

NATIONAL
ACADEMIES

Sciences
Engineering
Medicine

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: How DOTs Manage to Keep Maintenance Workers Safe

February 9, 2023

1:30 – 3:00 PM



PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING



REGISTERED CONTINUING EDUCATION PROGRAM

Purpose Statement

Maintenance and other field workers are exposed to hazards that require a higher level of management than traditional office-based positions within state departments of transportation (DOTs). This webinar will explore the national state of practice and trends on the use of safety management systems to manage maintenance worker safety. Presenters will also provide a perspective from a national DOT leader in the area of safety and practices for managing heat stress.

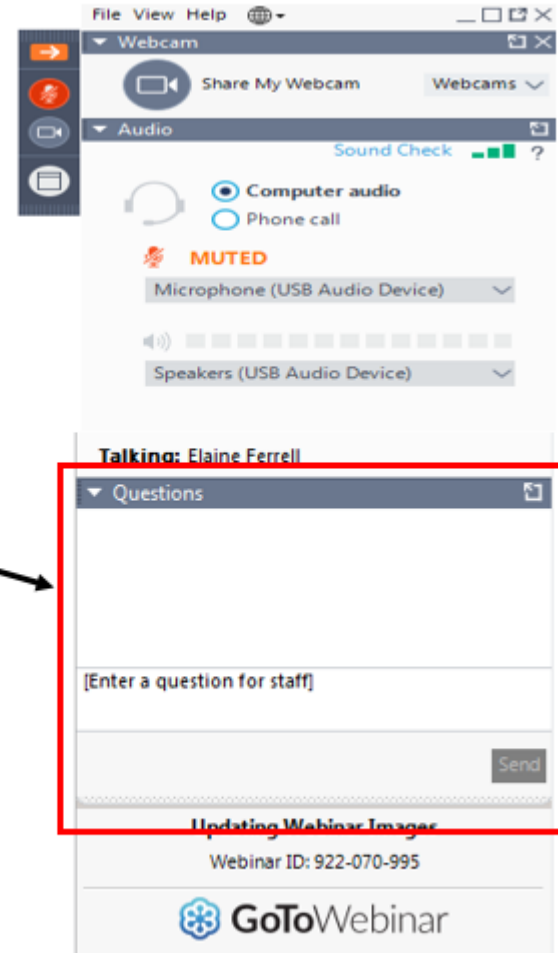
Learning Objectives

At the end of this webinar, you will be able to:

- Describe the national state of practice on use of safety management systems
- Explain how Texas DOT integrates and manages worker safety through their safety management system
- Use new and advanced approaches to managing heat stress with DOT employees

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters



Dr. Gabe Dadi
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University of Kentucky



Samuel Salazar
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Texas Department of Transportation



Dr. Chuma Nnaji
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Texas A&M University

Safety Managements Systems within DOTs: A State of the Practice

Gabe Dadi P.E., Ph.D.

W.L. Raymond and R.E. Shaver Chair
Associate Professor
University of Kentucky

Program Manager
Occupational Safety and Health
Kentucky Transportation Center

NCHRP Synthesis 591

- Literature Review
- Survey of DOTs
 - North American Association of Transportation Safety & Health Officials (NAATSHO)
 - AASHTO Committee on Maintenance
- Case Examples
- Conclusion

Safety Management System - Defined

“a DOT system to electronically report, manage, control, and audit issues related to employee safety. SMSs allow safety and health divisions in DOTs to become more agile, effective, and knowledgeable about the safety of employees. SMSs could be a commercial product, an in-house developed system, or even an Excel spreadsheet.”

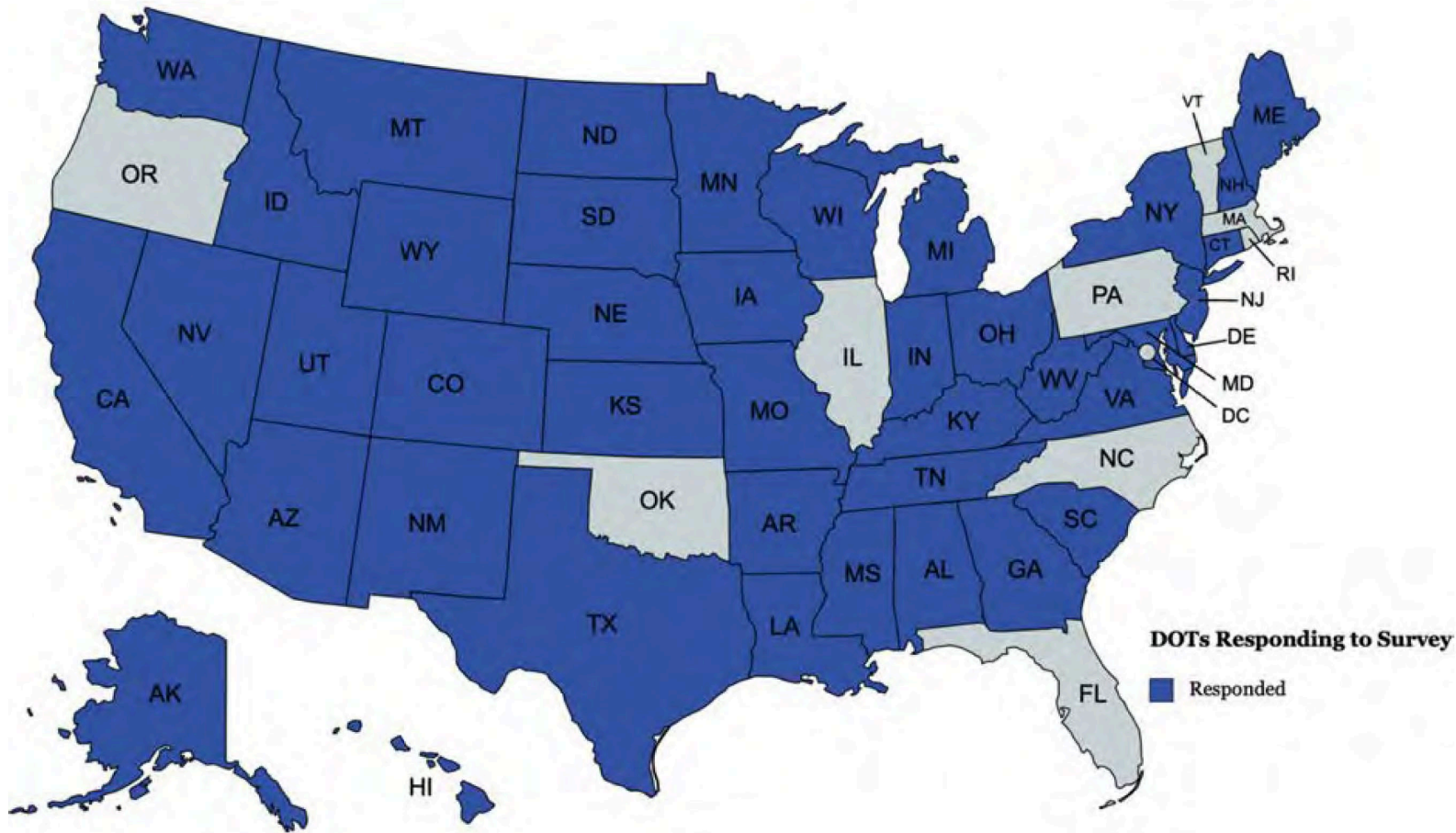


Figure 3.1. Map of DOTs responding to survey; n = 41.

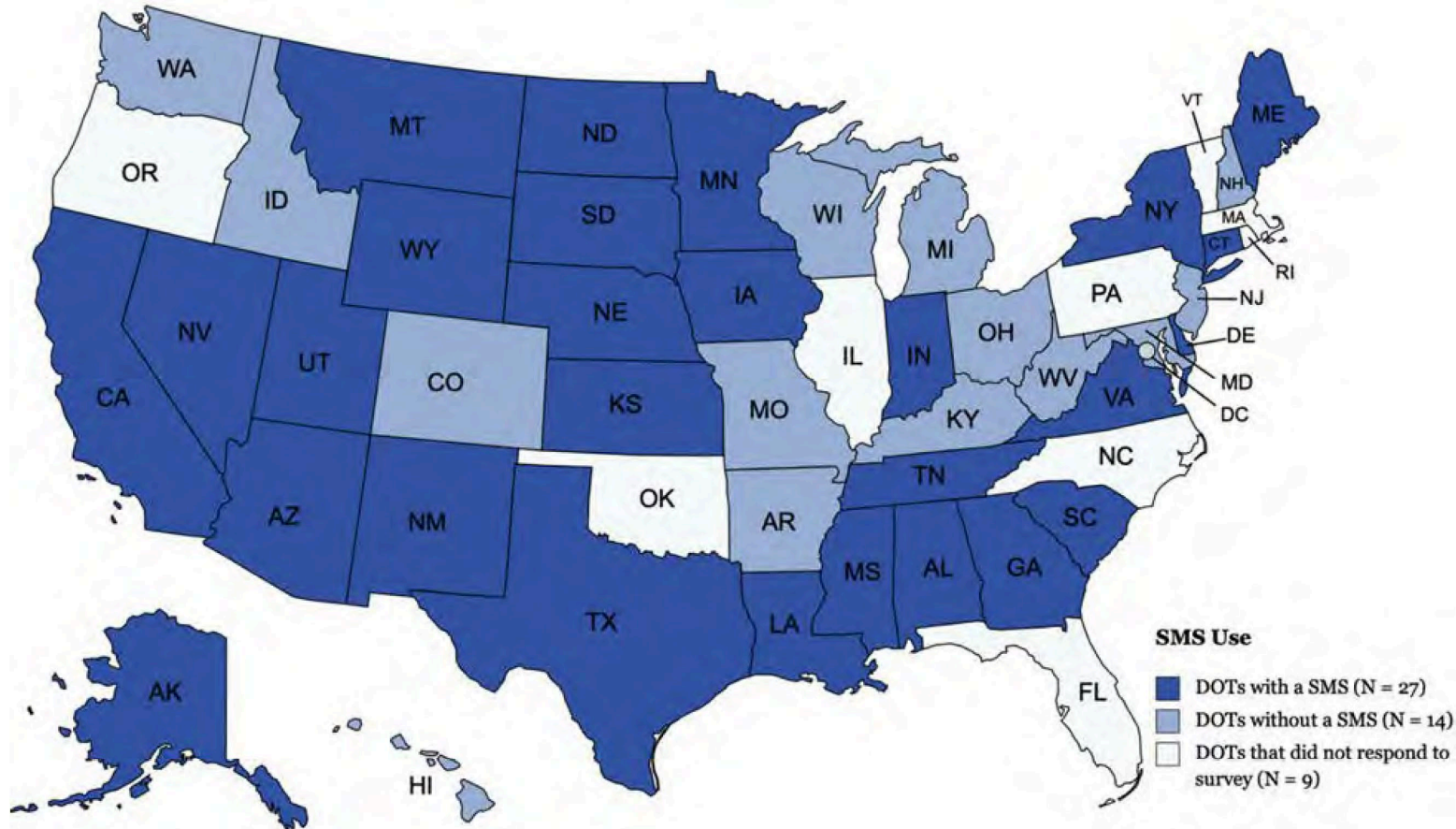


Figure 3.4. Map of DOTs that use an SMS; n = 41.

