Appendix 4

Coventry University and DFRMO Small Scale Study

CFBT / BA HOT WEAR HUMAN FACTORS INITIAL NEEDS ANALYSIS

Preliminary data were collected from two instructors undertaking CFBT. Each was instrumented with a different system to monitor skin surface temperature. In addition one instructor had rectal and aural temperature recorded alongside wearing a heart rate belt around the chest (Figure 1).

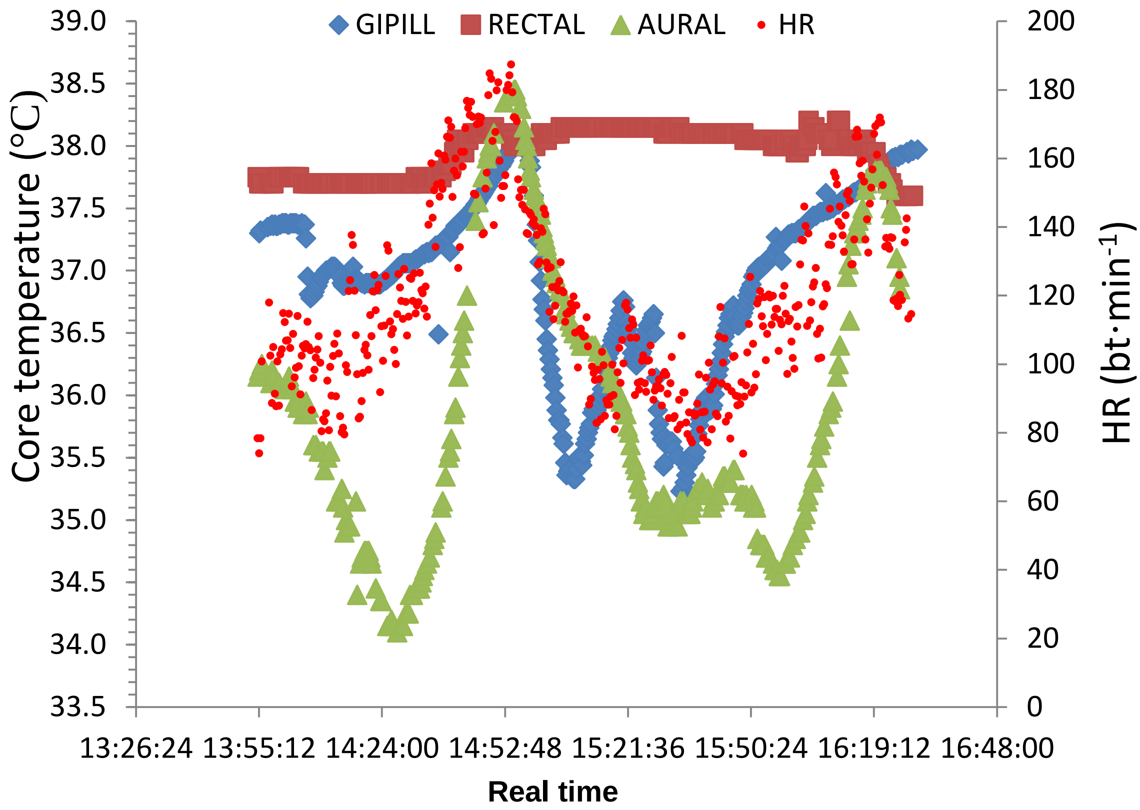

Figure 1: Core temperature (GIPILL – gastrointestinal pill; RECTAL and AURAL) and heart rate response of one CFBT instructor throughout CFBT demo and attack.

As expected aural and gastrointestinal temperature were more responsive to changes in environmental temperature then rectal temperature. The two core temperature spikes at ≈14:50 and 16:20 corresponded to the 1st and 2nd hot wears respectively. Importantly the magnitude of physiological strain was highlighted by core temperature (aural) reaching 38.5°C aligned to a peak heart rate of 187 bt·min^{-1} within a relatively short exposure time (≈30 min, 1st hot wear). Furthermore core temperature and HR moved towards these values in the 2nd hot wear where the instructor remained outside of the 'can'. 15 min post exposure it was noted that the instructors heart rate was around 140 bt·min^{-1}. Further monitoring and notation of specific activities undertaken by a range of instructors is required to enhance our understanding of the physical stresses experienced in CFBT instruction. Data are yet to be recorded from instructors in the 'hot house'. Skin surface temperature sensing sites also need to be considered in relation to body and fire orientation.

These data are supported by subjective responses and anecdotal report from the said instructor. Likely to be due to the extreme and rapid heat exposure experienced in the 'can' the instructor was able to differentiate between changes in core and skin surface temperature, highlighted by stating a thermal sensation score of 7 (Very Hot) on the upper arm when this body part was orientated towards the flame (Figure 2). The average overall whole body thermal sensation was reported to usually be 4 or 5 on this scale either 'comfortable' or 'warm' in these exercises. It is also noted that instructors are essentially acclimated to heat exposure, thus the magnitude of physiological stress is likely to be less than when an instructor has not been exposed for some time. The importance of hydration is also apparent here as the benefits of acclimation to heat are dramatically reduced when and individual is dehydrated.

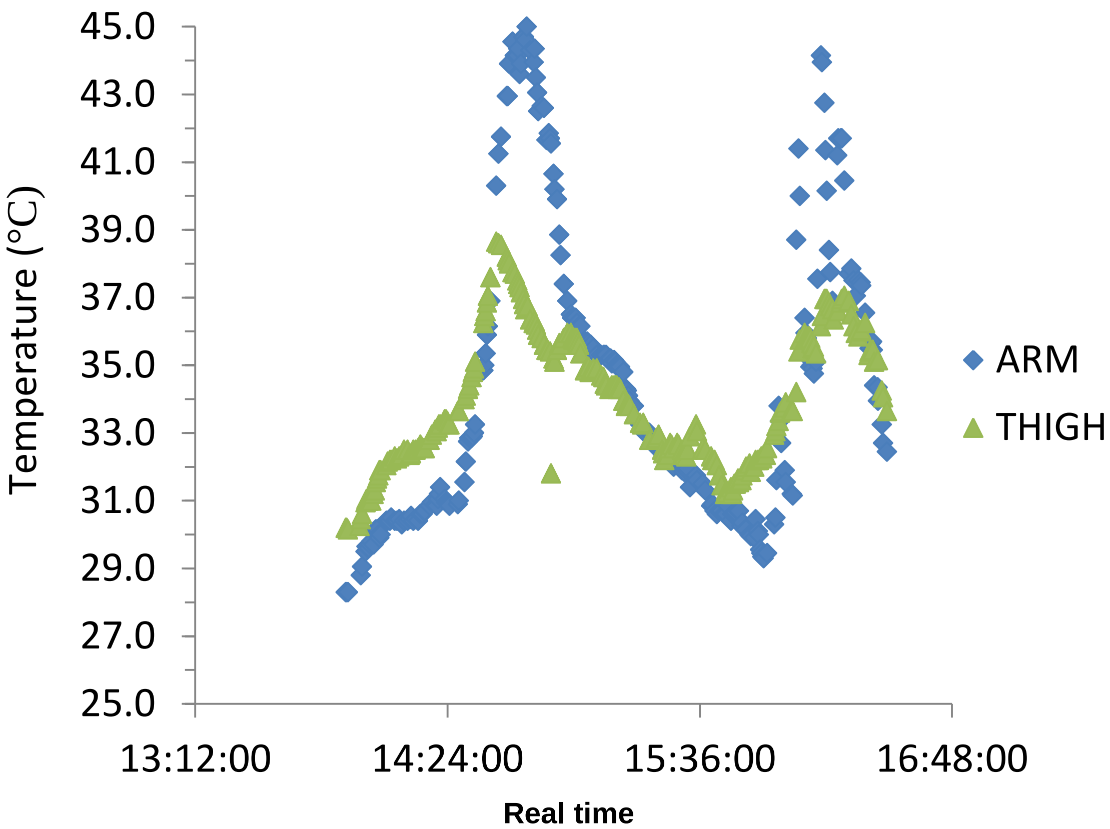

Figure 2: Upper arm and mid-thigh temperature of one CFBT instructor throughout CFBT demo and attack.

Daily monitoring log

A review of the current 'in house' health monitoring log revealed the need to modify the focus of some questions and add ones to seek more detailed human factors based information. In some instances data quality are proposed to be enhanced by applying a seven point response scale (-3 to 3) rather than 'yes' or 'no' answers in some instances (11 questions). However it is proposed to include 5 answer 'yes' or 'no' questions that require further information if the respondent answers 'yes'. For example if the response to the question 'Are you suffering from any cold, flu, diarrhoea and other illness?' is positive it is proposed that the instructor is asked to complete a short questionnaire (Wisconsin upper respiratory symptoms survey; WURSS) exploring the positive answer further (see attached). It is hoped that this, in combination with other variables, will contribute to understanding the 'Manston flu' commonly experienced by CFBT instructors.

In addition to the variables usually recorded at the start of the day and after the 1st and 2nd hot wears a requirement for monitoring body mass, in relation to sweat loss and hydration status has been identified. It is also considered beneficial for instructors to report a rating of perceived exertion (RPE, 6-20 scale), thermal sensation (TS, 0-8 scale) and thermal comfort (TC, 0-8 scale) after both the 1st and 2nd hot wears. Thus a modified version of the CFBT / BA hot wear monitoring log has been designed and renamed to emphasise the human factors focus (see attached). The trade-off to enhance reporting on human factors being that a new form needs to be completed every day rather than reporting on the same form on a daily basis throughout the week.

Initial scope for further work to inform the potential for modifying working practice

There is significant scope for the integration of further daily monitoring to develop our understanding of the physiological stress of repeat exposures to CFBT experienced by instructors.

Hydration: Body mass proposed to be monitored pre and post exposure as well as asking instructors to note the fluid ingested between 1st and 2nd daily exposures. Additional measures include both saliva and urine osmolality as a marker of hydration status pre and post exposure. Such data, alongside evaluating appropriate interventions will inform the introduction of fluid replacement guidelines for instructors. Further work could include a more thorough diet and fluid intake analysis.

Cooling strategies: Use of cooling jackets when undertaking CFBT. Significant potential benefits of cooling may have been overlooked, due to lack of objective data, in the past. The type of cooling garment (ice or phase change material would need to be considered). This is considered to be a key area of investigation, supported by the collaborators extensive experience of working with cooling garments worn under personal protective clothing (PPE). Linked to the above, should instructors be advised to consume a bolus of cool fluid prior to exposure?

Post CFBT exposure activity: There is potential for deep core body temperature to over shot if the periphery (skin) is rapidly cooled post exposure. This may contribute to fatigue, immune system depression etc.

Immune system function: Saliva collection could also provide samples to give a window to evaluate how aspects of immunity fluctuate within in instructors (such as salivary immunoglobulins, antioxidant capacity, proteases)