

*BIOPHYSICAL LABORATORY REPORT*  
Naval Clothing Research Textile Facility

From: N3.JG  
To: N2.RW; N2.HW

Via: N3, N2

Subj: THERMAL MANIKIN TESTING OF A MICRO-CLIMATE COOLING SYSTEM

1. Introduction:

- a. Requester: Richard Wojtaszek, Protective Clothing Division.
- b. Date of Request: Jul 98
- c. Project Number: 8L0264
- d. Purpose of Evaluation: Since the inception of the passive Micro-Climate Cooling (MCC), the problem to solve has been the place required for freezing the gel packs. Initial field evaluations may have utilized food freezers on a temporary basis. Since then, it has been decided, due to health reasons, that the food freezers can not be used to support freezing the gel packs on a permanent basis. The solution, paraffin packs designed to freeze at higher temperatures in cooling containers that only require a small foot print plus some source of energy to provide the cooling. This evaluation compared the standard Steele Vest® gel packs (frozen at 14°F) against two paraffin packs designed to freeze at 55°F and 65°F, and frozen at 45°F and 55°F, respectively. The test temperatures were 10°F below the designed freezing temperature.

2. Test Configurations:

- a. The Steele Vest® gel pack, the standard.
- b. A paraffin pack designed to freeze at 55°F.
- c. A paraffin pack designed to freeze at 65°F.

Each test configuration included the standard non-fire retardant utility uniform and a modified, four pocket, MCC vest constructed by Steele Vest® worn under a fire fighter's protective coverall.

3. Test Methodology:

The MCC test methodology was developed and described in a previous NCTRF report (1). In each test, the thermal manikin (TM) was allowed to reach thermal equilibrium with the candidate configuration, but without the gel/paraffin packs. The baseline (i.e., no cooling) power requirements were recorded, and then the frozen gel/paraffin packs were inserted into the pockets of the MCC vest. The power requirement was recorded at one-minute intervals for two hours for the torso region of the TM. The two hour average cooling rate was calculated from these readings. In order to isolate the effect of the conductive cooling provided by the gel/paraffin

packs from the evaporative heat exchange, a net cooling rate was calculated by subtracting the baseline cooling rate from the average cooling rate.

Two-hour test duration was dictated by the standard watch onboard Navy vessels, which is four hours. The test scenario simulated a sailor starting watch with fully frozen packs with a scheduled change of the packs after two hours. The assumption was that only one change was required for the four-hour watch.

Testing was conducted in the small NCTRF climatic chamber. Test conditions for MCC determinations were as follows:

MCC:

Ambient temperature = 35°C  
Skin temperature = 35°C  
Relative humidity = 40%  
Wind speed = 2.0 MPH

#### Statistical Analysis

The net cooling rate for each of the three MCC packs was statistically analyzed using a one-way analysis of variance (ANOVA). Significance was accepted at the 0.05 level. Post-hoc analysis with Sheffe's test was used to locate differences among the means.

#### 4. Results:

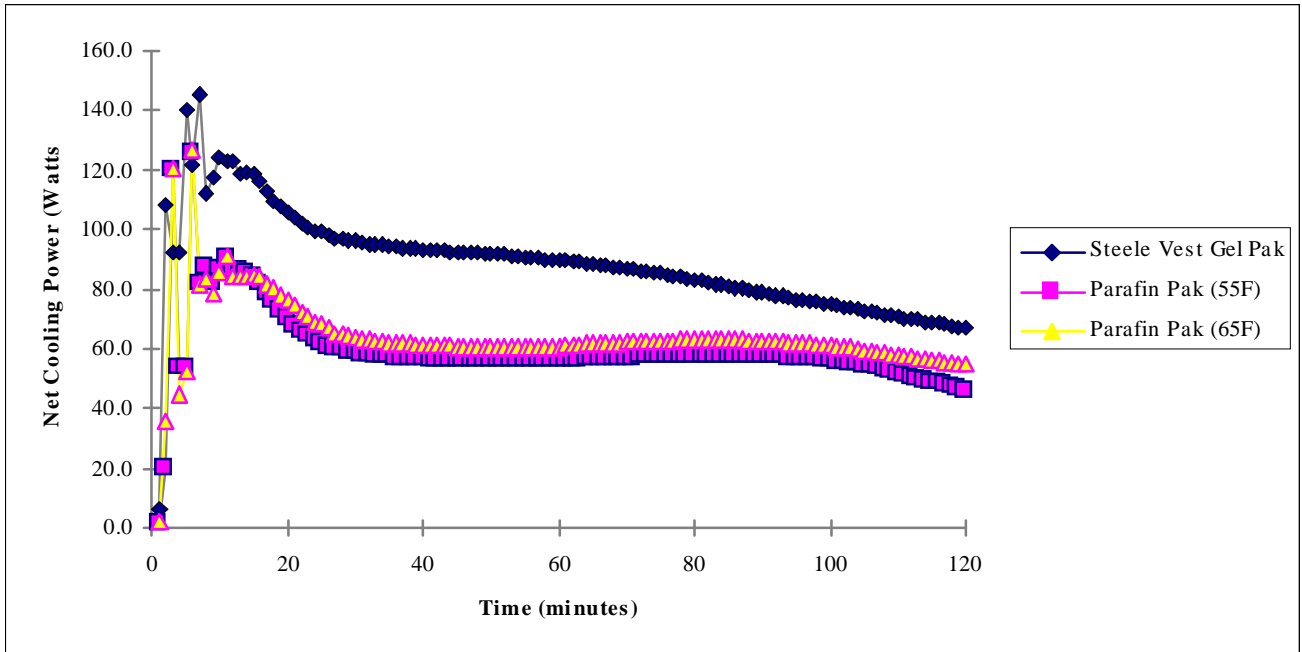
The Thermal Manikin results are given in Table 1.

Table 1. Two Hour Net Torso Cooling ((+/- S.D.), Watts) Yielded by the Gel/Paraffin Packs.

<b>Configuration</b>	<b>Net Torso Cooling (+/- S.D.)</b>
A, the standard	89.2(4.6)
B	59.5(2.0)
C	64.2(1.3)

Figure 1 provides a graphical presentation of the torso net cooling provided by the gel/paraffin packs.

Figure 1. Net Torso Cooling (Watts) of the Gel/Paraffin Packs.



#### Net Torso Cooling Comparison

Statistical analysis has shown configuration a to be significantly different from configurations b and c. It has also shown configurations b and c to be equivalent.

#### 5. Discussion/Conclusions/Recommendations:

Since these are preliminary tests intended to provide the Project Managers an initial baseline to work with, no recommendations are provided by the writer.

## References

- 1 Walter B. Teal, Jr., Evaluation of Passive Cooling With CB Protective Garments, Navy Clothing & Textile Research Facility Technical Report October 1995.

Appendix A Weights Of The Individual Gel/Paraffin Packs.

**Icepacks Weights  
(in Grams)**

	<b>65F</b>	<b>55F</b>	<b>Steele</b>
1	778.4	726.8	777.1
2	810.2	729.6	842.9
3	812.5	729.9	792.6
4	803.9	730.2	779.9
5	799.9	725.6	785.7
6	800.7	730.8	768.1
7	802.2	730.5	754.9
8	801.6	731.3	780.1
9	804.0	734.2	802.0
10	706.4	730.1	770.9
11	777.3	729.7	799.1
12	808.5	730.5	792.5
mean	<b>792.1</b>	<b>729.9</b>	<b>787.2</b>
stdev	29.2	2.1	22.2
coefVar	0.0368	0.0029	0.0282