Valero Benicia Asphalt Plant

by
Valero Marketing & Supply Company

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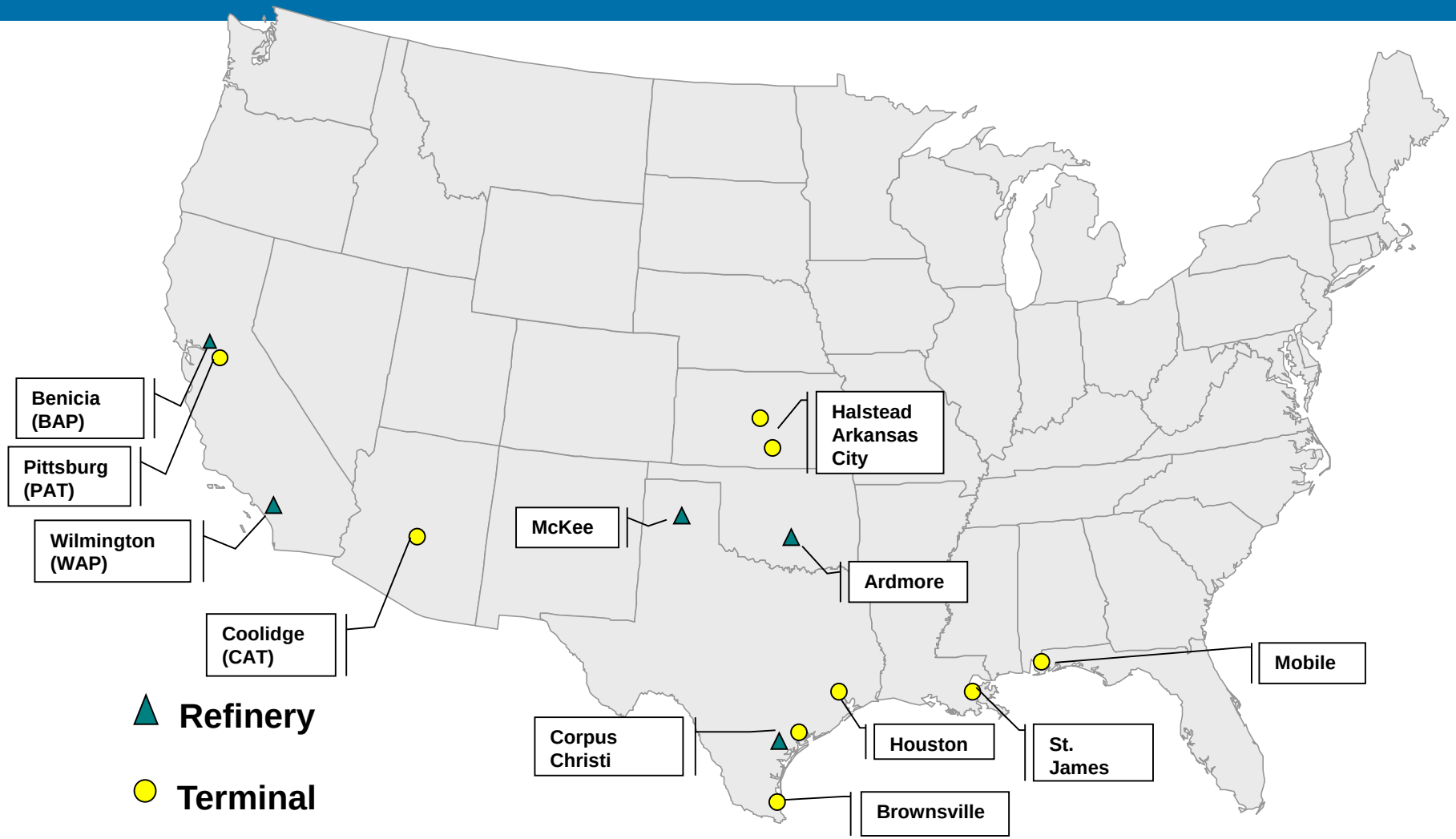
Introduction

- Who is Valero Asphalt?
- Where is Asphalt Used & by Whom?
- What is Asphalt Binder vs. Asphalt Mix?
- What is Cold Patch Mix?
- What is America's Most Recycled Product?
- How is Asphalt Binder Made?
- What are Asphalt Binder Specifications?
- What Asphalt Binders does Valero Make?
- How is Polymer Modified Asphalt Binder Made?
- What Testing is Performed and Why?

