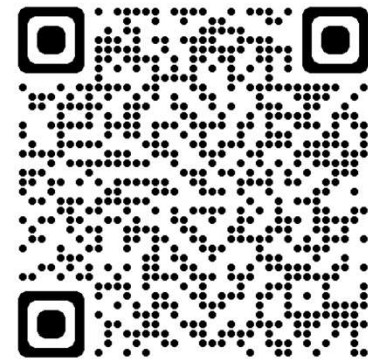**NAFMP**
North American Fatigue
Management Program

**From Risk to Resilience:
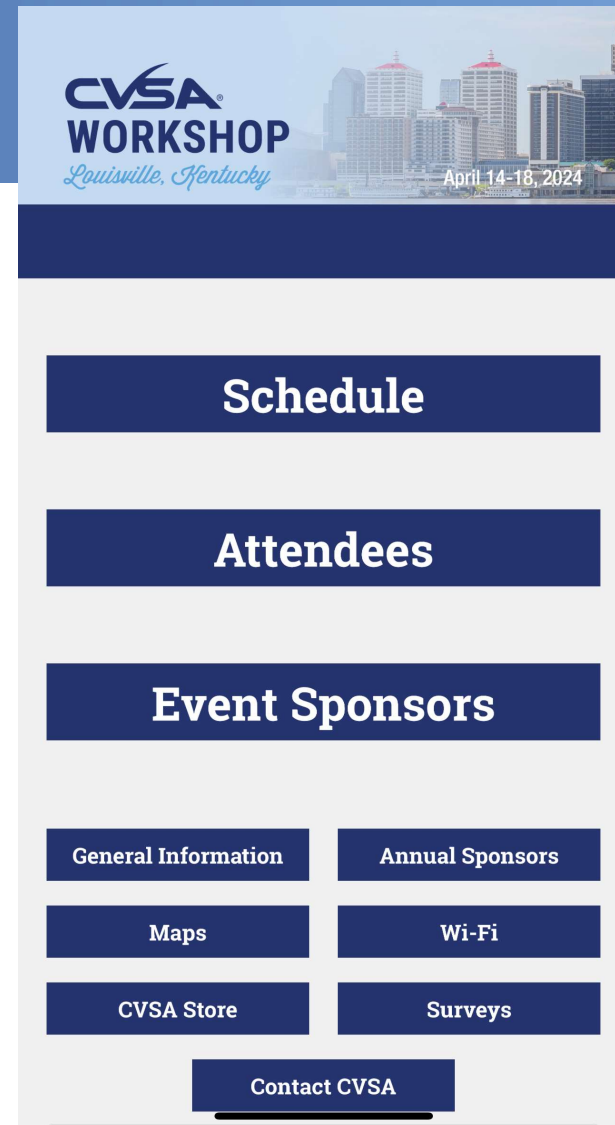Building a Fatigue-Proof Fleet
with Proven Solutions**

**CVSA Workshop
Louisville Kentucky
April 15, 2024**

**Get the slides at the bottom of the page of
nafmp.org/webinars**

# Check-In

Please check in to this meeting on the App

# Overview

1. Problem and Solution of Fatigue
2. Fatigue Management Program (FMP)
   1. Safety Culture
   2. Fatigue Risk Management System (FRMS)
3. Fatigue Management Technology Types
4. Implementation Considerations & Best Practices
5. Technology Catalogs
   1. NAFMP
   2. SWOV
   3. VTTI
   4. NHVR
6. Importance of Safety Culture
7. Next Steps, Resources and Contact Info

# Poll

**Alertness and fatigue are like an on/off switch, you are either awake or asleep**

- True
- False

# Vigilance Spectrum

- **Delta brain waves:** Deep sleep. 1 to 4 Hertz

- **Theta brain waves:** Sleeping or daydreaming when awake. 4 to 8 Hertz

- **Alpha brain waves:** Awake and calm. 8 to 12 Hertz

- **Beta brain waves:** Awake, alert, busy, and focused. 12 to 38 Hertz
  - **Low beta waves:** Thinking. 12 to 15 Hertz
  - **Beta waves:** Performing or focusing. 15 to 22 Hertz
  - **High beta waves:** Excited or anxious. 22 to 38 Hertz

- **Gamma brain waves:** Highly alert and conscious. 30 to 80 Hertz

# Poll

**The only cause of fatigue is insufficient sleep**

- True
- False

# Alertness Has Supply & Demand

- Supply Factors
  - Internal individual susceptibility: circadian rhythm, amount of sleep, time of day, time awake, stimulants, other drugs, health, genes, mood

- Demand Factors
  - Task related: Time on task, task complexity, task monotony

  - Environmental: Road conditions, weather, stress (heat, noise, vibration), vehicle design, social interaction, other stimulation

# Poll

**In truck/bus crash statistics, driver fatigue is…**

- The number 1 cause

- Not a significant cause

- Underrepresented

- Factors That Affect Fatigue In CMV Crashes
  - The National Transportation Safety Board believes that the incidence of driver fatigue is underrepresented in FARS in general and in FARS specifically with regard to CMV drivers.

  - Research has suggested that CMV driver fatigue is a contributing factor in **30 to 40 percent** of all CMV crashes.

# Crash Causation: 87% Driver Related   CVSA

- **Non-Performance:** Driver fell asleep, was disabled by heart attack or seizure or physically impaired for another reason

- **Recognition:** The driver was inattentive, distracted by something inside or outside the vehicle or failed to observe the situation adequately for some other reason

- **Decision:** Driver was driving too fast for conditions, misjudged the speed of other vehicles or followed other vehicles too closely

- **Performance:** Driver panicked, overcompensated or exercised poor directional control

# Crash Causation Associated Factors

- 14% Inadequate Surveillance
- 13% Fatigue
- 10% Felt Under Work Pressure From Carrier
-  9% Inattention
-  8% External Distraction
- **54% Total: Crashes where diminished vigilance was involved**

**FMCSA Large Truck Crash Causation Study**

# Poll

Is driver fatigue one of the top ten industry issues?

