

Investigation into the Impact of the Complex Thermal Environment in Special Vehicle Cabins on Human Occupants

Ya-nan Wu^{*}, Xiaofeng Liu, Wei Zhang, Wenxia Du, Xibin Kao, Ke Zhang, Bo Wang, Yi Li, Shujie Cui

Key Laboratory of Man-Machine-Environment, Institute for Hygiene of Ordnance Industry, Xi'an, China

Email address:

yananwu2007@163.com (Ya-nan Wu)

^{*}Corresponding author

Abstract

The complex man-machine-environment system in special equipment is distinguished by unique operational environments, specialized missions, advanced technological equipment, and highly skilled personnel. As informatization and unmanned operations continue to gain prominence, the remaining few individuals are experiencing a notable increase in workload. Furthermore, the intricate thermal conditions not only substantially impact human efficiency and endurance but also pose significant challenges to overall well-being and health. To safeguard occupants of special vehicles from excessive thermal loads and stress, extend their sustainable working time in high-temperature and high-humidity conditions, and enhance work efficiency, this paper conducts a comprehensive man-machine-environment system analysis through modeling, numerical simulation, and investigation-based validation of the internal thermal environment within special vehicles. By systematically analyzing high-intensity workloads, specialized environmental parameters, and typical operational scenarios, a numerical model for special state analysis is developed to quantitatively evaluate the interdependent factors among humans, machines, and the environment. The human thermal comfort index is employed as a characterization tool. Ultimately, the validity of the model parameters and indicators is confirmed through empirical research. This study supports investigations into the influence of complex thermal environments on passengers under "four special" conditions and provides a foundation for the design of modern information-based equipment and future man-machine interfaces in special vehicles.

Keywords

Special Vehicles, Thermal Environment, Thermal Comfort, Operational Effectiveness