Exhibit D

Research Project Requirement Template

Fast Detection and Prediction of Slippery Roadway Conditions for Enhanced Safety

Recipient/Grant (Contract) Number: 69A3552348306 (CY1-OSU-02)

Center Name: Southern Plains Transportation Center (SPTC)

Research Priority: Promoting Safety

Principal Investigator(s): Joshua Q. Li, Oklahoma State University

Project Partners: Oklahoma State University

Research Project Funding: Oklahoma State University: $75,000 (Federal) and $69,876 (Match)

Proposed Start and End Date: 10/1/2023 to 9/30/2024

Project Description: Black ice, a nearly invisible hazard, contributes to over 10% of weather-related crashes in the U.S., causing 200,000 annual accidents, 700 fatalities, and 65,000 injuries. Traditional methods for detecting black ice involve fixed sensors and signs, but new vehicle-based technology offers cost-effective real-time data. However, obtaining comprehensive road condition data during inclement weather remains expensive and risky. State agencies must collect pavement surface data for asset management, yet the relationships between surface characteristics, weather conditions, and ice formation are not adequately understood. Research is needed to predict slippery conditions using existing data. Prediction of slippery conditions can be potentially more critical than detecting slippery conditions due to changing climates and weather extremes.

This project aims to develop predictive models for slippery road conditions by collecting data with Mobile Advanced Road Weather Information Sensors (MARWIS) sensors and Pave3D 8K on roadway segments before, during, and after inclement weather. The collected data will be used to create predictive models for different weather scenarios. The primary goal is to develop predictive models that can anticipate slippery road conditions under different weather scenarios. These prediction models can then be applied to identify potentially slippery areas across Oklahoma, using the annually collected PMS datasets by ODOT. The primary goal of this project is to enhance highway safety.

The aforementioned goals will be achieved through four tasks: Task 1: Data Collection: Use MARWIS technology to measure road conditions, including temperature, humidity, and road state. This data will be collected on selected testing sites based on weather forecasts and in collaboration with ODOT; Task 2: Surface Characteristics: Assess field friction values and collect pavement surface characteristics data using the Grip Tester and Pave3D 8K technology to understand their impact on road slipperiness; Task 3: Slippery Road Prediction Models: Leverage data from MARWIS and surface characteristics and create predictive models using statistical and machine learning methods for forecasting road conditions during rainy or icy days; Task 4: Implementation: Incorporate statewide surface characteristics data from ODOT into the predictive models, presenting results in a Geographic Information System (GIS) database for better situational awareness and road maintenance support.

US DOT Priorities: The proposed fast detection and prediction of slippery roadway conditions can directly result in a reduced number of motor vehicle accidents and decreased crash severity levels in terms of injuries and fatalities under inclement weather conditions. The results of this project are anticipated to

contribute to the SPTC's strategic goals of making "our transportation system safer for all people and advance a future without transportation-related serious injuries and fatalities" and support the USDOT's goals related to Climate and Sustainability as well as Promoting Safety. This project will actively involve a female graduate researcher and include an underrepresented undergraduate student in outreach activities such as meetings, presentations, workshops, and field data collection. These actions align with USDOT's DEI initiatives and promote diverse perspectives in transportation-related research.

Outputs: Expected outcomes include the following: (1) Integrated sensors for detecting slippery road detection; (2) Fast detection process using ODOT's data; and (3) a GIS database for slippery-prone roads. The team plans to share findings through workshops, conference presentations, and journal papers. Through this project, the research team will create an inclusive and supportive research environment, fostering engagement among students with diverse perspectives in transportation-related research. A female graduate student will serve as the primary research assistant.

Outcomes/Impacts: This research supports state agencies in enhancing winter road maintenance, improving situational awareness, and decision-making. It aligns with the US DOT's safer transportation goals through friction-based slip detection, innovative tech like MARWIS and Pave3D 8K, incident management, and data analytics. The results from this project can be used by the transportation agencies to reduce accidents and motor vehicle fatalities. The research could also contribute to connected transportation systems and highway safety by integrating a new database with V2X technology for real-time road condition updates. This can lead to safer driving in inclement weather.

Final Research Report: