Fire
Tech Tips

United States Department of Agriculture
Forest Service
Technology & Development Program

March 2006
5100 0651–2312–MTDC

The Effect of Color on Temperatures Inside Hardhats

John Smith, Equipment Specialist, and Wes Throop, Mechanical Engineer

The Missoula Technology and Development Center was asked to determine the effect of a hardhat's color on the wearer's comfort. Wildland firefighters may select a hardhat's color based on their personal preferences, on the color of hardhats worn by their crew, or on their position in the Incident Command System.

MTDC conducted an informal test to evaluate the temperatures inside hardhats of various colors. The hardhats used were all new, cap-style Bullard FH911 Wildfire series hardhats. White, black, red, blue, yellow and orange hardhats were tested.

A simple test rack was set up that allowed full exposure of the hardhats to solar heating. Air circulated freely, providing some ventilation to the hardhat. The temperature inside each hardhat and the ambient air temperature at the test site were measured and recorded using type K thermocouples wired to a Campbell Scientific CR10X Datalogger (figure 1).

The thermocouples were in the center of each hardhat, 4 inches from the bottom rim, at about the same depth as the top of a wearer's head. Data were collected at 5-minute increments, over a 6- to 7-hour period, for three consecutive days.

Figure 1—The six hardhats on the test rack were wired to a datalogger that recorded the temperature inside the hardhat every 5 minutes.

For additional information, contact: *John Smith, equipment specialist; USDA Forest Service, MTDC; 5785 Hwy. 10 West; Missoula, MT 59808–9361. Phone: 406–829–6793; fax: 406–829–6744; e-mail: jrsmith01@fs.fed.us*

Test Results

The data show a consistent pattern of differential heat absorption by hardhats of different colors. For the three test days, ambient air temperatures ranged from 61.3 degrees Fahrenheit to 98.1 degrees Fahrenheit. The weather was mostly sunny with very little wind. During the test period each day, the temperatures inside all six hardhats generally rose above the ambient air temperature.

The temperature inside the white hardhat increased the least, with a 3-day average recorded increase of 1.3 degrees Fahrenheit above the ambient air temperature and a maximum increase of 4.5 degrees Fahrenheit. The temperature inside the black hardhat increased the most, an average of 9.1 degrees Fahrenheit with a maximum increase of 23 degrees Fahrenheit. The red and blue hardhats had the next highest temperature increases, averaging 6.9 and 6.7 degrees Fahrenheit, respectively. The yellow and orange hardhats were relatively cooler, increasing an average of 3.2 and 4.2 degrees Fahrenheit, respectively (figure 2).

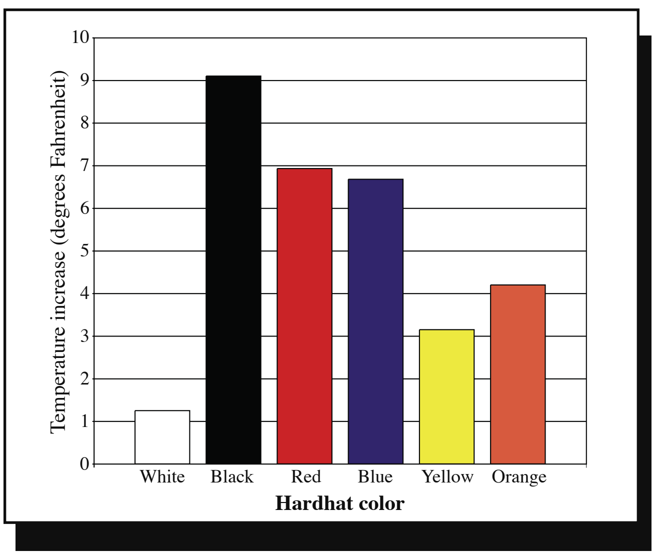

Figure 2—Hardhats with lighter colors were cooler—sometimes dramatically so—than hardhats with darker colors. The temperature increases are the average difference of the temperature inside the hardhat and the ambient air temperature over 3 days of testing.

The mean ambient air temperature during the warmest hour of the test was 95.8 degrees Fahrenheit. The average temperature in the white hardhat then was half a degree Fahrenheit cooler than the ambient temperature. During the coolest hour of the test, the mean ambient air temperature was 63.8 degrees Fahrenheit. The temperature in the black hardhat then averaged 10.2 degrees Fahrenheit warmer than the ambient air temperature.