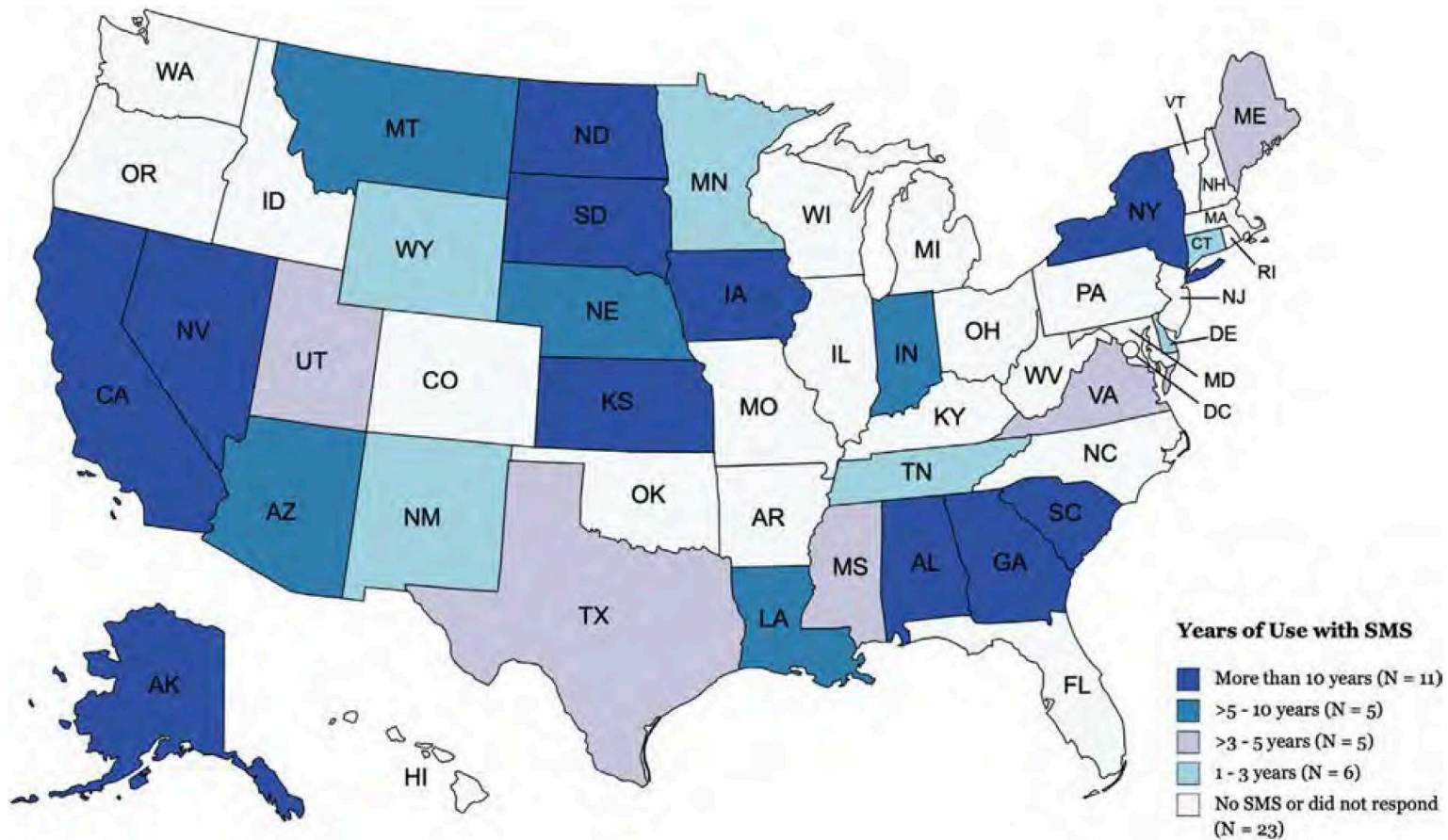


Figure 3.5. Map of years of SMS use; n = 41.

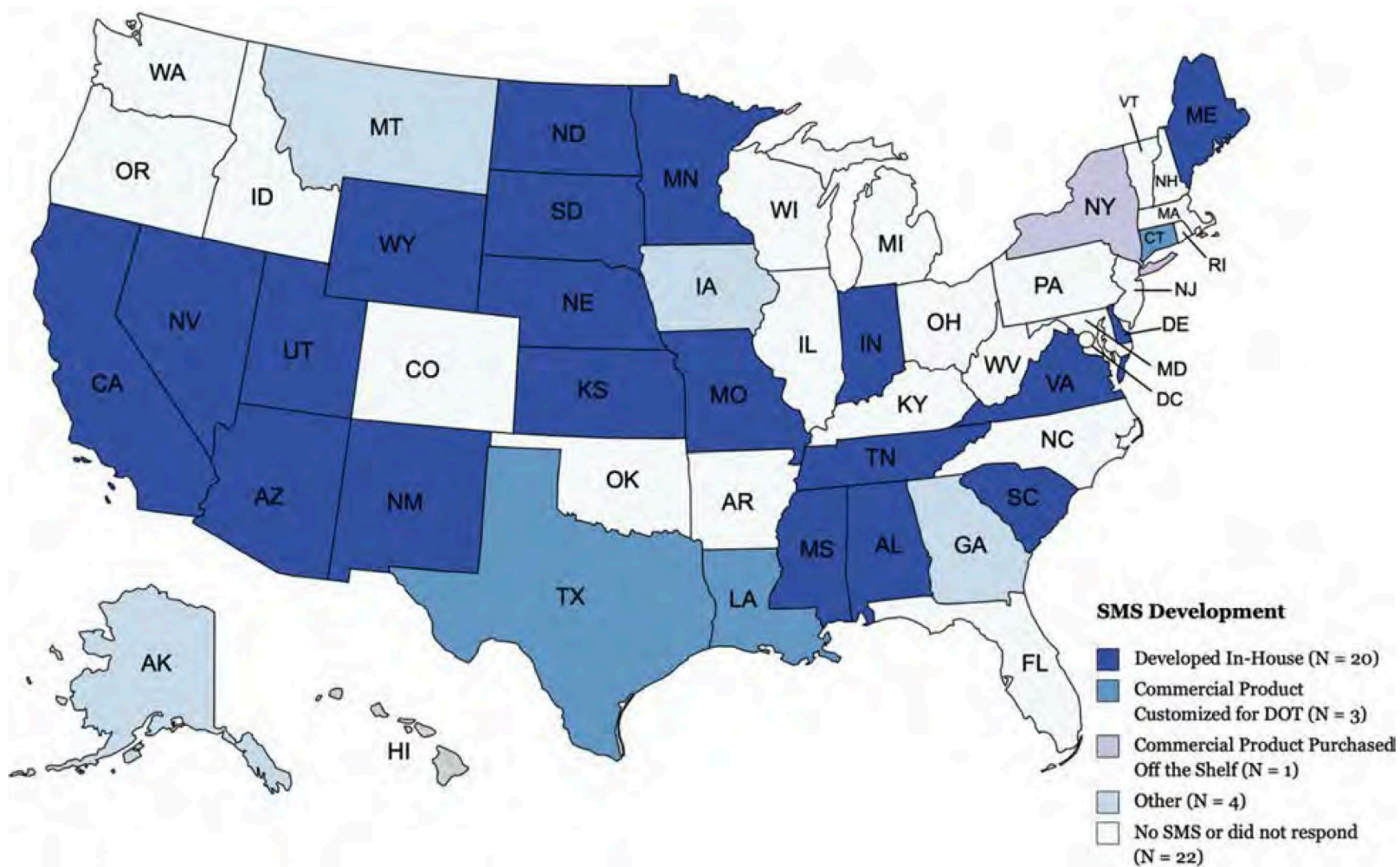


Figure 3.6. Map of development of SMS across DOTs; n = 41.