- Yes
- No

# ATRI Top Industry Issues



## 2023 Top Industry Issues

1. Economy (5)
2. Truck Parking (3)
3. Fuel Prices (1)
4. Driver Shortage (2)
5. Driver Compensation (4)
6. Lawsuit Abuse Reform (10)
7. Driver Distraction (#7 in 2018)
8. Driver Retention (7)
9. Detention / Delay at Customer Facilities (6)
10. Zero-Emission Vehicles

CRITICAL ISSUES IN THE TRUCKING INDUSTRY – 2023
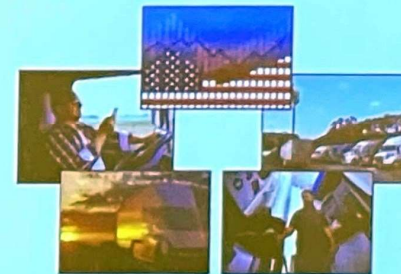
Prepared by
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October 2023

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TruckingResearch.org
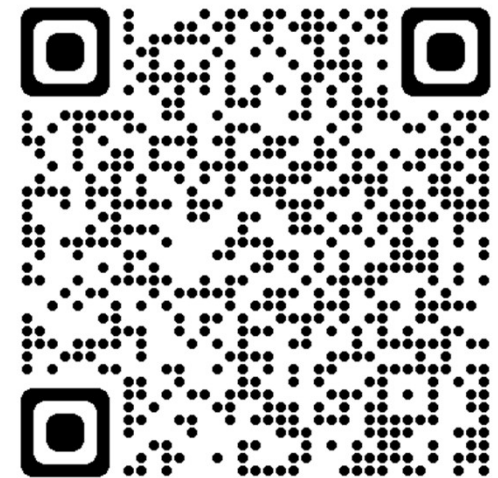
# Poll

- Why should a motor carrier manage fatigue?

# Benefits

- Lower Fatigue Related Crashes
- Lower Legal Liability Exposure
- Cost Reduction
  - Driver retention
  - Medical costs
  - Maintenance
- Labor force
  - Safer
  - More productive
  - Healthier & happier

# Disclaimer

- Solutions are on a continual path of evolution
- Solutions available today may not be available in the future
- Session is not meant as a recommendation or endorsement of any solution
- Broad overview of solutions on the market to address fatigued driving
- Vendor claims and/or system specifications have not been validated
- Costs for specific solutions vary widely and may be impractical for your fleet
- Again, this information session is meant to inform, not endorse

# Fatigue Management Program (FMP)

CVSA

1. Safety Culture
   - Education & Training
   - Partnership Among Carriers, Shippers, Receivers & Brokers

2. Fatigue Risk Management System
   - Sleep Disorder Screening & Treatment Program
   - Sound Scheduling Practices
   - Fatigue Management Technologies

# What Is a Safety Culture

- Shared behavior pattern and beliefs related to safety
- Safety is a value
- Safety is a part of company's identity
- Shared responsibility for safety
- Commitment to helping others perform safely

Module 2: Safety Culture

# Poll

What is the registration fee for an NAFMP course

a) $120.00

b) $30.00

c) $76.50

d) $0.00

e) $520.00

# Education & Training Courses

CVSA

- **eLearning Platform** & **PowerPoint Downloads All FREE!**
  - Motor carrier executives and managers
    - Module 1 (Intro), 2 (Safety Culture), 7 (Sleep Disorders), 10 (Technologies)
  - Motor carrier trainers
    - Module 5 (Train-the-Trainer)
  - Motor carrier dispatchers and driver managers
    - Module 9 (Scheduling)
  - Freight Shippers, Receivers, Brokers
    - Module 6 (Role of shippers & receivers on driver safety)
  - Drivers
    - Module 3 (Driver Ed), 8 (Sleep Disorders) & 9 (Scheduling)
  - Driver Families
    - Module 4 (Family Ed)

# Shipper and Receiver Best Practices

1. Realistic Trip Schedules
2. Reduce Loading/Unloading Delays
3. "Driver-Friendly" Queuing Practices
4. Off-Hour Parking Access

Module 6: Shippers & Receivers

# TCA/NITL Code of Ethics

- Established by the National Industrial Transportation League (NITL) and Truckload Carriers Association (TCA)
- Voluntary Guide to Good Business Relations
  - 25 shipper/receiver and 22 carrier/driver guidelines
- Often incorporated by reference into carrier-shipper contracts
- Has not solved all problems but has increased mutual understanding and cooperation

# Fatigue Risk Management System

1. **Applicability**: Operations at risk
2. **Identification & Data Collection**: Risk determination
   - **Predictive**: Previous experience, evidence-based scheduling, math models
   - **Proactive**: Self-reported, questionnaires, performance reviews, scientific literature review, planned vs actual time worked
   - **Reactive**: Determine if fatigue was a factor in crash, near crash or violation
3. **Assessment**: Classify hazards
   
   **Probability** + S**everity = Tolerability**
4. **Development**: Measures/countermeasures to reduce/eliminate risks
5. **Evaluation**: Continuously monitor effectiveness of FRMS

Implementation Manual: Chapter 4, Pages 57-74

# Step 1: Identify Operations

CVSA

- Different operations within a fleet experience varying risks of driver fatigue

- Determine whether FRMS strategies apply to entire organization or specific operations