Valero Asphalt Network

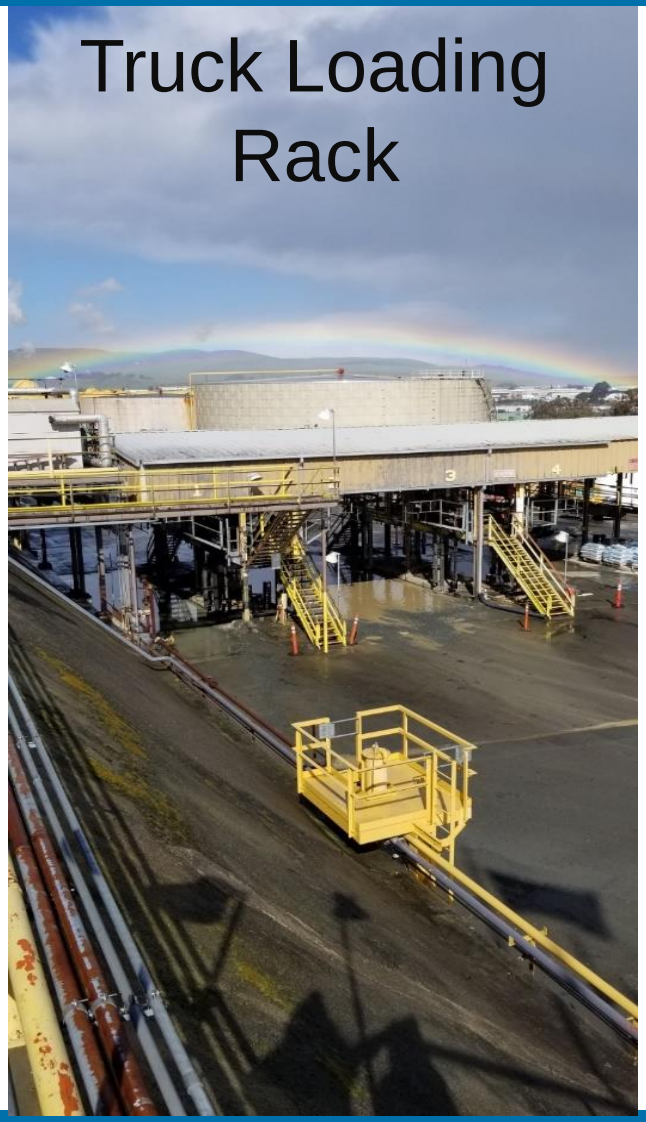


Benicia Asphalt Plant (BAP)

- BAP processes between 6500-14000 bbls/day or 1100-2500 tons/day of crude.
- From that crude, BAP produces between 2900-7000 bbls/day or 500-1250 tons/day of asphalt binder.
- BAP averages about 10.5K bbls/day of crude feed to make 1.8 million bbls/year or 320K tons/year of asphalt binder (~12K trucks/year)

BAP Environmental & Safety Highlights

- The synergies between BAP and the Benicia fuels refinery reduced loading/unloading and transportation emissions by eliminating secondary handling of the light-ends and crudes that was needed before BAP became Valero.
- BAP consumes only natural gas in its heaters, instead of refinery fuel gas, and is therefore low-emitting.
- BAP wastewater is sent to the refinery for processing rather than to the City.
- BAP must meet same environmental regulations as the Benicia fuels refinery.
- Since 2004, BAP has maintained its own Title V Permit and last received a minor deviation in 2015.
- Excellent Safety Record-No recordable injuries since 2005.
- BAP is a VPP Star Site



Who uses Asphalt?

Agencies

- State DOTs
- Federal Lands
- Cities
- Counties
- Airports

Industries

- Construction Industry
- Roofing Industries
- Patch Mix Manufacturers
- Emulsion Producers

Projects Using Valero Asphalt

- I-5
- I-80
- I-680
- I-780
- Hwy 37
- Hwy 99
- Hwy 101
- Racetracks
- Oakland Airport
- Alfred Zampa Bridge
- San Francisco Airport
- Projects All over California, Nevada, Arizona, and Mexico

- **Asphalt covers about 93 % of all roadways and parking lots in CA.**
- **CA has the largest and most complex roadway system in America, totaling 362K lane-miles (lm).**
- **179K lm in cities (49%)**
- **133K lm in counties (37%)**
- **50K lm state Hwys (14%)**
- **Numerous studies have found that more than 80 percent of all trips are made by car.**
- **Reprinted with permission from CalAPA.**

Asphalt Pavement

Asphalt pavements have played an important role in changing the landscape and the history of the U.S. since the late 19th century.

Laura Ingalls Wilder, author of the beloved *Little House on the Prairie*, tells of her first encounter with an asphalt pavement on a wagon journey through Topeka with her parents in 1894.

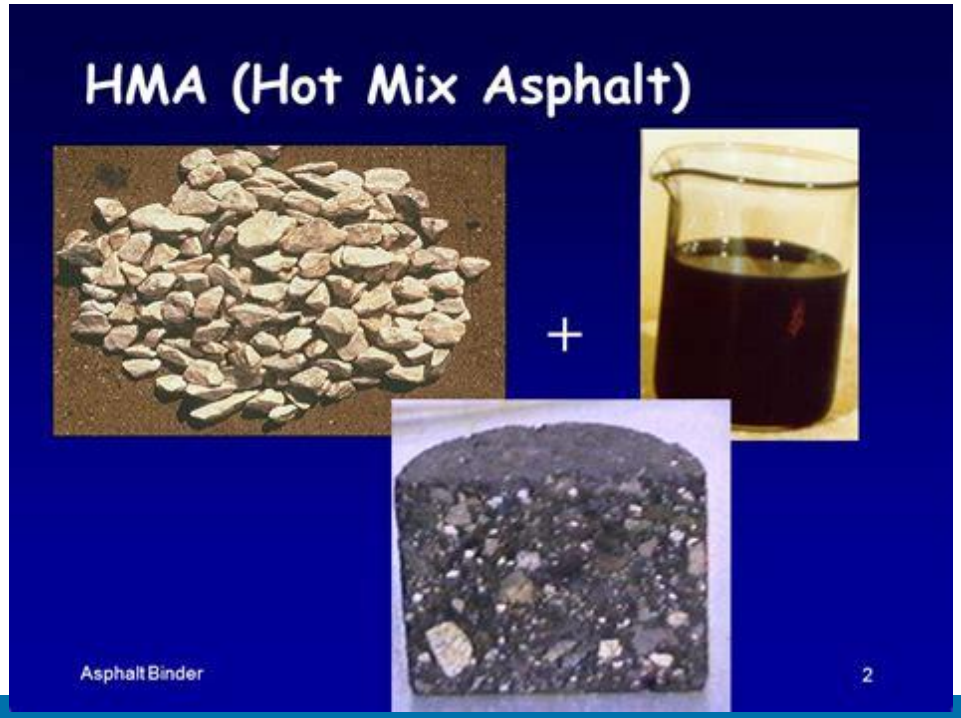
"In the very midst of the city, the ground was covered by some dark stuff that silenced all the wheels and muffled the sound of hoofs… We saw ladies all in silks…, walking with their escorts across the street. Their heels dented the street, and while we watched, these dents slowly filled up and smoothed themselves out. It was as if that stuff were alive. It was like magic.“ (NAPA-History of Asphalt)

What is Asphalt Binder?