SMS Users

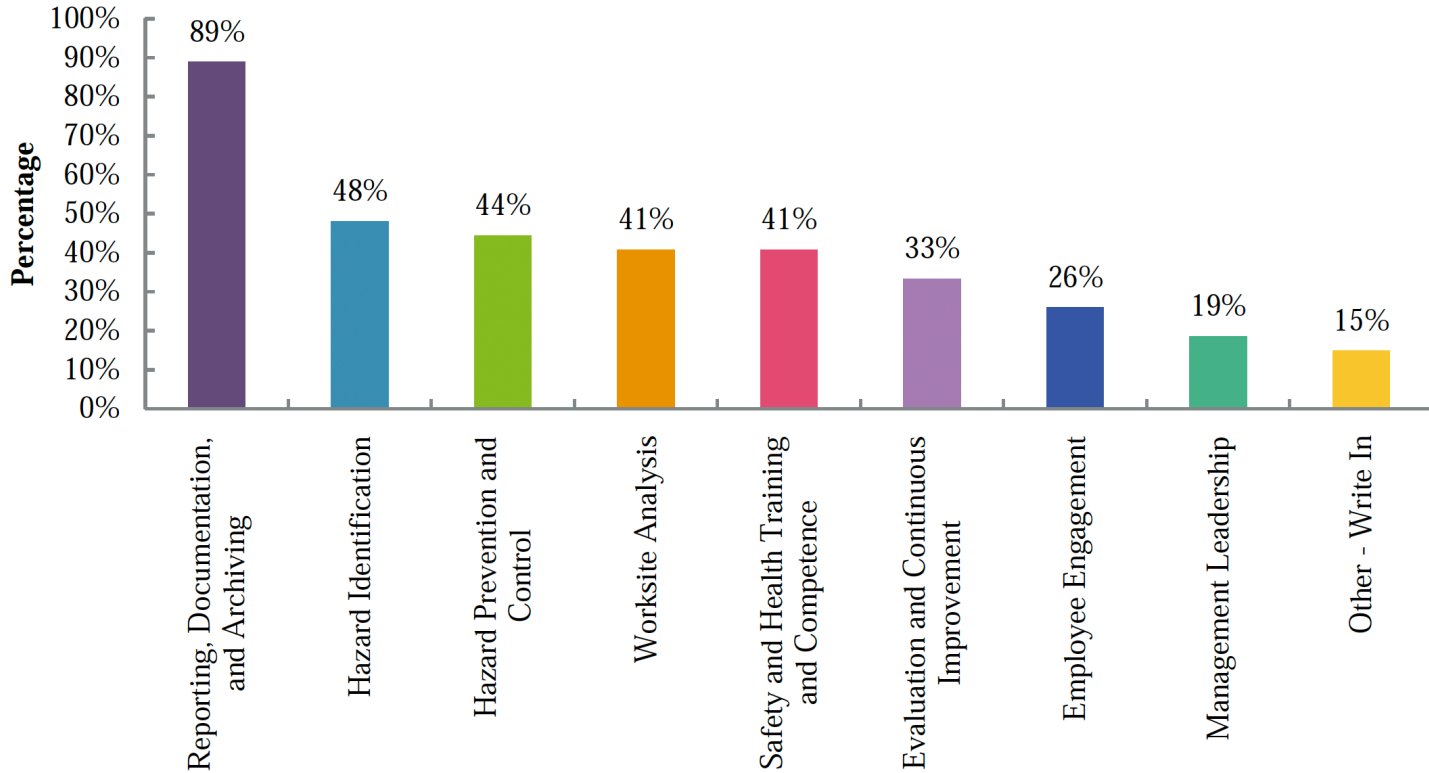


Figure 3.7. SMS components, elements, or characteristics; n = 27.

SMS Users

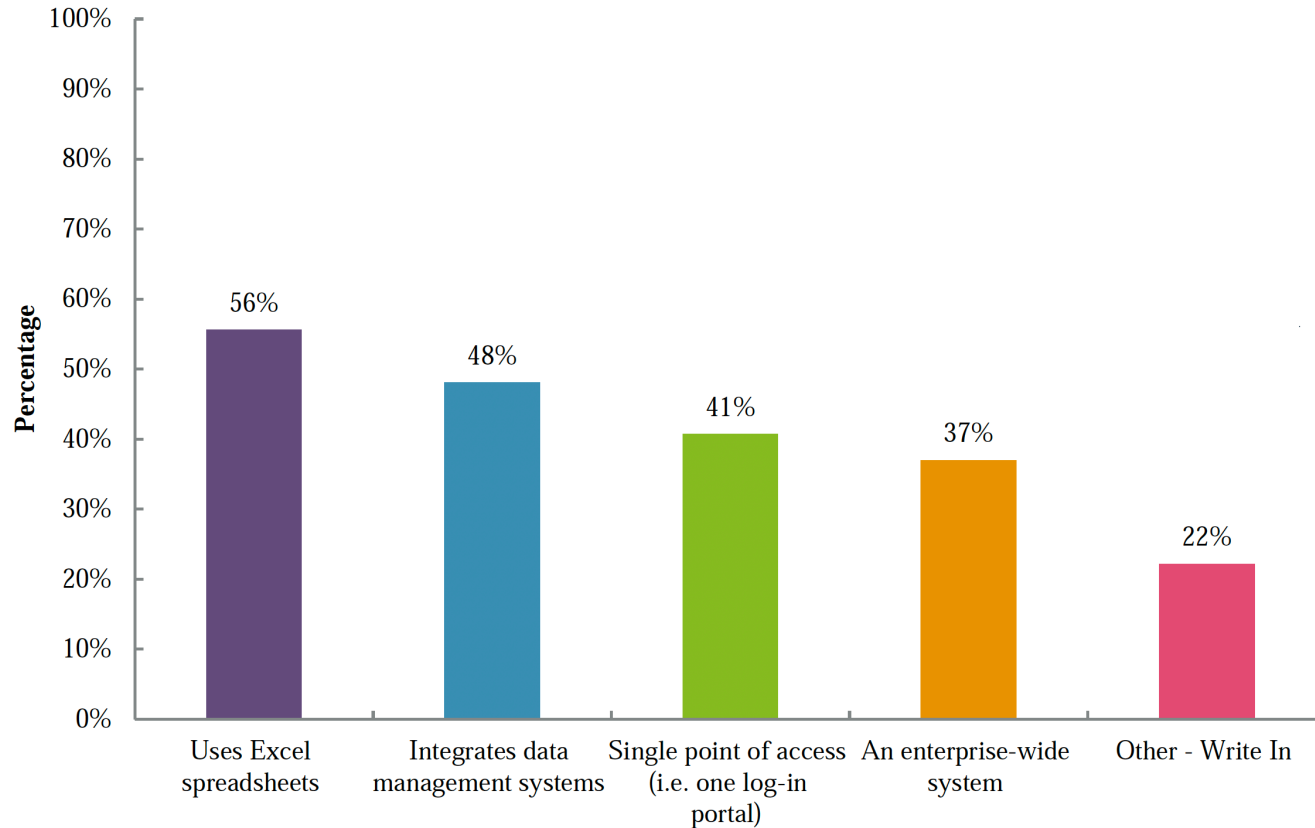


Figure 3.8. SMS operational characteristics; n = 27.

SMS Users

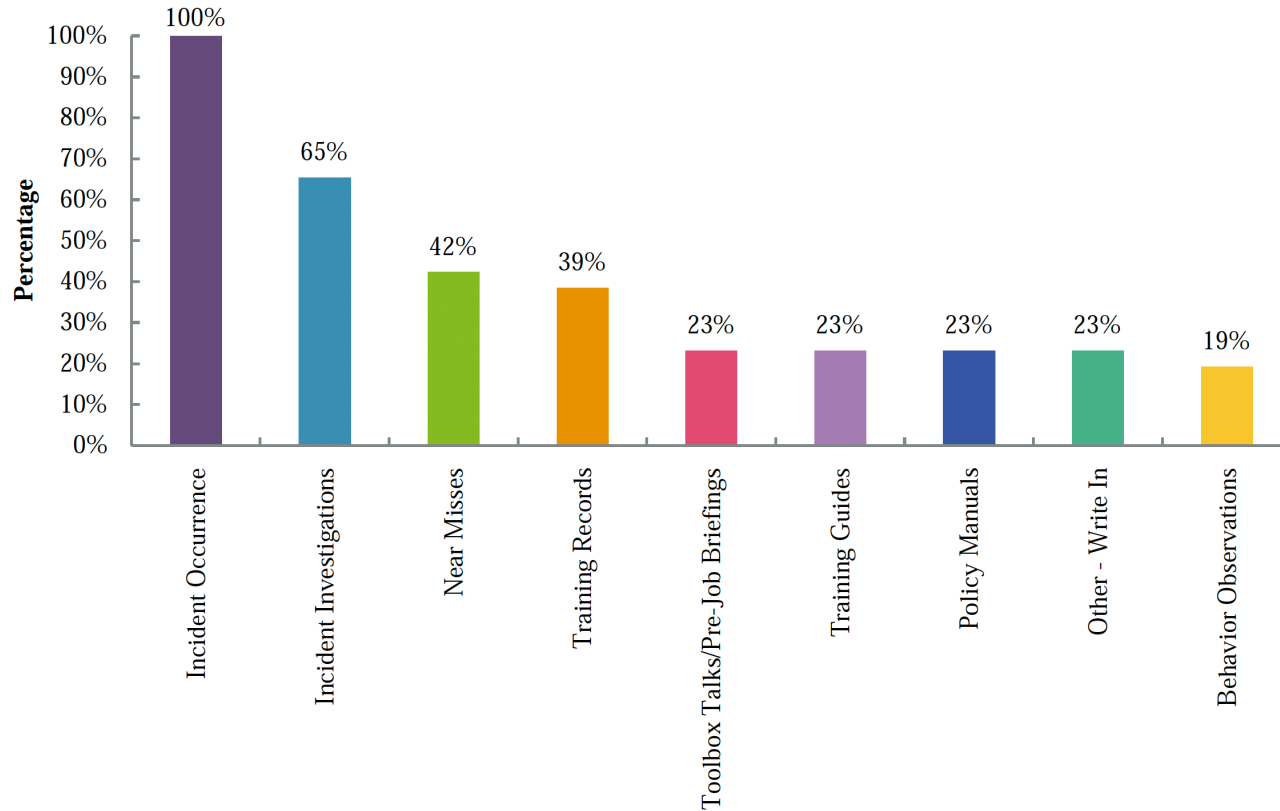


Figure 3.9. SMS Information collected; n = 27.

SMS User/Non-user Comparison

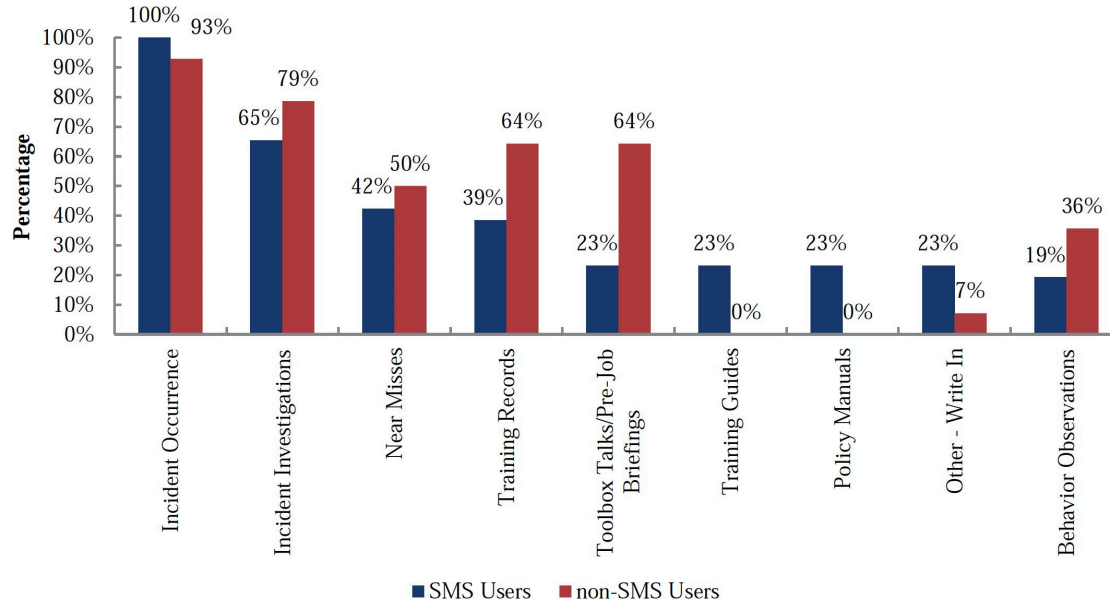


Figure 5.1. Comparison between SMS users and non-SMS users on the safety information collected.

