Electromagnetic Frequency Interference Test Plan Results

Presented to the EMFI workgroup

October 14, 2009

Test Plan Overview

- Purpose
  - To determine relative impact of reflective windows on some portable electronic devices
- Tested three types of devices
  - GPS monitoring ankle bracelets
    - Uses both GPS and cell phone signals
  - GPS navigation devices (Garmin)
    - Evaluated both the time to first fix (TTFF) and navigation/tracking ability
  - Cell phones
    - Tested both CDMA and GSM networks

Vehicles/Glazing Tested

- Manufacturer installed reflective windows
  - Mercedes S class (all around), BMW 7 (windshield only)
  - BMW 5 used as control
    - Also installed solar reflective film on windshield and on all windows for a second set of tests
  - Ankle bracelets, cell phones, and GPS navigation tested in these vehicles
- GPS time to first fix tested on Chevrolet Cavalier with and without reflective film


BMW 528
6BCU427

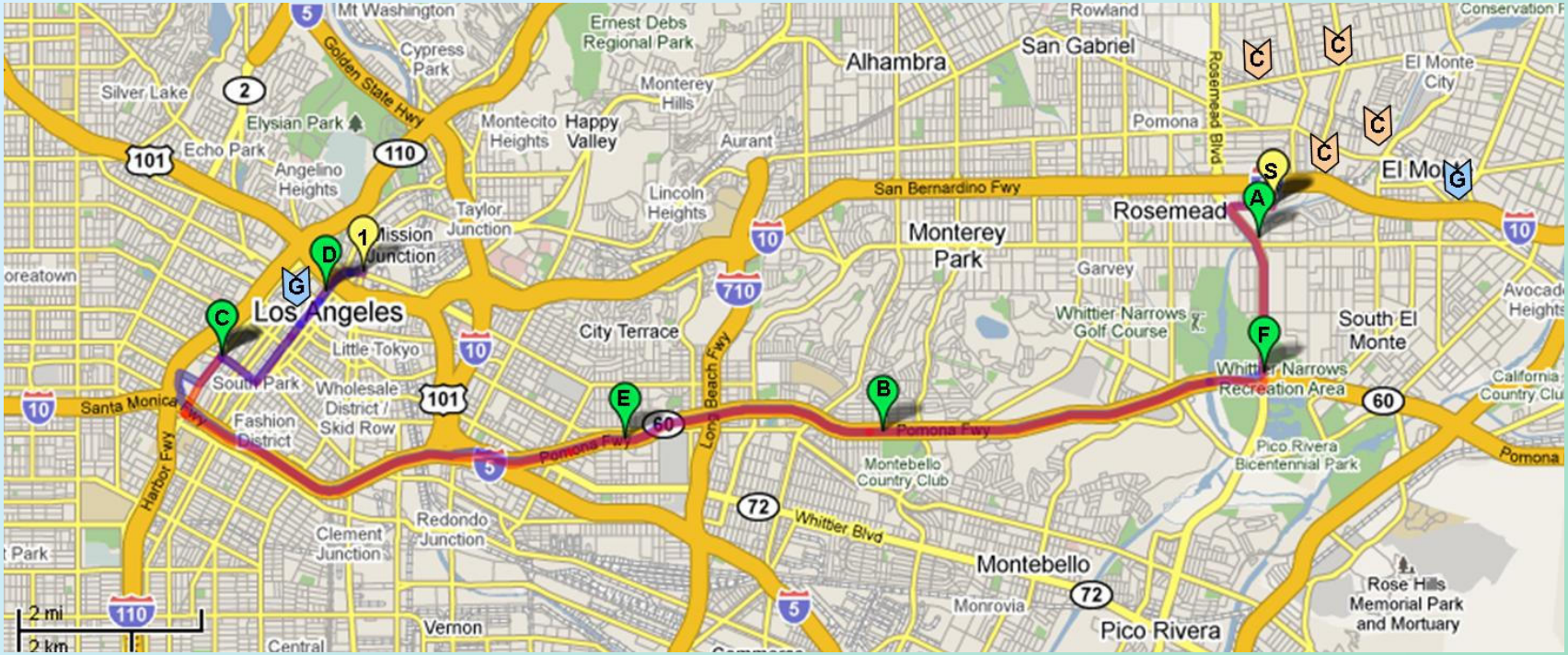

BMW 750
6BKW397

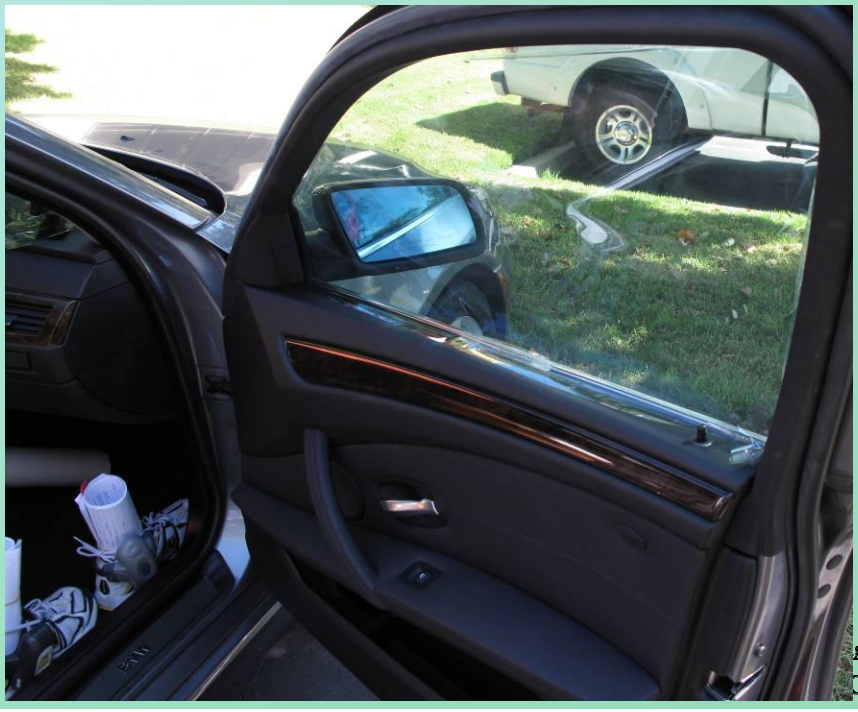

Mercedes S
6FBN089


Chevrolet Cavalier

Methods: Ankle Bracelets

- Used two types of ankle bracelets