- Asphalt binder, also known as bitumen, asphalt cement, neat asphalt , virgin asphalt or just asphalt is a sticky, black, and highly viscous liquid or semi-solid form of petroleum.
- It is the glue that holds aggregates together in a pavement.
- Liquid asphalt forms naturally, such as at the La Brea Tar Pits, but most of the asphalt binder used is derived from a crude oil refining process.
- BAP produces asphalt binders.

What is Hot Mix Asphalt?

- The term “asphalt”, could also refer to asphalt pavement or Hot Mix Asphalt.
- Hot mix asphalt (HMA) is “the black stuff” used as a pavement material. It is a combination of aggregate (rocks or gravel of various sizes, sand & dust) and asphalt binder (approximately 5%) mixed together at the Hot Mix Plant at elevated temperatures to forms a hard, strong construction material when cooled.
- This is what is produced by the contractors to whom we sell our binder.



- From 2011-17 CA produced an average of ~24.1 million tons/year of HMA.
- In 2017 CA HMA production topped 26 million tons produced from ~ 1.3 million tons of asphalt binder.
- BAPs average annual asphalt production could pave all four lanes of Highway 780 (6.8 miles long) 294 times.

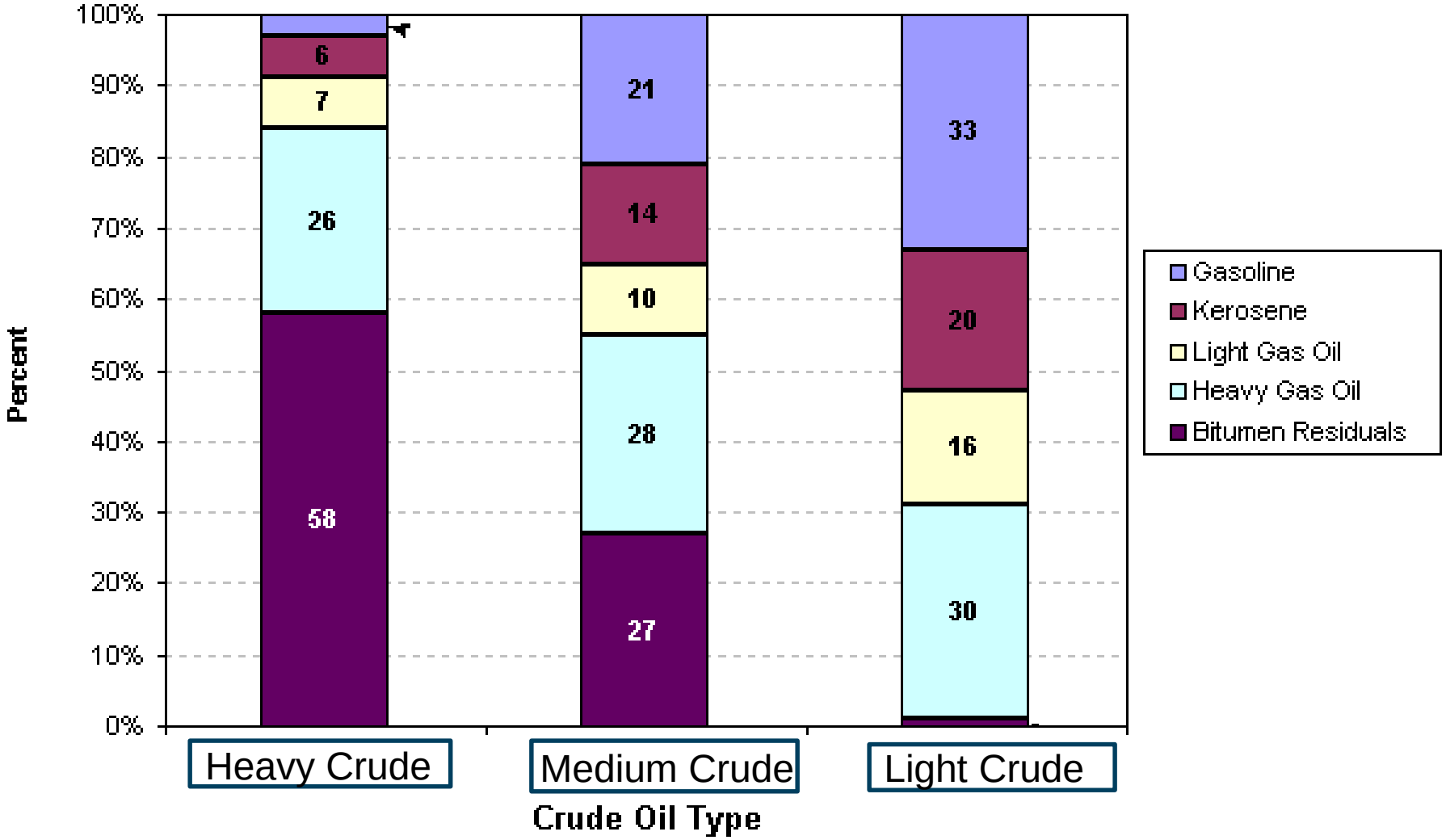
What is Cold Patch Mix?

Cold Patch Mix (CPM) is made using HMA and is produced at a lower temperature. This mix is easy to work with, compact and repair potholes with. Once placed, it is virtually indistinguishable from HMA. The CPM is effective in varying weather conditions.

