MarTREC
Maritime Transportation Research & Education Center

BIL MarTREC Tier 1 UTC Project Request Form
Completed form should not exceed 2 pages
Return to Amy Shell at shell@uark.edu

Submission Date: June 26, 2024
Lead Recipient/Grant Number: University of Arkansas / 69A3552348331
Principal Investigator Institution: Vanderbilt University
Center Name: Maritime Transportation Research and Education Center
USDOT Research Priority: Preserving the Existing Transportation System
Primary USDOT Strategic Goal (*select drop down*): Safety
Principal Investigator(s) with ORCID(s) and Contact Information: **Dr. Mark Abkowitz** (ORCID No. 0000-0002-7278-1008) Distinguished Professor of Civil and Environmental Engineering, PMB 351831, 2301 Vanderbilt Place, Nashville, TN 37235-1831, phone: 615-500-7619, email: mark.abkowitz@vanderbilt.edu; **Co-Principal Investigator: Dr. Ishita Dash** (ORCID No. 0000-0003-3308-9163), Postdoctoral Research Fellow, Vanderbilt University School of Engineering, PMB, 351831, 2301 Vanderbilt Place, Nashville, TN 37235-1831; phone: 615-630-9401; email: ishita.dash@vanderbilt.edu
Project Partners: *N/A*
Project Type (*select drop down*): Applied Research
Project Research Topic Type (*select drop down*): Disruption Response and Transportation Planning for Coastal and River Valley Communities
Transportation Modes Involved (*check all that apply*): ☒Waterway ☐Road ☐Rail ☒Pipeline ☐ Other
Research Project Funding: **(**USDOT + Matching funds = Total Cost): USDOT (MarTREC) funds: $100,000; matching: $50,000. Total Cost: $150,000.
Project Start and End Dates (Format month/day/year to month/day/year): 08/01/2024 to 12/31/2025
Project Title: Deploying Smart Watch Technology to Measure and Mitigate Heat Stress Among Maritime Transportation Workers
Project Abstract (Brief Description): As global temperatures continue to rise, workers in the maritime transportation industry are increasingly exposed to high-heat and high-humidity conditions, exacerbating their risk of developing heat-related illnesses. These illnesses range in severity from muscle cramps and spasms; to heat exhaustion, which if left untreated, can progress to heat stroke; to heat stroke, a life-threatening emergency that requires immediate medical attention. In the U.S., the number of days of exposure to extreme heat is predicted to more than double by the mid-21st century. The Occupational Safety and Health Administration has identified a variety of maritime transportation industries as heat-related “high risk”. They include port and harbor operations (port facility and waterfront terminal operations; maintenance services; waterfront terminal, wharf, seaway, canal and harbor operations; canal and harbor maintenance services), marine cargo handling (loading and unloading services at ports and harbors; marine cargo handling services; longshoremen and stevedoring services; ship hold cleaning services), navigational services to shipping (docking and undocking marine vessel services; cargo salvaging; harbor tugboat and piloting services; marine vessel traffic reporting), and other support activities for water transportation (marine cargo checkers and surveyors, drydocks and floating repair; ship scaling services not done at a shipyard; ship dismantling at floating drydock). If early warning indicators of heat stress can be identified, then the possibility of a worker developing a heat-related illness can be mitigated. Smart watches have the potential to function as a means for

detecting when a heat-related illness is imminent and/or progressing. Recent studies have demonstrated that skin temperature of an individual's wrist can predict whole-body thermal sensations. The proposed project is designed to address the following research questions: 1) What are the key indicators that can be used to quantify heat stress? 2) Can a smartwatch be used to measure heat stress among maritime transportation workers in high-risk industries? 3) Can heat stress predictive models be used to prevent the development of heat-related illnesses by incorporating a complete closed feedback loop? The project will begin by performing a comprehensive literature review to identify the state-of-the-practice and where research gaps currently exist. These results will inform the development of a conceptual approach with the goal of conducting a real-world pilot. Considerations contributing to this effort will include the following: 1) develop and test machine learning models to predict heat stress based on data collected from a commercially available smartwatch, 2) implement a closed feedback loop system that can alert workers and their supervisors in real-time about the onset of heat stress, enabling immediate intervention, 3) analyze the effectiveness and practicality of deploying smartwatch-based heat stress monitoring systems in mitigating the risk of heat-related illnesses among maritime transportation workers, and 4) investigate the impact of individual differences (e.g., age, fitness level, acclimatization status) on the accuracy and reliability of heat stress prediction.

USDOT Priorities: This project will provide meaningful insight into the ability of an innovative technology that is commercially available at a modest cost to identify maritime transportation worker heat stress and to mitigate heat stress risk so as to protect worker health and improve operational efficiency. This is extremely important given large expected increases in the number and intensity of extreme heat days.

Outputs (results of the work performed):
The project will establish a testbed for investigating the feasibility and transferability of a commercially available technology for evaluating climate risk associated with the likelihood and severity of heat stress experienced by maritime transportation workers. The research results will also address opportunities for developing and implementing risk mitigation strategies to better manage this threat.

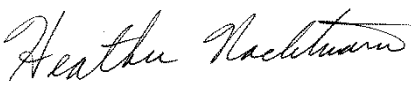
Outcomes/Impacts: This achievement will fill a substantial knowledge gap associated with climate risk at both the technical and practitioner level. Importantly, the work will provide proof-of-concept of a technology application with the potential for widespread adoption by the maritime transportation industry.

Technology Transfer Activities: Knowledge transfer will be pursued, including presentations of project results at major conferences (e.g., TRB annual meeting, Society of Risk Analysis, etc.) and publication in peer-reviewed journals. Vanderbilt will also seek to disseminate results to and obtain feedback from stakeholders via its connections with public and private sector entities.

Final Research Report: Upon completion of the project, provide a URL link to final report will be provided

Project Deliverables: ☒ PI agrees to submit all deliverables within 4 weeks after the project end date.

Data Management Plan (DMP): ☒ PI has reviewed and agrees to adhere to MarTREC DMP. Proposed project DMP must be attached to the submission email along with this form.

Center Director Approval Signature and Date:  07.23.24