

Beat the Heat in FRC



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Introduction

- Hot environments are thermal stressors
- Heart beats faster to circulate more blood to the skin for heat loss to the environment and sweating brings water to the skin's surface for heat loss by evaporation.
- Sustained peak heart rate - leading indicator that an individual's thermal regulatory control may not be adequate.
- Sustained peak heart rate - heart rate spends several minutes at or above (180 - subject's age)
- Represents cardiovascular demand of about 75% of maximum aerobic capacity.
- Dehydration affects heart rate.
- Weight loss greater than 1.5% over a shift indicates a greater risk of heat strain.



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Subjects

Well-acclimated (Driller, Motor man, Derrickman, and 3 Floorhands)

Clothing Ensembles

Day 1 - Work shirt and jeans

Day 2 - 4.5 oz Nomex, Royal Blue

Day 3 – 7.5 oz Dale Anti-Flame treated cotton, Gray; and

Day 4 - 6 oz Nomex, Royal Blue.



Fluid Replacement

Water coolers located in the doghouse and ground level. Subjects were encouraged to drink fluids as they would normally.



Environmental Measurements

Temperatures, relative humidity – QuesTemp34.
Air movement was estimated through observation.



Weight and Heart Rate

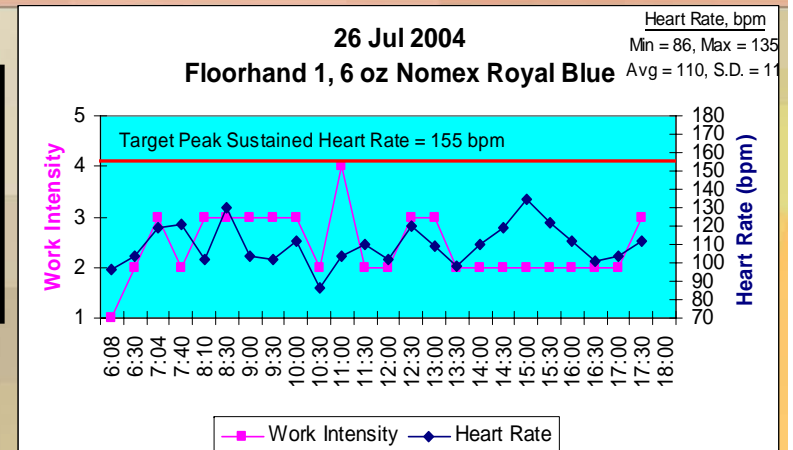
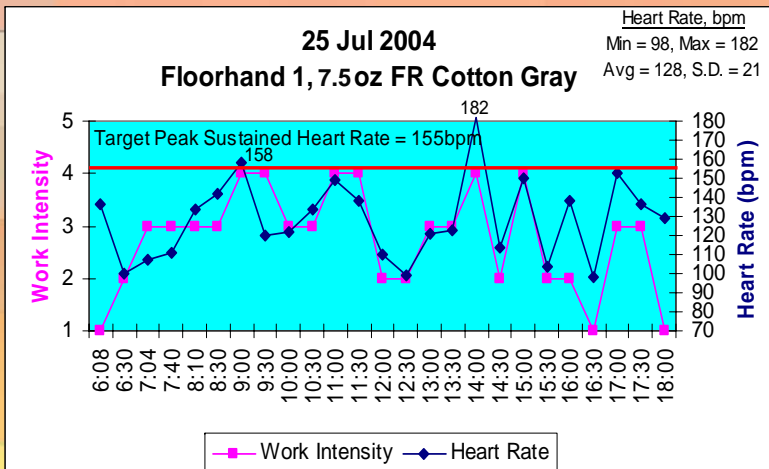
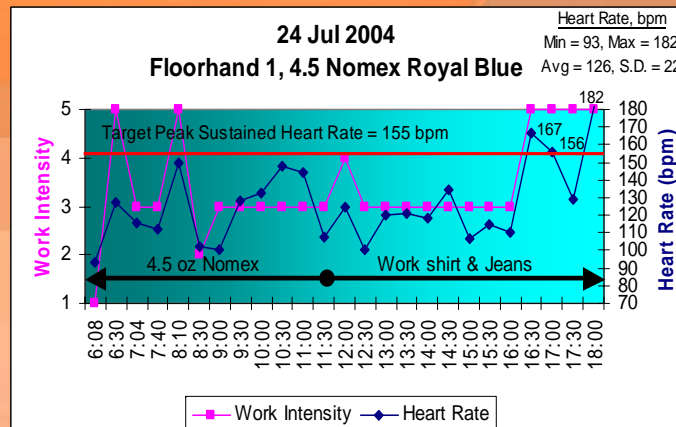
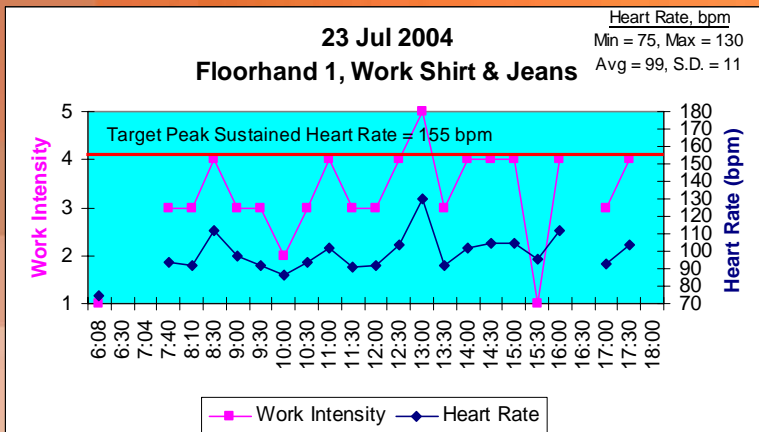
Subjects weighed to the nearest 0.5 lb at the beginning and end of the shift. Heart rate recorded using a Polar A3 watch and transmitter. Work intensity was categorized by observation and interviews.