America's Most Recycled Product

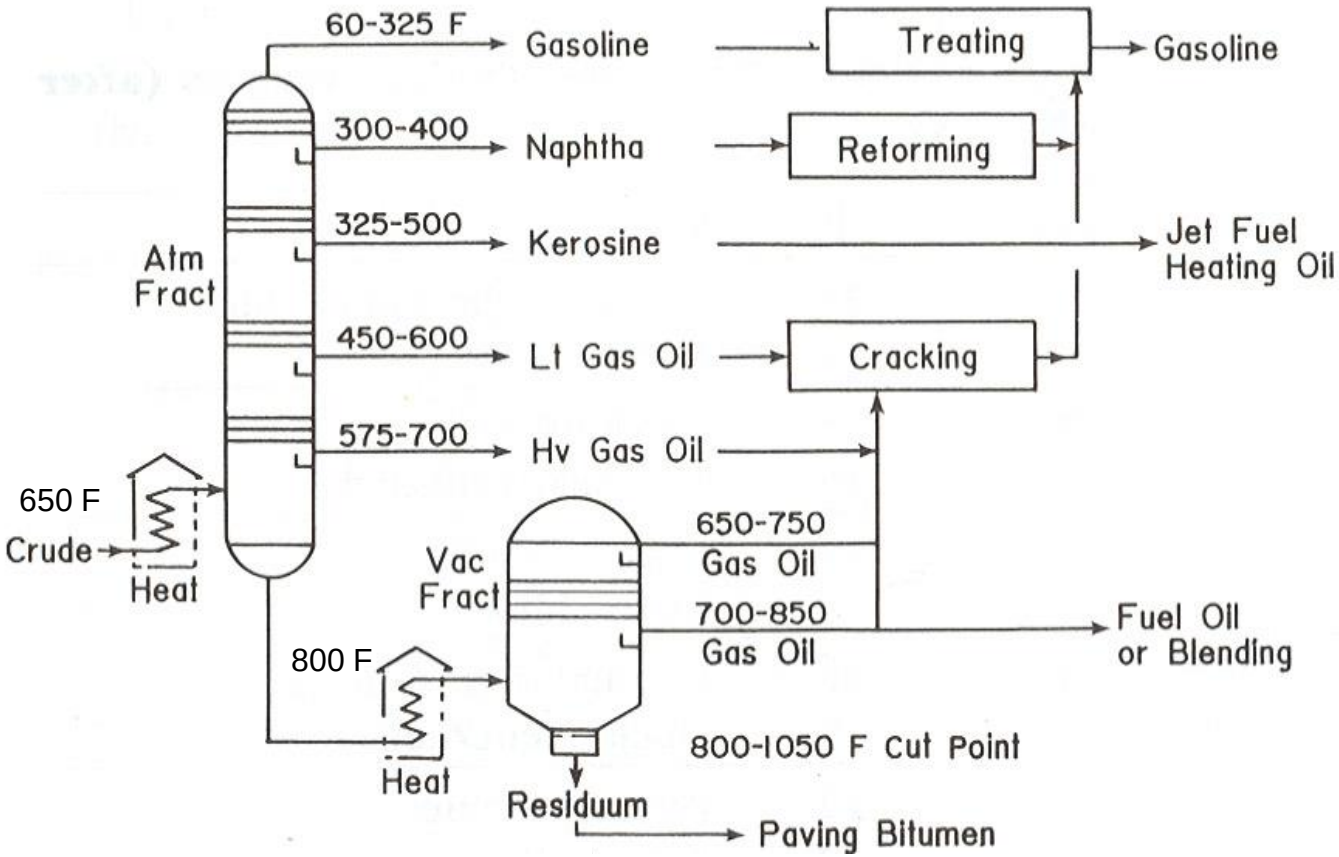
- **Asphalt pavements are America's most recycled product. The latest NAPA/FHWA survey of asphalt producers found that more than 76.2 million tons of reclaimed asphalt pavement (RAP) and nearly 950,000 tons of recycled asphalt roofing shingles (RAS) were used in new asphalt pavement mixes in the United States during in 2017.**
- **100 percent of reclaimed asphalt can be recycled into new or rehabilitated roadways.**
- **New technology, equipment and best-practices are resulting in modern asphalt pavement designs that will last 50 years or more and help eliminate mountains of RAP, RAS, discarded vehicle tires, and prevent water and air pollution.**
- **"Sustainable asphalt" video developed by the Asphalt Pavement Alliance**

Different Crudes, Different Yields



Asphalt Refining Process

Two-Stage Distillation Process



Climate Based Asphalt Binder Grading System

PG 64 - 22

Performance Grade

Average 7 day maximum pavement temperature (20 mm below surface, Deg C)

Minimum pavement temperature (1 day at surface, Deg C)

The Superpave performance grading system is used to characterize asphalt binders. The PG grade is identified in Celsius, by the high and low temperatures the pavement will experience. For example a PG 64−22 binder would be expected to yield good performance at temperatures from −22°C to 64°C (−8°F to 147°F).

AASHTO M320 PG Specifications-National

asphalt institute

Performance Grades

Max. Design Temp.	PG 46			PG 52							PG 58					PG 64						PG 70						PG 76					PG 82				
Min. Design Temp.	-34	-40	-46	-10	-16	-22	-28	-34	-40	-46	-16	-22	-28	-34	-40	-10	-16	-22	-28	-34	-40	-10	-16	-22	-28	-34	-40	-10	-16	-22	-28	-34	-10	-16	-22	-28	-34
Original																																					
≥230 °C	**Flash Point**																																				
≤ 3 Pa-s @ 135 °C	**Rotational Viscosity**																																				
≥ 1.00 kPa	**DSR G*/sin δ** (Dynamic Shear Rheometer)																																				
	46			52							58					64						70						76					82				
(Rolling Thin Film Oven) RTFO, Mass Change ≤ 1.00%																																					
≥ 2.20 kPa	**DSR G*/sin δ** (Dynamic Shear Rheometer)																																				
	46			52							58					64						70						76					82				
(Pressure Aging Vessel) PAV																																					
20 hours, 2.10 MPa	90			90							100					100						100(110)						100(110)					100(110)				
≤ 5000 kPa	**DSR G*sin δ** (Dynamic Shear Rheometer) Intermediate Temp. = [(Max. + Min.)/2] + 4																																				
	10	7	4	25	22	19	16	13	10	7	25	22	19	16	13	31	28	25	22	19	16	34	31	28	25	22	19	37	34	31	28	25	40	37	34	31	28
S ≤ 300 MPa m ≥ 0.300	**BBR S (creep stiffness) & m-value** (Bending Beam Rheometer)																																				
	-24	-30	-36	0	-6	-12	-18	-24	-30	-36	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	0	-6	-12	-18	-24
If BBR m-value ≥ 0.300 and creep stiffness is between 300 and 600, the Direct Tension failure strain requirement can be used in lieu of the creep stiffness requirement.																																					
ε_f ≥ 1.00%	**DTT** (Direct Tension Tester)																																				
	-24	-30	-36	0	-6	-12	-18	-24	-30	-36	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	-30	0	-6	-12	-18	-24	0	-6	-12	-18	-24

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We're driven.

