California Energy Commission's Fuel Efficient Tire Program

Agreement 600-07-006; Work Authorization 1-2008
Technical Assistance Contract

Staff Workshop

Bruce D. Lambillotte
February 5, 2009

Smithers Scientific Services, Inc.

California Energy Commission's Fuel Efficient Tire Program

Agenda

- Background
- Objectives
- Procedures and Findings

1. Assessment of Tire Stock Keeping Units (SKUs)
2. Estimate of Test Capacities
3. Model for Increasing Test Capacity
4. Costs, Logistics and Feasibility to Conduct Tire Rolling Resistance Testing

California Energy Commission's Fuel Efficient Tire Program

- Background
  - Contract 600-07-006 was awarded to Smithers Scientific Services to conduct work aimed at providing services and information to the California Energy Commission toward their efforts to establish efficiency standards for tire rolling resistance.
  - Objective was directed in accordance with California legislation AB844
  - First task identified as Work Authorization 1-2008

California Energy Commission's Fuel Efficient Tire Program

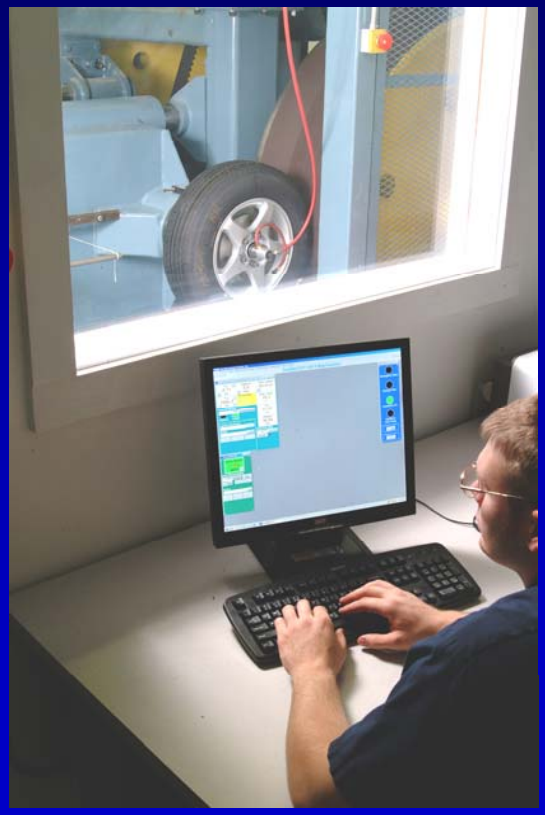
Work Authorization 1-2008 Objectives

- Objective #1: Assessment of Tire Stock Keeping Units (SKUs)
- Objective #2: Estimate of Test Capacities
- Objective #3: Model for Increasing Test Capacity
- Objective #4: Costs, Logistics and Feasibility to Conduct Tire Rolling Resistance Testing

California Energy Commission's Fuel Efficient Tire Program

Objective #1

- Assessment of Tire Stock Keeping Units (SKUs)
  - Procedure
  - Findings



California Energy Commission's Fuel Efficient Tire Program

Objective #1: Assessment of Tire Stock Keeping Units (SKUs)

- Procedure
  - ➔ Estimate number of stock keeping units that could be considered as potentially available for sale in the state of California
    - SKU defined as a specific market brand/tire design/size combination
  - ➔ Data resources included:
    - tire manufacturers' flagship brand websites and product catalogues
    - tire manufacturers' house brand websites and product catalogues
    - private brand websites and product catalogues
    - national and regional wholesale dealer websites
    - national and regional retail dealer websites
    - tire price lists obtained from dealers

California Energy Commission's Fuel Efficient Tire Program

Objective #1: Assessment of Tire Stock Keeping Units (SKUs)

- Procedure
  - Assessment includes both passenger tires and light truck (LT) tires
  - Assessment excludes:
    - winter tires
    - deep tread depth tires
    - temporary spares
    - tires of nominal rim diameters of 12" or less
    - low-production volume SKUs (< 15,000 annually)
    - "Special Trailer" service tires
    - commercial truck tires, agricultural tires, industrial tires, off-the-road tires and aircraft tires