- Identify operations that experience significant driver fatigue

# Step 2: Identify Fatigue Hazards

**CVSA**

- Fatigue hazards are a significant risk for fleet management operations

- Three processes for identifying fatigue hazards
  - Predictive
  - Proactive
  - Reactive

- Using all three processes can help make informed decisions based on scientific principles and data

# 2.a Predictive Processes

- Focuses on detecting factors that negatively impact driver alertness

- This information is used to develop driver schedules and workplace conditions that minimize the future effects of driver fatigue

- Three different ways
  - Previous experience
  - Evidence-based scheduling
  - Bio-mathematical models

# 2.b Proactive Processes

- Monitoring and analyzing reports of fatigue in the fleet operation
- Multiple data sources for fatigue identification should be used to create a more detailed and complete picture of fatigue in the operation
- Five approaches
  - Self-reported fatigue risks
  - Driver, dispatch, and manager fatigue questionnaires
  - Fatigue-related driver performance reviews
  - Review of fatigue-related CMV driving literature
  - Analysis of planned schedules and time worked vs actual schedules and time worked

# 2.c Reactive Processes

- Responding to identified fatigue-related events

- Include incident reporting, fatigue-related accident investigations, and near-miss reporting

- Triggered by fatigue reports, crashes, near-crashes, and violations

- Designed to identify how driver fatigue may have contributed to incidents

- Goals are to identify how fatigue may have been mitigated and prevent future occurrences

# Step 3: Assess Safety Risk of Fatigue Hazards

- There are two aspects of risk assessments
  - Measuring the likelihood of the fatigue hazard
  - Evaluating the severity of possible outcomes from it

- A dual assessment helps in prioritizing measures to control or mitigate identified fatigue hazards

# 3.a Define Risk Probability

| Category | Meaning | Value |
|---|---|---|
| Frequent | Likely to occur many times (has occurred many times) | 5 |
| Occasional | Likely to occur sometimes (has occurred infrequently) | 4 |
| Remote | Unlikely to occur but possible (has occurred rarely) | 3 |
| Improbable | Very unlikely to occur (not known to have occurred) | 2 |
| Extremely Improbable | Almost inconceivable the event will occur | 1 |

Adapted from the International Civil Aviation Organization

# 3.b Define Fatigue Risk Severity

| Category | Meaning | Value |
|---|---|---|
| Catastrophic | • Multiple deaths<br>• Equipment destroyed | A |
| Hazardous | • A large reduction in safety margins, physical distress, or a workload such that drivers cannot be relied upon to perform their tasks accurately or completely<br>• Serious injury<br>• Major equipment damage | B |
| Major | • A significant reduction in safety margins or a reduction in the ability of drivers to cope with adverse operating conditions as a result of increased workload or as a result of conditions impairing efficiency<br>• Serious incident<br>• Injury to persons | C |
| Minor | • Nuisance<br>• Operating limitations<br>• Use of emergency procedures<br>• Minor incident | D |
| Negligible | • No significant consequences | E |

Adapted from the International Civil Aviation Organization

# 3.c Fatigue Risk Assessment Matrix

| Risk Probability | | Risk Severity | | | | |
|---|---|---|---|---|---|---|
| | | Catastrophic A | Hazardous B | Major C | Minor D | Negligible E |
| Frequent | 5 | 5A | 5B | 5C | 5D | 5E |
| Occasional | 4 | 4A | 4B | 4C | 4D | 4E |
| Remote | 3 | 3A | 3B | 3C | 3D | 3E |
| Improbable | 2 | 2A | 2B | 2C | 2D | 2E |
| Extremely Improbable | 1 | 1A | 1B | 1C | 1D | 1E |

Adapted from the International Civil Aviation Organization

# 3.d Risk Tolerability Matrix

| Fatigue Risk | Assessment Risk Index | Suggested Criteria |
|---|---|---|
| Intolerable Region | 5A, 5B, 5C, 4A, 4B, 3A | Unacceptable under the existing circumstances. |
| Tolerable Region | 5D, 5E, 4C, 4D, 4E, 3B, 3C, 3D, 2A, 2B, 2C | Acceptable based on risk mitigation. May require management decision. |
| Acceptable Region | 3E, 2D, 2E, 1A, 1B, 1C, 1D, 1E | Acceptable. |

Adapted from the International Civil Aviation Organization

# Step 4: Develop Fatigue-Related Performance Measures and Countermeasures

- Appropriate controls and mitigation strategies should be selected and implemented

- It is critical to communicate these controls and mitigation strategies to relevant personnel to ensure they understand what each hazard is and how the strategies are designed to reduce fatigue hazards

# Sample Controls and Mitigation Strategies CVSA

- Scheduling tools/practices: NAFMP Module 9

- Cooperation with shippers, receivers and brokers: NAFMP Module 6 & webinar recording

- Protocols for napping/resting: NAFMP Module 3

- Sleep disorder prevention, screening, and treatment: NAFMP Modules 7 & 8 and webinar recording

- Fatigue management technologies: NAFMP Module 10 & webinar recording

# Step 5: Continuously Evaluate the FRMS for Effectiveness

- Data gathered should be compared to the safety performance objectives of the FMP

- Gradual decreases of fatigue should provide insight into the effectiveness of the FMP

- Dramatic decreases of fatigue should not be expected immediately

- Behavioral change requires time, and patience is needed when determining the overall effectiveness of the FMP

# Evaluation Determination

- If mitigation strategies perform to an acceptable standard, they should become part of the normal monitoring and evaluation of the FMP

- However, if the selected mitigation strategies do not perform to an acceptable standard, FRMS processes should be reviewed and revised and/or new approaches should be considered

# Poll

- What are the two main components of a fatigue management program?