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Results

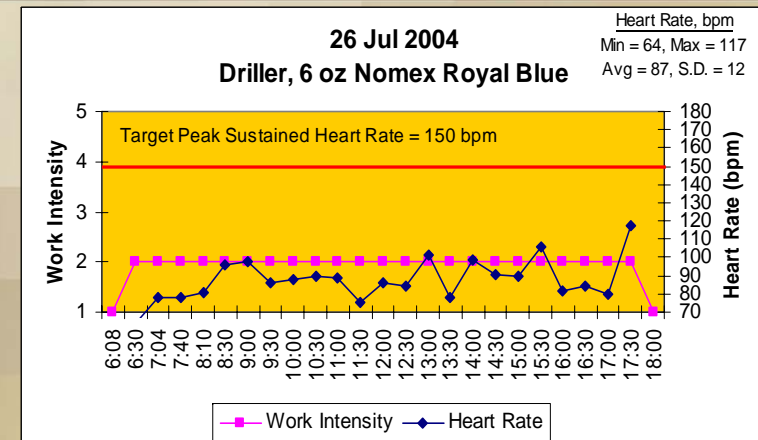
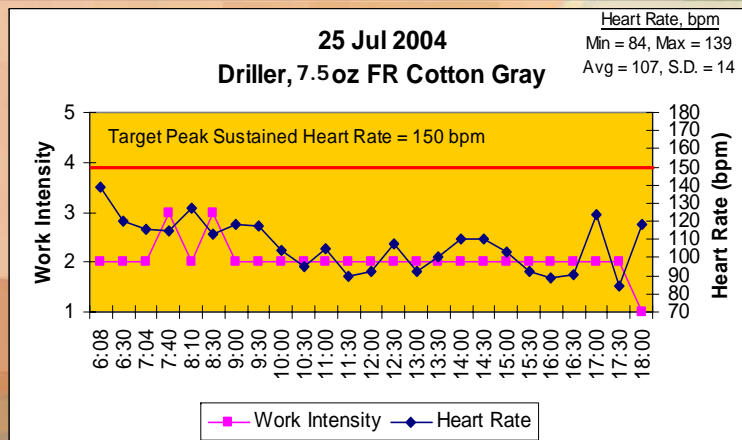
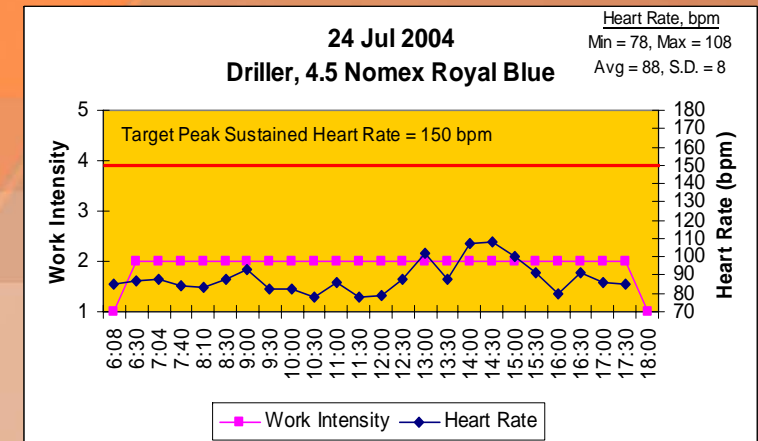
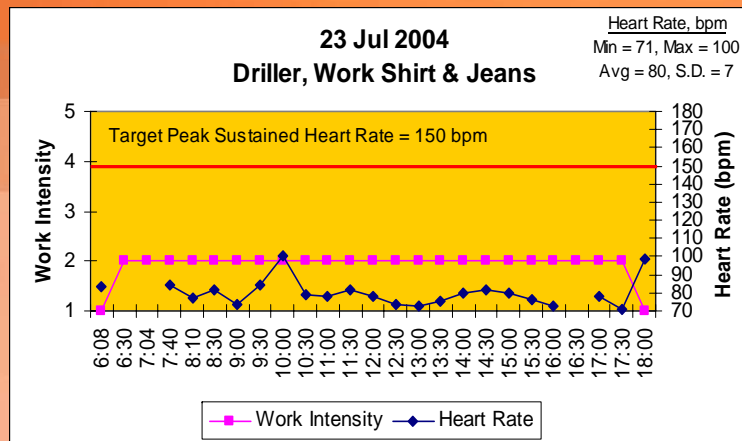
- Heart rate (bpm) and corresponding work intensity recorded manually every 30 minutes
- Heart rate compared to Target Peak Sustained Heart Rate