California Energy Commission's Fuel Efficient Tire Program

Objective #1: Assessment of Tire Stock Keeping Units (SKUs)

- Procedure
  - ➔ Special issues:
    - SKU definition: project definition vs. commercial definition
    - "common green tires" cannot be ascertained
    - replacement and original equipment (OE) tire classifications
    - low volume SKUs
    - regionally marketed tires
  - ➔ Establish an industry-wide estimate utilizing the list of tire brands developed for this Work Authorization

California Energy Commission's Fuel Efficient Tire Program

Objective #1: Assessment of Tire Stock Keeping Units (SKUs)

- Findings
  - Definition of brand categories
  - Market shares of brand categories
  - Total number of SKUs
  - Specific brand examples

California Energy Commission's Fuel Efficient Tire Program

Objective #1: Assessment of Tire Stock Keeping Units (SKUs)

- Findings
  - Brand categories: "Primary Brands" and "Other Brands"
  - "Primary Brands"
    - source: "MarketProfile." Tire Review Sept. 2008: 10-11.
    - 31 passenger tire brands
    - 27 light truck tire brands
  - "Other Brands"
    - lesser marketed sales brands, but still representing approximately 12.4% of the dealer channel share of passenger tires and 8.8% of the light truck tire shares
    - brands identified by Smithers Scientific Services, Inc.

California Energy Commission's Fuel Efficient Tire Program

Objective #1: Assessment of Tire Stock Keeping Units (SKUs)

- Findings: tire market shares

	Passenger Tires	**Light Truck Tires**
Primary Brands: number tires sold in U.S.	178,730,280	31,181,280
Market shares, %	87.6	91.2
Other Brands: number tires sold in U.S.	25,299,720	3,008,720
Market shares, %	12.4	8.8

➔ Calculated using 2007 RMA Replacement Shipments values of 204.03 million P-Metric Tires and 34.19 million Light Truck Tires published in "MarketProfile." Tire Review Sept. 2008: 10-11.

California Energy Commission's Fuel Efficient Tire Program

Objective #1: Assessment of Tire Stock Keeping Units (SKUs)

- Findings: SKUs – brand category

	Passenger Tires	**Light Truck Tires**	**Total**
Primary Brands: # Tire SKUs	13,950	2,354	16,304
Other Brands: # Tire SKUs	6,758	942	7,700
Total SKUs	**20,708**	**3,296**	**24,004**

California Energy Commission's Fuel Efficient Tire Program

Objective #1: Assessment of Tire Stock Keeping Units (SKUs)

- Findings: SKUs – passenger car tire specific brand examples

Brand	Market Share, %	SKUs
Goodyear	12.80	790
Michelin	8.70	1,062
Firestone	8.60	246
Bridgestone	7.10	882
BFGoodrich	4.70	412
Cooper	4.60	301
General	3.25	314
Multi-Mile	2.70	687
Uniroyal	2.65	232
Toyo	2.60	627
Dayton	2.55	272
Hankook	2.55	613

California Energy Commission's Fuel Efficient Tire Program

Objective #1: Assessment of Tire Stock Keeping Units (SKUs)

- Findings: SKUs – Light Truck (LT) tire specific brand examples

Brand	Market Share, %	SKUs
Goodyear	10.25	113
BFGoodrich	8.85	87
Bridgestone	7.20	77
Michelin	7.05	66
Firestone	6.80	73
Cooper	6.60	267
Multi-Mile	5.50	120
General	4.95	52
Kelly	3.40	74
Toyo	3.20	82
Mastercraft	2.90	127
Cordovan	2.55	59

California Energy Commission's Fuel Efficient Tire Program

Objective #2

- Estimate of Test Capacities
  - Procedure
  - Findings

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Procedure
  - The model for worldwide rolling resistance test machine availabilities was based upon the following information sources:
    - primary research in the form of private interviews with industry sources
    - secondary research of Smithers' proprietary database
  - Included in model:
    - all world tire manufacturers' rolling resistance machines
    - all independent testing laboratories' machines
  - Not included in model:
    - rolling resistance equipment located at original equipment vehicle manufacturers' facilities
    - rolling resistance rigs located at rolling resistance equipment manufacturers' facilities