# Fatigue Management Program (FMP)

1. **Safety Culture**
   - Education & Training
   - Partnership Among Carriers, Shippers, Receivers & Brokers

2. **Fatigue Risk Management System**
   - Sleep Disorder Screening & Treatment Program
   - Sound Scheduling Practices
   - Fatigue Management Technologies

# Fatigue Susceptibility

- Sleep Deprivation
  - Sleep-related behaviors
  - Sleep hygiene
- Individual Differences
  - Genetic variations
  - Health & fitness
- Medical conditions
  - Medications
  - Sleep disorders
    - Insomnia, narcolepsy, restless leg syndrome, sleepwalking, abnormal circadian rhythms, obstructive sleep apnea (OSA)

# Obstructive Sleep Apnea

- **Apnea** = stoppage of breathing lasting 10+ seconds
- OSA = breathing stops repeatedly during sleep due to closures of the upper airway
- Apnea rate per hour:
  - <5 = normal
  - >5 = OSA
- OSA severity (mild, moderate, severe) based on rate
- Some people with severe OSA can have 100 per hour
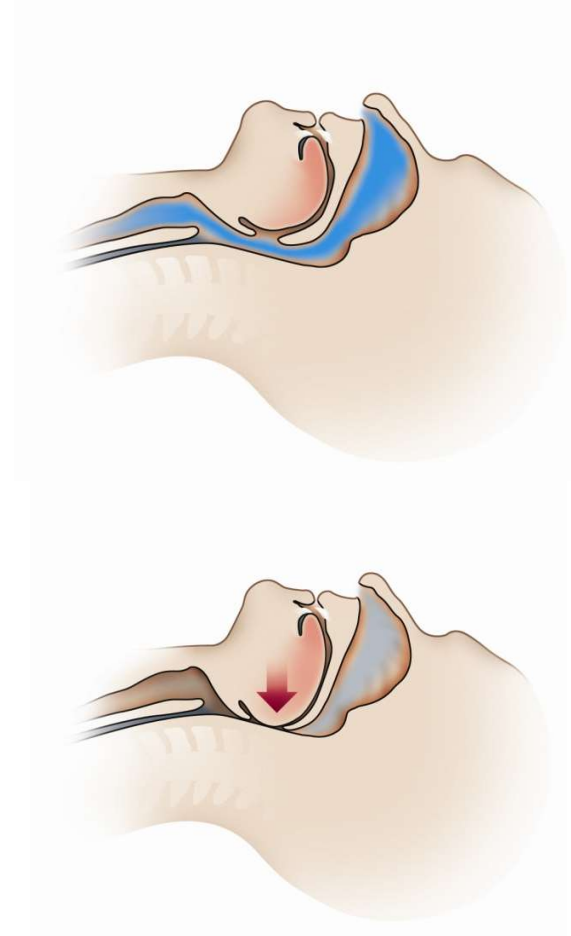
# Sleep Disorders Management Program

1. Education
2. Screening
3. Testing
4. Treatment
5. Monitoring

Module 7: Sleep Disorders Management (Motor Carriers)

Module 8: Sleep Disorders Management (Drivers)

Webinar: A Motor Carrier's Guide to Establishing a Sleep Disorders Management Program

# Poll

What type of risk identification process and risk control is a sleep disorders management program?

a) Predictive
b) Proactive
c) Reactive
d) None of the above
e) All of the above

# Scheduling Practices

- Sound scheduling and routing
- Time of day, recent sleep, continuous hours awake, cumulative sleep debt
- Shared responsibility mitigating driver fatigue in work schedules
- Regular schedules
- Forward vs backward scheduling
- Consider travel time to employment location
- Consider rests and naps during work shift
- Maximum of 16 hrs. per day or less
- Maximize benefits of scheduling tools
- Develop customized strategies for managing fatigue

Module 9: Driver Scheduling and Tools

# Poll

What type of risk identification process and risk control is sound scheduling?

a)  Predictive
b)  Proactive
c)  Reactive
d)  None of the above
e)  All of the above

# Fatigue Management Technologies Types

1. Scheduling & Trip Planning
2. Fitness for Duty Testing
3. Performance Monitoring
4. Driver Monitoring

Module 10: Fatigue Technologies

Webinars: The Alertness Toolkit and NAFMP Solutions Series

# Scheduling & Trip Planning

- Fatigue Prediction Mathematical Models

- Route Optimization Tools

- Dispatch and Communication Tools

# Fitness for Duty Testing

- Psychomotor Vigilance Tests
- Reaction Time Tests
- Speech Analysis
- Fatigue Questionnaires
- Behavioral Observation
- Wellness Check

# Performance Monitoring

- Computer Vision

- Steering Movements

- Lane Departure

- Telematics Systems
  - GPS Tracking
  - Fuel Consumption
  - Harsh Braking and Acceleration Events

# Driver Monitoring (DM)

- Computer Vision

- Eye-Tracking

- Physiological Sensors

- Activity Trackers

- Other Emerging Technologies

# DM - Computer Vision

- Eyelid Detection

- Gaze Tracking

- Head Pose Monitoring

# DM - Eye-Tracking

- Percentage of Eyelid Closure over the Pupil over Time (PERCLOS)

- Blink Rate and Duration

# DM - Physiological Sensors

- Electroencephalography (EEG)

- Heart Rate Variability (HRV)

- Skin Conductance

# DM - Activity Trackers

- Movement Patterns

- Sleep Quality Monitoring

# DM - Other Emerging Technologies

- Skin Temperature

- Speech Analysis

- Facial Expression Analysis

- Brain-Computer Interfaces (BCIs)