SMS User/Non-user Comparison

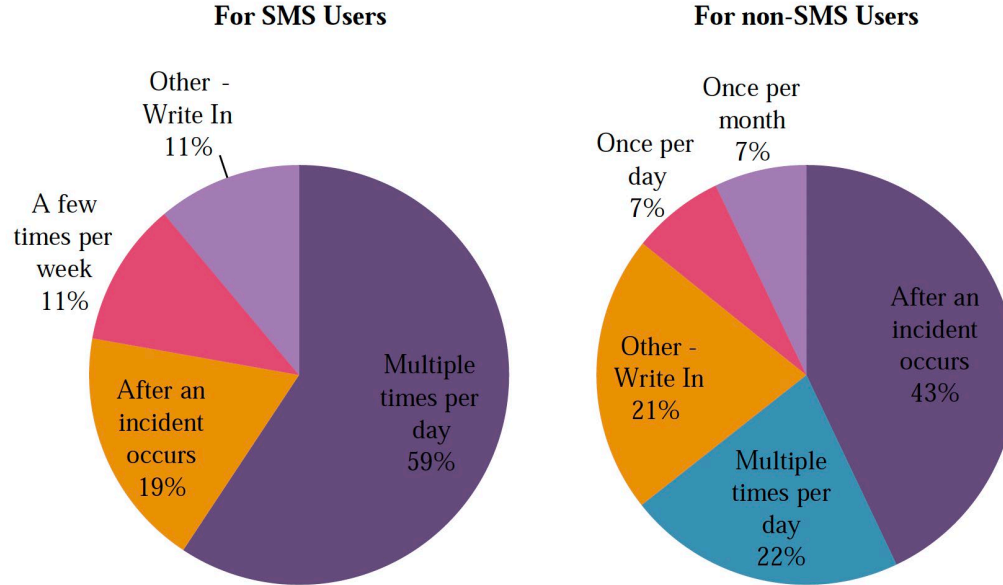


Figure 5.2. Comparison between SMS users and non-SMS users on safety data collection frequency.

SMS User/Non-user Comparison

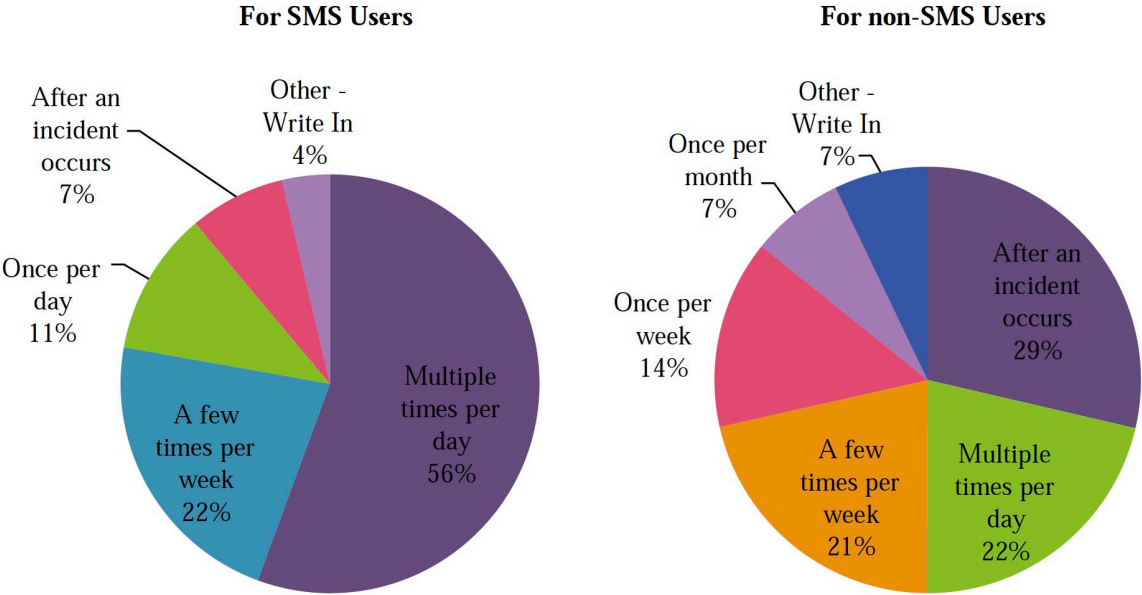


Figure 5.3. Comparison between SMS users and non-SMS users on safety data access frequency.

Who to Interview?

- 5 interviews
 - Have implemented an SMS;
 - Use the SMS for reporting and tracking; and
 - Have used their SMS for more than 3 years
- Connecticut, Nevada, Tennessee, Texas, and Virginia

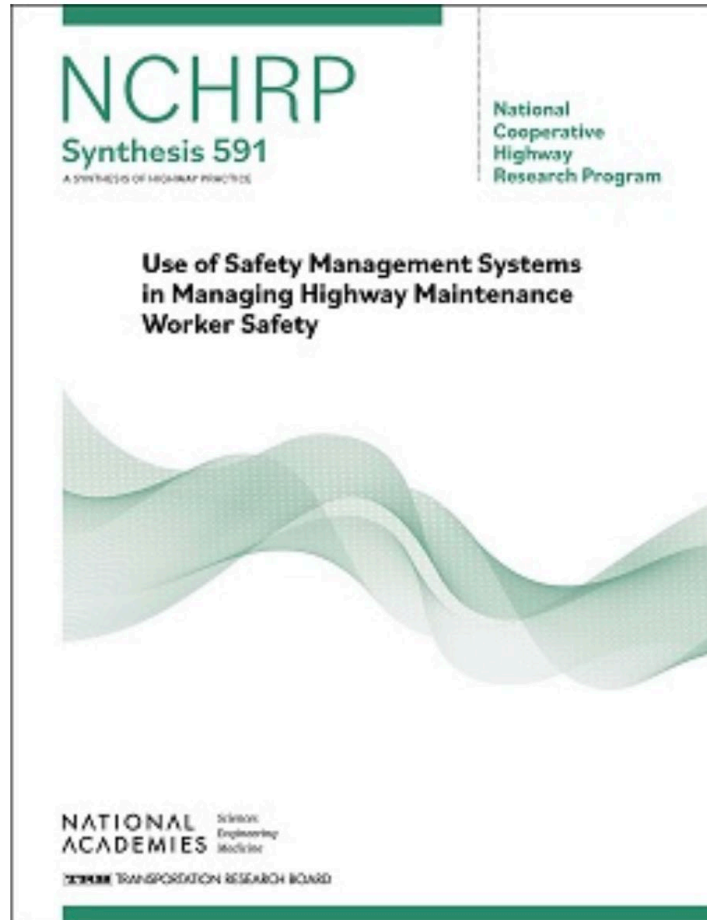
Summary

DOT	SMS Features	Benefits	Lessons Learned
Connecticut	<ul style="list-style-type: none"> • Uses a segment of a commercial product • Safety data collection, accidents and injury management, data analysis and trend identification 	<ul style="list-style-type: none"> • Have not conducted an official analysis • Gained a proactive view of safety • Customize data analysis to get a deeper look at trends • Better allocation of resources 	<ul style="list-style-type: none"> • Required significant time (1 year) and effort • Whole agency buy-in
Nevada	<ul style="list-style-type: none"> • Crash investigation, workers' comp claims, training tracking, and trend analysis 	<ul style="list-style-type: none"> • Decrease in recordable injuries by 48% over 9 years • Cost per claim decreased by 57% • Estimated \$300,000 savings per quarter 	<ul style="list-style-type: none"> • Leadership commitment and accountability • Foster commitment and culture
Tennessee	<ul style="list-style-type: none"> • Safety dashboard • Training materials • Safety Mondays • Trend analysis 	<ul style="list-style-type: none"> • Estimated savings from workers' comp and property damage of \$1M due to decline in severity of incidents 	<ul style="list-style-type: none"> • Culture.. "Work 4 Us" • Leadership and buy-in
Texas	Listen to Sam		
Virginia	<ul style="list-style-type: none"> • Equipment/vehicle incidents • Occupational health (e.g., silica/lead exposures, physicals, drug and alcohol screening) • PPE tracking 	<ul style="list-style-type: none"> • Used existing systems (i.e., MS Sharepoint and InfoPath) • Readily accessible data, reduced paper and related effort 	<ul style="list-style-type: none"> • May not go as well initially • Collaborate with stakeholders, get feedback, accept criticism • Hold to a continuous improvement mindset and look to push through "showstoppers"

Conclusions

- Most users have an in-house system using current database platforms
- Mostly used for incident investigations
- Cost not considered a challenge or deterrent
- Need for written policies and procedures
- SMS users are collecting more safety data, more often than non-users

