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Wildfire Risk & Preparedness for Urban Rail Operators Supporting Large Stadium Events

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14. ABSTRACT
The project team, in collaboration with partners and stakeholders, developed a four-hour training course designed to build a foundational understanding of how wildfire hazards affect rail systems infrastructure operations and how this knowledge can help equip urban rail operators with tools and best practices for proactive risk management. Led by the University of Hawai'i and the National Disaster Preparedness Training Center, in partnership with Haley & Aldrich, Inc., this technical report presents an overview of the four modules and scenario planning exercise that together make up the four-hour Wildfire Risk & Preparedness for Urban Rail Operators Supporting Large Stadium Events course.

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1 inch (in) = 2.5 centimeters (cm)	1 millimeter (mm) = 0.04 inch (in)
1 foot (ft) = 30 centimeters (cm)	1 centimeter (cm) = 0.4 inch (in)
1 yard (yd) = 0.9 meter (m)	1 meter (m) = 3.3 feet (ft)
1 mile (mi) = 1.6 kilometers (km)	1 meter (m) = 1.1 yards (yd)
	1 kilometer (km) = 0.6 mile (mi)
AREA (APPROXIMATE)	**AREA (APPROXIMATE)**
1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)	1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)	1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)	1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)	10,000 square meters (m^2) = 1 hectare (ha) = 2.5 acres
1 acre = 0.4 hectare (he) = 4,000 square meters (m^2)	
MASS - WEIGHT (APPROXIMATE)	**MASS - WEIGHT (APPROXIMATE)**
1 ounce (oz) = 28 grams (gm)	1 gram (gm) = 0.036 ounce (oz)
1 pound (lb) = 0.45 kilogram (kg)	1 kilogram (kg) = 2.2 pounds (lb)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)	1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons
VOLUME (APPROXIMATE)	**VOLUME (APPROXIMATE)**
1 teaspoon (tsp) = 5 milliliters (ml)	1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 tablespoon (tbsp) = 15 milliliters (ml)	1 liter (l) = 2.1 pints (pt)
1 fluid ounce (fl oz) = 30 milliliters (ml)	1 liter (l) = 1.06 quarts (qt)
1 cup (c) = 0.24 liter (l)	1 liter (l) = 0.26 gallon (gal)
1 pint (pt) = 0.47 liter (l)	
1 quart (qt) = 0.96 liter (l)	
1 gallon (gal) = 3.8 liters (l)	
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)	1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)	1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)
TEMPERATURE (EXACT)	**TEMPERATURE (EXACT)**
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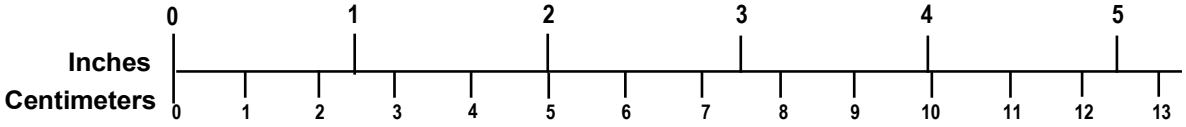

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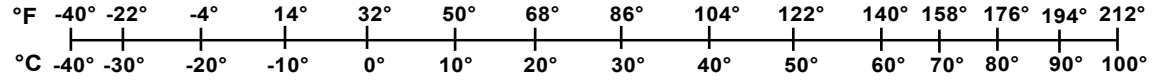

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Contents

Executive Summary

The project team developed a four-hour training course designed to build a foundational understanding of how wildfire hazards affect rail systems infrastructure and operations, and how this knowledge can help equip urban rail operators with tools and best practices for proactive risk management. Led by the University of Hawai‘i and the National Disaster Preparedness Training Center (NDPTC), in partnership with Haley & Aldrich, Inc., the project is funded through the Federal Railroad Administration’s Consolidated Rail Infrastructure and Safety Improvement (CRISI) Program. This technical report presents an overview of the four learning modules inclusive of a scenario planning exercise that together make up the four-hour Wildfire Risk & Preparedness for Urban Rail Operators Supporting Large Stadium Events course.