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Caltrans Specifications and "PG Plus"

Performance Graded Asphalt Binder

Property	AASHTO Test Method	Specification Grade				
		PG 58-22 [a]	PG 64-10	PG 64-16	PG 64-28	PG 70-10
Original Binder						
Flash Point, Minimum °C	T 48	230	230	230	230	230
Solubility, Minimum % [b]	T 44	99	99	99	99	99
Viscosity at 135°C, [c] Maximum, Pa·s	T 316	3.0	3.0	3.0	3.0	3.0
Dynamic Shear,	T 315					
Test Temp. at 10 rad/s, °C		58	64	64	64	70
Minimum G*/sin(delta), kPa		1.00	1.00	1.00	1.00	1.00
Maximum G*/sin(delta), kPa		2.00	2.00	2.00	2.00	2.00
RTFO Test, [e] Mass Loss, Maximum, %	T 240	1.00	1.00	1.00	1.00	1.00
RTFO Test Aged Binder						
Dynamic Shear,	T 315					
Test Temp. at 10 rad/s, °C		58	64	64	64	70
Minimum G*/sin(delta), kPa		2.20	2.20	2.20	2.20	2.20
Ductility at 25°C Minimum, cm	T 51	75	75	75	75	75
PAV [f] Aging, Temperature, °C	R 28	100	100	100	100	110
RTFO Test and PAV Aged Binder						
Dynamic Shear,	T 315					
Test Temp. at 10 rad/s, °C		22 [d]	31 [d]	28 [d]	22 [d]	34 [d]
Maximum G*sin(delta), kPa		5000	5000	5000	5000	5000
Creep Stiffness,	T 313					
Test Temperature, °C		-12	0	-6	-18	0
Maximum S-value, Mpa		300	300	300	300	300
Minimum M-value		0.300	0.300	0.300	0.300	0.300

Notes:

a. Use as asphalt rubber base stock for high mountain and high desert area.

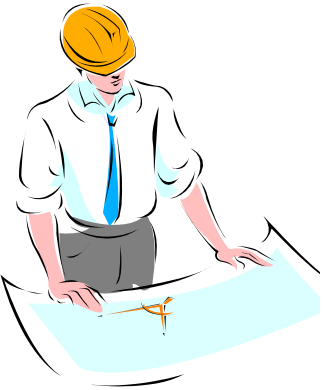
b. The Engineer waives this specification if the supplier is a Quality Supplier as defined by the Department's "Certification Program for Suppliers of Asphalt."

c. The Engineer waives this specification if the supplier certifies the asphalt binder can be adequately pumped and mixed at temperatures meeting applicable safety standards.

d. Test the sample at 3°C higher if it fails at the specified test temperature. G*sin(delta) remains 5000 kPa maximum.

e. "RTFO Test" means the asphaltic residue obtained using the Rolling Thin Film Oven Test, AASHTO Test Method T 240 or ASTM Designation: D 2872. The residue from mass change determination may be used for other tests.

f. "PAV" means Pressurized Aging Vessel.



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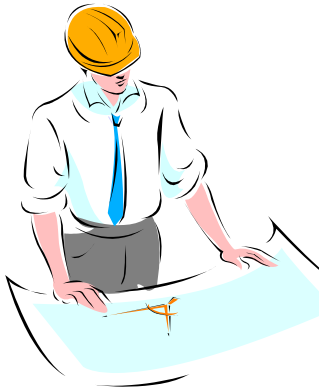
Caltrans Modified Asphalt Specs – More "PG Plus" Specifications

PG Modified Asphalt Binder

Property	AASHTO Test Method	Grade		
		PG 58–34 M	PG 64–28 M	PG 76–22 M
Original Binder				
Flash point, min °C	T 48	230	230	230
Solubility, min %	T 44[a]	97.5	97.5	97.5[b]
Viscosity at 135 °C[c], max, Pa·s	T 316	3.0	3.0	3.0
Dynamic shear, Test temperature at 10 rad/s, °C min G*/sin(delta), kPa	T 315	58 1.00	64 1.00	76 1.00
RTFO test[d], Mass loss, max, %	T 240	1.00	1.00	1.00
RTFO Test Aged Binder				
Dynamic shear, Test temperature at 10 rad/s, °C min G*/sin(delta), kPa	T 315	58 2.20	64 2.20	76 2.20
Dynamic shear, Test temperature at 10 rad/s, °C max (delta), degree	T 315	80[e]	80[e]	80[e]
Elastic recovery[f], Test temperature °C min recovery, %	T 301	25 75	25 75	25 65
PAV[g], temperature, °C	R 28	100	100	110
RTFO Test and PAV Aged Binder				
Dynamic shear, Test temperature at 10 rad/s, °C max G*sin(delta), kPa	T 315	16 5000	22 5000	31 5000
Creep stiffness, Test temperature, °C max S-value, MPa min M-value	T 313	-24 300 0.300	-18 300 0.300	-12 300 0.300



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What Asphalt Binders does BAP make?