  - ProTech and Satellite Tracking of People (STOP)
- Drove on track from El Monte, CA to downtown Los Angeles and return
- Placed ankle bracelets in front footwell (to downtown) and rear footwell (from downtown)
- Tested in BMW 5 no film, BMW 5 windshield film, BMW 5 all film, BMW 7, Mercedes S
- Tracks evaluated for drops in GPS signal during each segment


Mt Washington
Ernest Debs Regional Park
Rowland
Alhambra
San Gabriel
Conservation F
Cypress Park
Golden State Hwy
Monterey Hills
El Monte City
Silver Lake
Elysian Park
Montecito Heights
Happy Valley
Aurant
Pomona
Rosemead Blvd
Echo Park
Angelino Heights
Lincoln Heights
San Bernardino Fwy
Rosemead
Taylor Junction
Monterey Park
Los Angeles
Garvey
Avocado Heights
City Terrace
Whittier Narrows Golf Course
South El Monte
Little Tokyo
Whittier Narrows Recreation Area
South Park
Wholesale District / Skid Row
Santa Monica Fwy
Fashion District
Pomona Fwy
Long Beach Fwy
California Country Club
Harbor Fwy
Montebello Country Club
Pico Rivera Bicentennial Park
Redondo Junction
Clement Junction
Whittier Blvd
Montebello
Monrovia
Rose Hills Memorial Park and Mortuary
Pico Rivera
Vernon
Central
2 mi
2 km