Participants who take the course and actively engage with the material will be able to understand foundational wildfire science concepts and how they apply to urban rail systems and large stadium events, identify tools and best practices for proactive wildfire risk management, including preparedness planning and situational awareness, and apply these concepts through scenario-based learning and real-world examples. The target audience for this course includes rail operators, transit agencies, emergency managers, and city and state government transportation departments.

The four-hour training course contains four modules, three breakout sessions, and one scenario planning case study. Module 1 (see Section 2.1), titled Foundations of Wildfire Risk in Urban Rail and Stadium Event context, focuses on why wildfire risk matters for urban rail operators in wildland-urban and metropolitan areas. This module also covers basics of wildfire science, urban rail exposures to wildfire risk, and how to quantify wildfire exposure using a variety of publicly available resources and datasets. Module 2 (see Section 2.2), titled Risk to Rail: Infrastructure and Operations, focuses on wildfire risks to and from rail systems, electrified systems and rail, operational impacts of wildfire, and passenger and workforce safety. Module 3 (see Section 2.3), titled Planning: Preparedness and Event Readiness, focuses on pre-season planning, smoke management, sensitive groups, and situational awareness. Module 4 (see Section 2.4), titled Delivery: Day of Event and Implementation Activities, focuses on contingency plan implementation, weather resiliency, first- and last-mile mitigation, and emergency center operations. Included in Module 4 is a scenario planning exercise with SoFi Stadium in Los Angeles as its FIFA venue location, where participants work in groups to develop a four-phase preparedness plan covering risk thresholds, mitigation actions for the venue, communication protocols, and multi-agency coordination.

1. Introduction

This technical report presents an overview of the four modules and a scenario planning exercise that together make up the four-hour Wildfire Risk & Preparedness for Urban Rail Operators Supporting Large Stadium Events course.

1.1 Background

Led by the University of Hawai‘i and the National Disaster Preparedness Training Center (NDPTC), in partnership with Haley & Aldrich, Inc., the project is funded through the Federal Railroad Administration’s (FRA) Consolidated Rail Infrastructure and Safety Improvement (CRISI) Program. The project team developed a four-hour training course designed to build a foundational understanding of how wildfire hazards affect rail systems infrastructure operations and how this knowledge can help equip urban rail operators with tools and best practices for proactive risk management.

1.2 Objectives

Participants who take the course and actively engage with the material will be able to understand foundational wildfire science concepts and how they apply to urban rail systems and large stadium events, identify tools and best practices for proactive wildfire risk management, including preparedness planning and situational awareness, and apply these concepts through scenario-based learning and real-world examples. The target audience for this course includes rail operators, transit agencies, emergency managers, and state government transportation departments.

1.3 Overall Approach

The project team worked in close collaboration with the NDPTC during the development of the course outline and the drafting of course materials. Previous research on the impacts of wildfire on the Class I passenger and freight rail network in California was the foundation on which the training was built (Kim et al., 2025). The project team referenced climate action and adaptation plans, as well as hazard vulnerability and risk assessments conducted by Los Angeles County, Santa Clara Transportation Authority, and Los Angeles County Metropolitan Transportation Authority (LA Metro) (Los Angeles County Metropolitan Transportation Authority, 2019; Los Angeles County, 2021; Santa Clara Valley Transportation Authority, 2023). The Vulnerability Assessment and Adaptation Framework published by the Federal Highway Administration, as well as the Caltrans Climate Change Vulnerability Assessment Statewide Summary Report, were also referenced (Filosa et al., 2017; California Department of Transportation, 2019). These documents provided critical information on how hazards such as extreme heat and wildfire impact rail systems. Wildfire subject matter experts provided guidance and feedback on the structure of and critical information for Module 1, which focuses on the foundations of wildfire risk in an urban rail and stadium event context. Breakout rooms were incorporated into the training to give participants an opportunity to engage with the material and one another, as well as reflect on their own professional and personal experiences with wildfire hazards. The scenario planning exercise (incorporated into Module 4) allows participants to work together to imagine, model, and prepare for multiple plausible future scenarios to build resilience and inform response strategies.