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Procedure
  - Premises for the operations model included:
    - test protocol: draft ISO 28580
    - capacity availabilities studied at 25% and 50% levels
    - 25% and 50% represented compliance test availability levels which reflected allowances for competing machine time resource demands, including normal tire development testing and original equipment qualification work
    - extrapolations for capacity were based upon:
      - 8-hour and 24-hour test days; 250-day work year
      - 8-hour and 24-hour test days; 350-day work year

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Findings
  - Test machines available
  - Duration of test cycle: 1 tire
  - Model for test capacity: tires per day; 1 machine
  - Model for test capacity: tires per year; 1 machine
  - Model for test capacity: global

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Findings: test machine availability premises (total = 45 machines)
  - Tier 1 tire manufacturers
    - largest four (4) world tire manufacturers with an estimated four rolling resistance test machines each (16 machines total)
  - Tier 2 tire manufacturers
    - next seven (7) largest world tire manufacturers with an estimated two rolling resistance test machines each (14 machines total)
  - Tier 3 tire manufacturers
    - an estimated seven (7) of the world's Tier 3 tire manufacturers with one rolling resistance machine each (7 machines total)
  - Contract testing
    - four (4) independent testing companies with two (2) rolling resistance machines each (8 machines total)

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Findings: test cycle duration; minutes

Time per Individual Tire Test ISO 28580 Protocol	Passenger Car Tire	LT Tire; Load Index ≤ 121
Task	Task Time (minutes)	
Tire Receiving and Log-In	10	10
Tire Handling and Mounting on Wheel*	10*	10*
Thermal Conditioning*	180*	360*
Thermal Conditioning after Pressure Adjustment*	10*	10*
Assembly Mount on Test Machine	10	10
Break-in	30	50
Data Collection	10	10
Assembly Dismount from Test Machine	10	10
Tire Dismount from Wheel*	5*	5*
Data Handling-Reporting	10	10
Total Time (minutes)	80	100
*Tasks Excluded from Total Time		

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Findings: test capacity: one (1) machine; per day

Capacity Available for Compliance Testing	Test time per tire; min.	Tires per 8 hour test day	Tires per 24 hour test day
25% availability: passenger tires	80	1	3
50% availability: passenger tires	80	3	9
25% availability: LT tires	100	1	3
50% availability: LT tires	100	2	6

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Findings: test capacity: one (1) machine; 250 work days per year

Capacity Available for Compliance Testing	Annual Capacity Basis: 8-hour test day	Annual Capacity Basis: 24-hour test day
25% availability: passenger tires	250	750
50% availability: passenger tires	750	2,250
25% availability: LT tires	250	750
50% availability: LT tires	500	1,500

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Findings: test capacity: one (1) machine; 350 work days per year

Capacity Available for Compliance Testing	Annual Capacity Basis: 8-hr. test day	Annual Capacity Basis: 24-hr. test day
25% availability: passenger tires	350	1,050
50% availability: passenger tires	1,050	3,150
25% availability: LT tires	350	1,050
50% availability: LT tires	700	2,100

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Findings: global test capacity; 250 work days per year

Capacity Available for Compliance Testing	Annual Capacity Basis: 8-hr. test day	Annual Capacity Basis: 24-hr. test day
25% availability: passenger tires	11,250	33,750
50% availability: passenger tires	33,750	101,250
25% availability: LT tires	11,250	33,750
50% availability: LT tires	22,500	67,500

California Energy Commission's Fuel Efficient Tire Program

Objective #2: Estimate of Test Capacities

- Findings: global test capacity; 350 work days per year

Capacity Available for Compliance Testing	Annual Capacity Basis: 8-hr. test day	Annual Capacity Basis: 24-hr. test day
25% availability: passenger tires	15,750	47,250
50% availability: passenger tires	47,250	141,750
25% availability: LT tires	15,750	47,250
50% availability: LT tires	31,500	94,500

California Energy Commission's Fuel Efficient Tire Program

Objective #3

- Model for Increasing Test Capacity
  - Procedure: premises for model
  - Findings
    - expenditures
    - timing

