat illness
2. A ready-made heat stress plan would be beneficial
    a. Requests were made by several stakeholders for an exemplary heat defence plan to be created in order for companies to easily access and implement our best-practise, recommendations.
    b. In order to address this issue, the following steps were taken:
        i. A ready-made heat defence plan was made and included in Appendix 4
3. Cooling oases
    a. The recommendation to establish “cooling oases” or rest areas equipped to provide workers with a reprieve from heat stress was well reviewed by most attendees.

    b. In order to address this issue, the following actions were taken:
        i. Creating a section on cooling oases in the Heat-Shield heat defence plan/document
4. Pre-planned breaks
    a. Pre-planned were well received, however, some respondents raised concerns that employers may be hesitant to adopt these measures since they were calling for the cessation of work.
    b. In order to address this issue, the following steps were taken:
        i. Highlighting the importance of administering pre-planned breaks in the infographics
        ii. Creating a section on pre-planned breaks in the heat defence plan
5. Hydration is critical but difficult
    a. Essentially all responders agreed that hydration was important and generally easy to implement intervention. A major exception to this was in the agricultural industry where delivering water to workers out in the fields can be very difficult. Methods of bypassing this issue was stocking water caches around the field, as well as at cooling oases sights as well as getting water carrier belts and devices for the workers.
    b. In order to address this issue, the following steps were taken:
        i. Infographics were made in order to promote water consumption and inform on how to deliver water to workers.
        ii. A hydration section was added to the heat defence plan
6. Clothing
    a. Optimising clothing worn at work to maximize heat loss was essentially unanimously recognised as a highly effective and easy to implement cooling intervention.
    b. In order to address this issue, the following steps were taken:
        i. Industry-specific infographics were made which include recommendations on what ideal clothing ensembles would be
7. Large discrepancy in resources
    a. A notable finding was the large discrepancy between feasible interventions and philosophies towards heat stress, often based on income. While this is partially an educational issue outlined above, it also highlights the need to be resource conscious with the recommendations.
    b. Accordingly, infographics were made with main effective and low-cost interventions:
        i. Provide the workers with plenty of hydration
        ii. Optimize clothing
        iii. Provide pre-planned rest breaks in cooled areas
        iv. Adjust the time of working hours to cooler parts of the day if possible.
8. Weather notification platforms
    a. Attendees regularly reported their approval of advanced warning platforms, in particular those which can deliver individualized recommendations to employers and employees.
    b. In order to address this issue, the following steps were taken:
        i. The advanced weather warning systems was highlighted in both the pre-planned heat defence plan and an infographic
9. Requests for information on other industries

a. Another common bit of feedback was a request for information on other sectors not included in the present horizon 2020 project (e.g. miners, garbage collectors, railway workers etc.).
b. As this falls out of the scope of the Heat-Shield project, no further actions were taken to address this issue.

10. Optimize building design
    a. Some attendees requested for specifics in regard to what can be done to optimize buildings to minimize heat stress.
    b. As this falls out of the scope of the Heat-Shield project, no further actions were taken to address this issue.

Dissemination infographics

The dissemination infographics that have been discussed throughout this report can be found in Appendix 3. The major considerations taken into account for the creation of these materials were to create materials that were simple, gave direct and easy to follow guidelines and did not overwhelm the reader but additionally gave information to where more detailed information could be found in the event that the reader desired more information. Also, as the stakeholder feedback identified that both information on why occupational heat stress is an issue, as well as what should be done to combat occupational heat stress, both these aspects were included in the infographics. Multiple variations on these infographics were produced in order to provide a variety of perspectives, highlighting points that were more likely to be of interest to employers, employees, and health and safety officers. Similarly, different infographics were made to reflect some of the specific issues unique to each of the five target industries. The following list is by no means an exhaustive list of infographics and more may be created in the future as the need arises.

Breakdown of infographics:

Infographic 3.1: Infographic for the agricultural industry
Infographic 3.2: Infographic for the construction industry
Infographic 3.3: Infographic for the manufacturing industry
Infographic 3.4: Infographic for the tourism industry
Infographic 3.5: Infographic for the transportation industry
Infographic 3.6: General infographic for workers
Infographic 3.7: General infographic for health officers
Infographic 3.8: General infographic for employers
Infographic 3.9: General infographic about hydration
Infographic 3.10: Infographic for healthcare practitioners

Brief heat-defence plan

As stated above, another general point raised in the collected feedback was that it would be useful if there was a pre-made heat defence plan that could be sent to companies for them to follow. A one-size-fits-all type of plan can be difficult to create, due to the problem of available resources and type of operation differing enormously from company to company. Therefore, with this concern in mind, we created a brief five-page heat defence plan, located in Appendix 4, that focuses primarily on basics of what should be contained in any heat defence plan and could be employed by any occupational firm, regardless of size and resources. These basics include: create a plan, pay attention to the weather, assess the known risks at the company, include extra

breaks, reorganize the day to take advantage of cooler periods, keep workers hydrated, create appropriate rest areas, know what low cost cooling options do work, optimize workers clothing, and know the signs and symptoms of heat illness and hot to treat them. Additionally, at the end of this document, information for the Heat-Shield website is provided to allow for readers to get more detailed information if they so choose.

Appendix 1: Original PowerPoint presentation

Procedures to minimize detrimental effects of Occupational heat stress

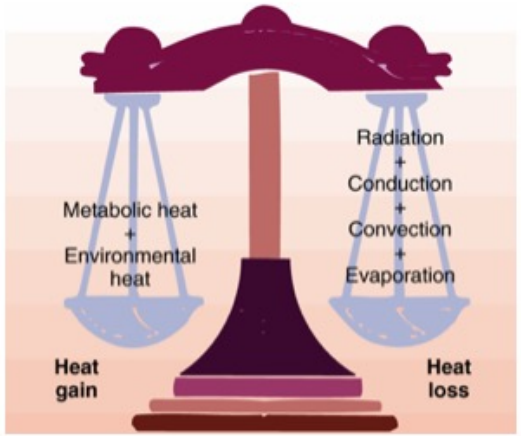
HEAT SHIELD

General guidelines and specific (sustainable) solutions

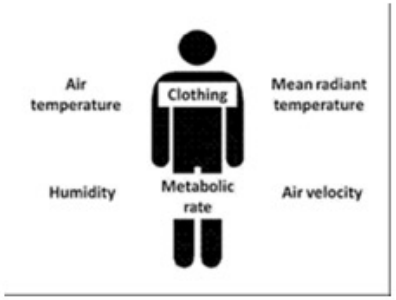
promoting productivity and at the same time prevent heat health hazards

INSERT VENUE + contact info for the presenter

Heat is essential for life – BUT too much heat will make you fatigue and in worst case cause heat illness



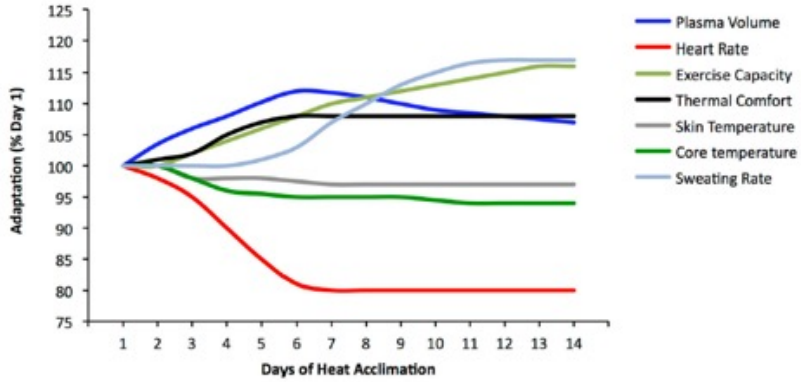
Temperature regulation and balance between the heat you produce and heat-exchange with the environment is therefore essential



Heat stress depends on the weather as well as your individual physiology and working conditions

I am used to work in the heat so it is no problem for me!