1.4 Scope

The four-hour training course focuses on wildfire risk and preparedness for urban rail operators and includes a FIFA venue case study. The project team developed curricula on wildfire risk to urban rail networks in a large venue and sports events context using 2026 U.S. World Cup host cities as case studies. Course content centers on hazard characterization and transportation-and venue-specific risk while equipping participants with the skills needed to identify tools and best practices for proactive wildfire risk management, including preparedness planning and situational awareness. In addition, the project team leveraged and adapted existing training material whenever possible.

1.5 Organization of the Report

The four-hour training course contains four modules, three breakout sessions, and one scenario planning case study. Module 1 (see Section 2.1), titled Foundations of Wildfire Risk in Urban Rail and Stadium Event context, focuses on why wildfire risk matters for urban rail operators in wildland-urban and metropolitan areas. This module also covers basics of wildfire science, urban rail exposures to wildfire risk, and how to quantify wildfire exposure using a variety of publicly available resources and datasets. Module 2 (see Section 2.2), titled Risk to Rail: Infrastructure and Operations, focuses on wildfire risks to and from rail systems, electrified systems and rail, operational impacts of wildfire, and passenger and workforce safety. Module 3 (see Section 2.3), titled Planning: Preparedness and Event Readiness, focuses on pre-season planning, smoke management, sensitive groups, and situational awareness. Module 4 (see Section 2.4), titled Delivery: Day of Event and Implementation Activities, focuses on contingency plan implementation, weather resiliency, first- and last-mile mitigation, and emergency center operations. Included in Module 4 is a scenario planning exercise with SoFi Stadium in Los Angeles as its FIFA venue location, where participants work in groups to develop a four-phase preparedness plan covering risk thresholds, mitigation actions for the venue, communication protocols, and multi-agency coordination. In addition, a breakout session follows each module and asks participants to think about pertinent questions related to the topics of the last lesson.

2. Course Development

The following sections detail the material included in each module of the four-hour Wildfire Risk and Preparedness for Urban Rail Operators Supporting Large Stadium Events training course.

2.1 Foundations of Wildfire Risk in Urban Rail and Stadium Event Context

Module 1 was developed based on background research on urban rail system features and vulnerabilities, wildfire science, wildland-urban interface conditions, and wildfire forecasting resources relevant to large stadium events. This module's learning objectives focused on how to recognize wildfire and smoke impacts on urban rail operations, identify key system sensitivities, and understand how forecast information can support preparedness decisions.

Research on urban rail informed the definition of the system as an interconnected network of rail services, stations, power systems, signaling equipment, maintenance facilities, and passenger access points, and supported the identification of infrastructure and operational sensitivities that may affect safety, service continuity, and crowd movement during event operations (Federal Transit Administration, 2013; Kim et al., 2025).

Wildfire science research focused on concepts needed to support risk interpretation. The fire triangle concept was drawn from Northwest Fire Science materials and used to frame the relationship between heat, fuel, and oxygen in ignition and combustion (Northwest Fire Science Consortium, n.d.). Research on fire spread pathways, including direct flame contact, radiant heat, ember exposure, and structure-to-structure or vegetation-to-structure pathways, was informed by the National Institute of Science and Technology (NIST) Hazard Mitigation Methodology document (Maranghides et al., 2022).

The project team also reviewed wildland-urban interface definitions to understand how rail corridors, maintenance facilities, and stations may be exposed where developed areas intersect with vegetative fuels—which helped connect wildfire concepts to the event operations context (U.S. Fire Administration, n.d.).

Forecasting references were emphasized because the training relies on time-phased preparedness decisions. The project team reviewed publicly available tools and datasets, including the National Interagency Fire Center's National Significant Fire Potential Outlook and 7-Day Significant Fire Potential products, the United States Geological Survey 7-Day Fire Danger Forecast, National Weather Service (NWS) Red Flag Warnings, and Air Quality Index information for wildfire smoke (National Interagency Coordination Center, n.d.; National Weather Service, n.d.; AirNow, n.d.). These sources informed how the module links changing wildfire and smoke conditions to preparedness actions before and during large stadium events.