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Results - Control

Driller works predominantly in the air-conditioned doghouse (constant temperature and relative humidity) and has a relatively constant Level 2 physical work intensity, making him a good control for the study.

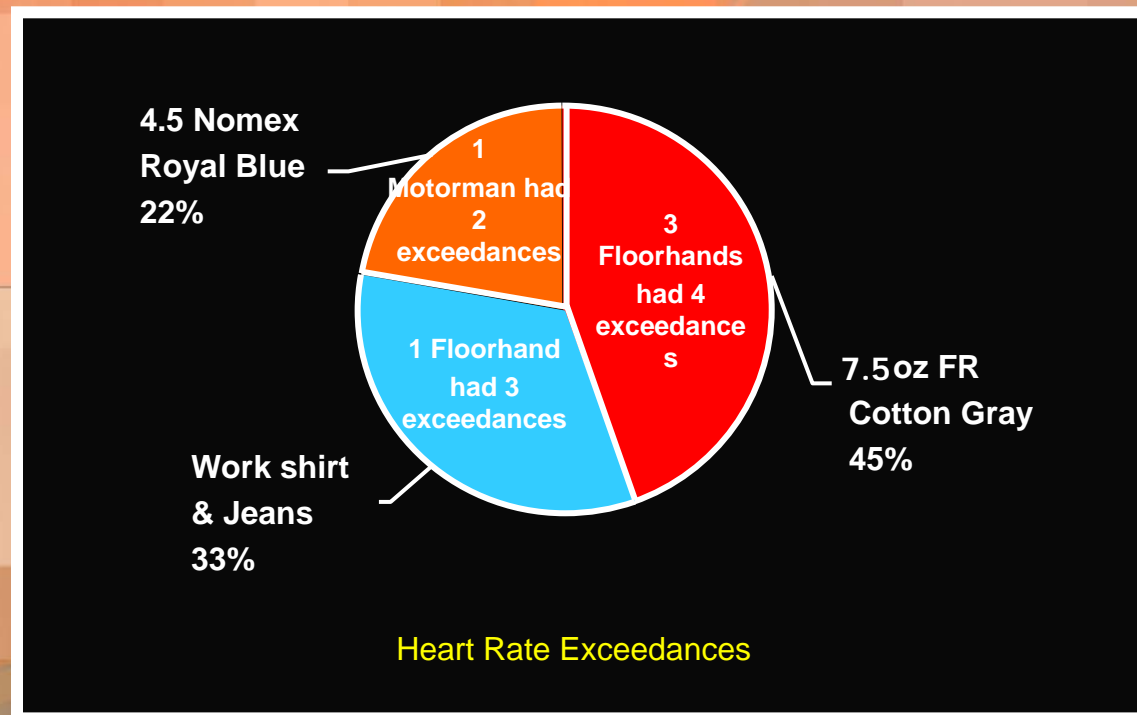


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Discussion

None of the subjects lost >1.5% of his body weight; while wearing the 7.5 oz Flame Resistant Cotton, several subjects “gained” weight due to the lack of evaporation of sweat.