TRUE: In the initial days of a hot period important adaptations take place – therefore especially important to be aware during the first days of a heat wave.



However: Even for people with many years work experience in hot settings - we observe large individual differences in the impact of heat on performance and physiological symptoms

Pacing procedures to prevent excessive fatigue

WBGT °C			Light Work		Moderate Work		Heavy Work		Very Heavy Work	
DPCU	Body Armour	MOPP4	Work/Rest (min)	Water (L/h)	Work/Rest (min)	Water (L/h)	Work/Rest (min)	Water (L/h)	Work/Rest (min)	Water (L/h)
<25	<22	<19	NL	¾	NL	¾	50/10	¾	30/30	¾
25-26	22-23	19-20	NL	¾	NL	¾	40/20	¾	20/40	¾
27-28	24-25	21-22	NL	¾	50/10	1	30/30	1	20/40	1
29-30	26-27	23-24	NL	¾	40/20	1	30/30	1	10/50	1
31	28	25	NL	¾	30/30	1	20/40	1	5/55	1
32	29	26	50/10	1	20/40	1¼	10/50	1¼	5/55	1¼
33	30	27	40/20	1¼	10/50	1¼	10/50	1¼	CM	1¼
34	31	28	30/30	1¼	10/50	1¼	CM	1¼	CM	1¼
35	32	29	20/40	1¼	CM	1¼	CM	1¼	CM	1¼
36	33	30	10/50	1¼	CM	1¼	CM	1¼	CM	1¼
≥37	≥34	≥31	CM	1¼	CM	1¼	CM	1¼	CM	1¼

Work will be affected in the heat – plan your effort and breaks in advance rather than waiting for your body to stop you

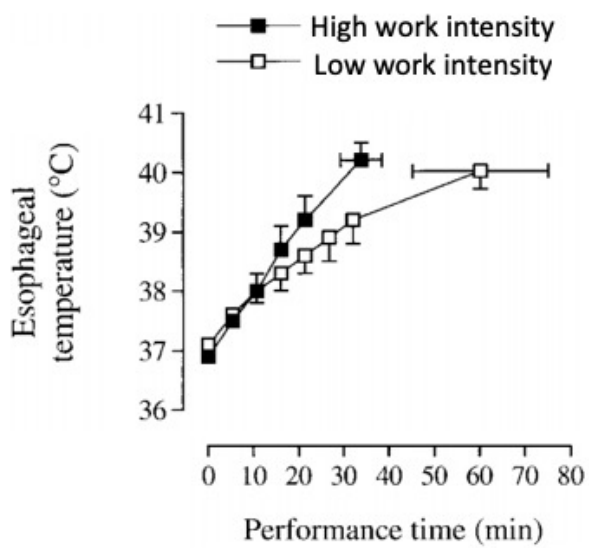
Some countries have tight work-rest regulations and that may be necessary during high heat stress conditions – but planned brief breaks (with hydration and intermittent cooling) or wise work planning/pacing may increase performance and lessen break time

Decreasing work intensity allows for longer work duration

Lowering exercise intensity lowers our metabolic rate

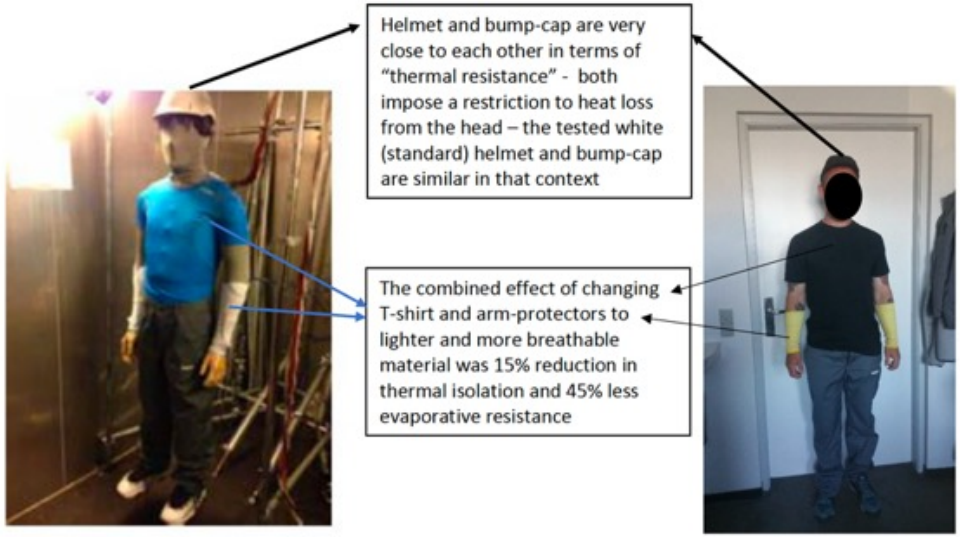
This slows down how quickly our core temperature

This allows us to work for longer and potentially get more done with less negative side effects



Dressing right - Clothing

Clothing can be beneficial for protection (both from solar radiation and physical damage) but improvements to clothing design can help lower thermal strain.