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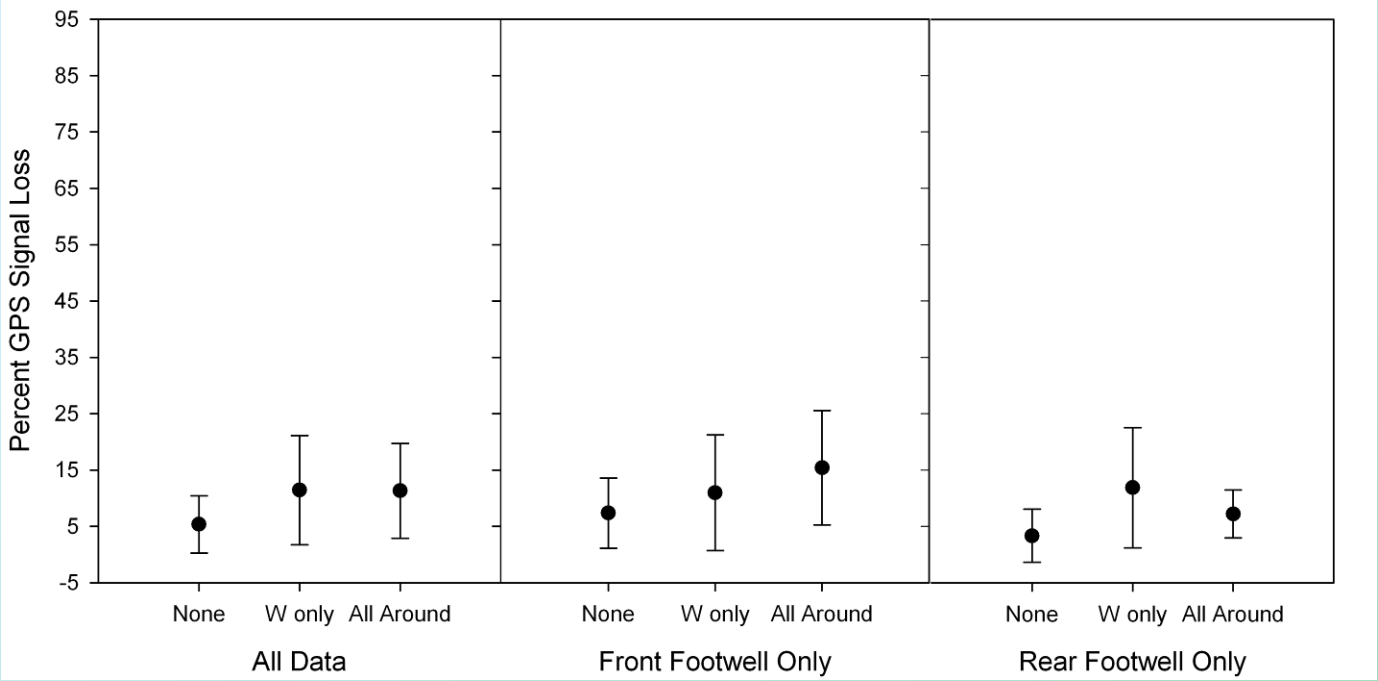