California Energy Commission's Fuel Efficient Tire Program

Objective #3: Model for Increasing Test Capacity

- Procedure: premises for model – capacity increase cost of one (1) test rig
  - Addition of test capacity via capital investment is feasible and positive from a return-on-investment standpoint
  - Single position test rig to be added
  - Purchase includes new hardware, installations, computer interface, and software
  - Use of existing building
  - HVAC expenditures required
  - Mounting equipment and stock of new wheels required
  - Training for new staffing required
  - Model line item costs applicable for both tire manufacturers and independent testing companies

California Energy Commission's Fuel Efficient Tire Program

Objective #3: Model for Increasing Test Capacity

- Findings: model for test capacity increase cost – add one (1) test rig

Machine hardware	$375,000
Installation/HVAC/wiring	$100,000
Training and operations launch; engineering oversight; man hours	$ 35,000
Training and operations launch; technician man hours	$ 40,000
Tire mounting equipment/compressor	$ 15,000
Wheels	$ 40,000
Calibrations and launch proficiency testing	$ 25,000
Training	$ 20,000
Total	$650,000

California Energy Commission's Fuel Efficient Tire Program

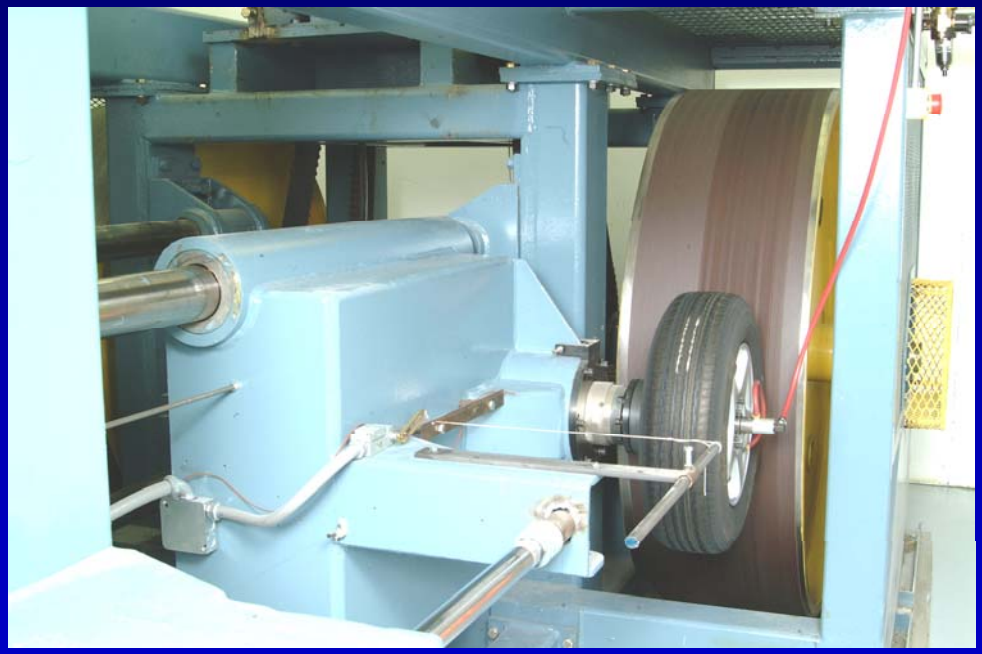
Objective #3: Model for Increasing Test Capacity

- Findings: model for test capacity increase
  - ➔ Timing estimate:
    - equipment delivery: 10 - 12 months
    - installation: 2 - 3 months
    - calibration, training and proficiency: 2 - 3 months
    - total = 14 - 18 months

California Energy Commission's Fuel Efficient Tire Program

Objective #4

- Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing
  - Procedure
  - Findings



California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Procedure
  - Estimates of first-time costs (testing only; not including tire costs) were calculated for the "Primary" and "Other" brands using cumulative SKUs and example fees of $180 per passenger tire and $200 per light truck tire (3-tire tests)
  - Estimates of first-time costs (testing only; not including tire costs) were calculated for the Tier 1 and Tier 2 tire manufacturers using:
    - totals of SKUs by brand reallocated to their respective manufacturers
    - example test fees of $180 per passenger tire and $200 per light truck tire
    - premise of 3-tire test per SKU

