



FIELD TESTING AUTONOMOUS HEATED FOOTWEAR FOR FROSTBITE PREVENTION IN EXTREME COLD ENVIRONMENTS

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BACKGROUND



Photo courtesy of the Department of Defense

DoW Arctic Strategy (2024)

“This increasingly accessible region is becoming a venue for strategic competition, and the United States must stand ready to meet the challenge alongside Allies and partners.”

“Advancements in research and development will be fundamental to future Arctic operations to improve Joint Force Arctic capabilities...”

Armed Forces Health Surveillance Center

~ 300 incidents of frostbite injury during most recent reporting period (2024-2025)

Ministry of Defence of Ukraine

In January 2026, more than 1,600 Ukrainians sought medical treatment for frostbite (92% hospitalized); Mean Temp (Jan 2026): -9 °C (15 °F)



BACKGROUND



Photo courtesy of Naval Health Research Center



KEY FEATURES OF HEATED SOCK USED IN FIELD TEST



Photos courtesy of CRG Defense



METHODS

Setting/Location

- Operation Musk Ox II (Canadian Arctic)
- Arctic Edge 2026 (Fort Greely, AK)
- Test Conditions: **-15 to -40 °C** (5 to -40 °F)

Participants

- 10 Active-duty Service Members (male)
- Age: 29 ± 4 yr
- Height: 180 ± 7 cm
- Weight: 86.4 ± 4.9 kg
- Participants performed cold-weather military training while wearing autonomous heated footwear