Clothing

When possible, change from bulkier clothing into lighter, loose fighting clothing which exposes more skin (not always ideal depending on solar load, threat of scrapes, bumping head, etc))

Alternatively, alterations such as adding ventilation patches into protective wear can help improve heat loss efficiency

The benefits of increasing air speed

Increasing air velocity helps increase heat loss to the environment by both our primary heat loss pathways – dry and evaporative heat loss

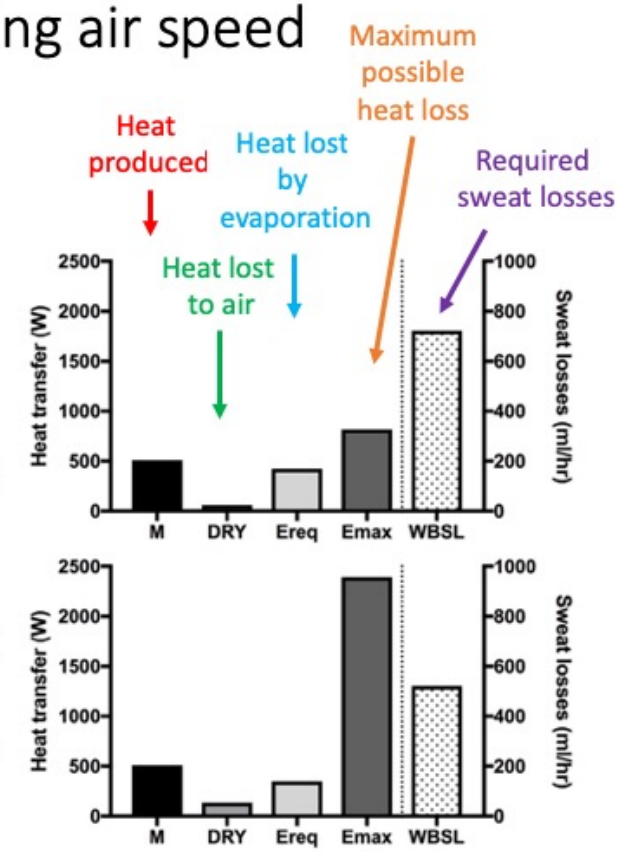
By increasing air speed, we need to sweat less

The maximum amount of heat we can lose to the environment is dramatically increased

Relatively inexpensive

Requires fans to be transported from location to location

New models of fans are battery and/or solar powered and designed to be more portable



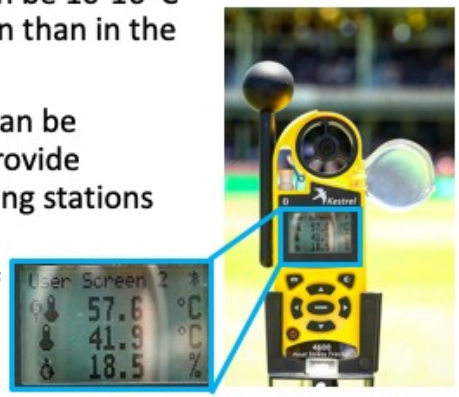
Cooling options - Climate control

Air conditioning

- AC most effective form of cooling
- Expensive and not useable in the field
- Can be effective for small designated cooling zones, or car AC
- Temperatures only slightly below skin temperature needed for cooling (~28°C)
- Effectiveness can be increased with air flow

Shading

- On sunny days, the temperature can be 10-16ºC higher in the sun than in the shade
- Portable tents can be assembled to provide temporary cooling stations
- This carries the disadvantage of having equipment needing to be relocated

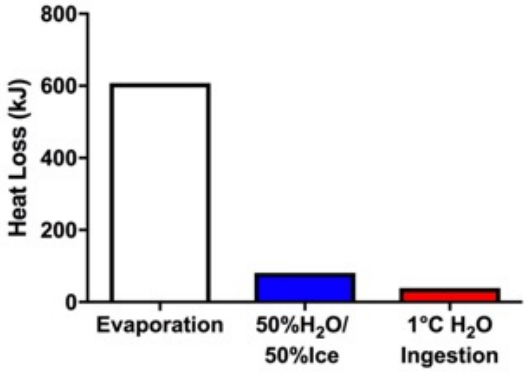


Cooling benefits of water – in you and on you

Drinking cold water is a good way to maintain hydration and help cool workers.

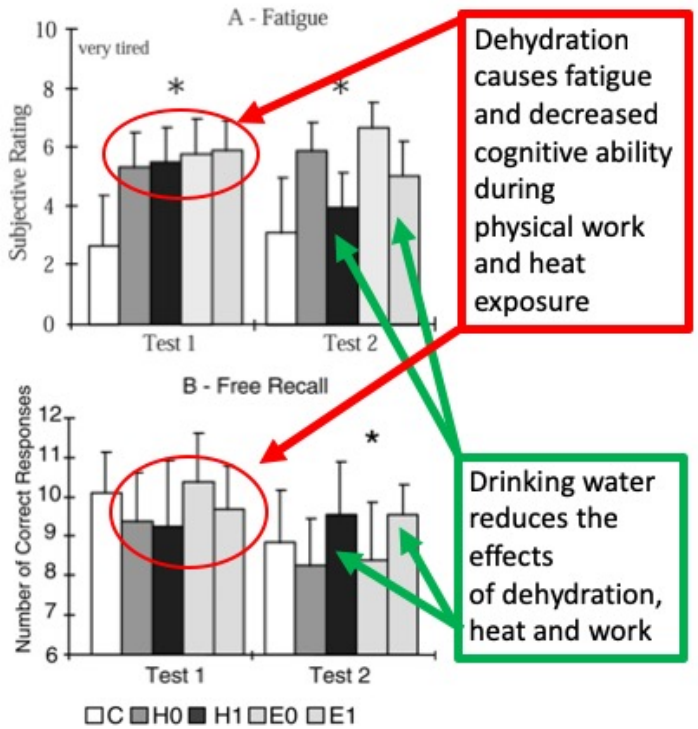
It takes considerably more heat to melt ice compared to warming fluid, so adding crushed ice to water can double the heat loss for the same amount of fluid

The most potentially effective way to lose heat through water is by having it evaporate from the skin (like sweat). However, this method is highly dependent upon environmental conditions and not practical when wearing large amounts of clothing.



Heat lost to 250 ml of fluid

Effects of dehydration



Dehydration causes fatigue and decreased cognitive ability during physical work and heat exposure

Drinking water reduces the effects of dehydration, heat and work

Sweating is critical for our ability to lose heat to the environment BUT it comes at the cost of losing body water

Being dehydrated makes any amount of work we do feel worse than if we were to do the work not dehydrated

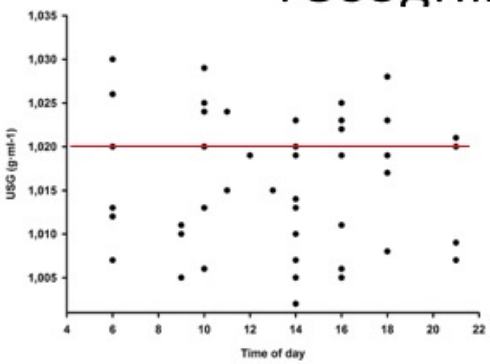
Being dehydrated also interferes with our thinking abilities

This is especially true for complex tasks

This likely contributes to the increase in work site accidents like collisions and falls that occur during heatwaves

These negative effects can be offset by drinking water

Prevalence of dehydration and recognizing dehydration

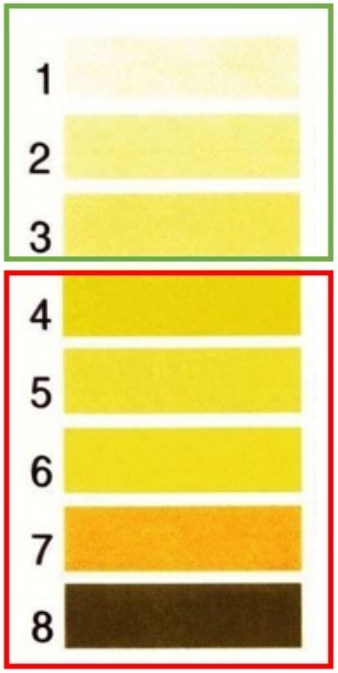


Danish aluminium extrusion workers

~40% of Danish aluminium extrusion workers show up to work dehydrated
This has been a result that has been observed on every continent and is worse in hotter and more humid locations
Best ways to observe hydration levels is urination frequency, urine colour and thirst
Drink regularly and before thirst to keep hydrated

If your urine colour is between 1-3, you are drinking enough water

If your urine colour is between 4-8, you need to drink more water



When to cool?