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

Findings: reported by brand

- ➔ estimates of first-time test costs (examples)
- ➔ summary of first-time test costs by brand category

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: first time test costs by brand: examples

Primary Tire Brands: Passenger Tires			
Brand	**% Market Share**	**SKUs**	**Compliance Test Costs; based upon $180/tire; 3-tire test***
Goodyear	12.80	790	$426,600
Michelin	8.70	1,062	$573,480
Firestone	8.60	246	$132,840
Bridgestone	7.10	882	$476,280
BFGoodrich	4.70	412	$222,480
Cooper	4.60	301	$162,540

*testing only; excludes tire costs

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: first time test costs by brand: examples

Primary Tire Brands: Light Truck Tires			
Brand	**% Market Share**	**SKUs**	**Compliance Test Costs; based upon $200/tire; 3-tire test***
Goodyear	10.25	113	$67,800
BFGoodrich	8.85	87	$52,200
Bridgestone	7.20	77	$46,200
Michelin	7.05	66	$39,600
Firestone	6.80	73	$43,800
Cooper	6.60	267	$160,200

*testing only; excludes tire costs

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: summary of first time test costs by brand category

	# SKUs	No. Tires to be Tested Basis: 3-Tire Test	Test Fees*
Primary Brands: passenger tires	13,950	41,850	$7,533,000
Primary Brands: light truck tires	2,354	7,062	$1,412,400
Other Brands: passenger tires	6,758	20,274	$3,649,320
Other Brands: light truck tires	942	2,826	$565,200
Total	24,004	72,012	$13,159,920

*testing only; excludes tire costs

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: reported by manufacturer
  - definition of 'tiers"
  - manufacturers of brands
  - SKUs/numbers of tires to be tested by manufacturer
  - estimated manufacturers' test expenses (excluding tire costs)
  - allocation of test fees
  - logistics of testing (various scenarios)

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Smithers' definitions: Tier 1/Tier 2/Tier 3 tire manufacturers
  - ➔ Tier 1 tire manufacturers
    - largest four (4) world tire manufacturers – Michelin, Bridgestone, Goodyear, and Continental
  - ➔ Tier 2 tire manufacturers
    - next seven (7) largest world tire manufacturers – Pirelli, Sumitomo, Yokohama, Hankook, Cooper, Kumho, and Toyo
  - ➔ Tier 3 tire manufacturers
    - next sixty-four (64) largest world tire manufacturers

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: tire manufacturers of brands - passenger tire examples

Brand	% Market Share	Manufacturer(s)
Goodyear	12.80	Goodyear
Michelin	8.70	Michelin
Firestone	8.60	Bridgestone
Bridgestone	7.10	Bridgestone
BFGoodrich	4.70	Michelin
Cooper	4.60	Cooper
General	3.25	Continental
Multi-Mile	2.70	Cooper, Hankook, Yokohama, two(2) Tier 3 companies
Uniroyal	2.65	Michelin
Toyo	2.60	Toyo
Dayton	2.55	Bridgestone
Hankook	2.55	Hankook

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: tire manufacturers of brands – light truck tire examples

Brand	% Market Share	Manufacturer(s)
Goodyear	10.25	Goodyear
BFGoodrich	8.85	Michelin
Bridgestone	7.20	Bridgestone
Michelin	7.05	Michelin
Firestone	6.80	Bridgestone
Cooper	6.60	Cooper
Multi-Mile	5.50	Cooper, Hankook, Yokohama, two(2) Tier 3 companies
General	4.95	Continental
Kelly	3.40	Goodyear
Toyo	3.20	Toyo
Mastercraft	2.90	Cooper
Cordovan	2.55	Cooper, Hankook, Yokohama, two(2) Tier 3 companies

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: Passenger SKUs/tires to be tested by manufacturer

Manufacturers	SKUs Primary Brands	SKUs Other Brands	Total SKUs	Total Tires to be Tested
Michelin	1,766	151	1,917	5,751
Bridgestone	1,483	361	1,844	5,532
Goodyear	1,650	392	2,042	6,126
Continental	1,003	388	1,391	4,173
Pirelli	891	0	891	2,673
Sumitomo	598	0	598	1,794
Yokohama	1,420	199	1,619	4,857
Hankook	1,059	294	1,353	4,059
Cooper	1,386	1,054	2,440	7,320
Kumho	797	561	1,358	4,074
Toyo	672	231	903	2,709
Tier 3	1,225	3,127	4,352	13,056
Total	13,950	6,758	20,708	62,124