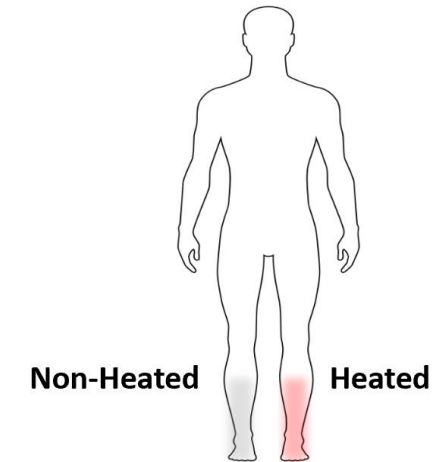
System Testing



55 hours of testing
Control vs Heated



HSR Testing

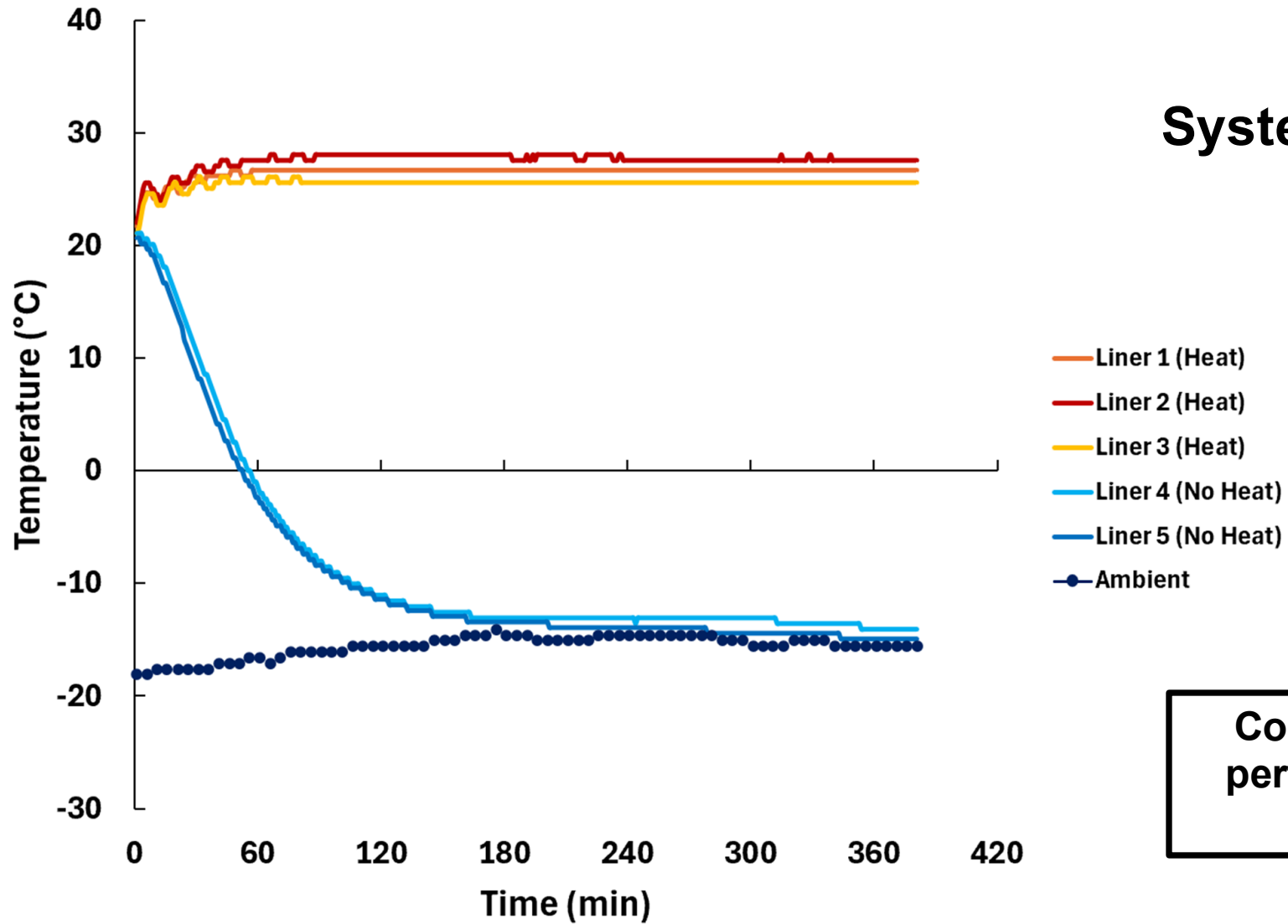


Photos courtesy of Naval Health Research Center



RESULTS

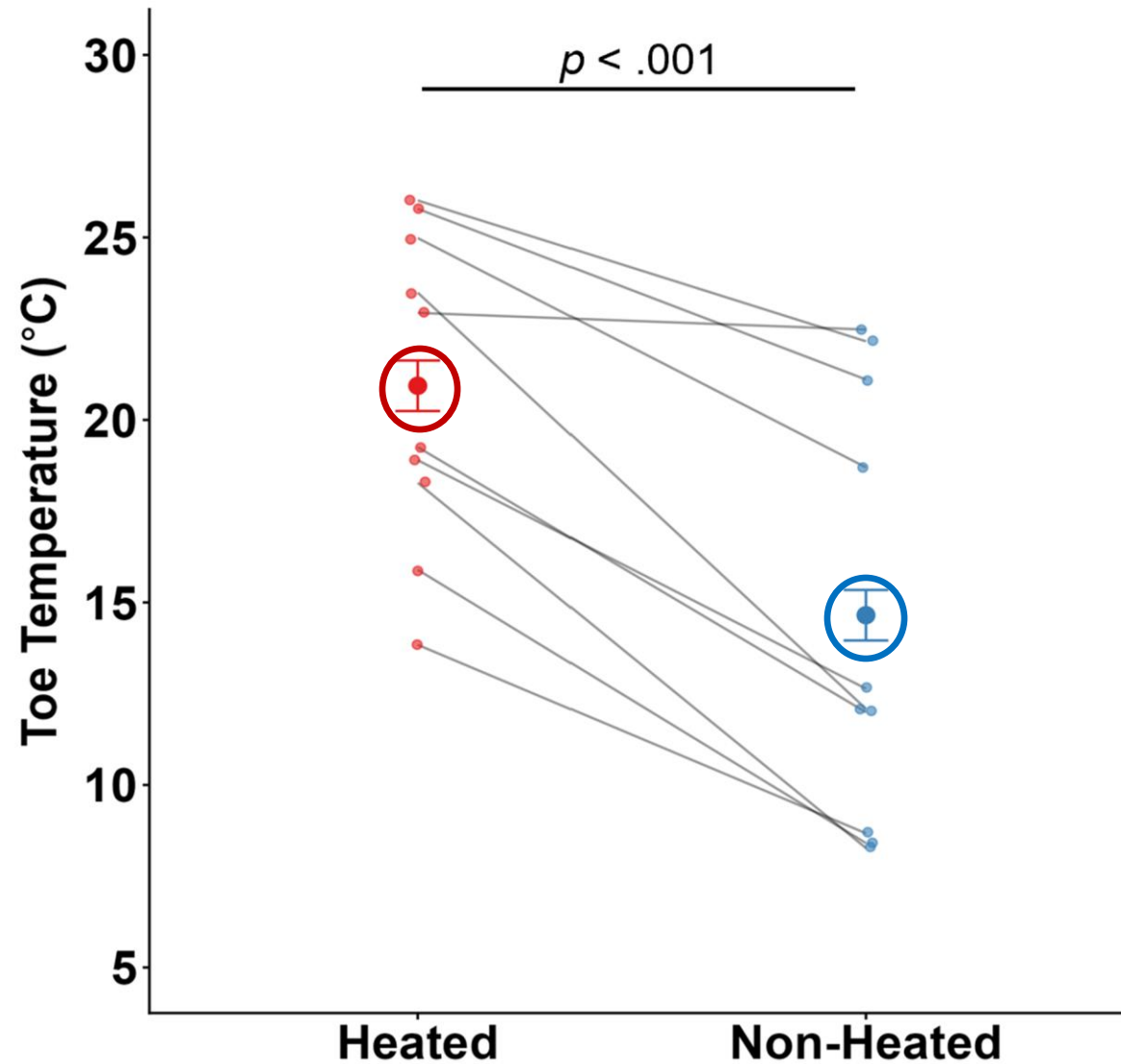
System Testing



Consistent heating
performance (25 °C)
for up to 7 hr



RESULTS



HSR Testing

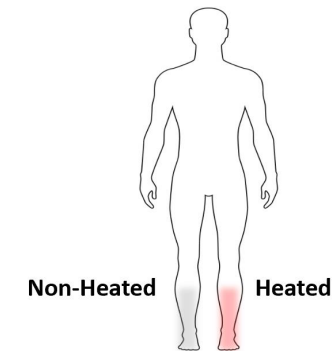


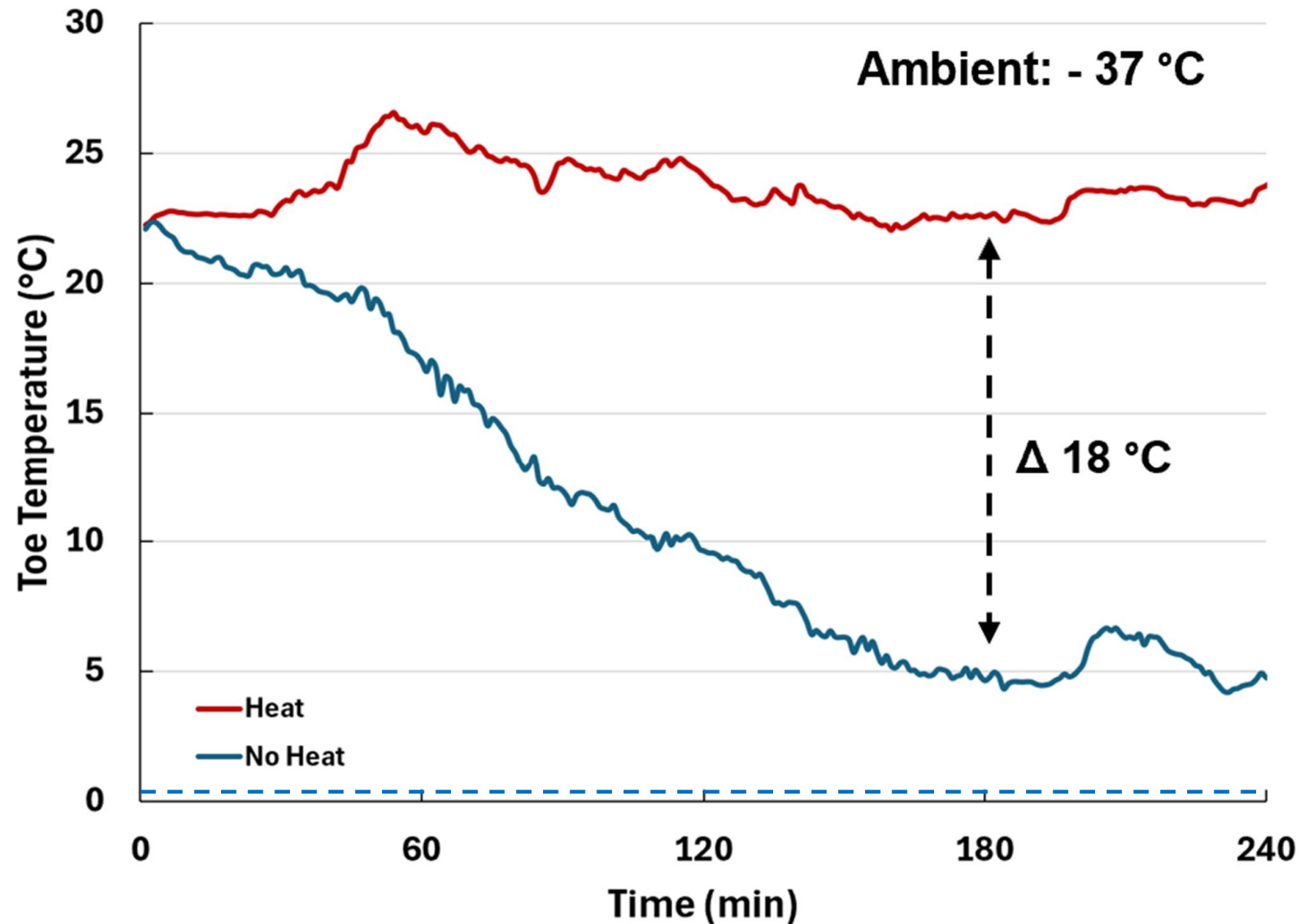
Photo courtesy of Naval Health Research Center

Significantly warmer toe temperatures over 4 hr test with autonomous heated socks

Ambient: -15 to -37 °C



RESULTS



More prominent differences in toe temperature occur at colder temperatures and during static activity



CONCLUSIONS

- **System Testing** – Consistent heating performance during extreme cold temperatures, even with batteries cold-soaked for multiple hours prior to use.
- **HSR Testing** – Findings demonstrate higher toe temperatures during extreme cold-weather military training, with more prominent differences when participants were unable to organically preserve toe temperatures.
- **Technology** – Cold-weather military operational testing supports technology as a viable option for lessening the risk for cold-weather injuries (frostbite)
- **Future Efforts** – Goal is to get technology to more users for additional feedback on integration, long-term field use, and additional heating applications.

Thank You

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