<https://www.trb.org/Publications/Blurbs/182782.aspx>



Thank you!
gabe.dadi@uky.edu

How DOTs Manage to keep Maintenance Workers Safe

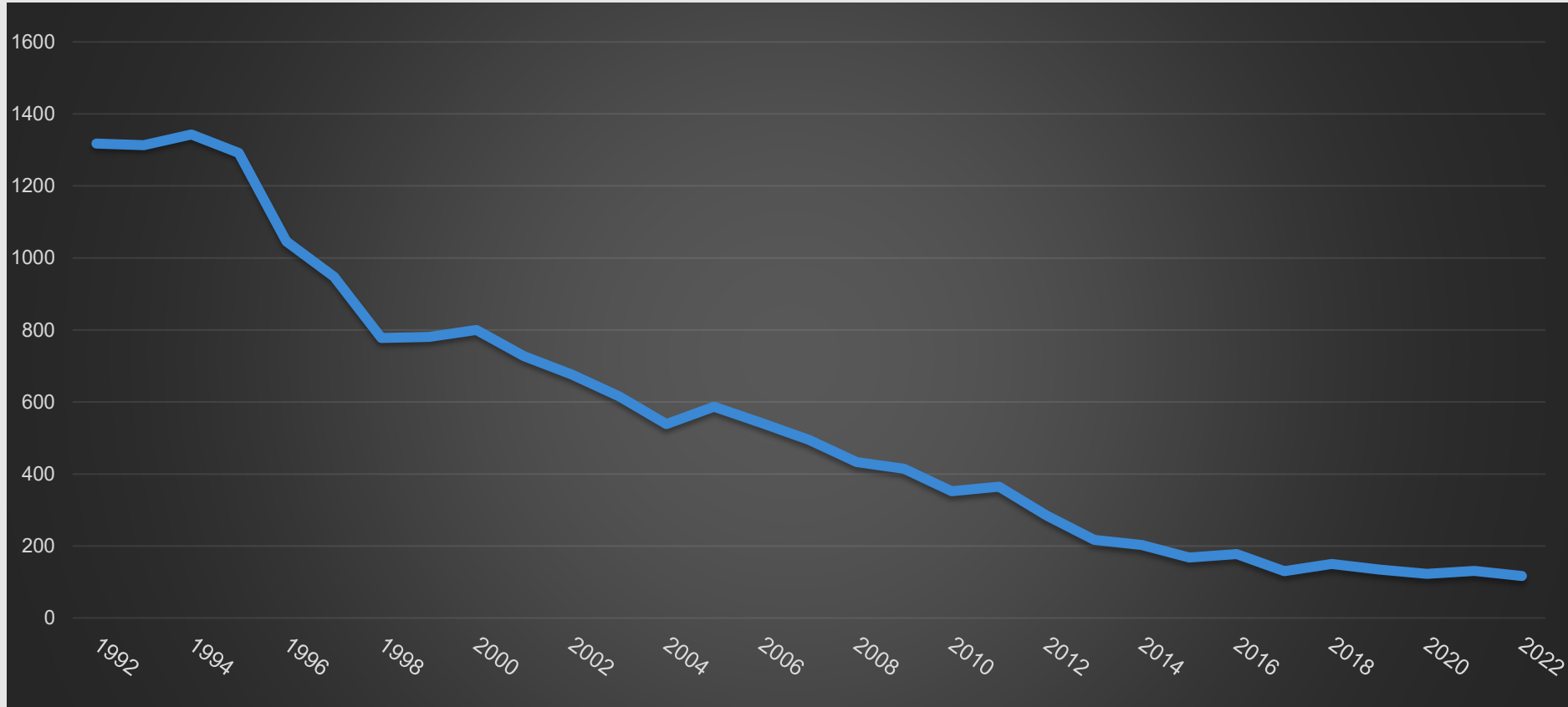
Samuel Salazar

Occupational Safety Division Director, TxDOT

Appreciating the past...

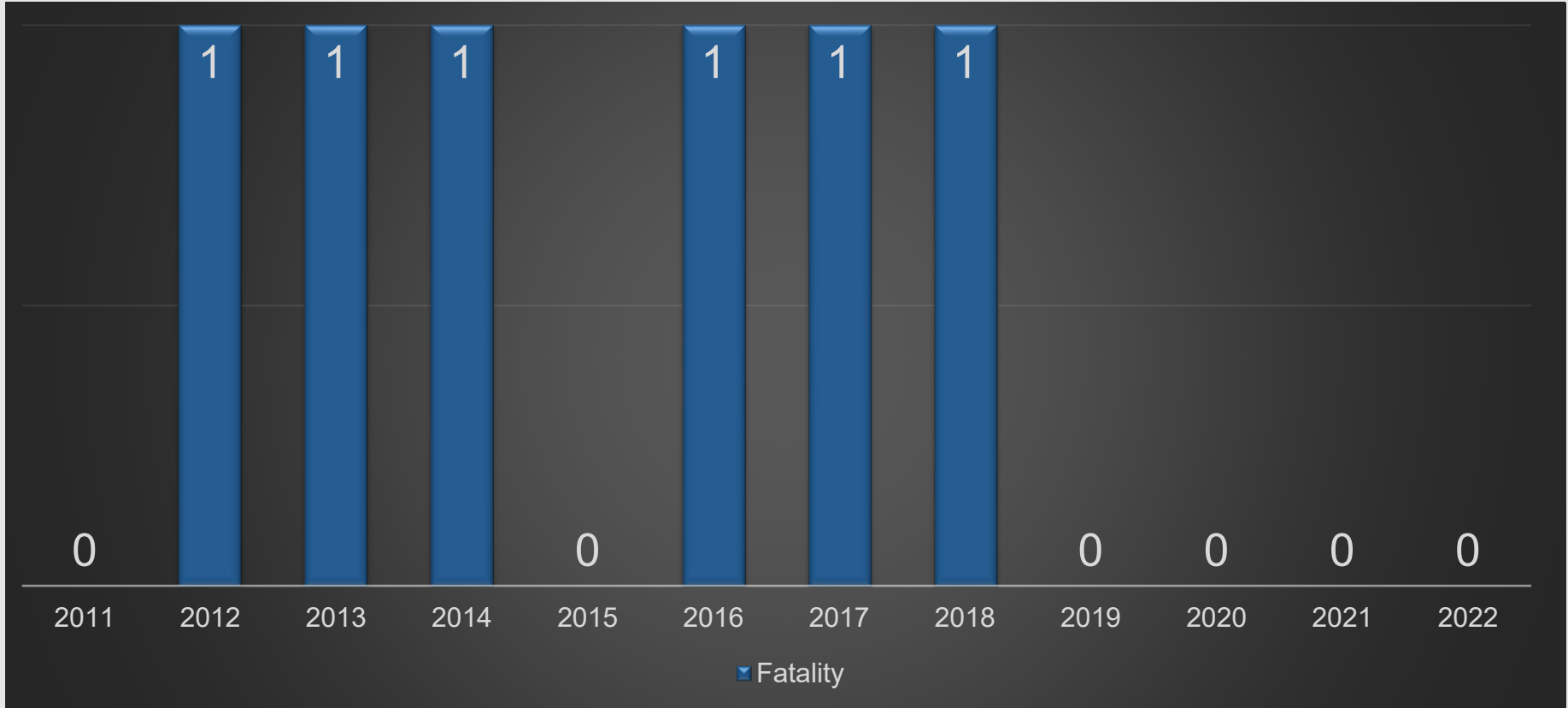


Injuries Per Year

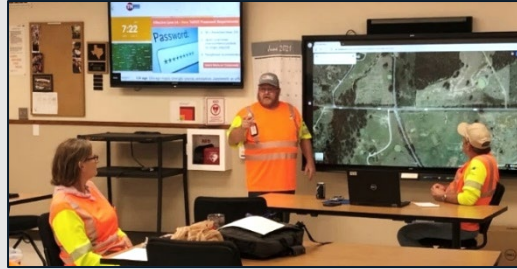


117 Injuries/0.87 Incidence Rate FY2022

Fatalities by Fiscal Year



Workers on Foot



Traffic Control Plan (Internal)

Communication

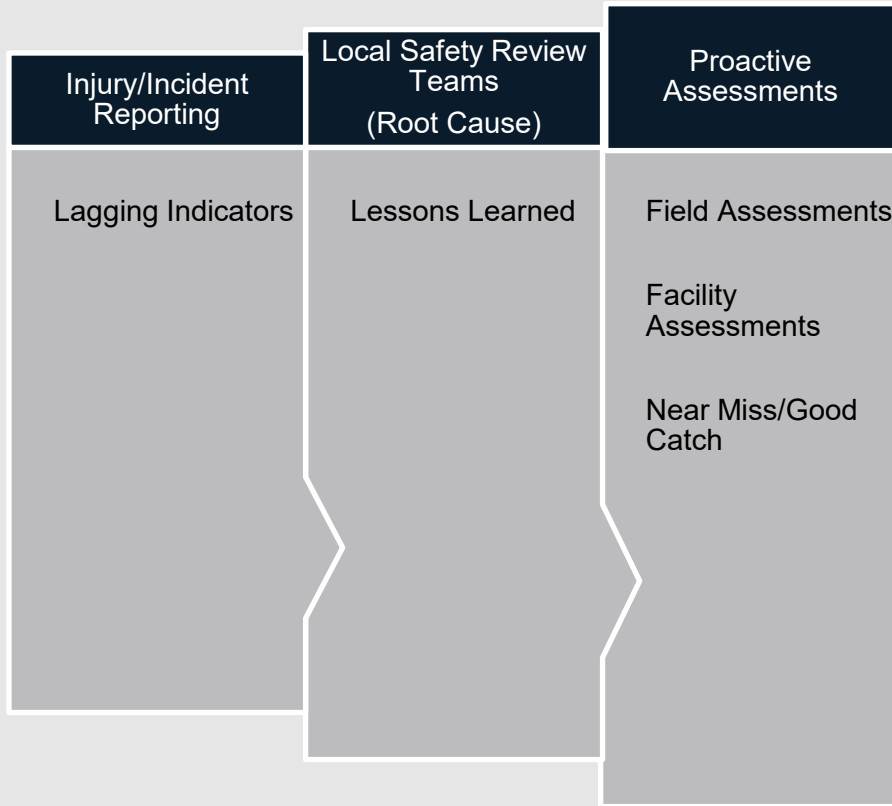


Adjust your Plan

Blind spot awareness



Data Drivers



346 Location: Maintenance Cleburne Response

TxDOT Safety Checklist

Date of Visit * 03/11/2021

Completed By Robert Godina

District * 02 - Fort Worth

Work Group * 020001 - Maintenance Cleburne

Supervisor Name Jeff Chenault

Supervisor Email * Jeff.chenault@txdot.gov

Send Audit to Additional Recipient

Safety Officer/Specialist

Type of Work Being Performed **Curvert and Storm Drain Mar**

Work Site Location Information

GPS Map Lookup for Work Site Location

Address 4001 U.S. 67

City Cleburne

State Texas

Postal Code 76031

Morning Tailgate/Play of the Day Questions

Attended Morning Tailgate Meeting? * Yes No

Can we reduce the exposure?