During the warmest hour, the difference in temperature between the coolest and warmest hardhats was just 3.2 degrees Fahrenheit (white compared to black). During the coldest hour, the difference between the coolest and warmest hardhats was 8.9 degrees Fahrenheit (white compared to black). Figure 3 illustrates the average increase in temperatures inside hardhats during the warmest and coldest hours.

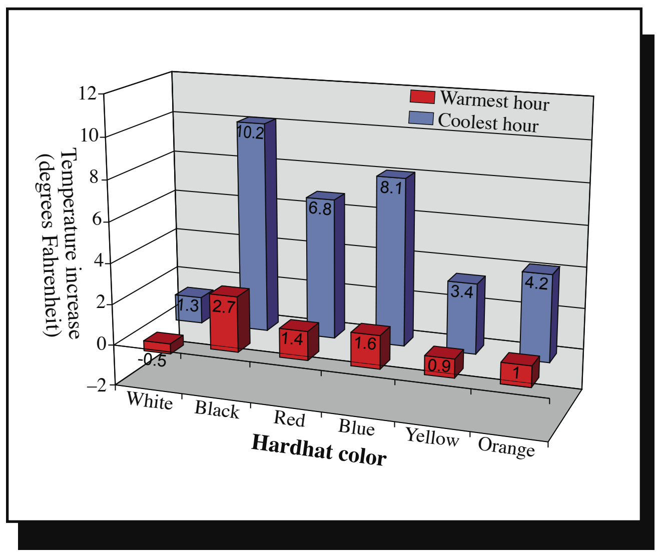

Figure 3—During the warmest hour of the 3-day test, the difference between the temperature of the ambient air and the temperatures inside hardhats of different colors was less than during the coolest hour of the test.

Conclusions

This test shows measurable differences in the amount of heat absorbed by hardhats of different colors. The data support the basic principle that lighter colors absorb less solar radiation, generating less heat inside a hardhat than darker colors. While the heating effect is less pronounced when temperatures are warmest, firefighters wearing lighter colored hardhats generally will be subjected to less heat gain throughout the day.

About the Authors

John Smith joined MTDC in 2005 as an equipment specialist. He graduated from the University of Montana with a bachelor's degree in education and taught elementary school in Ovando, MT. He began his Forest Service career in 1974 as a wildland firefighter on the Superior District of the Lolo National Forest. A Missoula smokejumper for more than 2 decades, John's experience as assistant loadmaster foreman, master parachute rigger, and safety program manager will be applied to fire equipment development.

Wes Throop is a project engineer at MTDC. He received his bachelor's degree in mechanical engineering from the University of Idaho in 1983. Wes has worked as a smokechaser, hotshot, and engine foreman for the Forest Service, and as a civilian mechanical engineer for the U.S. Department of the Navy. Before coming to MTDC in 1999, he worked as a mechanical engineer at the test reactor area of the Idaho National Engineering and Environmental Laboratory near Idaho Falls, ID.

Library Card

Smith, John. 2006. The Effect of Color on Temperatures Inside Hardhats. Tech Tip 0651–2312–MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 4 p.

Describes the results of 3 days of tests measuring temperatures inside six different hardhats with colors ranging from white to black. When temperatures were the hottest, the white hardhat was 3.2 degrees cooler than the black hardhat. When temperatures were the coolest, the black hardhat was 8.9 degrees warmer than the white hardhat. The red and blue hardhats were not as warm as the black hardhat and the yellow and orange hardhats were not as cool as the white hardhat.

Keywords: comfort, personal protective equipment, temperature

---

Single copies of this document may be ordered from:

USDA Forest Service, MTDC
5785 Hwy. 10 West
Missoula, MT 59808–9361
Phone: 406–329–3978
Fax: 406–329–3719
E-mail: *wo_mtdc_pubs@fs.fed.us*

Electronic copies of MTDC's documents are available on the Internet at: *http://www.fs.fed.us/t-d* (Username: t-d, password: t-d).

For further technical information, contact John Smith at MTDC.

Phone: 406–329–3900
Fax: 406–829–6744
E-mail: *jrsmith01@fs.fed.us*

Forest Service and Bureau of Land Management employees can search a more complete collection of MTDC's documents, videos, and CDs on their internal computer network at: *http://fsweb.mtdc.wo.fs.fed.us/search.*