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: Light Truck SKUs/tires to be tested by manufacturer

Manufacturer	SKUs Primary Brands	SKUs Other Brands	Total SKUs	Total Tires to be Tested
Michelin	232	47	279	837
Bridgestone	204	59	263	789
Goodyear	257	88	345	1,035
Continental	72	0	72	216
Pirelli	34	0	34	102
Sumitomo	16	14	30	90
Yokohama	149	55	204	612
Hankook	133	75	208	624
Cooper	751	224	975	2,925
Kumho	220	54	274	822
Toyo	95	62	157	471
Tier 3	191	264	455	1,365
Total	2,354	942	3,296	9,888

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: test expenses by manufacturer – Tier 1

Manufacturer	Passenger Tires to be Tested	Passenger Tire Test Expenses	LT Tires to be Tested	LT Tire Test Expenses	Total Expenses*
Michelin	5,751	$1,035,180	837	$167,400	$1,202,580
Bridgestone	5,532	$995,760	789	$157,800	$1,153,560
Goodyear	6,126	$1,102,680	1,035	$207,000	$1,309,680
Continental	4,173	$751,140	216	$43,200	$794,340

*testing only; excludes tire costs

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: test expenses by manufacturer – Tier 2

Manufacturer	Passenger Tires to be Tested	Passenger Tire Test Expenses	LT Tires to be Tested	LT Tire Test Expenses	Total Expenses*
Pirelli	2,673	$481,140	102	$20,400	$501,540
Sumitomo	1,794	$322,920	90	$18,000	$340,920
Yokohama	4,857	$874,260	612	$122,400	$996,660
Hankook	4,059	$730,620	624	$124,800	$855,420
Cooper	7,320	$1,317,600	2,925	$585,000	$1,902,600
Kumho	4,074	$733,320	822	$164,400	$897,720
Toyo	2,709	$487,620	471	$94,200	$581,820

*testing only; excludes tire costs

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Findings: summary of test expenses - industry

Passenger Tires to be Tested	Passenger Tire Test Expenses	LT Tires to be Tested	LT Tire Test Expenses	Total Expenses*
62,124	$11,182,320	9,888	$1,977,600	$13,159,920

*testing only; excludes tire costs

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Allocation of Passenger Tire Test Fees: annualized cost/tire; Tier 1/Tier 2 manufacturers

Manufacturer	Test Expenses	Calculated US Sales; tires (YR 2007)	Annualized Test Costs per Tire
Michelin	$1,035,180	33,885,983	$0.03
Bridgestone	$995,760	38,153,610	$0.03
Goodyear	$1,102,680	34,804,118	$0.03
Continental	$751,140	8,773,290	$0.09
Pirelli	$481,140	2,346,345	$0.21
Sumitomo	$322,920	4,403,647	$0.07
Yokohama	$874,260	7,866,328	$0.11
Hankook	$730,620	8,580,433	$0.09
Cooper	$1,317,600	19,219,142	$0.07
Kumho	$733,320	5,202,765	$0.14
Toyo	$487,620	5,523,384	$0.09

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Allocation of LT Tire Test Fees: annualized cost/tire; Tier 1/Tier 2 manufacturers

Manufacturer	Test Expenses	Calculated U.S. Sales; tires (YR 2007)	Annualized Test Costs per Tire
Michelin	$167,400	6,310,905	$0.03
Bridgestone	$157,800	5,384,925	$0.03
Goodyear	$207,000	5,370,680	$0.04
Continental	$43,200	2,273,635	$0.02
Pirelli	$20,400	410,280	$0.05
Sumitomo	$18,000	54,134	$0.33
Yokohama	$122,400	1,670,345	$0.07
Hankook	$124,800	1,208,779	$0.10
Cooper	$585,000	4,920,836	$0.12
Kumho	$164,400	564,135	$0.29
Toyo	$94,200	1,147,807	$0.08