2.2 Risk to Rail: Infrastructure and Operations

Research for Module 2 focused on identifying how wildfire and related hazards may affect rail infrastructure, operations, service continuity, and passenger and workforce safety in urban rail systems serving large stadium venues. In addition, research revealed both direct wildfire impacts and indirect cascading effects that may disrupt service, complicate crowd management, or affect health and safety (Federal Transit Administration, 2013; Los Angeles County, 2021; Santa Clara Valley Transportation Authority, 2023; Kim et al., 2025).

Wildfire impacts to rail infrastructure and operations were informed by climate and transportation risk assessments (Los Angeles County Metropolitan Transportation Authority, 2019; Los Angeles County, 2021; Santa Clara Valley Transportation Authority, 2023). These documents provided risk assessment information on wildfire-related transportation system vulnerabilities relevant to urban rail, as well as those associated with extreme heat, such as rail buckling and increased maintenance needs from damaged infrastructure.

The Los Angeles Climate Action Plan and the Metro Climate Action and Adaptation Plan informed the review of indirect and cascading wildfire impacts on urban rail operations, which may include damage to cell towers, power outages, ashfall on light rail tracks, reduced wheel-rail adhesion, and increased cleanup requirements (Los Angeles County Metropolitan Transportation Authority, 2019; Los Angeles County, 2021). These plans also showed how wildfire and smoke conditions can affect operations and safety, including air quality monitoring, ventilation and air filtration adjustments, vulnerable passenger populations, workforce exposure, service disruptions, speed restrictions, evacuation challenges, and interagency coordination.

2.3 Planning: Preparedness and Event Readiness

Module 3 focused on translating wildfire and smoke risk information into event-specific preparedness and adaptation actions for urban rail operators serving large stadium venues. The research emphasized identifying "event-critical" assets, developing event-specific trigger points, selecting mitigation and adaptation measures, and managing risks for groups that may be more sensitive to wildfire smoke or operational disruptions (National Wildfire Coordinating Group, n.d.; Los Angeles County Metropolitan Transportation Authority, 2019).

The methodology included reviewing operational preparedness practices relevant to internal and external communication, workforce training, crowd management, smoke management, and situational awareness. These topics were informed by the LA Metro Special Event Transportation – Guidance and Opportunities (SetGo) Playbook, which provided guidance on preparedness actions for large events and complex transportation operations (Los Angeles County Metropolitan Transportation Authority, 2025).

The project team's research also investigated how wildfire smoke and poor air quality may affect passengers and staff with different exposure or mobility needs. Sensitive groups include people with mobility limitations, pregnant people, older adults, children, and people with respiratory or cardiovascular conditions (AirNow, n.d.; Kuhn & Gupta, 2024). Other research helped characterize potential air quality concerns for pregnant people and fetal health, as well as potential effects of poor air quality on the lungs and heart, which helped support preparedness actions that account for both infrastructure continuity and public health protection (Momaya, 2024; Artemis Hospitals, n.d.).

2.4 Delivery: Day of Event and Implementation Activities

Module 4, Delivery: Day of Event and Implementation Activities, was developed to support the learning objective related to identifying tools and best practices for proactive risk management, including event day preparedness.

Background research focused on operational practices that help transit agencies move from preparedness planning to real-time event delivery, and included topics such as contingency plan implementation, weather resiliency, first- and last-mile mitigation, and emergency operations

center (Los Angeles County Metropolitan Transportation Authority, 2025). Emergency Operations Center (EOC) content was adapted from the San Francisco Bay Area Regional Transportation Emergency Management Plan (2018), which informed activation levels, incident monitoring, resource coordination, and unified communication during event operations.