# Poll

What type of risk identification process and risk control are fatigue management technologies?

a) Predictive
b) Proactive
c) Reactive
d) None of the above
e) All of the above

# Making Sense of FMTs

- Must be scientifically and operationally sound
- Not all FMT concepts will work for every fleet
- All FMT concepts contain limitations
- Some FMT concepts overlap
  - Occur both at the driver level and back-office level
  - Occur both out-of-vehicle and in-vehicle
- All systems are not created equal
- Designed to aid the driver, not solve the problem

# No Silver Bullet

- FMTs are only one piece of the puzzle
- Must be used within an overall FMP to shape positive safety culture
- However, when used correctly, technology can reshape driving behavior leading to fewer driver errors

# FMT Cost

- Often a limiting factor when determining use
  - Initial purchase price
  - Return on investment
  - Fleet size and locations
  - Training
- Financing vs. outright purchase
- Must look at the big picture

# Return On Investment

- May be viewed as the most important aspect for FMT fleet integration
  - Impact of avoiding just one fatigue-related crash per year
- Indirect cost benefits should also be considered
  - FMCSA score, cost of driver replacement, environmental clean up, etc.
- Other factors that play a role on ROI
  - Fleet size
  - Self insured vs. non-self insured
  - Type of operation

# Return On Investment:
# Lane Departure Warning System Example

**CVSA**®

- LDWS have shown direct cost benefits (ATRI, 2009)
  - Benefits over five-year period outweigh costs of purchasing, installation, and maintenance
  - Payback periods (time to recoup initial cost) vary depending on annual vehicle miles traveled (VMT)
  - For every $1 spent on LDWS, more than $1 in benefits were returned across all groups

| Average VMT | Low End | High End |
|---|---|---|
| 80,000 | $1.54 | $3.03 |
| 120,000 | $2.31 | $4.54 |
| 160,000 | $3.09 | $6.06 |

**Anticipated benefits per dollar spent on LDWS (no financing). Adapted from Houser, A. et al. (2009).**

# Tech-Celerate Now ROI Calculator

**CVSA**

- [FMCSA Website](#)

| Results Per Truck | Per Truck | Entire Fleet |
|---|---|---|
| Benefits | $13,857 | $277,150 |
| Costs | $2,725 | $54,491 |
| Benefits-Costs | $11,133 | $222,658 |

# ADAS Included in FMCSA ROI Calculator

- Braking systems
  - e.g., air disc brakes, automatic emergency braking, and adaptive cruise control systems
- Steering systems
  - e.g., lane keep assist, lane centering and adaptive steering control
- Warning systems
  - e.g., lane departure, forward collision, and blind spot detection
- Monitoring systems
  - e.g., driver- and road-facing cameras for driver training, and camera-based mirror systems for enhancing driver field-of-view

# Fleet Size & Locations

- Number of power units
  - Affects initial purchase costs
  - Vehicle out-of-service time
  - Drivers

- Terminal/shop locations
  - Single versus multiple installation locations
  - Affects cost & personnel resources

# Potential Legal Implications

- Consider company policies and procedures
  - Driver video
  - Driver and vehicle data
  - Use of video and data

- Awareness of security concerns
  - Storage of collected video and data
  - Who has access to video and data

# Driver Behavior: Possible Influences

- Potential for creating positive or negative effects
  - Both cannot occur concurrently
- The positive
  - Promotes greater self awareness
  - Reshapes driving habits and routines
  - Encourages safety conscious work environment
- The negative
  - Reliance on FMT to prevent crashes and near crashes
  - Complacency in driving
- Reinforces the need for an overall positive safety culture to eliminate the negative side of the coin

# Policies for Driver Compliance

- Constructed by the fleet FMP Steering Committee
- Establish before FMT installation
- Clear and concise
  - What are the compliance standards?
  - Penalties for non-compliance
- Thoroughly discussed with all drivers
  - Safety meetings
  - Posted in terminals/dispatch office
- Maintain the standard
  - Do not selectively enforce
  - Drivers must be held accountable for their actions

# Driver Performance Measures

- FMTs that record data or transmit in real time
- Goes hand-in-hand with driver compliance
  - Performance measures must be reasonable
  - Driver has sufficient knowledge and training to meet the minimum performance level
- Back-office
  - Analysis and review in a timely manner
  - Driver training/coaching to meet minimum performance level

# Driver Acceptance

- Critical ingredient to successful FMT implementation
- Set the example from the top down
- Provide validity, facts, and benefits
- Emphasize driver assistance and not continual supervision
  - Not "big brother"
- Remain open minded to questions, apprehension and suggestions
- Ensure drivers do not view FMTs as punishment

# FMT Training

- Shop technicians (in-vehicle FMTs)
  - Proper installation techniques
  - Routine FMT inspection

- Drivers
  - How the FMT functions
  - What to expect
  - Type(s) of alerts if applicable
  - What to do when alerted
  - Observing the FMT in action
  - Avoiding negative driver responses
    - Keep in mind that without driver acceptance, not likely to be successful

# Operational Protocols

- Predefined written procedures
  - Creates standardized format and method
  - Ensures end result can be replicated regardless of personnel
  - Detail oriented and easily accessible
- Potential protocol needs
  - FMT installation and maintenance
  - Driver training
  - Driver non-compliance
  - Data analysis, review, and storage

# Fundamental Technology Problems

- Single channel FMTs are most common
- Potentially no independent review and validation of system
- Driver acceptance
- Technology never stops evolving
  - What is here today, may be gone tomorrow
  - However new technologies may be available

