Fog Detection and Warning System (FDWS)

Presenter

John Liu
Deputy District Director, District 6
Maintenance and Operations
California Department of Transportation
Presentation Topics

Purpose

Radiation | Tule Fog

Original Concept

Lessons Learned from CAWS and Other Systems

FDWS Overview
  • Technical Approach
  • Data Flows
  • Field Hardware
  • Central Control System – Cameleon
  • Outreach

Ongoing Issues | Concerns

What’s Next?

Questions
Purpose

The imperative to eliminate or minimize deadly multi-vehicle accidents during the San Joaquin Valley’s Winter/Fog Season, along a 12-mile stretch of State Route 99 in Fresno and Tulare Counties.

November 3, 2007 crash involving 81 vehicles including 11 big rigs, 2 fatalities, and 68 injuries
Radiation | Tule Fog

- Forms day or night under clear skies with calm winds
- Heat is absorbed by the earth’s surface during the day is radiated into space
- As the surface continues to cool, provided a deep layer of moist air is present, the humidity will reach 100%
- Varies in depth from 3 feet to about 1,000 feet
- Always found at ground level and usually remains stationary
- Reduced visibility to near zero at times - making driving very hazardous
Original Concept

• Speed data from sensors and commercially available sources
• GPS for vehicle locations
• Smart phones to warn for stopped traffic
CAWS and Other Systems


CVTMC - Operation Fog | CHP Pace Program (1992)

Tennessee Low Visibility Warning System (1994)
FDWS Overview
Technical Approach

Detection
Visibility (Fog)
Traffic (Presence | Speed)
Microwave Vehicle Detection System (MVDS)

Advanced Warning
Changeable Message Signs (CMS)
Smart-Extinguishable Message Signs (EMS)
Highway Advisory Radio (HAR)

Verification (Visual)
CCTV

Field Communications
Central Control System
Cameleon
FDWS Overview

ITS Elements

- 29 FCMS-Standard
- 4 FCMS-Color
- 6 PCMS
- 41 MVDS
- 22 Visibility Sensors
- 11 CCTV-Standard
- 2 HAR-BlackMax

Cost
$12 Million

Prime Contractor
Fog Detection and Warning System (FDWS)

FDWS Overview
Data Flows

- Visibility Sensors
  - (Prevailing visibility conditions in feet)

- FDWS Controller
  - Safe Speed Algorithm
  - Visibility Algorithm
  - Weather Share

- Caltrans Fresno TMC
- Local/State Agencies
- CHP Fresno Dispatch
- Pace Program

Speed Sensors
1/4 mile apart (Present vehicle speeds)

CMS/EMS: 1/2 mile apart
**FDWS Overview – CMS Message Priority**

Table 1. System Fog/PACE/Vehicle-Speed Warning Logic

<table>
<thead>
<tr>
<th>Priority</th>
<th>Conditions</th>
<th>Warning Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None of the following</td>
<td>Sign is blank</td>
</tr>
<tr>
<td>1</td>
<td>$200' \leq \text{VISIBILITY} &lt; 800'$ AND $\text{SPEED} \geq 45$</td>
<td><strong>FOG AHEAD</strong></td>
</tr>
<tr>
<td>2</td>
<td>$0 \leq \text{VISIBILITY} &lt; 200'$ AND $\text{SPEED} \geq 45$</td>
<td><strong>DENSE FOG AHEAD</strong></td>
</tr>
<tr>
<td>3</td>
<td>CHP_PACE AND $\text{SPEED} \geq 45$</td>
<td><strong>DENSE FOG CHP PACE DO NOT PASS</strong></td>
</tr>
<tr>
<td>4</td>
<td>$\text{VISIBILITY} &lt; 800'$ AND $35 \leq \text{SPEED} &lt; 45$</td>
<td><strong>FOG AHEAD TRAFFIC SLOWS TO 40 MPH</strong></td>
</tr>
<tr>
<td>5</td>
<td>$\text{VISIBILITY} &lt; 800'$ AND $25 \leq \text{SPEED} &lt; 35$</td>
<td><strong>FOG AHEAD TRAFFIC SLOWS TO 30 MPH</strong></td>
</tr>
<tr>
<td>6</td>
<td>$\text{VISIBILITY} &lt; 800'$ AND $15 \leq \text{SPEED} &lt; 25$</td>
<td><strong>FOG AHEAD TRAFFIC SLOWS TO 20 MPH</strong></td>
</tr>
<tr>
<td>7</td>
<td>$\text{VISIBILITY} &lt; 800'$ AND $5 \leq \text{SPEED} &lt; 15$</td>
<td><strong>FOG AHEAD TRAFFIC SLOWS TO 10 MPH</strong></td>
</tr>
<tr>
<td>8</td>
<td>$\text{VISIBILITY} &lt; 800'$ AND $0 \leq \text{SPEED} &lt; 5$</td>
<td><strong>STOPPED TRAFFIC AHEAD</strong></td>
</tr>
</tbody>
</table>