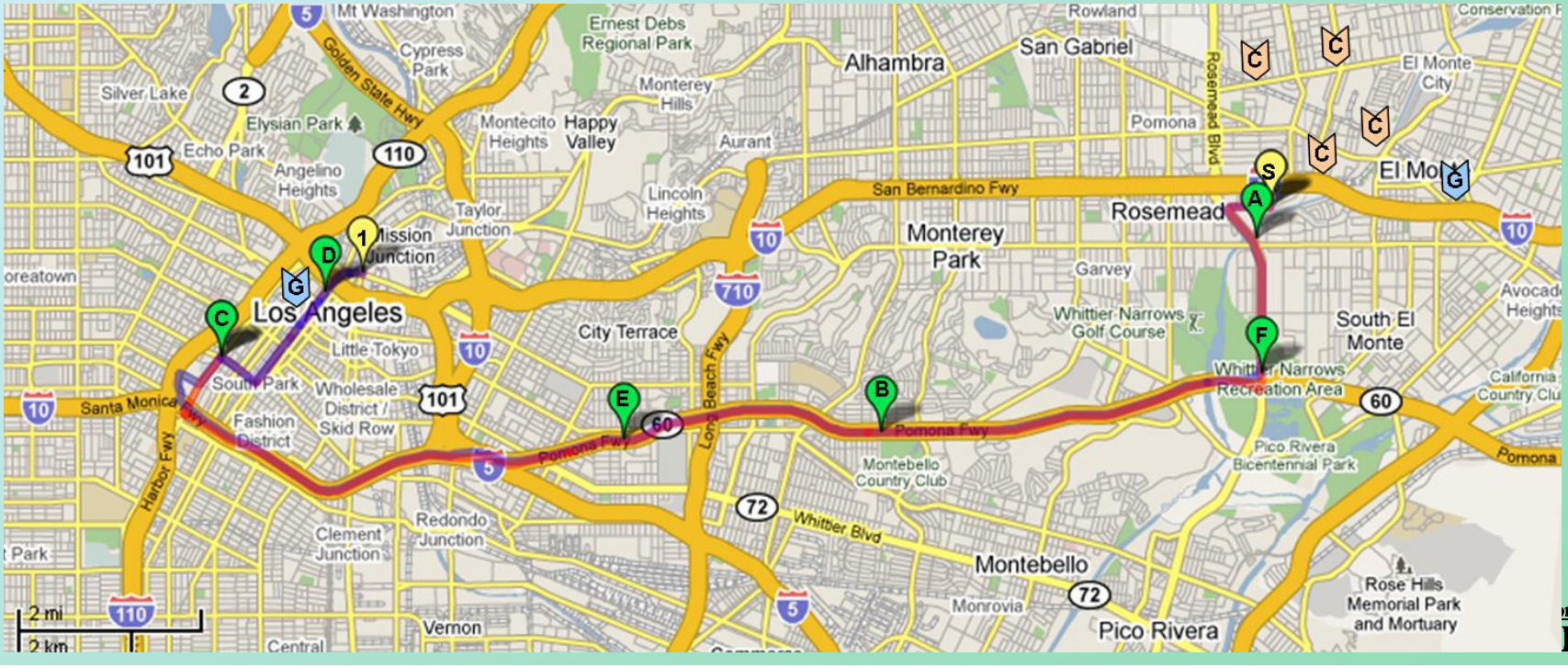
Results: Ankle Bracelets