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Test logistics: variables studied in scenarios

Scenario	Workdays Per Year	% Capacity Available	Hours/Day Test Operation
1	250	25	8
2	250	25	24
3	250	50	8
4	250	50	24
5	350	25	8
6	350	25	24
7	350	50	8
8	350	50	24

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Test logistics: 8-hr shift/25% machine time availability/250 day year; Scenario # 1

Manufacturer	Total Test Rigs Required to Complete Testing in One Year	Model Capacity; # Rigs	Test Years Required; Captive Capacity
Michelin	26.35	4	6.6
Bridgestone	25.28	4	6.3
Goodyear	28.64	4	7.2
Continental	17.56	4	4.4
Pirelli	11.10	2	5.6
Sumitomo	7.54	2	3.8
Yokohama	21.88	2	10.9
Hankook	18.73	2	9.4
Cooper	40.98	2	20.5
Kumho	19.58	2	9.8
Toyo	12.72	2	6.4
Tier 3	57.68	7	8.2
Total	288.05	37	

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Test logistics: 24-hr shift/25% machine time availability/250 day year; Scenario # 2

Manufacturer	Total Test Rigs Required to Complete Testing in One Year	Model Capacity; # Rigs	Test Years Required; Captive Capacity
Michelin	8.78	4	2.2
Bridgestone	8.43	4	2.1
Goodyear	9.55	4	2.4
Continental	5.85	4	1.5
Pirelli	3.70	2	1.9
Sumitomo	2.51	2	1.3
Yokohama	7.29	2	3.6
Hankook	6.24	2	3.1
Cooper	13.66	2	6.8
Kumho	6.53	2	3.3
Toyo	4.24	2	2.1
Tier 3	19.23	7	2.7
Total	96.02	37	

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Test logistics: 8-hr shift/50% machine time availability/350 day year; Scenario # 7

Manufacturer	Total Test Rigs Required to Complete Testing in One Year	Model Capacity; # Rigs	Test Years Required; Captive Capacity
Michelin	6.67	4	1.7
Bridgestone	6.40	4	1.6
Goodyear	7.31	4	1.8
Continental	4.28	4	1.1
Pirelli	2.69	2	1.3
Sumitomo	1.84	2	0.9
Yokohama	5.50	2	2.8
Hankook	4.76	2	2.4
Cooper	11.15	2	5.6
Kumho	5.05	2	2.5
Toyo	3.25	2	1.6
Tier 3	14.38	7	2.1
Total	73.29	37	

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Test logistics: 24-hr shift/50% machine time availability/350 day year; Scenario # 8

Manufacturer	Total Test Rigs Required to Complete Testing in One Year	Model Capacity; # Rigs	Test Years Required; Captive Capacity
Michelin	2.22	4	0.6
Bridgestone	2.13	4	0.5
Goodyear	2.44	4	0.6
Continental	1.43	4	0.4
Pirelli	0.90	2	0.4
Sumitomo	0.61	2	0.3
Yokohama	1.83	2	0.9
Hankook	1.59	2	0.8
Cooper	3.72	2	1.9
Kumho	1.68	2	0.8
Toyo	1.08	2	0.5
Tier 3	4.79	7	0.7
Total	24.43	37	

California Energy Commission's Fuel Efficient Tire Program

Objective #4: Costs, Logistics, and Feasibility to Conduct Tire Rolling Resistance Testing

- Test logistics: summary - sorted by "Average Test Years Required"

Scenario	Workdays Per Year	% Capacity Available	Hours/Day Test Operation	Total Test Rigs Required to Complete Testing in One Year	Max. Test Years Required for a Manufacturer;* Captive Capacity	Average Test Years Required; Captive Capacity
1	250	25	8	288.05	20.5	8.2
5	350	25	8	205.75	14.6	5.9
3	250	50	8	102.61	7.8	3.0
2	250	25	24	96.02	6.8	2.7
7	350	50	8	73.29	5.6	2.1
6	350	25	24	68.58	4.9	2.0
4	250	50	24	34.20	2.6	1.0
8	350	50	24	24.43	1.9	0.7

*total captive test rigs available = 37 per capacity model