Safe Days of Summer

Evaluate & hydrate

TO BEAT HEAT ILLNESS

- » Evaluate how you feel and keep an eye on your teammates for symptoms of heat-related illness.
- » Plan your hydration and take Hydration Huddles throughout the day.
- » Employ PPE such as cooling towels, hat/neck shades, summer balaclavas, and sunscreen.

HEAT ILLNESS PREVENTION TOOLBOX

PLAN YOUR HYDRATION

- Use the Play of the Day meeting to go over hydration and heat-illness prevention strategies.
- Schedule hydration huddles throughout the day.
- **In excessive heat, drink at least 8 oz. of water every 15-20 minutes.**
- Plan to bring at least 2.5 gallons of water per person to make sure you have enough water for the day.

BE VIGILANT

Evaluate how you feel. Dehydration can cause fatigue, dizziness, muscle cramps and confusion. Do not rely on thirst to indicate when you should hydrate. By the time you are thirsty you are already dehydrated.

Look out for heat illness symptoms in yourself and your teammates.

Heat Stroke

The most serious heat-related health problem. This is a medical emergency. Call 9-1-1. Do not give them anything to drink.

Heat Exhaustion

This is a serious condition is caused by the loss of large amounts of body fluid by sweating. Move them to cool area, place cool wet cloths on them. They may sip water.

Heat Cramps

Painful muscle spasms. Stop activity and hydrate with water and electrolyte drinks.



STAY HYDRATED

- If you drink electrolytes, have 3 glasses of water for every 1 electrolyte beverage.
- Remind others on your team to hydrate.
- Remember to eat light, healthy meals with foods that are high in water content.

EVALUATE YOUR HYDRATION

One method of checking hydration is to watch the color of your urine. Pale yellow or nearly clear means you are probably adequately hydrated.

HOT WEATHER PPE

Don't forget about the availability of cooling towels, hat/neck shades, summer balaclavas, and sunscreen to protect you from the heat. All of these approved PPE items can be found in the Safety Catalog.

Equipped

TO AVOID INJURY

How do you avoid injury? Scan the QR code with your phone camera! Email your safety share: SafetyMissionZero@txdot.gov.



Photos appreciated!

AVOID INJURY TOOLBOX



PPE TO PROTECT YOUR BODY

All personal protective equipment shall be worn as designed and intended by the manufacturer.

- Safety toe footwear that meets the ASTM F2413-18 and Electrical Hazard Standards (to provide foot protection)
- Department approved white or yellow hard hat (for head protection related to hazards of impact, falling or flying objects, or electrical shock or burns.)
- ANSI Class III reflective shirts (that increase visibility of workers on foot and around equipment)
- Hand protection: always assess the job hazards and use gloves that provide the most protection for each job task.
- Eye protection that meets the ANSI/ISEA Z87.1 or higher; to include tinted or clear safety glasses, prescription safety eyewear, goggles, face shields, and over-the-glasses eyewear
- Hearing protection such as earplugs or earmuffs. Hearing protection shall be used at noise levels above 90 decibels and should be worn above 85 decibels.

Check out the Occupational Safety catalog for PPE options.

Safe Days of Summer



- » Eliminate potential hazards before you or someone else gets injured.
- » Emphasize wearing the correct PPE for the conditions and type of work.
- » Ease stress by taking a mental break; that employs deep breathing, listening to music or exercise.

AVOID INJURY TOOLBOX

STRETCH AND FLEX

Stretching exercises before work and during breaks will help relax and give muscles/joints a chance to move, reducing the chance of repetitive motion injuries. They also increase focus and renew energy throughout the day.

3 POINTS OF CONTACT

Use 3 points of contact when climbing on or off equipment, ascending and descending stairs or ladders and watch placement of hands and feet before committing.



Safe Days of Summer 2022

WALK WITH PURPOSE

Falls from the same level may result in serious injuries. Walk slowly and purposefully. Maintain good housekeeping practices. Scan the area ahead and around you as you walk.

EQUIP YOUR MIND

TxDOT's Wellness program is shining a 'Spotlight on Stress' by encouraging employees to take stress breaks a few times a week to manage daily stress. Start your morning tailgate meetings with 5 minute deep breathing exercises and mindful meditations. 'Equip Your Mind' by clearing out distractions and enhance your focus on the task at hand with this proven technique. Try this mindful breathing meditation session for stress release. For more information about 'Spotlight on Stress', visit the HRD Wellness website page.



From Your Safety Partners at OCC



- » Encourage people to ask questions and give thorough explanations.
- » Ensure each person understands his or her role in the job.
- » Everyone can execute the plan with confidence.
- » Empower workers to speak up when a situation becomes unsafe.

COMMUNICATION TOOLBOX

PLAY OF THE DAY

Use this time to plan the day ahead. Embrace tools such as Google Earth and JSAs to identify hazards in advance.

TAILGATE MEETING

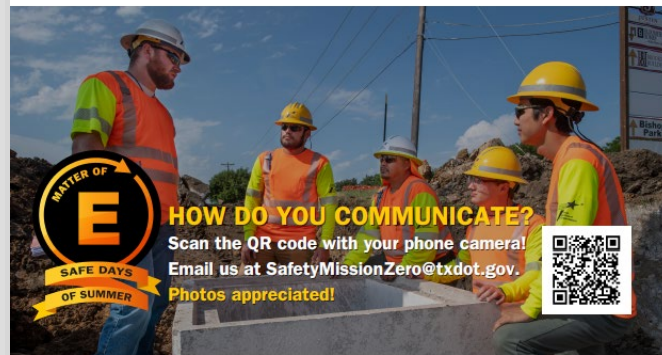
Discuss specific and operational topics related to the task to ensure each worker's assignment is understood. Review common hazards that may exist on the job.

SAFETY TIMEOUT

Evaluate your situation. When necessary call a timeout to ensure everyone's safety.

STOP. SPEAK. ACT!

Exercise your right to speak up when the plan goes off course. Work together to develop a new plan and make sure that all employees involved are aware.



Safe Days of Summer 2022

From Your Safety Partners at OCC

Safe Days of Summer

Expect the unexpected

INTERNAL TRAFFIC CONTROL PLANS
REDUCE RISKS IN WORK ZONES

- » Elevate communications by using radio communications in the work zone.
- » Ensure that equipment has enough space to move safely.
- » Effective ITCs will help prevent vehicle incidents and employee injuries.

ELIMINATE RISK TOOLBOX



15-50 RULE

The 15-50 rule positions vehicles and equipment at least 15 feet on either side and 50 feet from front and back.

Proper staging can ensure that equipment has enough space to move safely around equipment, personnel, and hazards behind the cones.

IDENTIFY HAZARDS

Hazard identification is an essential function when performing roadway operations. When in the work zone, common hazards include:

- ditches
- mailboxes
- power lines
- high grass
- culverts
- fixed objects

Find ways to identify these items ahead of time when planning and make them known to other workers to avoid incident or injury.

CENTERLINE SAFETY

Adjust operations and equipment so that workers are moved away from the centerline. Perform operational tasks from the right of way side. Workers can also choose to spot from the passenger side of the equipment if equipment cannot be adjusted.

- Avoid standing next to the centerline, if possible.
- Avoid having your back to traffic.
- Keep your head on a swivel.

RADIO COMMUNICATION

Elevate communication with radio communication while in the work zone. Communicating with each other will be critical for employee safety. Operators should communicate their intentions in order to keep their work area clear of any foot traffic, vehicles, or other equipment. Situational awareness will also be key in helping communicate any unexpected dangers like work zone intrusions. Radios can alert other workers to seek escape if they are in the vicinity.



From Your Safety Partners at OCC

Safe Days of Summer 2022

Expect the unexpected

INTERNAL TRAFFIC CONTROL PLANS
REDUCE RISKS IN WORK ZONES

ELIMINATE RISK TOOLBOX

PREVENT RUN OVERS & BACK OVERS

Run overs, caught-in-betweens and being struck by equipment have the potential to severely injure workers on foot who might be too close to the equipment. Proper equipment staging and maintaining a circle of safety around equipment can help keep workers safe behind the cones.



Safe Days of Summer 2022

TURN AROUND LOCATIONS

Planning strategic turn around locations can help avoid unnecessary U-turns. During the play-of-the-day meeting, take time to look at safe areas where equipment and vehicles can make these turns in alignment with operations. Tools, such as Google Earth, provide a glimpse of the area so that turn around locations can be identified in advance and all employees can benefit from these discussions.

CIRCLE OF SAFETY

As equipment moves in and through the work zone, a circle of safety should be maintained at all times. Depending on the type of equipment, there may be significant blind spots resulting in areas where the operator cannot see employees on the ground. Workers on foot should avoid entering into the circle of safety when possible. If they must step into the circle of safety, ensure that the equipment is turned off. Any employees on foot should make eye contact with the operator before proceeding.



From Your Safety Partners at OCC

In Summary...

Use your data

Develop good dashboards

Move on to proactive exposure reduction

Be engaged



HEAT STRESS MANAGEMENT IN CONSTRUCTION

Dr. Chuma Nnaji

Learning Objectives

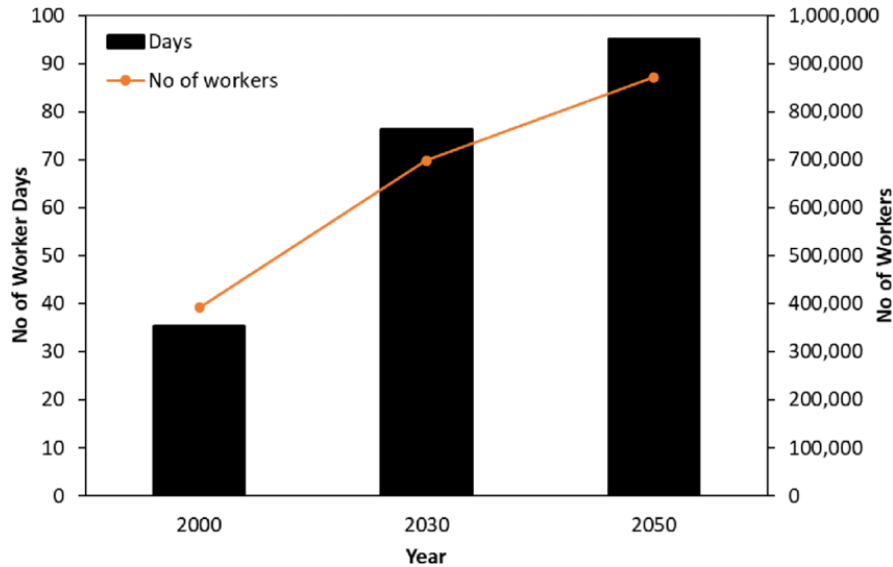
At the end of this presentation, participants should be able to:

1. Identify heat stress risk factors
2. List elements of a heat stress management program
3. Discuss emerging heat stress mitigation strategies



Source: Istock

Impact of Temperature on Worker Health and Safety



Source: Pazer, Epstein, Jaffe & Fein, P.C.