- High degree of variability with GPS drops occurring in all vehicles
- Most GPS drops occurred in “urban canyon” but approximate location was still obtained through the cell phone back-up
- CDCR staff would not find any of the tracks in our study suspicious and drops of this nature are common

Methods: Cell Phones

- Made three calls with each cell phone type (CDMA and GSM) along the route at pre-determined points
- Phone calls were two minutes in length and quality of call recorded

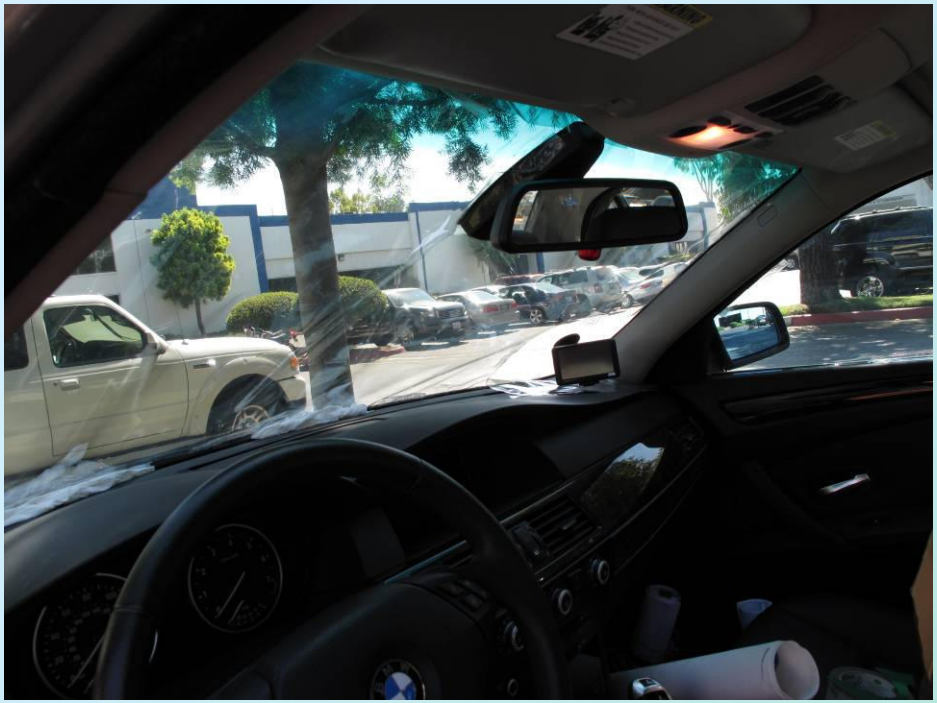


Results: Cell Phones

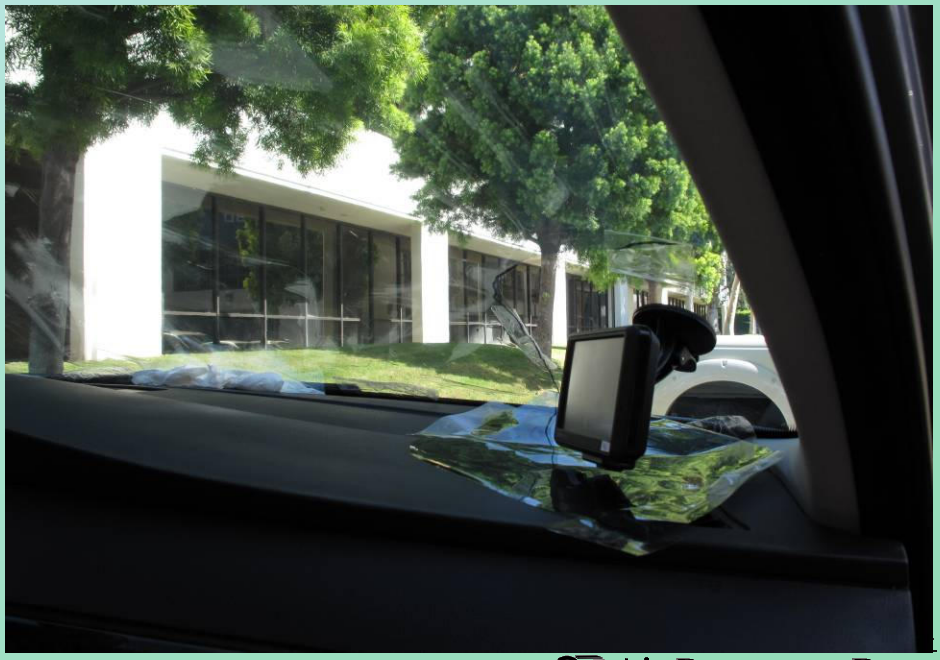
- Glazing type did not impact the ability to make a cell phone call
- No calls were dropped and call quality was not affected

Methods: GPS Navigation

- Drove on same route through downtown as with cell phone and ankle bracelet tests
- Tested the GPS with antennas and deletion windows
  - Deletion windows in the BMW 7 and Mercedes S could not accommodate the GPS unit due to the high dashboard; deletions only tested in the BMW 5 with aftermarket film
- Compared track length with actual distance traveled
  - Greater track length = more deviance due to navigation errors