# FMT Evaluation

- Research the new technology
  - University and government studies
  - Current testing
- Contact vendor for specifications and cost
  - FMT classification and concept
  - Technical documentation
  - Expected service life
- Create benchmarks for comparison to current FMTs of same concept
- Determine projected cost-benefit of new FMT

# Best Practices

1) Must be integrated into overall FMP
2) Take full advantage of the FMT capabilities
3) Develop well-defined protocols
4) Explain the role of FMTs with drivers
5) Create meaningful driver expectations
6) Present consistent and detailed feedback for drivers
7) Maintain a positive atmosphere
8) Reinforce that safety is everyone's responsibility

# Recent Technology Catalog Sources

**CVSA**

- 2020 Review of Commercially Available Devices to Detect Fatigue and Distraction in Drivers
  - By Institute for Road Safety Research in the Hague, Netherlands

- 2019 Commercial Motor Vehicle Operator Fatigue Detection Technology Catalog and Review
  - By National Surface Transportation Safety Center for Excellence - Virginia Tech Transportation Institute (VTTI) Research Team

- 2019 Research Report - Fatigue/distraction detection technology use in the Australian road freight transport sector
  - By Australia's National Heavy Vehicle Regulator (NHVR)

# Fatigue & Distraction Detection Report

- 2020 Review of Commercially Available Devices to Detect Fatigue and Distraction in Drivers
- By Institute for Road Safety Research in the Hague, Netherlands
  - Stichting Wetenschappelijk Onderzoek Verkeersveiligheid (SWOV)
- Commissioned by
  - Shell Global Solutions International B.V.
  - BP International Limited
  - Total S.A.
  - Chevron Services Company
- Provides a detailed comparison of ≈100 technologies
- Recommendations on devices to consider for further testing/use

# SWOV Report Conclusions

- Due to extensive scientific evaluation, low cost, and high acceptability, fitness-for-duty tests score best. These systems do not monitor fatigue in real time

- Real-time systems, with the most promising candidates being EEG and computer vision systems. It is not clear how acceptable these devices would be to drivers

- A broad field study is recommended, which may also include systems that combine activity tracking and computational modelling and an established method using eyelid closure and steering movements

- If the aim is to monitor fatigue and distraction in real-time, only computer vision that focus on the driver are plausible candidates but drivers may find these devices difficult to accept

- Overall, there appears to be no single perfect fatigue/distraction system that meets all requirements; a combination of devices and methods may be needed

# SWOV Report Review Criteria

Five points scale:     − −     −     +/−     +     ++

1. **Validity**
Device should respond when the person is showing signs of fatigue or distraction

2. **Intrusiveness**
Device that interferes strongly with the driving or the driver is likely to be abandoned

3. **Availability**
   • Which development stage the product has reached, and how long the product has been on the market, and whether there are signs of continuous development and evaluation, and whether customer support is provided

4. **Robustness**
   • Device works for different drivers, and under different driving conditions

5. **Acceptability**
   • Devices that need to be worn or interfere with driving may score low on this criterion, but also devices that record the driver and send the information into the cloud for further processing may cause privacy issues and be less accepted

6. **Sustainability**
   • How frequently the device needs to be charged, needs replacing or repairing

7. **Cost**
   • Purchasing the system, any subscription fees or maintenance plans, or costs for repairs and replacements

8. **Compatibility**
   • Does system interfere with other systems inside the vehicle, such as communication devices, or navigation systems

# SWOV: Heart Rate (HR)/HR Variability

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| Warden | – | +/– | – | – | +/– | – | NA | +/– |
| Holux DFD-100 | +/– | – | – | – | – | – | NA | – |
| Canaria | – | +/– | – | +/– | – | – | NA | – |
| Holux WRL-8110 | – | +/– | – | – | + | – | NA | +/– |

# SWOV: Head Nodding

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| Co-pilot | − | +/− | + | − | − | +/− | − | − |
| Alert Me | − | − | + | − | − | − | + | − |
| Safeguard | − | − | − − | +/− | − | − − | NA | − |

# SWOV: Camera Systems -Without Computer Vision

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| MTData | − | +/− | + | + | +/− | − | +/− | + |
| SmartDrive | + | − | + | +/− | − | + | NA | − |
| Lytx | +/− | − | ++ | ++ | − | + | NA | +/− |

# SWOV: Computer Vision –Road Monitoring

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| Mobileye | – | +/– | + | – | + | + | NA | + |
| Autovue | – | +/– | +/– | +/– | + | +/– | NA | + |
| Safetrak | + | +/– | – | +/– | + | – | NA | + |

# SWOV: Computer Vision – Driver Monitoring

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| Stonkam | +/− | +/− | + | + | +/− | +/− | + | +/− |
| MR688 | +/− | +/− | +/− | + | − | + | + | +/− |
| TS DFM | − | +/− | + | + | +/− | + | +/− | +/− |
| Abto | − | +/− | − | − | +/− | +/− | NA | +/− |
| Delphi | + | − | − | + | +/− | − | NA | +/− |
| Guardvant | +/− | − | + | + | − | +/− | NA | +/− |
| Eyesight | +/− | − | ++ | + | + | ++ | − | +/− |
| F16 System | +/− | +/− | +/− | − | +/− | − | ++ | +/− |
| Guardian | + | +/− | ++ | + | − | ++ | − | +/− |
| Soteria | +/− | +/− | − | − | − | − | NA | +/− |
| SmartTrans | − | − | − | − | +/− | − | NA | +/− |
| HxGN Mine Protect | − | +/− | +/− | + | − | +/− | NA | +/− |
| Toucango | − | +/− | + | +/− | +/− | +/− | − | +/− |