Before work

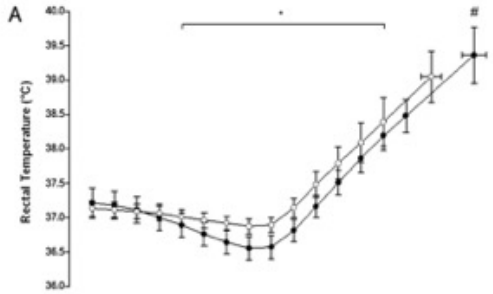
- Drink at least 2 cups of cold water before starting work
- Try and have a cold bath or shower before going to work –This will help lower body temperature before work

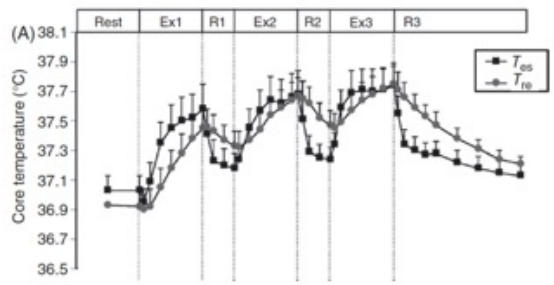
During work

- Drink 1 cup of preferably cold water every hour
- Take planned breaks regularly and try to cool during these breaks using the methods explained

After work

- Try to continue to drink 1 cup of cool water every hour
- Have a cold shower or bath
- Heat a meal that has plenty of salt to replace what was lost in your sweat





Signs and symptoms of heat illness

Signs and Symptoms of Heat Illness

Heavy sweating	Headache
Paleness	Nausea or vomiting
Muscle Cramps	Fainting
Tiredness	Skin: may be cool and moist
Weakness	Pulse rate: fast and weak
Dizziness	Breathing: fast and shallow

If you experience any of these symptoms:
Move to a cool area out of the sun if possible
Sit down and take a quick rest
Drink plenty of cool water
Apply a cool wet cloth to your skin

Appendix 2: Pre and post workshop questionnaires

HEAT-SHIELD – influence of occupational heat-stress and procedures to minimize detrimental effects

<u>Pre-presentation questions</u> – all information will remain confidential and anonymous. We will use the feedback and important information that you provide to optimize our guidelines and adjust how to advise others on heat-prevention procedures.

What is your role and area within the company/organization? E.g. manufacturer, labourer, management	
Do you have any additional roles or titles within the company? E.g. union representative, shop steward	
Years of experience with the company:	

Are you aware of local (company) or national "heat-prevention-plans" (procedures initiated when it is hot)	If yes, briefly describe:
How many months each year is heat in the workplace a problem?	
How often do you think high temperatures affects your personal productivity during the hot months of the year? (select one)	No/minimal influence in limited period of year Moderate influence (mainly peak summer) High impact (during major part of summer)
How often do you think high temperatures affects your company's productivity during the hot months of the year? (select one)	No/minimal influence in limited period of year Moderate influence (mainly peak summer) High impact (during major part of summer)

How many days per year would you estimate you are affected by high temperatures at work?	Give number:
When it does get hot, how much do you feel the affects your health and performance? (select one)	No/ minimal effect The heat mildly affects my health and performance The heat moderately affects my health and performance The heat greatly affects my health and performance
Does the company implement heat prevention actions during hot periods? List types of actions implemented.	1. 2. 3. Etc.
List any additional actions/procedures/solutions you find relevant to adopt during hot periods.	1. 2. 3.

Please rank (score from 1 [low] to 10 [high]) the importance of the listed factors in relation to implementing heat-prevention-procedures.	Prevent loss of productivity (individual or company capacity): Prevent/minimize risk of heat-health hazards: Comply with company or national regulations: For safety reasons: Minimize impact on well-being i.e. reduce heat-related symptoms (such as thirst, thermal discomfort etc.): Benefit income (my individual piecework rate): Benefit income (company economy):
List and rank any additional factors:	
The currently implemented heat prevention actions, are they effective? Please explain their impact.	

HEAT-SHIELD – influence of occupational heat-stress and procedures to minimize detrimental effects

<u>Post-presentation questions</u> – all information will remain confidential and anonymous. We will use the feedback and important information that you provide to optimize our guidelines and adjust how to advise others on heat-prevention procedures.

Were there any of the proposed solutions or procedures for heat prevention that you disagreed with or did not understand the rationale behind/ need to implement them?	If yes briefly describe which:
List the top-three heat-prevention procedures or solutions (either some of the presented or you own best advice for others)	1. 2. 3.
Were there any of the proposed solutions or procedures that you were unaware of (or did not find relevant or feasible to use) before the presentation that you would now consider using or suggest others to use for future practice?	If yes briefly describe which:

Do you see any barriers that might preclude you or your company from implementing new or already identified solutions?	If yes, please list the main issues you see:
Is there any general or specific information you are aware of concerning heat stress – recommendations or practices you think would be valuable to share – that you feel were not included in the presentation?	If yes, briefly describe which:
Is there any information about heat stress that you would like to know more about that you feel was not covered in this presentation?	If yes, briefly describe which:

Appendix 3: Dissemination infographics

Appendix 3.1: Infographic for the agricultural industry

OCCUPATIONAL HEAT STRESS IN THE AGRICULTURAL INDUSTRY

How to keep workers safe and productive in hot weather

HEAT IMPAIRS THE PRODUCTIVITY AND HEALTH OF WORKERS

- Heat stress impairs both physical and mental work capacity
- Substantial productivity losses – surpassing 15% on hot days
- Work-site injuries (e.g. slips, trips AND falls) Can increase during hot weather
- Signs of heat illness emerge (e.g. cramps, exhaustion, headache, dizziness, nausea)
- All above issues worsened by dehydration
- ***~70%*** of all European workers arrive to work dehydrated

AGRICULTURAL WORKERS PARTICULARLY AT RISK

- Physically demanding work (causing internal heating)
- Conducted outdoors where high temperature and humidity levels impair heat loss
- Exposure to sun can increase ambient temperature by up to 16°C
- Greenhouses create hot and humid conditions year round
- Limited access to water (in the field)