Paving Grades (Neat or Virgin Binder)

- PG 58-22
- PG 64-10
- PG 64-16
- PG 64-22
- PG 64-28
- PG 70-10

Paving Grades (Modified Binder)

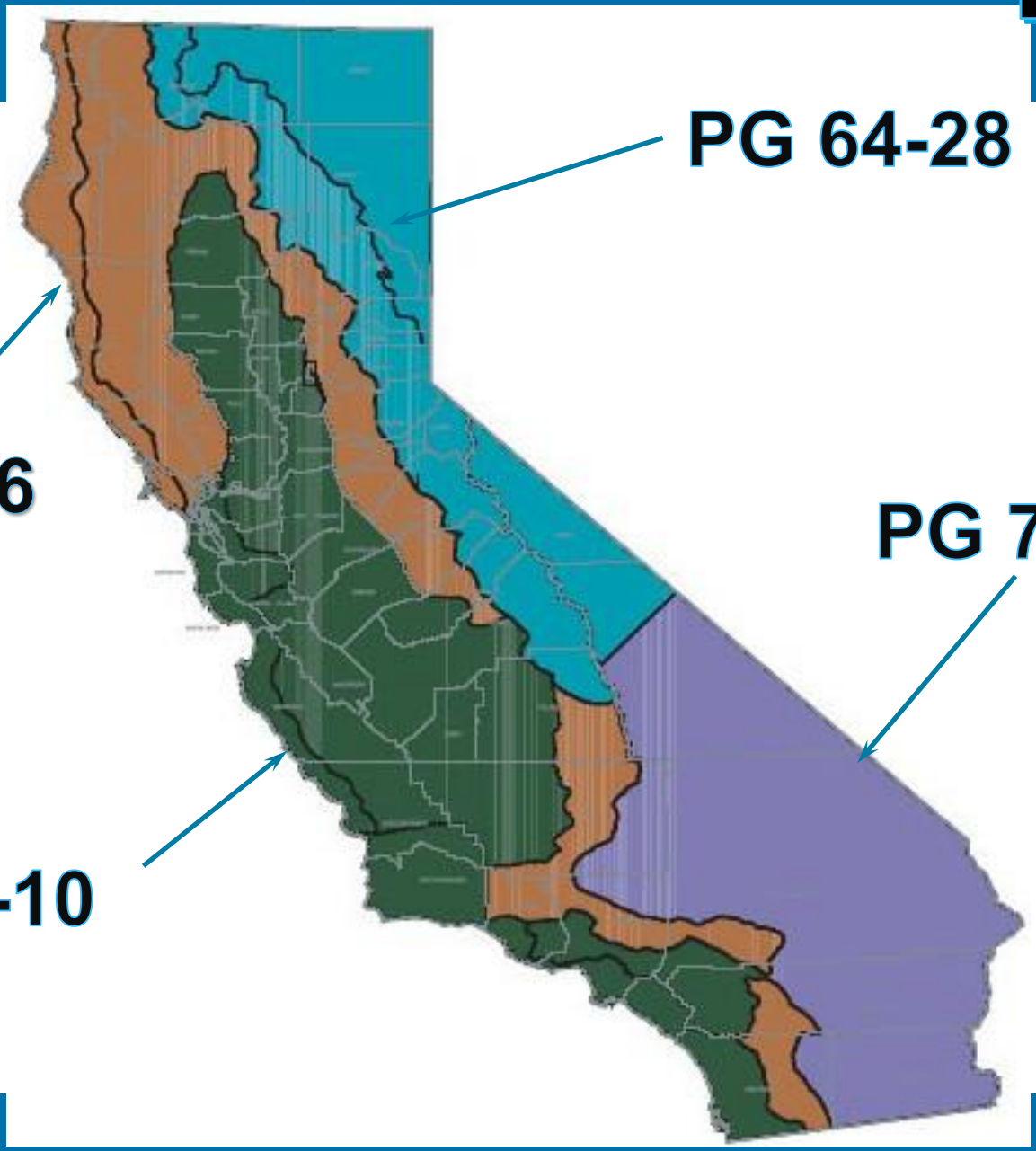
- PG 58-34M
- PG 64-28M
- PG 76-22M

Specialty Grades

- Slow Cure Cutbacks
- Emulsion Base Stock
- Cold Patch Base

Valero must meet the National AASHTO standards as well as Caltrans Certification Program for Suppliers of Asphalt to be allowed to sell asphalt for use in state and federal projects. Additional requirements include having an accredited testing lab, a QC manual, and a monthly submission of samples and test data to Caltrans.

CA PG Binder Map



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Polymer-Modified Asphalt (PMA) Production