# SWOV: Computer Vision – Road/Driver Monitoring

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| Idrive | + | +/– | +/– | +/– | +/– | +/– | NA | +/– |
| Exeros | – | +/– | + | +/– | – | +/– | NA | +/– |
| Zendu Cam | – | – | +/– | – | – | +/– | NA | +/– |
| Nauto | + | – | ++ | + | – | ++ | + | +/– |
| Streamax | +/– | + | ++ | + | + | + | +/– | +/– |

# SWOV: Activity Trackers

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| Readiband | + | +/− | ++ | +/− | +/− | + | +/− | +/− |
| Cat Smartband | + | +/− | ++ | +/− | +/− | + | + | +/− |
| CAS–5 | ++ | + | ++ | +/− | +/− | ++ | NA | + |
| Bodycap | − | − | + | − | − | − | + | +/− |

# SWOV: EEG Systems

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| Smart Cap | + | − | ++ | + | − | + | NA | − |
| B-Alert | ++ | − | ++ | +/− | − | ++ | + | − |
| Emotiv | ++ | − | ++ | − | − | +/− | +/− | − |
| DSI 10/20 | + | − | + | + | − | + | − | − |
| Freerlogic | − | + | − | − | + | − | NA | + |

# SWOV: Skin Conductance

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|--------|----------|---------------|--------------|------------|---------------|----------------|------|---------------|
| EDVTCS | − | − | + | +/− | + | ++ | − | − |
| StopSleep | +/− | +/− | + | +/− | +/− | +/− | +/− | +/− |

# SWOV: Fitness-for-Duty Tests

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|--------|----------|---------------|--------------|------------|---------------|----------------|------|---------------|
| FIT | + | + | + | +/− | + | ++ | +/− | + |
| Fatigue-o-meter | +/− | + | ++ | + | + | ++ | + | + |
| OSPAT | + | + | + | + | + | ++ | ++ | + |
| PVT | ++ | + | ++ | ++ | ++ | ++ | ++ | + |
| EyeCheck | − | + | − | − | +/− | − | +/− | |
| 2B-Alert Web | +/− | ++ | ++ | − | + | + | ++ | +/− |
| Pulsar informatics | + | + | + | +/− | +/− | + | + | + |
| DriveABLE | ++ | − | + | +/− | − | ++ | − | + |

# SWOV: Steering Movements

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| ASTiD | +/− | + | + | +/− | + | ++ | NA | + |
| Bosch / Mercedes | − | + | + | +/− | + | ++ | NA | + |

# SWOV: Eye Tracking

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| SmartEye | + | – | ++ | + | + | ++ | +/– | – |
| Vigo | – | – | + | – | – | +/– | + | – |
| SmoothEye | – | + | +/– | – | + | – | + | + |
| Ellcie | +/– | – | + | +/– | +/– | +/– | + | – |

# SWOV: PERCLOS Systems

| Device | Validity | Intrusiveness | Availability | Robustness | Acceptability | Sustainability | Cost | Compatibility |
|---|---|---|---|---|---|---|---|---|
| Optalert | ++ | +/− | ++ | + | + | ++ | − | +/− |
| DD850 | +/− | +/− | + | +/− | +/− | + | + | + |

# SWOV: Other

- Fatigue Model: CAS-5 - Circadian Alertness Simulation
- Temperature Monitoring: Bodycap eTact and e-Celsius Performance

# VTTI Catalog Rating Grouping

2019 Commercial Motor Vehicle Operator Fatigue Detection Technology Catalog and Review

- Validated: Empirically studied and effective technologies using sound experimental and statistical techniques

- Promising but insufficient data: Likely to be effective technologies, but minimal published research exists

- Unvalidated: Technologies that have not been empirically researched

- Ineffective: Fatigue technologies that were found to be ineffective at improving safety

- Unlikely to be used in the future: Fatigue technologies that are outdated

# NHVR Trial Info

- Australia's National Heavy Vehicle Regulator (NHVR)

- Fatigue Monitoring Trial Homepage

- Phase 1 Fatigue Monitoring Trial Report Summary

- Phase 2 Research Report - Fatigue/distraction detection technology use in the Australian road freight transport sector

# NHVR Trial Phase 1 Conclusions

- Oculomotor measurement devices or face monitoring systems using in-vehicle cameras provide real-time monitoring of driver fatigue and also driver distraction. These devices offer most value to users

- There is limited evidence however on the reliability and validity of fatigue and distraction detection technologies, especially from independent third-party assessments

- The review indicates that devices should not be implemented as a standalone tool for fatigue management. Rather, the technology should be used as part of a Fatigue Risk Management System

# NHVR Trial Phase 2 – Selected Findings

- Effective use of fatigue and distraction detection technology will profoundly reduce the frequency of fatigue and distraction events
- Distraction events are far more prevalent and outnumber fatigue events by a factor of four to one
- Importance of adopting a collaborative (as opposed to mandated) approach between company management and drivers
- A stated preference by most drivers to encourage the use of FMTs that identify unsafe events alerts rather than approaches based on continuous surveillance
- There is increasing industry awareness and focus through the use of FMTs on the centrality of driver fitness for duty as a key strategy to help reduce fatigue related crashes

# Poll

**A safety culture is nice to have but not necessary for an effective fatigue risk management system**

- True
- False

# Effectiveness of FRMS

*"While FRMS are likely to be effective, in organizations where safety cultures are insufficiently mature and resources are less available, these systems may be challenging to implement successfully"*

How Effective are Fatigue Risk Management Systems (FRMS)? A Review

# NTSB Crash Investigation



NTSB Crash Investigation Page

# Crash Investigation Results: Driver

- Expired CDL/Medical?
- Prior violations, convictions, crashes?
- Tested positive for alcohol or drugs?
- Speeding?
- New driver / New truck?
- Pre-existing medical conditions?
- Prescription drug use?
- Calling, texting, not facing the road?
- Not holding steering wheel?