SIMPLE & EFFECTIVE MEASURES TO PROTECT AGAINST THE HEAT

- Pay attention to weather forecasts (or subscribe to hot weather alerts) and have a heat-defence plan for your company in place ***before*** heatwaves strike
- Add extra work breaks (~1.5 min breaks every 30 min or 10 min every 2 hours)
  - Field studies have shown these extra breaks increase net productivity compared to no breaks, as workers start to work slower without breaks
- Make sure drinking water is available at all times
  - In the field, this can be achieved by hydration bags, water belts or by caching water in pre-determined water/break stations
- Establish cooling areas where workers can rest, either air-conditioned and ventilated indoors or shaded with open-air exposure outdoors
- Rearrange work hours to cooler times, either by starting the work shift earlier or by performing the most physically demanding or outdoor tasks earlier in the day
- Optimize clothing: if outdoors, wear loose, light, long sleeves (to protect from UV radiation) clothing made of breathable fabric and a hat
- If wearing tough, protective clothing try to incorporate ventilation patches in the armpits, elbows, behind the knees, and groin area to help promote airflow

If you want to know more, visit www.heat-shield.eu or contact consult@heat-shield.eu for free guidance and consultancy on heat-health actions for your company

Appendix 3.2: Infographic for the construction industry

OCCUPATIONAL HEAT STRESS IN THE CONSTRUCTION INDUSTRY

How to keep workers safe and productive in hot weather

HEAT IMPAIRS THE PRODUCTIVITY AND HEALTH OF WORKERS

- Heat stress impairs both physical and mental work capacity
- Substantial productivity losses – surpassing 15% on hot days
- Work-site injuries (e.g. slips, trips AND falls) Can increase during hot weather
- Signs of heat illness emerge (e.g. cramps, exhaustion, headache, dizziness, nausea)
- All above issues worsened by dehydration
- ***~70%*** of all European workers arrive to work dehydrated

CONSTRUCTION WORKERS PARTICULARLY AT RISK

- Physically demanding work (causing internal heating)
- Outdoors, high temperature and humidity levels impair heat loss
- Exposure to sun can increase ambient temperature by up to 16°C
- Limited access to water (on large worksites)

SIMPLE & EFFECTIVE MEASURES TO PROTECT AGAINST THE HEAT

- Pay attention to weather forecasts (or subscribe to hot weather alerts) and have a heat-defence plan for your company in place ***before*** heatwaves strike
- Add extra work breaks (~1.5 min breaks every 30 min)
  - Field studies have shown these extra breaks increase net productivity compared to no breaks, as workers start to work slower without breaks
- Make sure drinking water is available at all times
  - In the field, this can be achieved by hydration bags, water belts or by caching water in pre-determined water/break stations
- Establish cooling areas where workers can rest, either air-conditioned and ventilated indoors or shaded with open-air exposure outdoors
- Rearrange work hours to cooler times, either by starting the work shift earlier or by performing the most physically demanding or outdoor tasks earlier in the day
- Optimize clothing: if outdoors, wear loose, light, long sleeves (to protect from UV radiation) clothing made of breathable fabric and a hat
- If wearing tough, protective clothing try to incorporate ventilation patches in the armpits, elbows, behind the knees, and groin area and ventilation holes in (certified) helmets to help promote airflow

If you want to know more, visit www.heat-shield.eu or contact consult@heat-shield.eu for free guidance and consultancy on heat-health actions for your company

Appendix 3.3: Infographic for the manufacturing industry

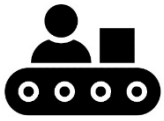
OCCUPATIONAL HEAT STRESS IN MANUFACTURING

How to keep workers safe and productive in hot weather

HEAT IMPAIRS THE PRODUCTIVITY AND HEALTH OF WORKERS

- Heat stress impairs both physical and mental work capacity
- Substantial productivity losses – surpassing 15% on hot days
- Work-site injuries (e.g. slips, trips AND falls) Can increase during hot weather
- Signs of heat illness emerge (e.g. cramps, exhaustion, headache, dizziness, nausea)
- All above issues worsened by dehydration
- ***~70%*** of all European workers arrive to work dehydrated

MANUFACTORING WORKERS PARTICULARLY AT RISK



- Physically demanding work (causing internal heating)
- Hot machinery and limited access to cooling can result in exceptionally hot and humid working conditions indoors
- Limited access to water (on large worksites)

SIMPLE & EFFECTIVE MEASURES TO PROTECT AGAINST THE HEAT

- Pay attention to weather forecasts (or subscribe to hot weather alerts) and have a heat-defence plan for your company in place ***before*** heatwaves strike
- Add extra work breaks (~1.5 min breaks every 30 min)
  - Field studies have shown these extra breaks increase net productivity compared to no breaks, as workers start to work slower without breaks
- Make sure drinking water is available at all times
  - Consider adding water stations around the manufacturing building
  - Otherwise consider hiring someone during the summer whose job is specifically to deliver water to workers
- Establish cooled rest areas that are either air-conditioned or well-ventilated
- Rearrange work hours to cooler times, either by starting the work shift earlier or by performing the most physically demanding or outdoor tasks earlier in the day
- **Optimize clothing:** for protective clothing (e.g. coveralls) incorporate cooling vents into sheltered areas of the uniform (e.g. armpits, groin area, elbow and behind the knees) to promote air flow through the clothing
- If protective clothing not needed, wear light clothing exposing as much skin area as possible

If you want to know more, visit www.heat-shield.eu or contact consult@heat-shield.eu for free guidance and consultancy on heat-health actions for your company

Appendix 3.4: Infographic for the tourism industry

OCCUPATIONAL HEAT STRESS IN THE TOURISM INDUSTRY

How to keep workers safe and productive in hot weather

HEAT IMPAIRS THE PRODUCTIVITY AND HEALTH OF WORKERS

- Heat stress impairs both physical and mental work capacity
- Substantial productivity losses – surpassing 15% on hot days
- Work-site injuries (e.g. slips, trips AND falls) Can increase during hot weather
- Signs of heat illness emerge (e.g. cramps, exhaustion, headache, dizziness, nausea)
- All above issues worsened by dehydration
- ***~70%*** of all European workers arrive to work dehydrated

TOURISM – A VARIABLE INDUSTRY WITH VARIABLE STRESSORS

- Some jobs may be physically demanding (causing internal heating)
- Outdoor workers exposed to high temperature and humidity levels
- Exposure to sun can increase ambient temperature by up to 16°C
- Indoor environments may contain hot equipment with low cooling (e.g. kitchens)
- Limited access to water or limited opportunity to take cooling breaks

SIMPLE & EFFECTIVE MEASURES TO PROTECT AGAINST THE HEAT

- Pay attention to weather forecasts (or subscribe to hot weather alerts) and have a heat-defence plan for your company in place ***before*** heatwaves strike
- Add extra work breaks (~1.5 min breaks every 30 min)
  - Field studies have shown these extra breaks increase net productivity compared to no breaks, as workers start to work slower without breaks
- Make sure drinking water is available at all times
  - Further, emphasize drinking before and after work to restore water balance
- Establish cooling areas where workers can rest, either air-conditioned and ventilated indoors or shaded with open-air exposure outdoors
- **Optimize clothing:** if outdoors, wear loose, light, long sleeves (to protect from UV radiation) clothing made of breathable fabric and a hat
  - If indoors, wear loose, light, breathable clothing with as much skin exposed as possible
- If access to cooling (e.g. indoor jobs, rest stations), provide cool water or tubs containing cold water where workers can submerge their arms to provide cooling