- Incidence rate from **0.03** in 2017 to **0.28** per 10,000 employees in 2018 (Sabrin et al 2021)
- **13x** more likely to die from heat-related illness (Calvert 2013)

Heat Stress Risk

Environmental and work-related factors

- High air temperature
- High humidity
- Amount of clothing
- Rate of body movement
- Amount of weight lifted
- Wind speed (fan or breeze)
- Location (sun or shade)



Source: ForConstructionPros.com

Aggravating Heat Stress Risk Factors

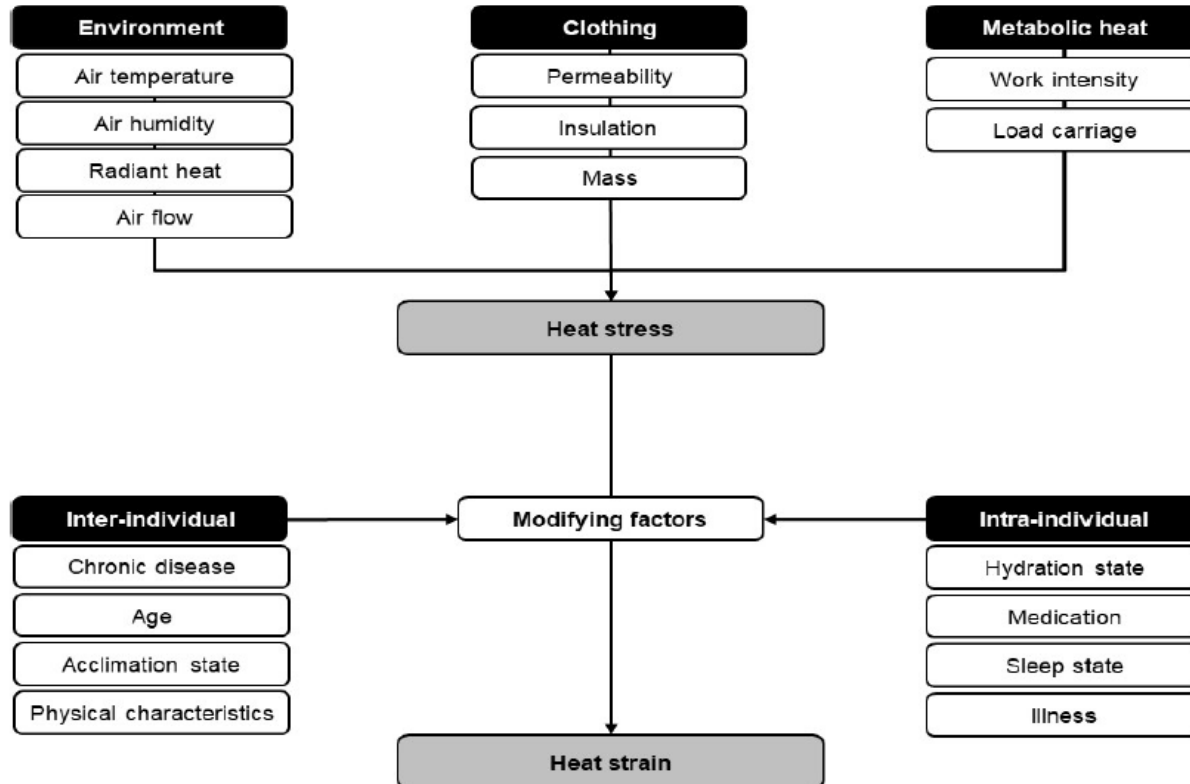
Susceptible conditions (Individual factors):

- Previous heat illness
- Respiratory infection
- Skin infection
- Fever
- Dehydration
- Stomach flu
- Insomnia
- Diabetes and heart disease
- Individual physical condition

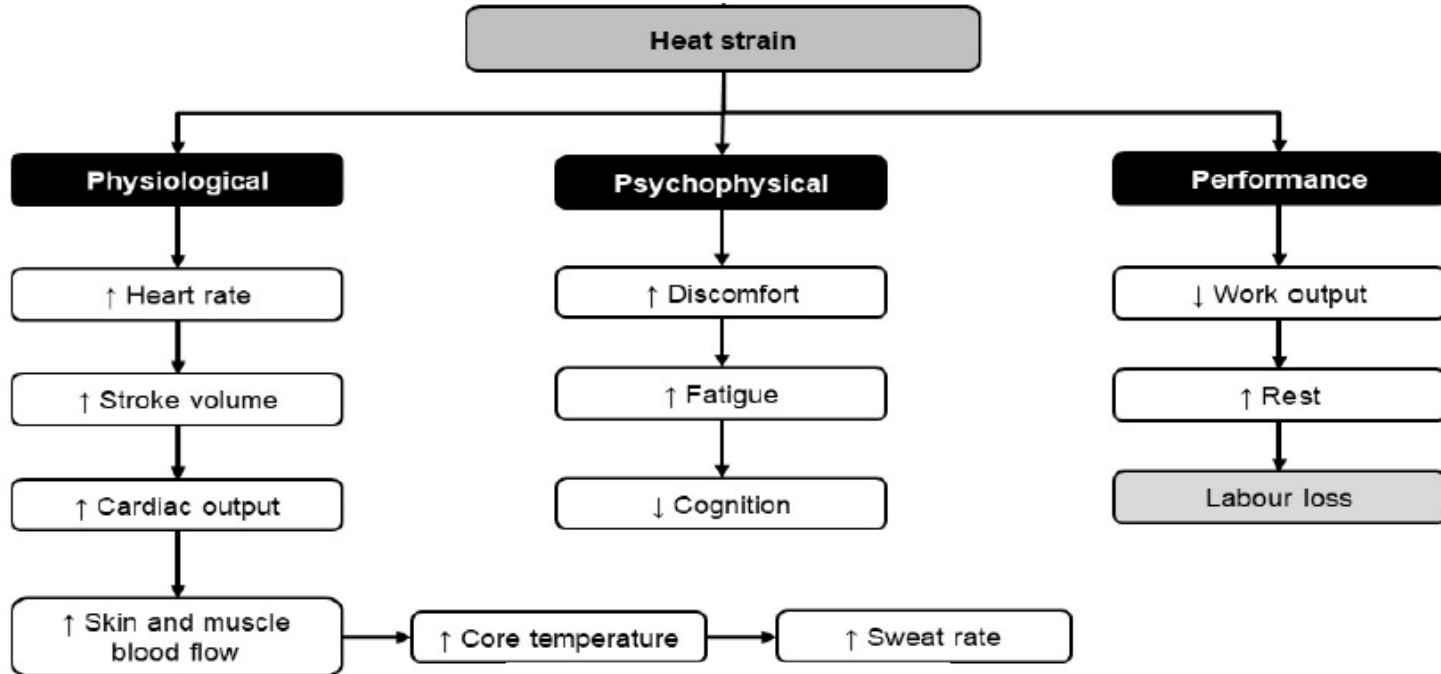


Source: Getty Images

Occupational Heat Stress

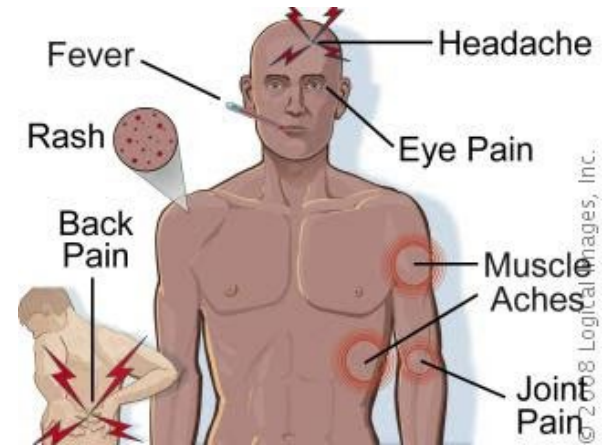


Occupational Heat Stress

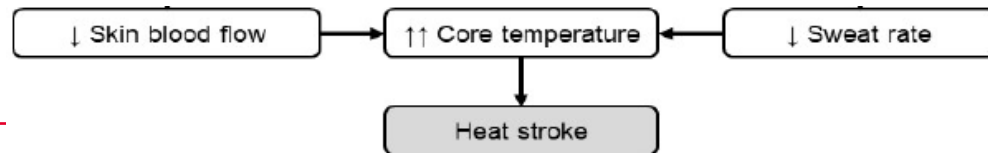


Symptoms of Hyperthermia

- Headaches, dizziness, lightheadedness or fainting
- Weakness and moist skin
- Mood changes such as irritability or confusion
- Upset stomach or vomiting
- Dry, hot skin with no sweating
- Seizures or convulsions



Heat stroke: Failure of the body's temperature-regulating mechanism when exposed to excessively high temperatures