Heart rate is strongly correlated with work intensity. In this study, exceedances of the Target Peak Sustained Heart Rate occurred in 4 of 6 subjects (3 Floorhands and 1 Motor man) and in 3 of 4 clothing ensembles (work shirt and jeans; 4.5 oz Nomex; and 7.5 oz flame resistant cotton) (Figure below).



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Work-rest schedules using ACGIH criteria for Floorhand 1 on 23 and 24 July 2004.

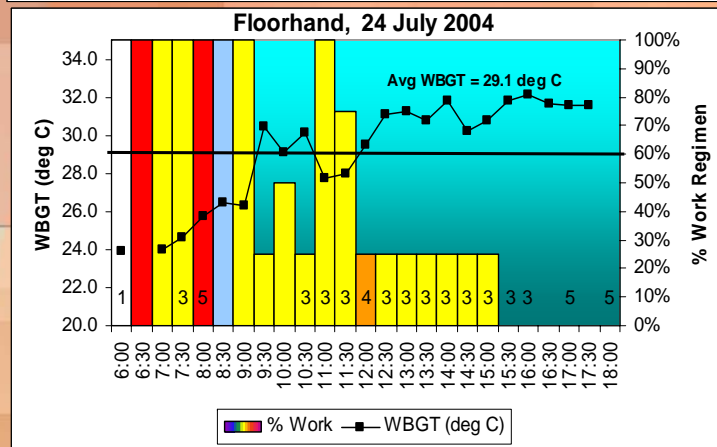
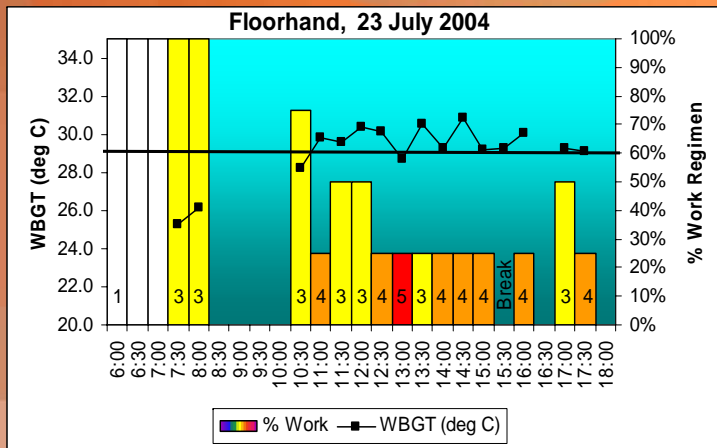


Table 1. ACGIH 2004 Screening Criteria for Heat Stress Exposure (WBGT values in °F)

Work Demands	Acclimatized				Unacclimatized			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
100% Work	85.1	81.5	78.8		81.5	77	72.5	
75% Work; 25% Rest	86.9	83.3	81.5		84.2	79.7	76.1	
50% Work; 50% Rest	88.7	85.1	83.3	81.5	86	82.4	79.7	77
25% Work; 75% Rest	90.5	87.8	86	85.1	87.8	84.2	82.4	79.7

Recommendations for Work-Rest schedules are available from various sources. These schedules cross-reference the WBGT with the Work Intensity to recommend a % Work: % Rest schedule. The 2004 ACGIH Screening Criteria for Heat Stress Exposure is presented above. The conservative criteria were developed to ensure that most workers will not experience a core body temperature above 100.4 °F.

Recommendations for 23 July would have been excessively conservative; roughly 50% of the shift would have been spent working only 25% of the time, while the subject's heart rate averaged only 64% of the target heart rate throughout the shift.

Recommendations for 24 July would have prevented the exceedances because all work of Levels 4 and 5 Intensity would have been prohibited beginning at 1600 hrs.

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Conclusions and Recommendations

- Drinking water - Cool water (~59 °F) - generally, at least a cup of water every 30 minutes.
- “Weighing in” each morning and evening helps workers monitor the effectiveness of their fluid replacement.
- Shaded break areas with drinking water - 76 °F adequate.
- Fans and portable evaporative coolers
- Monitoring heart rate provides immediate feedback
- Scheduling higher intensity work for nights when the radiant heat load is reduced
- Optimizing location orientation for prevailing wind.
- Buddy System to monitor their team members
- “Stop the Job” when their buddy needs a break.