If you want to know more, visit www.heat-shield.eu or contact consult@heat-shield.eu for free guidance and consultancy on heat-health actions for your company

Appendix 3.5: Infographic for the transportation industry

HEAT STRESS IN THE TRANSPORTATION INDUSTRY

How to keep workers safe and productive in hot weather

HEAT IMPAIRS THE PRODUCTIVITY AND HEALTH OF WORKERS

- Heat stress impairs both physical and mental work capacity
- Substantial productivity losses – surpassing 15% on hot days
- Work-site injuries (e.g. slips, trips AND falls) Can increase during hot weather
- Signs of heat illness emerge (e.g. cramps, exhaustion, headache, dizziness, nausea)
- All above issues worsened by dehydration
- ***~70%*** of all European workers arrive to work dehydrated

TRANSPORTATION WORKERS PARTICULARLY AT RISK

- Relatively trapped in work environment with minimal control over: ambient conditions, change of body posture, self-pacing, cooling/hydration breaks
- Interior conditions of vehicles highly influenced by environmental conditions (at the mercy of high temperature, humidity, and solar radiation)
- Limited access to food, water and rest breaks
- Adequate sleep critical for maintaining focus

SIMPLE & EFFECTIVE MEASURES TO PROTECT AGAINST THE HEAT

- Pay attention to weather forecasts (or subscribe to hot weather alerts) and have a heat-defence plan for your company in place ***before*** heatwaves strike
- Attempt to have access to drinking water at all times
- If access to water is limited during the work shift, place extra emphasis on drinking plenty of water before and after the work shift
- The cooler the driver, the less they will sweat, and dehydration will be slowed
- Use air-conditioning when possible
- Minimize solar radiation via low-transmissivity/high-reflectivity glazing elements, solar shading solutions (sunshades), and high-reflectivity paints
- Alternatively, increasing ventilation when ambient temperature is lower than 36°C will facilitate heat loss at a lower energy cost than air-conditioning
- Wear appropriate clothing: loose, light, breathable clothing which exposes as much skin as feasible will help encourage heat loss
- Reschedule tasks to cooler times of day whenever possible

If you want to know more, visit www.heat-shield.eu or contact consult@heat-shield.eu for free guidance and consultancy on heat-health actions for your company

Appendix 3.6: Infographic for workers

HEAT-HEALTH impact industrial productivity

HOT FACTs upon which you can ACT to minimize detrimental effects on company performance

ACUTE ACCIDENTS and WORKERS HEALTH

- More mistakes and elevated risk of work injuries
- Accumulated fatigue and sickness symptoms
- Prolonged health hazards – e.g. doubled risk of kidney diseases
- 70% of all European workers fail to hydrate in the heat

LOST WORK-TIME and efficiency

- Heat stress impairs both physical and mental work capacity
- Substantial productivity losses – surpassing 15% on hot days

Develop a HEAT and HYDRATION PLAN

- MITIGATION measures may *halve the risk of mistakes* and reduce the loss of effective working hours by more than 50%
- a scheduled hydration plan and close access to water can halve the loss of productivity
- consider if work and especially heavy task may be scheduled to least hot hours of the day
- Brief breaks are cost-neutral and may benefit productivity on the long run – using planned brief breaks to cool and hydrate will lower fatigue and unplanned breaks – hence you win on the overall outcome

Want to know more visit www.heat-shield.eu or contact consult@heat-shield.eu for free guidance and consultancy on heat-health actions for your company

WORKING IN THE HEAT

– here is what you should know on hydration

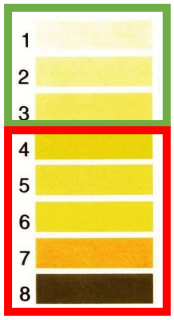
Your hydration is of immense importance for your health and performance

- On the prolonged perspective inadequate hydration increase the risk of kidney related diseases and makes you more vulnerable to heat exhaustion

- Acutely, dehydration doubles the risk of making mistakes if you work with complex tasks and it impairs your physical performance

- Nevertheless, 70% of all European workers exposed to high heat fail to remain optimally hydrated

If you don't want to be in that category – stay hydrated!



- Your urine colour should be very light (i.e. in the green box of the figure) and you should urinate frequently –infrequent and concentrated (dark yellow) urine are strong indicators of insufficient water intake.
- Secure adequate water and electrolyte intake (with easy access all day)
- Drinking plenty of water *before and after work* is as important as drinking water *during* work
- If you are a "heavy-sweater", water needs may be very high, and you will also need to add extra salt to your meals to secure rehydration.
- Don't overdrink but **find your balance** and needs
- Thirst is usually not an adequate indicator – a scheduled drinking plan may be a good start to secure good hydration habits

Want to know more visit www.heat-shield.eu or sign up as individual user at http://www.heatshield.zonalab.it/ for personalized guidance and heat alerts

Appendix 3.7: Infographic for employers

MAINTAINING WORKER PRODUCTIVITY IN THE HEAT

How to keep your workers productive and healthy in hot weather

DAMAGE TO YOUR BOTTOM LINE

- Heat stress impairs both physical and mental work capacity
- Substantial productivity losses – surpassing 15% on hot days
- Increases both heat and work-related injuries (increasing worker-compensation pay-outs)

DAMAGE TO YOUR WORKERS' HEALTH

- Short-term risk of heat illness (e.g. cramps, exhaustion, heat stroke)
- Accumulated fatigue and sickness symptoms
- More mistakes and elevated risk of work injuries e.g. bumps and falls
- Prolonged health hazards – e.g. doubled risk of kidney diseases
- All negative effects of heat worsened by dehydration
- ~70% of all European workers arrive to work dehydrated

DEVELOP A HEAT AND HYDRATION PLAN

- MITIGATION measures may *halve the risk of mistakes* and reduce the loss of effective working hours by more than 50%
- Dehydration and self-driven breaks are worse for overall productivity than pre-planned rest and washroom breaks
- Routine breaks in cool/shaded areas with regular access to water can halve the loss of productivity
- If possible, reschedule heaviest labour tasks to coolest hours of the day
- Using planned brief breaks to cool and hydrate will lower fatigue and unplanned breaks – hence you win on the overall outcome

For more information on these and other ways to heat-proof your workplace, visit www.heat-shield.eu or contact consult@heat-shield.eu for free guidance and consultancy on heat-health actions for your company