Heat Stress Management Program

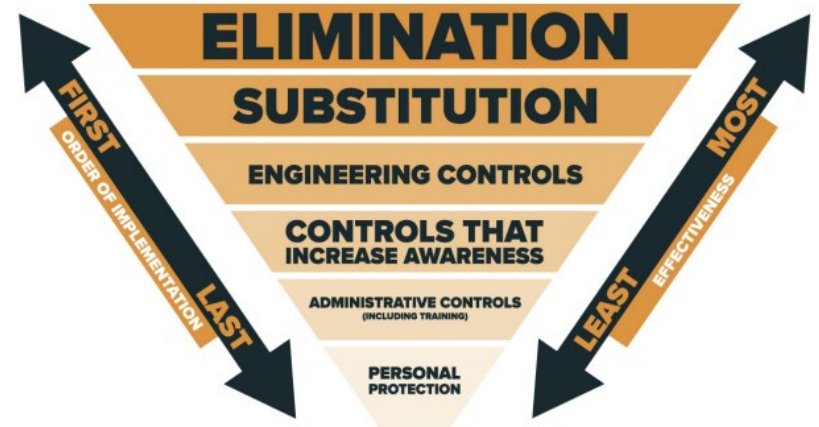
- Heat stress policy
- Heat stress program or hot weather plan:
 - Risk assessment process
 - Control measures: general controls and job-specific controls
 - Training and education of workers
 - Incident response, reporting and investigation including first aid
 - 'Check' elements: workplace inspections, annual audits, documentation



Risk Assessment and Control



Heat Stress Risk Assessment



Hierarchy of Risk Controls

Heat Stress Management Strategies

Environment sensing methods

- Wet Bulb Globe Temperature (WBGT)
- Heat index meters



Active cooling methods

- Cooling vest
- Personal fans
- Heat-Reflecting vest



Human sensing method

- Wearable devices



Environment Sensing Methods

- WBGT is a composite temperature used to estimate the effect of:
 - temperature,
 - humidity,
 - wind speed (wind chill)
 - solar radiation

$$\text{WBGT} = 0.77T_w + 0.2 T_g + 0.1 T_d$$

where:

T_w : Natural wet-bulb temperature (humidity indicator)

T_g : Globe thermometer temperature (measured with a globe thermometer to measure solar radiation)

T_d : Dry-bulb temperature (normal air temperature)



Source: OHS.com

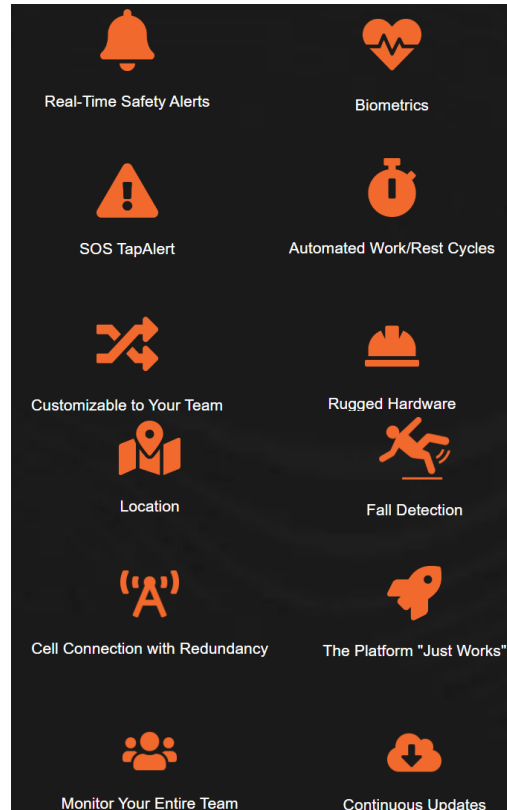
Environment Sensing Methods

Heat Stress Category (WBGT)	Moderate Work		Hard Work	
	Work/Rest Cycle	Water Intake Per Hour	Work/Rest Cycle	Water Intake Per Hour
White ≤76.9°F (≤24.9°C)	60/15 MINUTES	300 ml (1/3 qt)	40/20 MINUTES	500 ml (1/2 qt)
Green 77-81.9°F (25-27.7°C)	60/15 MINUTES	750 ml (3/4 qt)	40/20 MINUTES	1000 ml (1 qt)
Yellow 82-84.9°F (27.8-29.4°C)	40/20 MINUTES	1000 ml (1 qt)	30/30 MINUTES	1000 ml (1 qt)
Red 85-88.9°F (29.5-31.6°C)	30/30 MINUTES	1000 ml (1 qt)	Exercise is forbidden. Very high risk for heat casualties.	
Black ≥89°F (≥31.7°C)	Exercise is forbidden. Very high risk for heat casualties.			

Human Sensing Method

SlateSafety (formerly FireHud)

- ◆ Collects, transmits, and alerts on critical biometrics (including **estimated core temperature**) in real-time
- ◆ Provides hands-off alerting for custom-set exertion levels
- ◆ Easy to use with large groups of people
- ◆ Passive wearable armband, a purpose-built dedicated IoT network
- ◆ Rugged and passive device



Human Sensing Method

Zephyr

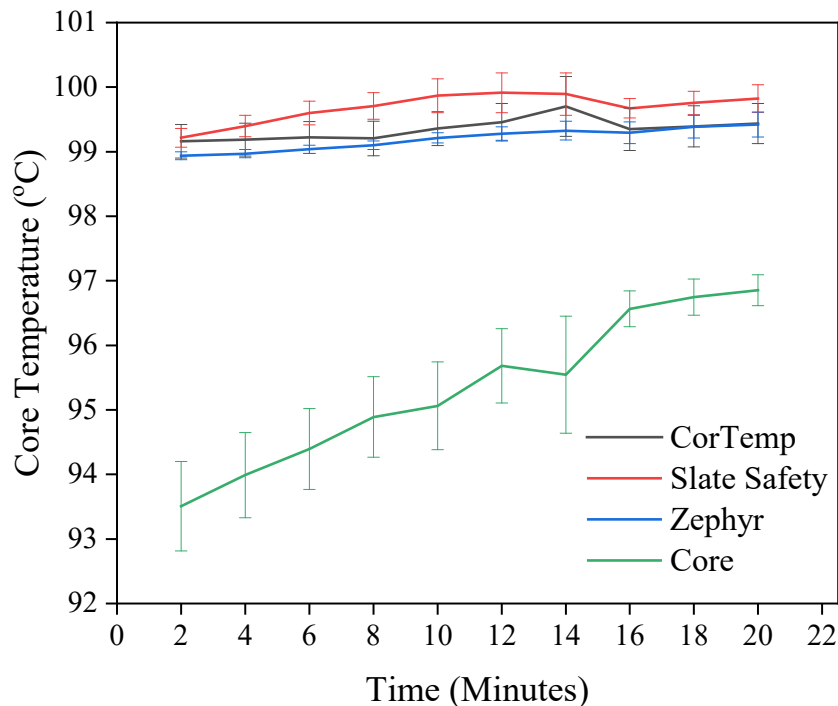
- ✦ Physiological data: Heart rate; Breathing rate, Heart rate variability
- ✦ Accelerometry data: posture, activity level, peak acceleration, accelerometer, impact
- ✦ Caloric burn, **estimated core temperature**, heart rate recovery
- ✦ GPS/Accessory input: GPS Speed, GPS distance, GPS elevation, Blood Pressure, SpO2



Source: Menke et al. 2015



Human Sensing Method



Sensors and CoreTemp pill Trend data (n=10)

Sensor Bias and Precision

CT Devices	Bias	Precision (SD)	95% Limits of Agreement	
			Lower	Upper
Slate Safety	0.20	0.35	-0.49	0.88
Zephyr	-0.03	0.34	-0.70	0.67
Core*	-2.10	1.31	-4.66	0.45

N.B.: Clinically acceptable limits of bias and precision were $\leq \pm 0.5^{\circ}\text{C}$ and $\leq \pm 1^{\circ}\text{C}$, respectively (Edwards et al. 2009).

*needed additional calibration

Six Prevention and Control Steps

1. Know the signs and symptoms of heat stress
2. Watch out for symptoms in yourself and others
3. Wear sunscreen, a hat, and lightweight, loose-fitting clothing
4. Drink water often – avoid drinks with alcohol or caffeine
5. Take breaks in the shade and more often on hot days
6. Know how your workplace deals with heat stress



Source: shutterstock.com

Take Away

1. Construction workers are 13x more likely to die from heat-related illness
2. Heat events will become much more common
3. Individual, environmental, and work-related factors impact heat stress
4. Heat stress management program is paramount
5. Emerging human-sensing technologies could improve heat stress monitoring



Source: Maine.gov

A large crowd of people is gathered in front of a brick building. The crowd is dense and extends across the foreground. The building is multi-story with a brick facade and a balcony. The sky is clear and blue. A white text box is overlaid in the center of the image, containing the text "Thank you!".

Thank you!

Today's presenters



Dr. Gabe Dadi
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University of Kentucky



Samuel Salazar
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Texas Department of Transportation



Dr. Chuma Nnaji
cnnaji@tamu.edu
Texas A&M University

Upcoming events for you

May 9-10, 2022

TRB's International Conference on
Road Weather and Winter
Maintenance

MAY 15-18, 2023

TRB's National Aviation System
Planning Symposium

[https://www.nationalacademies.org/trb/
events](https://www.nationalacademies.org/trb/events)



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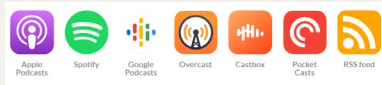
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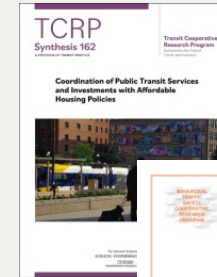
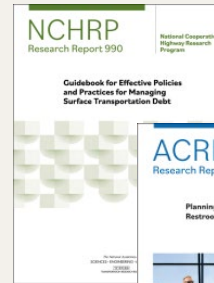
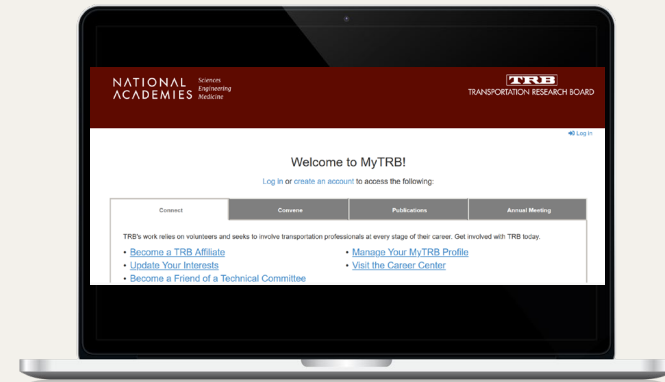
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