Simplified

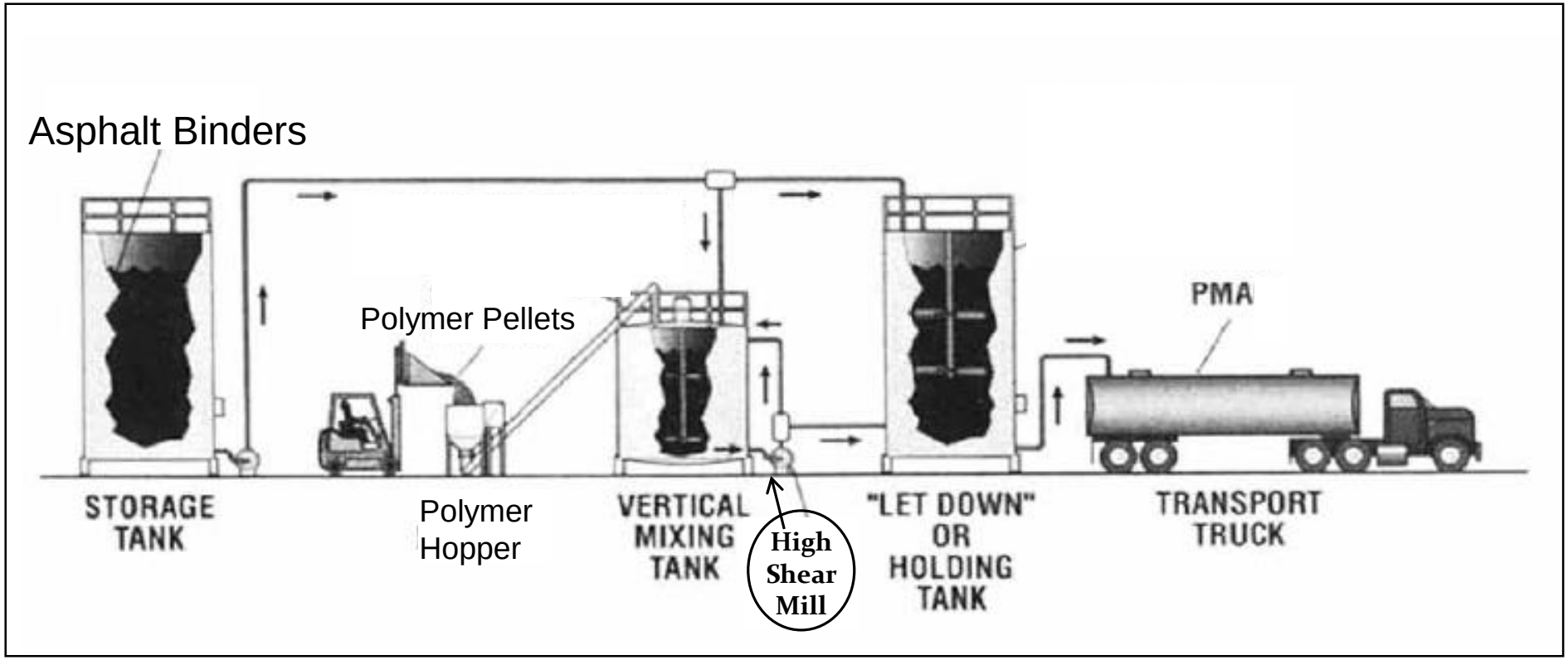
Asphalt A + Asphalt B + Polymer Modifier = Polymer Modified Asphalt

Polymer Modifier

There are a number of different types of polymer modifiers used to modify asphalt binders. They help improve the asphalts elastic properties, increases the asphalt's temperature flexibility and enhances its aging performance.

When used in road construction, modified asphalt along with the proper asphalt mix design can increase the road service life.

Polymer-Modified Asphalt (PMA) Production



What Tests are Performed and Why?

Test Equipment Utilized	Properties Measured	Purpose
Rotational Viscometer (RV)	Viscosity of binder at storage and pumping temperatures	Ensure the binder can be stored and pumped through the logistics system (refinery, transport and HMA plant).
Dynamic Shear Rheometer (DSR)	Viscosity and elastic properties of the binder at high and intermediate temperatures.	Improve rutting and fatigue cracking resistance in Hot Mix Asphalt (HMA)
Rolling Thin Film Oven (RTFO)	Binder conditioning step in the testing process.	Simulate the aging/hardening that the binder undergoes in the HMA.
Pressure Aging Vessel (PAV)	Binder conditioning step in the testing process.	Simulate aging under long-term road service (+10 years)
Bending Beam Rheometer (BBR)	Flexibility of binder at low service temperatures. The m-value (rate of change of stiffness) is the critical data point from the test.	Improve the ability of HMA to contract under low temperature conditions without cracking.