Appendix 3.8: Infographic for health officers

HEAT-RELATED INJURIES ARE OCCUPATIONAL INJURIES

How to keep workers safe and productive in hot weather

INJURY RATES ESCALATE IN THE HEAT

- Heat stress impairs both physical and mental work capacity
- Work-site injuries (e.g. slips, trips, falls and bumps) increase during hot weather
- Signs and symptoms of occupational heat stress emerge (e.g. cramps, exhaustion, headache, dizziness, nausea, fainting, etc)
- Prolonged health hazards – e.g. doubled risk of kidney diseases
- All above-mentioned issues are worsened with dehydration
- ***~70%*** of all European workers arrive to work dehydrated
- All up, heat-related illness substantially reduces productivity – surpassing 15% on hot days

PROTECT YOUR WORKERS, PROTECT YOUR COMPANY - DEVELOP A HEAT AND HYDRATION PLAN

- MITIGATION measures may *halve the risk of mistakes* and reduce the overall physical strain on the body
- Be aware of upcoming bouts of hot weather and have a heat defence plan ready
- For employers/managers concerned of productivity losses, dehydration and self-driven breaks are worse for overall productivity than pre-planned rest and washroom breaks
- Routine breaks in cool/shaded areas with regular access to water can reduce the physical strain on the body and improve worker comfort
- If possible, reschedule heaviest labour tasks to coolest hours of the day
- Ensure workers wear light, breathable loose-fitting clothing

For more information on these and other ways to heat-proof your workplace, visit www.heat-shield.eu or contact consult@heat-shield.eu for free guidance and consultancy on heat-health actions for your company

Appendix 3.9: Hydration-specific infographic

WORKING IN THE HEAT?

High sweat losses are a threat to your hydration

Hydration is a matter of maintaining the body balance of both water and electrolytes – i.e. ingest fluid and salt to match the amount you lose through sweating

- If you work in moderate temperatures your thirst will keep you adequately hydrated – BUT IN THE HEAT that is not sufficient to secure that you stay hydrated

Accordingly, 70% of all European workers exposed to high heat fail to remain hydrated

If you don't want to be in that category

Read these steps to secure adequate daily water and salt intake

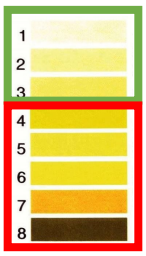
IT IS NOT just a matter of drinking during work - **day-to-day rehydration is equally important!**

Find your individual balance – there is large variation from person to person

If you are a "heavy-sweater", water needs may be very high, and you will benefit from adding extra salt to your meals to secure rehydration.

Sign up as user at below link to get personalized guidance or use these tips to estimate **your needs**

- Estimate your average sweat output on hot days by weighing before/after work and add the amount of ingested fluid during the day
- If your total sweat loss is below 2 litres – it will be sufficient to drink plain water - with equal amount during work and add extra water with your main meals (to rehydrate from day to day)
- If you sweat more than ~ 2 litres you will lose between 3 and 6 grams of salt per litre and most likely surpass your habitual dietary intake. In this case a little extra salt on your meals or add electrolytes (NaCl) to your drink is needed to keep your hydration in balance



- **A scheduled drinking plan can in this case be a good start to secure good hydration habits**
- Looking at urine colour (should be in the green box) and frequency; very infrequent and concentrated (dark yellow) urine are strong indicators of insufficient water intake.

If you want to know more, visit www.heat-shield.eu or sign up as individual user at http://www.heatshield.zonalab.it/ for personalized guidance and heat alerts

HEAT SHIELD

Appendix 3.10: Infographic for healthcare practitioners

PREVENTING HEAT-RELATED INJURIES IN PEOPLE WITH NON-COMMUNICABLE DISEASES (NCD)

Suggestions for workers with NCDs that work in hot environments or during periods of increased heat

NCD PATIENTS ARE AT HIGH RISK

Temperatures and prevalence of NCDs are both increasing worldwide and thus, more people with NCDs will be working in hotter environments

- This can have detrimental effects on patient's health, loss of productivity as well as increased healthcare costs

- Workers with NCDs are more prone to heat-related injuries, such as heat stroke and heat fatigue

SIMPLE & EFFECTIVE ADVICE TO NCD PATIENTS TO PROTECT AGAINST THE HEAT

- Pay attention to weather forecasts (or subscribe to hot weather alerts) and have a heat-defense plan ***before*** heatwaves strike

- Drink plenty of fluid and avoid alcohol
  - Have with you hydration packs, water belts, and rehydrating during breaks
- Optimize clothing: if outdoors, wear loose, light, long sleeves (to protect from UV radiation) clothing made of breathable fabric and a hat
- If wearing tough, protective clothing try to incorporate ventilation patches in the armpits, elbows, behind the knees, and groin area to help promote airflow
- Slow down when it's hot

- Lookout for heat-related illnesses
  - **Heat Exhaustion**: when you become very hot and start feeling weakness, headache, cramps, sickness, feeling faint, heavy sweating and intense thirst
  - **Heat Stroke**: when you start feeling confusion, seizures and loss of consciousness

A READY-MADE HEAT-DEFENSE PLAN FOR KEEPING WORKERS SAFE AND PRODUCTIVE IN THE HEAT

Have a plan

Don't be caught off guard! Have a plan in place for what you need to do during periods of high heat stress ***before*** hot weather occurs. This heat defence plan can serve as the back-bone of your plan, but make sure that you have everything you need to enact your heat defence plan when you need it. This can be in terms of materials, such as having coolers or water containers ready which can be filled to provide workers with elevated hydration demands. This can also be in terms of making sure your employees are aware of the heat defence plan and know what they should do to take care of themselves and their colleagues during periods of hot weather.

Pay attention to the weather

Again, don't be caught off guard! Sign up to a weather notification service that will alert you to when a period of hot weather which could affect your workers' health and productivity is approaching. We recommend using our very own Heat-Shield weather notification system which can be found at www.heat-shield.eu. Not only will you get weather notifications, but you will also receive recommendations on heat defence actions you should take based on the weather, the type of work you do and the clothing ensemble you wear to work.

Assess the risk

It is important to note that ***everyone*** is susceptible to heat related injuries and that studies have shown that young healthy men actually make up most of heat related injuries. With that said, you should take the time to make a list of people who might be at extra risk for heat related injuries. This list should include: older workers, workers who have particularly physically demanding jobs, workers who operate in particularly hot areas (e.g. exposed to the sun, works close to hot machinery), new workers who have not experienced occupational heat stress before and workers who have had issues with the heat in previous summers. When hot weather hits, you may consider giving these workers lighter tasks, giving them extra break time,

or checking in with them every now and then to make sure they are feeling alright. It can also be a good idea to invoke a “buddy system” where workers have a pre-determined “buddy” that they check in with every half hour to make sure they are feeling alright.

Give extra breaks

It may seem counterintuitive but giving your workers extra breaks throughout the day will not affect your net productivity and may actually increase your productivity during periods of heat stress. This is because when the weather heats up, workers will naturally start to take more unplanned breaks and slowing down their work efforts. By giving pre-planned breaks, we recommend 2 minutes every 30 minutes, you can reduce the number of unplanned breaks workers take and use this time to actively cool them using fans, cool water, or other methods (see below).