Deletion area cut to ~4%
of total windshield area

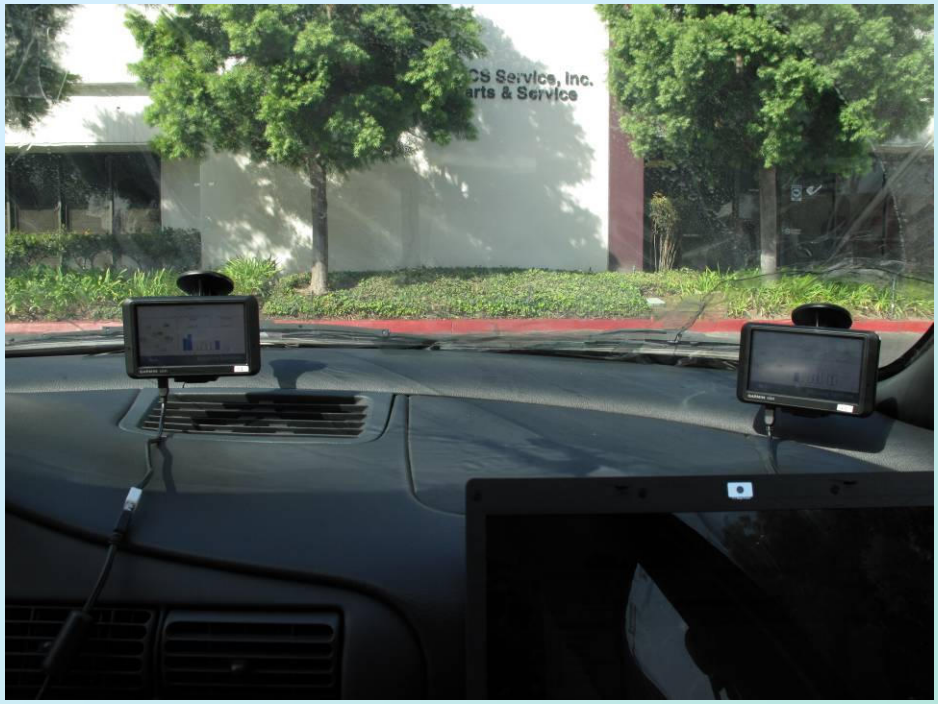


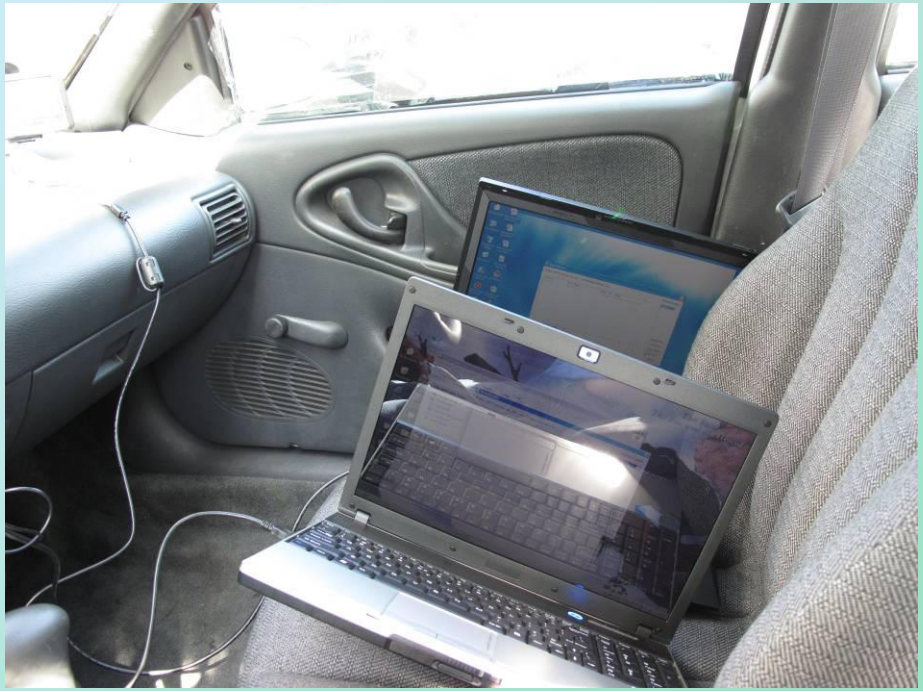
Results: GPS Navigation

Date	Route	Vehicle	Reflective Glazing	GPS Unit	Unit in Deletion	Antenna in Deletion	Percent deviance
9/23/2009	ARB to LA	BMW 5	None	G1	No	No	3.59
9/23/2009	ARB to LA	Merc. S	All (-R)	G2	No	No	3.25
9/23/2009	ARB to LA	Merc. S	All (-R)	G1	No	No	2.90
9/22/2009	LA to ARB	BMW 7	W Only (-R)	G1	No	No	2.65
9/24/2009	LA to ARB	BMW 5	All (+R)	G1	No	No	2.65
9/24/2009	LA to ARB	BMW 5	All (+R)	G2	No	No	2.65
9/22/2009	ARB to LA	BMW 7	W Only (-R)	G2	No	No	2.56
9/22/2009	ARB to LA	BMW 7	W Only (-R)	G1	No	No	2.21
9/23/2009	LA to ARB	Merc. S	All (-R)	G2	No	No	1.96
9/22/2009	LA to ARB	BMW 7	W Only (-R)	G2	No	No	1.96
9/24/2009	LA to ARB	BMW 5	W Only (+R)	G1	No	No	1.96
9/23/2009	ARB to LA	BMW 5	None	G2	No	No	1.86
9/24/2009	LA to ARB	BMW 5	W Only (+R)	G2	No	No	1.61
9/24/2009	ARB to LA	BMW 5	W Only (+R)	G1	No	**Yes**	1.52
9/24/2009	ARB to LA	BMW 5	W Only (+R)	G2	**Yes**	No	1.52
9/23/2009	LA to ARB	BMW 5	None	G2	No	No	1.47
9/23/2009	LA to ARB	Merc. S	All (-R)	G1	No	**Yes**	1.26
9/24/2009	ARB to LA	BMW 5	All (+R)	G1	No	**Yes**	1.17
9/24/2009	ARB to LA	BMW 5	All (+R)	G2	**Yes**	No	1.17
9/23/2009	LA to ARB	BMW 5	None	G1	No	**Yes**	0.77