2.5 Case Study: SoFi Stadium, Inglewood, California

The Module 4 case study was developed as an applied scenario-planning exercise focused on SoFi Stadium in Los Angeles. The learning objective was to help participants synthesize concepts from modules one to four and apply the content to a realistic stadium event context. The exercise was designed to move participants from understanding wildfire and smoke risk to making practical preparedness decisions in groups. The case study was structured around a scenario-planning methodology (Federal Emergency Management Agency, 2013). Participants define the planning objective, develop or review an event scenario, analyze potential impacts, identify response strategies, and test and refine their approach. This structure helps participants connect hazard information, risk thresholds, communication needs, and agency coordination into one decision-making process. Each group receives a scenario package for SoFi Stadium, including venue information, data and tools, risk thresholds, and a scenario type assignment. Using these materials, each group develops a four-phase preparedness plan organized by planning horizon: one month before the event, 10 days before the event, one to three days before the event, and the hours immediately before the event. For each planning horizon, participants apply risk thresholds, identify mitigation actions, develop communication protocols, and define multi-agency coordination needs.

The exercise asks participants to consider which thresholds matter, what decisions they trigger, and how actions may differ under low-uncertainty versus high-uncertainty hazard forecasts. The exercise also supports group discussion about implementation feasibility. Through this process, the case study reinforces the training's core learning objectives by requiring participants to integrate wildfire risk and smoke exposure, transit operations, communications, weather monitoring, and day-of-event decision-making into a single preparedness plan.

3. Conclusion

This wildfire risk and preparedness training course was designed to build a foundational understanding of how wildfire hazards affect rail systems infrastructure and operations, and how this knowledge can help equip urban rail operators with tools and best practices for proactive risk management. Research focused on translating wildfire science, transportation vulnerability information, public forecasting tools, air quality guidance, and special event operations practices into practical training content for rail operators, emergency managers, state transportation departments, and other stakeholders involved in event delivery.

Course material begins with identifying the core wildfire concepts needed to understand potential risks to urban rail systems. This included review of fire behavior drivers, the fire triangle, wildland-urban interface conditions, and methods for characterizing wildfire exposure. Publicly available data sources and forecasting tools, including wildfire risk datasets, significant fire potential outlooks, fire danger forecasts, Red Flag Warnings, and Air Quality Index information, were reviewed for their relevance to event planning and operational decision-making. These sources supported a forecast-driven approach that links changing hazard conditions to preparedness actions at different planning horizons.

Research also examined how wildfire and related hazards can affect urban rail infrastructure and service continuity. Climate vulnerability and transportation risk assessments were used to identify direct and indirect impacts to rail assets and operations, including damage to power, signal, track, station, and communication systems; heat-related infrastructure stress; smoke and air quality impacts; power outages; ashfall; and service disruptions. In addition, these reports helped define the types of operational challenges that may arise during large events, including crowd management, passenger and workforce safety, and coordination with emergency response partners.

Furthermore, research emphasized the importance of identifying assets and functions that are critical to event operations, defining conditions that may trigger operational changes, and selecting mitigation measures that are feasible within specific planning timeframes. The project team's research also provided information related to passengers and staff who may be more sensitive to smoke, poor air quality, mobility disruptions, or extended exposure during crowded event conditions. Special event transportation playbooks and regional emergency management plans informed mitigation measures related to contingency plan activation, weather resiliency, first- and last-mile coordination, public communication, and interagency coordination. These sources helped connect preparedness planning to real-time operations, especially during situations when agencies must coordinate across multiple organizations.

The SoFi Stadium case study served as the culminating application of the training. Scenario planning was selected as the exercise methodology because it allows participants to be strategic and proactive in preparation for multiple plausible future hazards, in order to build resilience and inform response strategies. By developing four-phase preparedness plans, participants apply the full training sequence to a realistic operational setting. The exercise requires groups to evaluate thresholds, select mitigation actions, define communication protocols, and consider how forecast uncertainty affects decisions.

Overall, the research produced a training course that connects technical hazard information with operational decision-making. The outcome is a practical, applied training experience that helps

participants understand how foundational wildfire science relates to urban rail systems, identify tools and best practices for proactive risk management, and strengthen decision-making through scenario-based learning and real-world examples.

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Abbreviations and Acronyms

ACRONYM	DEFINITION
CRISI	Consolidated Rail Infrastructure and Safety Improvements
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
FRA	Federal Railroad Administration
NDPTC	National Disaster Preparedness Training Center
NIST	National Institute of Science and Technology
NWS	National Weather Service