Reorganize the work day

An easy, low cost and effective way to maintain your workers’ health and performance in the heat is to reschedule the workday. This can be done by one of two ways (or both): 1) Start the work day 1 to 2 hours earlier. This allows for your employees to be active during overall cooler hours of the day. 2) Schedule the days so the most physically demanding tasks (where workers will be producing the most amount of heat internally) to the coolest hours of the day and save the easiest tasks for the hottest hours of the day. The same approach can be used for indoor and outdoor tasks, where the outdoor tasks should be performed during the coolest parts of the day.

STAY HYDRATED!

This is probably the most important point of the entire plan. All of the negative effects that heat can have on the body are made worse by dehydration. This especially true for decreasing your workers cognitive performance, which can lead to mistakes, accidents and injuries. Furthermore, being chronically dehydrated will increase your workers’ likelihood of developing kidney disorders further down the line. What is particularly worrisome is that ~***70%*** of workers come to the job in a dehydrated state. Encourage workers to drink regularly. This can be helped by putting up posters in common areas like break rooms that help to remind workers to drink. Water stations should be set up in multiple locations at job sites. For

outdoor work, workers can be encouraged to carry hydration backpacks or belts with water bottles on them, in order to have consistent access to water. Alternatively, “water caches” such as coolers containing water or large water jugs hidden in the shade of a tree can be set up in the field at the start of the work day in areas where workers will pass by. Additionally, for those who are “heavy sweaters”, simply drinking water may not be sufficient to remain hydrated and these individuals should add extra salt to their diet. Of note, this may be inappropriate advice for people with heart and blood pressure issues. If a worker has one of these issues, they should check with their doctor before adding extra salt to their diet.

Create “cooling oases”

As stated above, taking pre-planned breaks is essential for maintaining worker productivity, and this can be optimized by taking these breaks in “cooling oases” where workers can befit from extra cooling. For example, indoors, small dedicated rooms with air conditioning and cool water can be set up. If no rooms are available, areas away from hot machinery, equipped with electric fans and (cool) fresh water could be helpful. Outdoors, selecting an area with plenty of natural air flow that is in the shade is ideal. If no natural shading is present, portable sun canopies can be purchased and set up along with the water supplies for the “water caches” discussed above.

Cooling options during breaks

For extra cooling during breaks, several options exist:

Ice slurry ingestion: this can be done by adding shaved ice to ingested fluids, purchasing an ice slushy/slurry/Slurpee machine for a company break room, or just cooling the water if the addition of ice is not possible (although for the greatest cooling effect, ice is desirable).

Arm immersion: this can be achieved by purchasing a large tub, filling it with water and ice and having your workers submerge their arms as deep as possible into the water. As there are many blood vessels relatively close to the surface in the arms, this has been shown to be a very effective way to deliver effective cooling quickly and in a not-too-complicated fashion.

Cooling vests: Typically, these are better worn over prolonged periods (as described below). Cooling vests come in two forms: phase change materials and evaporative cooling. Phase change vests contain ice or a cooled gel that gradually cool the person wearing the vest as they work. These vests are highly effective, however, once all the cooling substance has melted, the cooling effectiveness will cease. Therefore, the vests need to be changed fairly regularly for the cooling effect to continue. This requires a cooling source such as a freezer to be relatively close to the work site which may cause logistical issues. Evaporative cooling vests just need to be wet and as the water evaporates gradually, the vests provide cooling. These vests are typically not as effective as the phase change vests and are not effective in very humid environments but are less of a logistical challenge to operate.

Ice towels: This method is a cheaper alternative to cooling vests and can be a good solution during periods with very high heat stress (for cooling during breaks) or in emergency situations with acute need to lower skin temperature (and if used over prolonged periods lower deep core temperature as well). This method essentially consists of wetting towels with water and then filling the towels with ice.

Stationary Ventilation: As mentioned above, by improving air flow across the skin, the body's natural heat loss processes are enhanced. This is especially true if the skin is wetted with a spray, cloth, or sponge. This way, extra evaporative cooling happens in addition to the normal evaporative cooling the workers would get from sweating.

Cooling options during work

For very hot jobs, cooling the employee while they work is sometimes needed. However, the options available are fairly limited. The most useful method is typically wearing a cooling vest. Cooling vests come in two forms: phase change materials and evaporative cooling. Phase change vests contain ice or a cooled gel that gradually cool the person wearing the vest as they work. These vests are highly effective, however, once all the cooling substance has melted, the cooling effectiveness will cease. Therefore, the vests need to be changed fairly regularly for the cooling effect to continue. This requires a cooling source such as a freezer to be relatively close to the work site which may cause logistical issues. Evaporative cooling vests just need to be wet and as the water evaporates gradually, the vests

provide cooling. These vests are typically not as effective as the phase change vests and are not effective in very humid environments but are less of a logistical challenge to operate.

Additionally, new types of clothing that have personal fanning units incorporated into the clothing have recently come on the market and can provide an added cooling benefit for the worker.

Optimize clothing

A very simple and effective way to improve worker comfort, health and performance in the heat is to simply ensure they are wearing appropriate clothing for the conditions. Clothing that should be worn in hot conditions should be light, loose, made of breathable fibres, and have large knitting patterns, which again, allow for the clothes to "breath", that is for more air to pass across the skin surface. If the employee is working outdoors, it is advisable that they wear long pants and long-sleeved shirts as well as a hat to protect their skin against solar radiation. Also, lighter colour clothing may be advisable outdoors, as this too will help reflect solar radiation. Indoors, workers are advised to again wear light, loose clothing, however they should try and expose as much skin as possible to facilitate heat loss. For those working in industries where thicker, protective clothing is required, buying versions of these items of clothing that have mesh patches incorporated into more protected areas such as the armpits, groin, elbows and behind the knees are advisable.

Signs and symptoms of heat illness

It is important to be aware of the signs and symptoms of heat illness and for all employees to be aware of the signs and symptoms of heat illness. These include:

- Cessation of sweating
- Paleness
- Muscle Cramps
- Tiredness
- Weakness
- Dizziness
- Headache
- Confusion
- Nausea or vomiting
- Fainting
- Skin: may be cool and moist
- Pulse rate: fast and weak
- Breathing: fast and shallow

Treating heat illness

In the event of a worker experiencing the symptoms of heat illness, you should:

1. Move them to a cool area and out of the sun
2. Sit down and take a quick rest
3. Drink plenty of cool water
4. Apply a cool water on skin

If the worker loses consciousness, emergency medical services should be called immediately. In the interim, whatever cooling is available should be applied until emergency personnel arrive. These cooling interventions can be as simple as wetting the skin, applying ice to the body, particularly around the head and neck, and immersing the person in a tub of cool water if one is available.

For more information on these and other ways to heat-proof your workplace, visit www.heat-shield.eu or contact consult@heat-shield.eu for free guidance and consultancy on heat-health actions for your company.