Methods: GPS TTFF

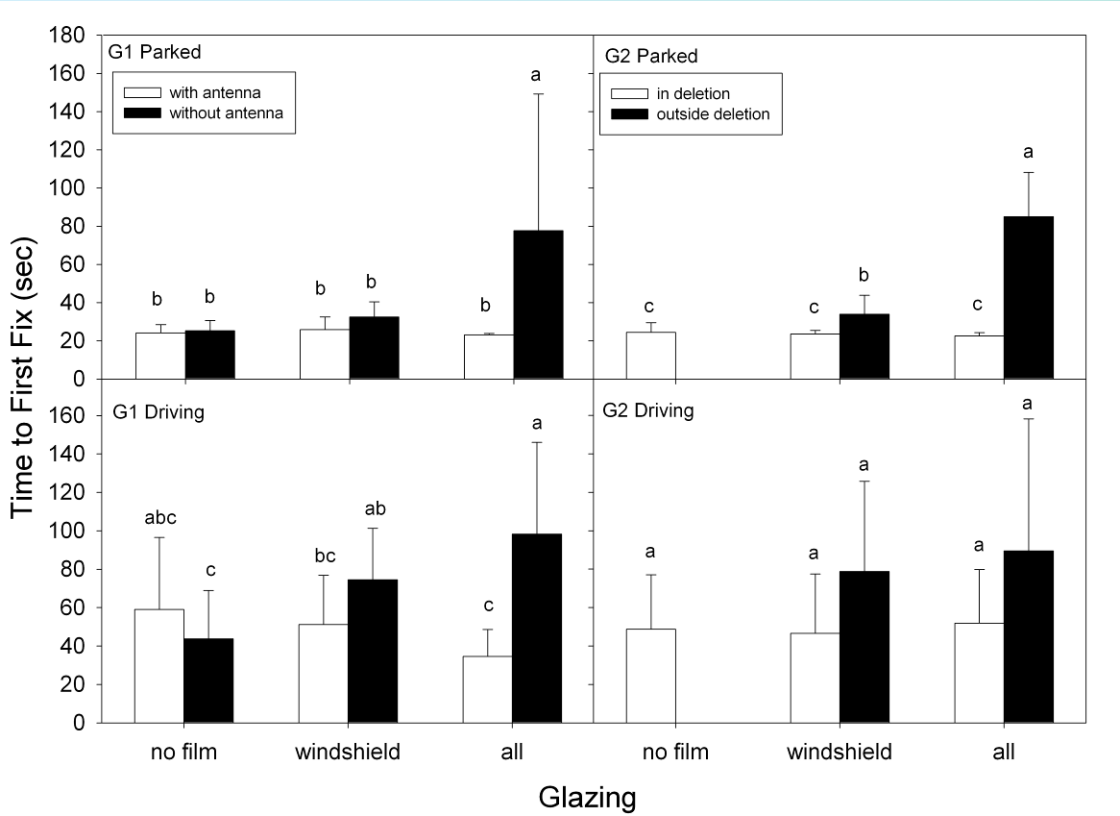
- Hooked up two GPS units to two laptop computers loaded with testing software
- Evaluated change in TTFF with antenna or unit in deletion window
- Evaluated change in TTFF while car parked and while driving
  - Both tests conducted in El Monte with no urban canyons but traveling under freeway twice





California Environmental Protection Agency
Air Resources Board

Results: GPS TTFF



- TTFF longer when driving than when parked
- Few effects when only the windshield has reflective coating
- Largest effects with all-around reflective glazing
- Antenna and deletion window both were effective in mitigating the effect of the reflective glazing

Summary

- No effect of reflective glazing observed on monitoring ankle bracelets or cell phones
- GPS navigation devices are most affected, with the largest effect observed in the TTFF with all-around reflective glazing
- Effects on GPS navigation devices completely mitigated by use of deletion window
  - Deletion window effect observed when placing device in window or placing external antenna in window

Conclusions

- Department of Corrections reviewed the ankle bracelet monitoring and stated that none of the test track data would raise any concerns
- Effectiveness of aftermarket GPS devices will be improved by the use of deletion windows
  - Automobile manufacturers will be required to indicate both with words and graphically the location of the deletion windows in the owner's manual
- Other devices (e.g., transponders, garage door openers) were not tested, but can be expected to behave similarly to the GPS devices in that effectiveness will be enhanced by placement of the device in the deletion windows

Next Steps

- ARB Test Plan Report
  - Under management review
  - Report to be posted on Cool Cars website soon
- ARB not planning any additional device testing at this time