Where, for a given CMS:

- **VISIBILITY** is the minimum visibility detected in a zone and the adjacent zone in each direction.
- **SPEED** is the minimum speed of downstream traffic in the same zone.
- CHP_PACE is an operator input indicating that CHP Pace program is in effect.

Note: messaging shown for Permanent CMS
FDWS – Detection
Visibility

• Density-deploy enough sensors to detect localized fog pockets
• Deploy off-the-shelf standalone sensors that provide estimated visibility distance
• Sensors do not require periodic recalibration
FDWS – Detection
Traffic Presence | Speed

Wavetronix (MVDS)
– Easy infill
– Solar powered

In-Pavement Loops
FDWS – Advanced Warning Signage

Fixed and Portable CMS
- Addco Brick
- Daktronics Color
- Legacy Model 500

Addco Trailer-Mounted PCMS
FDWS – Advanced Warning
Highway Advisory Radio

Enhance existing corridor deployments
- Reduce/eliminate null near Tulare County
- Synchronize broadcast to create (near) seamless coverage
- Update field/TMC technology to IP-based devices
- Utilize EMS for enhanced/smart messaging
FDWS – Verification

CCTV

Verification
- Pelco 35x Zoom Esprit Camera
- 7 pixels per meter (ppm) at ½ mile
FDWS
Field Communications

**PLC Architecture** (Programmable Logic Controllers)
- Proven in D11 – I-15 Reversible Lane Control System
- Autonomous field operations in the event of communication loss to the central control system
- PLCs interface to Cameleon Central Control System in TMC
- Communications via Ethernet TCP/IP

**Wireless Communications w/Backhaul**
- Supports high bandwidth operations
- CCTV and element to element control
- Central Control System to field
FDWS - Central Control System Cameleon

- Advanced Scripting / Full System Automation
- Reliable and Scalable ITS Solution
- Off-The-Shelf Functionality
- Device Priority Control Management
- Dynamic Message Sign Control
- NTCIP Support
- Alarm / Event Management
- Full Logging and Trending Capability
- Configurable Desktop
- Multiple Monitor Configurations
- Customizable Site Maps
FDWS - Central Control System Cameleon

Customizable Site Maps
FDWS – Outreach
www.foguniversity.com

- Web
- PIO/Media (Modern Marvels)
- Billboard
FDWS – Outreach
www.511.sjv
FDWS – Outreach
QuickMap, Apps, Social Media

www.quickmap.dot.ca.gov
FDWS – Conclusions
Ongoing | Concerns | Enhancements

Concerns
• Recurring Maintenance Cost
• Solar Technology
• Wire Theft
• Additional Fixed Objects Along Roadway

Enhancements
• Integrate PeMS (Performance Measurement System)
• Automate HAR Activation
• Replace PCMS
• Replace Solar Technology
• Evaluate In-Roadway Lighted Markers
• Perform 3rd Party Evaluation
• Social Media
FDWS – Conclusions
What’s Next?

• Expand the System?
• Replace with Phone Apps?
• Intelligent Vehicles?
Any Questions?

John Liu
Deputy District Director, District 6
Maintenance and Operations
California Department of Transportation
(559) 488-4144
john_liu@dot.ca.gov