Superpave Asphalt Binder Testing Equipment

DSR

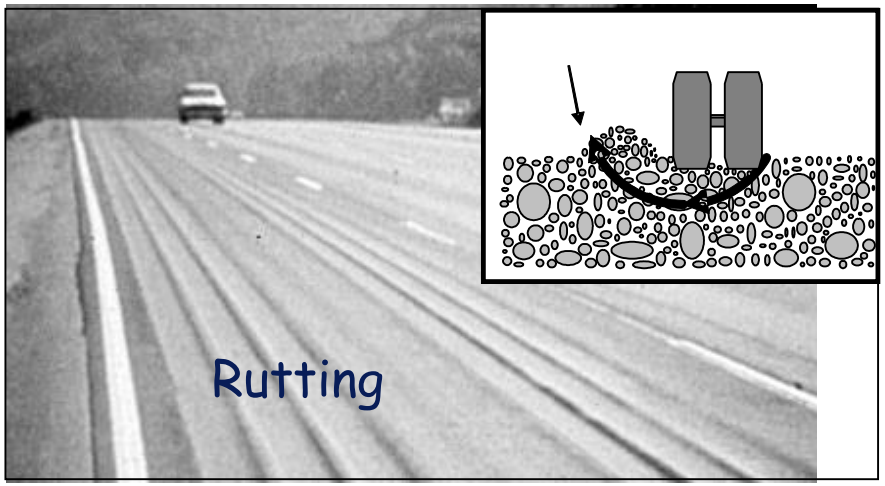
RV

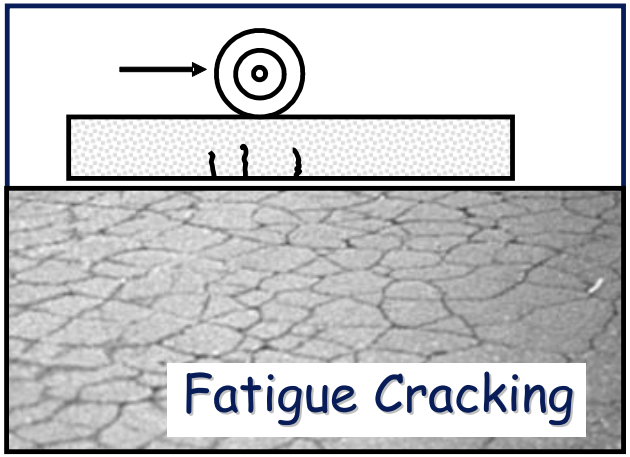
BBR

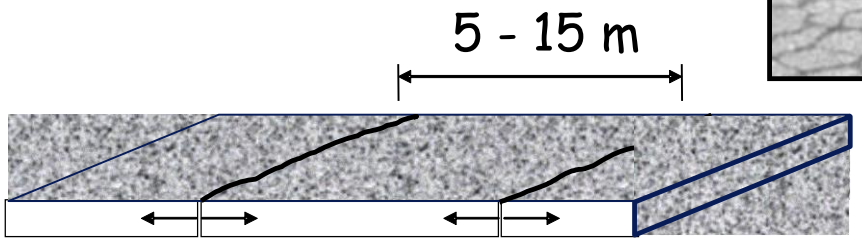
PAV

RTFO

Primary HMA Pavement Distress Modes







Thermal Cracking

Oakland Airport Runway Project

September 2017

- Valero PG 76-22M
  - 3 contractors
  - 2 asphalt plants
  - 24 hours per day
  - 14 days

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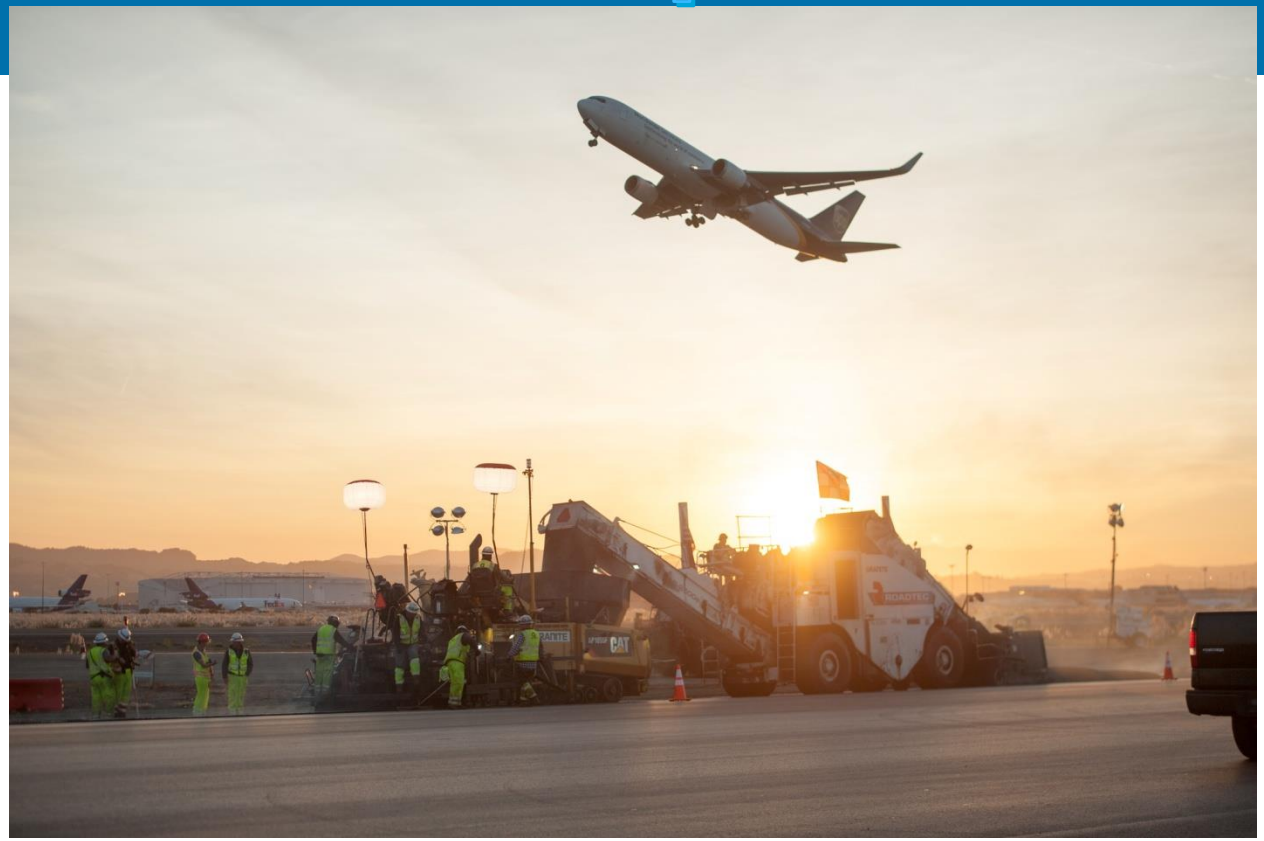
Oakland Airport Runway Project



- 4100 tons asphalt binder =165 truck loads
- 92000 tons HMA
- No flight interruptions
- Project completed on time

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Summary

- Valero Benicia Asphalt Plant is one of many asphalt plants and terminals owned or operated by Valero across the U.S. BAP is providing a very valuable product for CA in a safe and environmentally efficient manner.
- BAP must meet all the same environmental and safety requirements as the Fuels Refinery.
- BAP processes crude oil into asphalt binder which is then supplied to our customers to produce HMA, Roofing products or CPM.
- We supply asphalt to many agencies and contractors across CA, AZ, NV and Mexico.
- Asphalt binder is the “glue” used predominately in the production of asphalt pavements, but has many other applications as well.
- Asphalt pavement is America’s most recycled product.
- BAP produces a wide range of asphalt binders and polymer modified binders to meet national and state specifications.
- The Performance Grading System is based on the climate where the asphalt pavement will be constructed.
- Our lab is certified to performed the required testing on asphalts we supply. The asphalt binder is tested to ensure the properties will have good performance in the field.

Credit and Thanks to Our Friends

Asphalt Pavement Alliance (APA)

National Asphalt Pavement Association (NAPA)

California Asphalt Pavement Association (CalAPA)

CALTRANS

U.C. Berkeley

DeSilva Gates

Asphalt Institute

Valero Product Technical Personnel

Valero Benicia Asphalt Plant

The End

Questions or Comments?