- Kept a regular schedule?
- How long were prior workdays?
- How long prior sleep opportunity?
- What was the time of day?
- How many signs of upcoming stopped traffic were before crash?
- Responded to brake lights?
- Pressed the brakes?
- Died?

# Milk Tanker Crash Cause Determination

- NTSB determined that the probable cause of 2021 multivehicle crash in Arizona was the truck driver's failure to respond to the fully conspicuous traffic queue, likely **as the result of fatigue**

- Contributing to the crash was the carrier's
  - **Poor oversight of its drivers**
  - **Lack of fatigue management program**
  - **Failure to enforce its own policies, such as those regarding on-duty hours**

- All a consequence of the carrier's inadequate **safety culture**

**Read NTSB press release**

"A program to manage driver fatigue in agricultural transportation and collision avoidance technology would have prevented a fatal 2021 multivehicle collision in Phoenix where a tractor-trailer carrying milk crashed into stopped traffic"

# Next Steps

1. Complete FMP Template Now

2. Have drivers take Module 3: Driver Education & Training ASAP

3. Register for live courses and webinars and watch recordings

**All resources available from nafmp.org**

# Implementation Manual



Guidelines and Materials to Enable Motor Carriers to Implement a Fatigue Management Program

**IMPLEMENTATION MANUAL**

Sponsored by the North American Fatigue Management Program

**NAFMP**
North American Fatigue Management Program

# eLearning Platform: lms.nafmp.org

≡ **NAFMP**  English (en) ▾                          You are not logged in. (Log in)

**NAFMP**
North American Fatigue
Management Program

Fatigue Management Community Forum

No matter your role in managing fatigue, you are welcome to join in the conversation. Questions, comments, and feedback are encouraged. Thank you for your participation. Please select here to log in or create a new free account.

Search courses [🔍]

## Available courses

### Module 01

**FMP Introduction and Overview**

**Target Audience:** Carrier executives and other managers
**Estimated Duration:** 45 min

### Module 02

**Safety Culture and Management Practices**

**Target Audience:** Carrier executives and other managers
**Estimated Duration:** 1.5 hours

# PowerPoint Presentations

# ROI Calculator

CVSA

Français English

NAFMP
North American Fatigue
Management Program

About NAFMP ▼   Improve Driver Safety   Training ▼   ROI Calculator   Contact   Webinars   🔍

## ROI Calculator

## Return on Investment (ROI) Calculator

Estimate the monetary benefits of implementing the North American Fatigue Management Program either in its entirety or in select components in a customized program, i.e., fatigue management training, sleep disorder screening and treatment, technology deployment, and scheduling tools.

### Click on the links below to download the ROI Calculator and User Guide:

Calculator User Guide (PDF)   Calculator Download (Excel

**Access the Complete Training Program Online** →

❓ How to get started (PDF)

### Improve Driver Safety

Reduce fatigue-related risks, reduce crashes, improve alertness and promote job satisfaction.

# Webinars

# Questions & Other NAFMP Sessions

**CVSA**

**Rodolfo Giacoman**
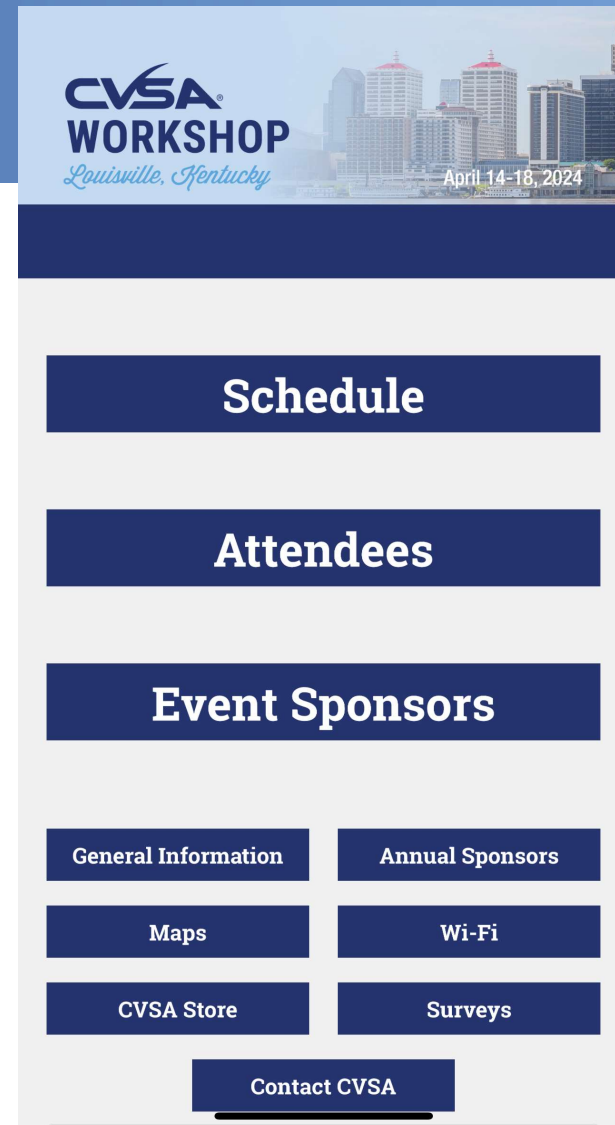
Fatigue Management Specialist
**Commercial Vehicle Safety Alliance**

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202-998-1830

# Feedback

Please rate this session in the App

# Thank You

**Please keep safe, well & alert**